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B.1 Point Source Pollutant Loadings

There are 51 active permitted point source discharges in the Big Darby Creek watershed (Table B.1.1, Figures B.1.1 and B.1.2). The facilities are discussed in this section in the same order as they appear in Table B.1.1.

Many (48) of the facilities are small wastewater treatment plants (WWTPs) serving small cities, villages, schools, businesses, and mobile home parks, and discharging from 2,000 to 100,000 gallons per day (gpd), which are generically called "package plants." The term "package plant" is used to describe a wastewater treatment system consisting of a prefabricated steel or concrete tank that is divided into an aeration chamber and settling chamber. Most package plants are preceded by some type of pretreatment, which removes untreatable matter, including plastics, rags, rocks, wood, etc. Occasionally, flow equalization tanks are also included. The package treatment system is generally followed with effluent polishing and disinfection either by chlorination followed by dechlorination or ultraviolet light. Sometimes the plant will have a sludge holding tank.

The pretreatment devices in a package plant are generally one or two of the following: a trash trap, which is a tank that has an outlet opening that is smaller than the inlet and is in the lower 1/3 of the tank; a bar screen, which is a rack of bars in front of the package plant inlet usually spaced 1-2" apart; and/or a comminutor which grinds the trash into small pieces.

A flow equalization tank assists in providing the package plant with a steady flow, hopefully over an entire day since water use and subsequent wastewater generation varies within a day. A constant flow of sewage facilitates the effective breakdown of organic material in the sewage by providing the microbiological fauna providing the treatment a "steady state" of nutrients. Consistent flow yields improved effluent quality.

When working properly, the aeration chamber facilitates the breakdown of up to 90% of the organic material in the wastewater by injecting large volumes of air into the water. This provides the oxygen required to facilitate the aerobic breakdown of the wastes by the microfauna. Carbon-based oxygen demanding substances, as measured by cBOD testing, are broken down by the activity of bacteria and protozoans. If enough detention time is provided in the aeration tank, breakdown of nitrogenous wastes (i.e., ammonia) will also occur. As the waste is "eaten" by the different microfauna, the microfauna multiply.

The following chamber in the tank is the settling chamber, also termed a clarifier. Its function is to permit settling of the microfauna, also known as sludge, by gravity. Some of the settled organisms are then pumped back to the aeration chamber to resume consumption of the raw wastewater components. Clear water is decanted over the top of a barrier or weir and moves onto the next stage of treatment, usually polishing and/or disinfection. If the system has been upgraded, a sludge holding tank will be present to store excess microfauna. When this tank fills, the "sludge" is dried or dewatered and taken to a land fill or directly removed to larger WWTP for digestion.

Table B.1.1. Big Darby Creek Watershed Discharger List. Listings that are shaded are no longer operating.

Entity	Receiving Stream	River Mile	NPDES #	Latitude/Longitude	Notes
Flat Branch WWTP	Big Darby Creek	78.48	1PP00006	401615/833311	FKA Transportation Research Center WWTP
Honda E. Liberty WTP	Flat Branch	4.80	1IW00270		
Honda Benton Road WTP	Flat Branch	2.21	4IW00270		
Zane School	Little Darby Creek	78.34(?)	Unpermitted		Abandoned
North Lewisburg WWTP	Spain Creek	1.5	1PB00039	401329/833239	
Reflections Subdivision WWTP	Buck Run	8.00	4PW00008		via ditch
Darby Creek Golf Course	Big Darby Creek	64.00	4PX00017		
Township School (Milford Center)	Big Darby Creek		Unpermitted		Tied in to Marysville WWTP
Fairbanks Local WWTP	Big Darby Creek	63.74	Pending		
Unionville Center School	Big Darby Creek		Unpermitted		Tied in to Marysville WWTP
Ranco Inc.	Big Darby Creek	54.1	4IC00008	400942/831920	
St. Johns Church	Robinson Run	8.04	4PT00006		
Darby Meadows WWTP	UT to Robinson Run	0.42	4PG00005	400942/831532	
Plain City WTP	UT to Big Darby Creek	52.11(0.2)	4IZ00070	400618/831532	Tied in to Plain City WWTP
Tuffco Sand and Gravel	Big Darby Creek	52.4	4IJ00011		
Plain City WWTP	Big Darby Creek	52.1	4PB00016	400613/831532	
Continued.					

Table B.1.1. Continued.

Entity	Receiving Stream	River Mile	NPDES #	Latitude/Longitude	Notes
Kimberly Woods WWTP	UT to Sugar Run	50.92(6.41-1.09)	4PG00010	400911/831403	Tied in to Marysville WWTP
New California Woods WWTP	Sugar Run	50.92(6.4)	4PG00017	400905/831509	Tied in to Marysville WWTP
Crottinger Estates WWTP	UT to Sugar Run	50.92(2.9-1.55)	4PG00003	400824/831516	Tied in to Marysville WWTP
Suburbans MHP WWTP	Big Darby Creek	49.68	4PR0031	400414831442	
Jonathan Alder High School	Ballenger Jones Ditch	2.55	Pending		
Dutch Kitchen WWTP	UT to Ballenger Jones Ditch	0.70	4PR00077	400408/831726	
COJV School District	Powell Ditch	2.68	4PT00104		
Canaan School	Yutzy Ditch	2.25	Pending		
Wisslohican Sanitary Sewer District	Big Darby Creek	45.00	4PG00024		
Canaan Community MHP WWTP	Fitzgerald Ditch	1.40	4PR00032	400103/831551	
Olen Corporation	Bidwell Ditch	0.20	4IJ00022002		Eliminating discharge by 2003
Olen Corporation	Big Darby Creek	43.53	4IJ00022001	400038/831510	Eliminating discharge by 2003
Olen Corporation	Big Darby Creek	43.28	4IJ00022003	400004/831532	Eliminating discharge by 2003
Battelle Memorial Institute	Big Darby Creek	40.67	4IN00004002	395808831445	
Battelle Memorial Institute	Big Darby Creek	40.55	4IN00004001	395802831445	
Battelle Memorial Institute	Big Darby Creek	40.46	4IN00004005		

Continued.

Table B.1.1. Continued.

Entity	Receiving Stream	River Mile	NPDES #	Latitude/Longitude	Notes
Battelle Memorial Institute	Big Darby Creek	40.40	4IN00004003	395808831446	
Lake Darby Estates WWTP	Big Darby Creek	40.00	4PU00001		
Battelle Memorial Institute	Big Darby Creek	39.80	4IN00004004	395731831427	
Battelle Memorial Institute	Big Darby Creek	39.71	4IN00004 006-8	395726831432	
Greentree MHP WWTP	Big Darby Creek	39.00	4PY00001		
Darby Dan Farms	Big Darby Creek	36.70	4PR00000		
Mechanicsburg WWTP	Little Darby Creek	39.20	1PB00037	400417/833450	
Triad Local Schools WWTP	Proctor Run	7.00?	1PT00099		
Monroe Elementary School	Spring Fork	6.80??	Pending		
Green Meadows MHP WWTP	Spring Fork	1.10	4PV00000	395924/832345	
Fisher Cast Steel	Little Darby Creek	14.00	4ID00001		via storm sewer
Jefferson Lodge MHP WWTP	Little Darby Creek	9.00	4PV00004	395653/831800	
Oakwood Acres MHP WWTP	Little Darby Creek	8.00	4PV00097	395650/831710	
West Jefferson WTP	Little Darby Creek	34.1(8.00)	4IX00070		Tied in to W. Jefferson WWTP
Jefferson Industries Corporation	Little Darby Creek	?	4II00000		Tied in to W. Jefferson WWTP
Capital Manufacturing Company	Little Darby Creek	?	4IN00131		Tied in to W. Jefferson WWTP

Continued.

Table B.1.1. Continued.

Entity	Receiving Stream	River Mile	NPDES #	Latitude/Longitude	Notes
B&B Motel WWTP	Little Darby Creek	7.00	4PV00107	395652/831411	FKA K&M MHP
West Jefferson WWTP	Little Darby Creek	5.35	4PB00024	395557/831603	
Oak Hills MHP WWTP	Big Darby Creek	29.29	4PV00008		Planned tie in to Darbydale regional WWTP, 2005
Darbydale Elementary WWTP	Big Darby Creek	29.00	4PT00105		Storm sewer to Big Darby Creek, Planned tie in to Darbydale regional WWTP, 2005
Pleasant Acres MHP WWTP	UT to Big Darby Creek	1.00	4PV00101		Planned tie in to Darbydale regional WWTP, 2005
Community Gardens MHP WWTP	UT to Big Darby Creek	1.00	4PV00015		Planned tie in to Darbydale regional WWTP, 2005
Alton Campground WWTP	Hamilton Ditch	0.50	4PX00041		
Timberbrook Estates WWTP	Clover Groff Ditch	25.7(11.18-3.00)	?	395844/831014	Tied in to City of Columbus sewers
Young Estates Subdivision WWTP	Clover Groff Ditch	25.7(11.18-2.75)	Unpermitted	395834/831025	Tied in to City of Columbus sewers
Thornapple Country Club WWTP	Clover Groff Ditch	2.65	4PX00029		
Cypress Wesleyan School WWTP	Clover Groff Ditch	1.30	Pending		
Quail Hollow WWTP	Hellbranch Run	25.7(9.1)	4PH00004	395511/831026	Tied in to City of Columbus sewers
Oakhurst Knolls WWTP	Hellbranch Run	5.81	4PH00000		
Lakeland Utilities	Hellbranch Run	1.50	4IY00033	395021/830933	No discharge
Pleasantview School	Hellbranch Run	1.14	4PT00106		

Continued.

Table B.1.1. Continued.

Entity	Receiving Stream	River Mile	NPDES #	Latitude/Longitude	Notes
Lakeland Utilities, Timberlake WWTP	Hellbranch Run	0.50	4PU00003	394947/830936	Planned tie in to Darbydale regional WWTP 2005
Dot-Mar MHP WWTP	Big Darby Creek	23.77	4PV00100		Planned tie in to Pickaway Correctional Institute in 2003
Pickaway Correctional Institute	Big Darby Creek	22.92	4PP00003	394730/830946	
Foxlair Farms Park WWTP	UT to Big Darby Creek @ RM 20.20	2.45	4PV00007		Planned tie in to Pickaway Correctional Institute in 2003
Clarks Lake Subdivision WWTP	UT to Big Darby Creek @ RM 20.20	1.54	4PG00014	394630/830947	Planned tie in to Pickaway Correctional Institute in 2003

Figure B.1.1. Schematic representation of permitted dischargers to the upper Big Darby Creek watershed, 2001/2002.

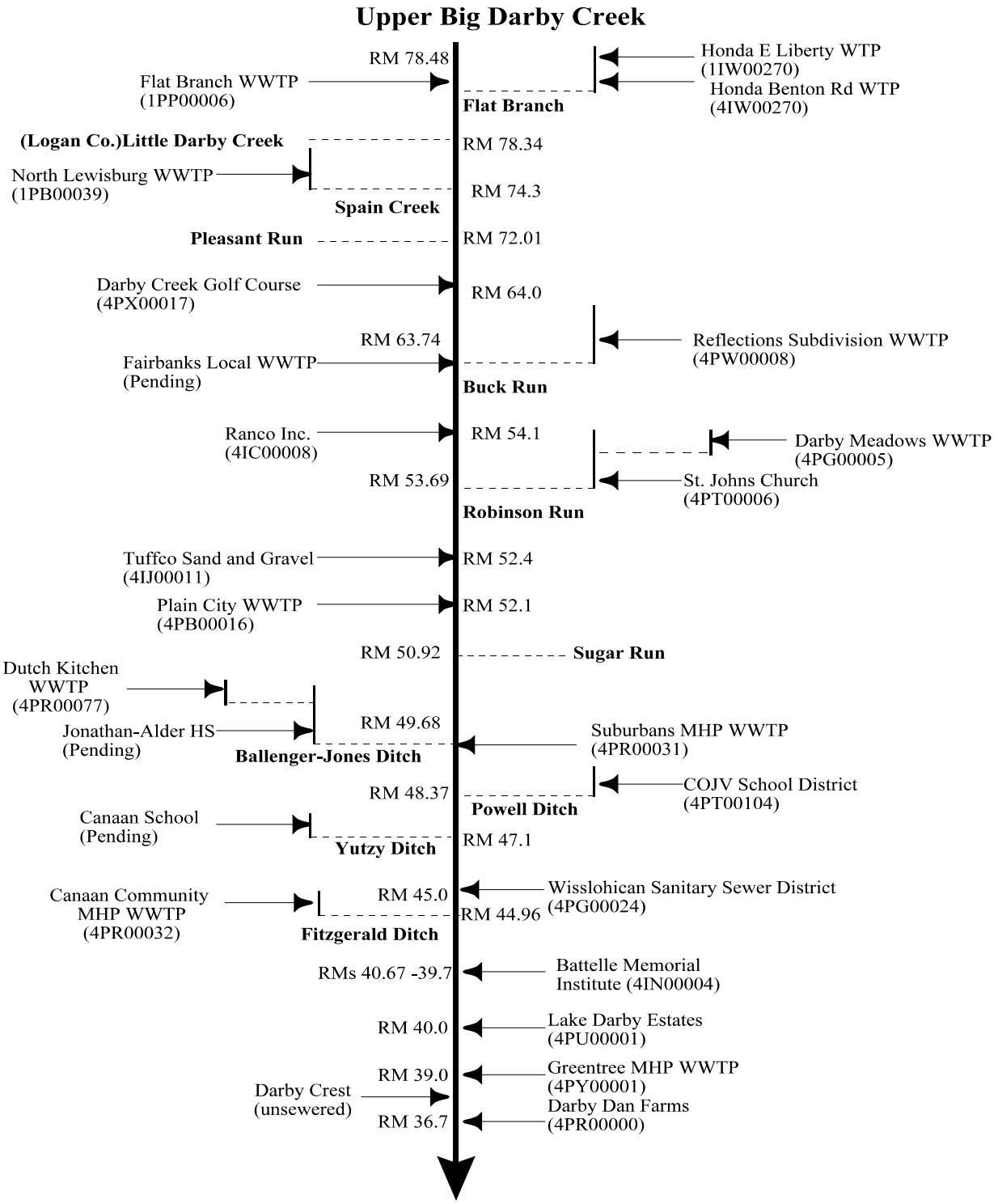
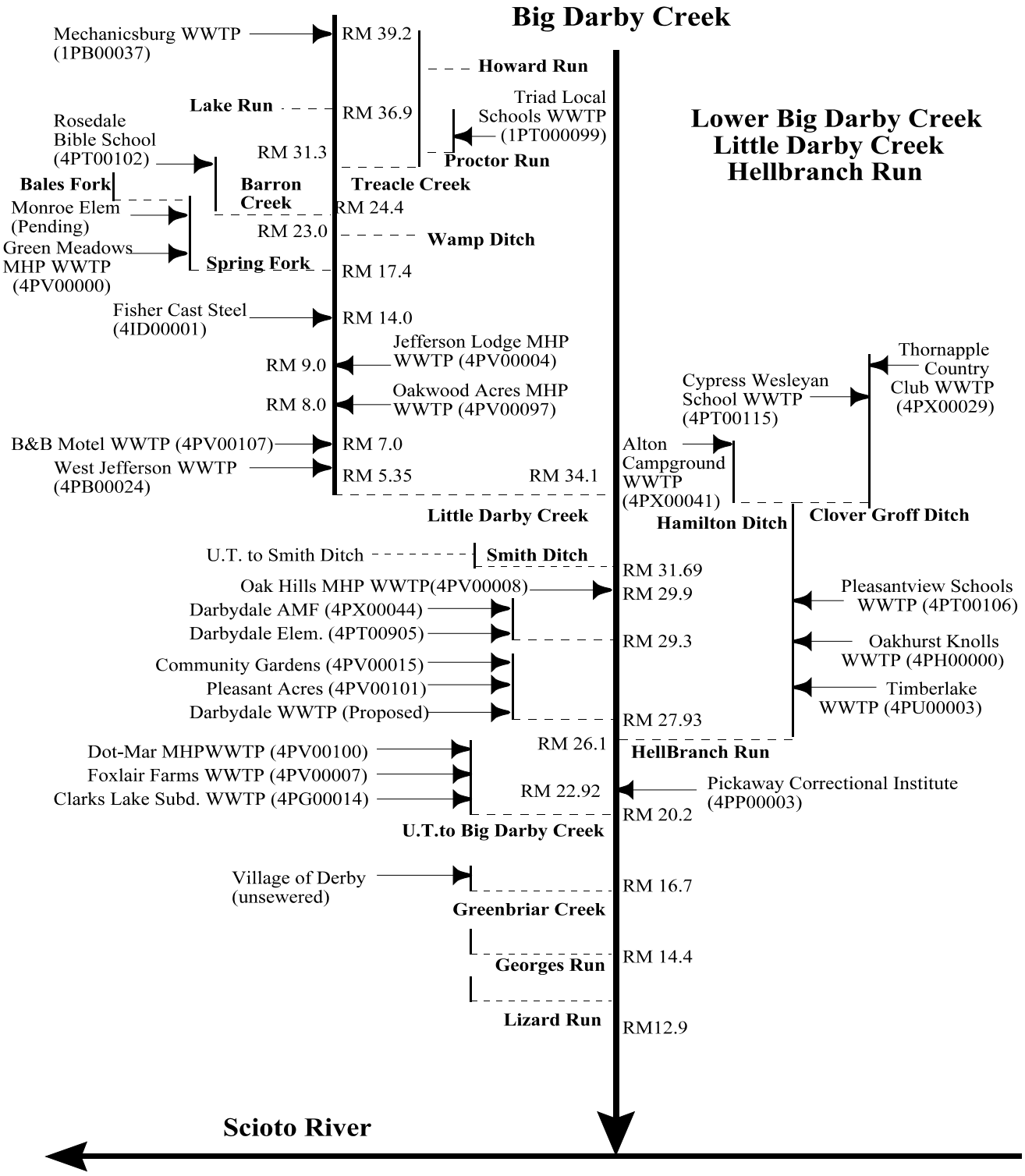


Figure B.1.2. Schematic representation of permitted dischargers to the lower Big Darby Creek watershed, 2001/2002.



Polishing treatment generally consists of sand filtration or a polishing pond. Both function to remove light weight "sludge" that did not settle in the clarifier. The treated wastewater then flows to a small disinfection tank. Disinfection, destruction of remaining microfauna in the wastewater, is generally achieved by chlorination by tablet or liquid bleach and followed at the outlet of the tank with dechlorination which is accomplished by tablets or liquid.. Occasionally, ultraviolet light will be used to provide disinfection; however, this is uncommon in package plants.

These "package plants" combine to account for approximately 4.5% of the wastewater flow, 9.4% of the $cBOD_5$ loading, 35.3% of the ammonia loading, and 6.8% of the suspended solids loading discharged to the Big Darby watershed (Figures B.1.1 to B.1.6). Many of these package plants are not properly maintained and operated, hence the disproportionate amounts of ammonia, $cBOD_5$, and suspended solids loadings documented as discharged from these facilities.

Flat Branch WWTP (RM 78.48)

The Flat Branch Wastewater Treatment Plant (WWTP) is located in Logan County along Township Road 157, in East Liberty, Ohio. Formerly known as Honda of America Transportation Research Area (TRC), the Flat Branch WWTP was constructed in 1979. The WWTP has not undergone any significant changes since construction.

Two separate divisions of Honda of America utilized the plant for treatment, Honda TRC and Honda of America Motorcycle Division Manufacturing Plant. The State of Ohio Department of Development assisted in the funding of the wastewater treatment plant as part of an economic development plan. The TRC Wastewater Treatment Plant was originally designed to provide sewers to Honda of America Motorcycle and later Honda's Automobile Division, as well as local industrial interests associated with the Honda manufacturing process. Marysville WWTP treats the industrial process wastewater from all manufacturing divisions of the Honda industrial complex while sanitary wastewater was diverted to TRC.

In 1996, the Logan County Board of Commissioners assumed ownership from the State of Ohio and thus oversight of TRC. The wastewater treatment plant name was officially changed to the Flat Branch WWTP and was promoted as a regional wastewater management facility for southeastern Logan County. The proposal was to increase capacity in order to serve the unincorporated communities of East Liberty and Middleburg as well as new residential housing subdivisions. Sewer extensions to these communities and subdivisions have not occurred and alternative treatment options and discharge locations are being investigated for these communities.

The Flat Branch WWTP currently receives sanitary wastewater from: TRC; one private residence; NEX and Midwest Express - both warehousing facilities for Honda; TNT Logistic North American Incorporated; and Harding Machine, a machine shop. In addition to sanitary wastewater, Harding Machine sends floor cleaning waste to the Flat Branch WWTP for treatment a few times a year.

Figure B.1.3. Percent contributions of permitted Wastewater Treatment Plants to the 50th Percentile Loadings of CBOD (kg/da) in the Big Darby Creek watershed, 2001.

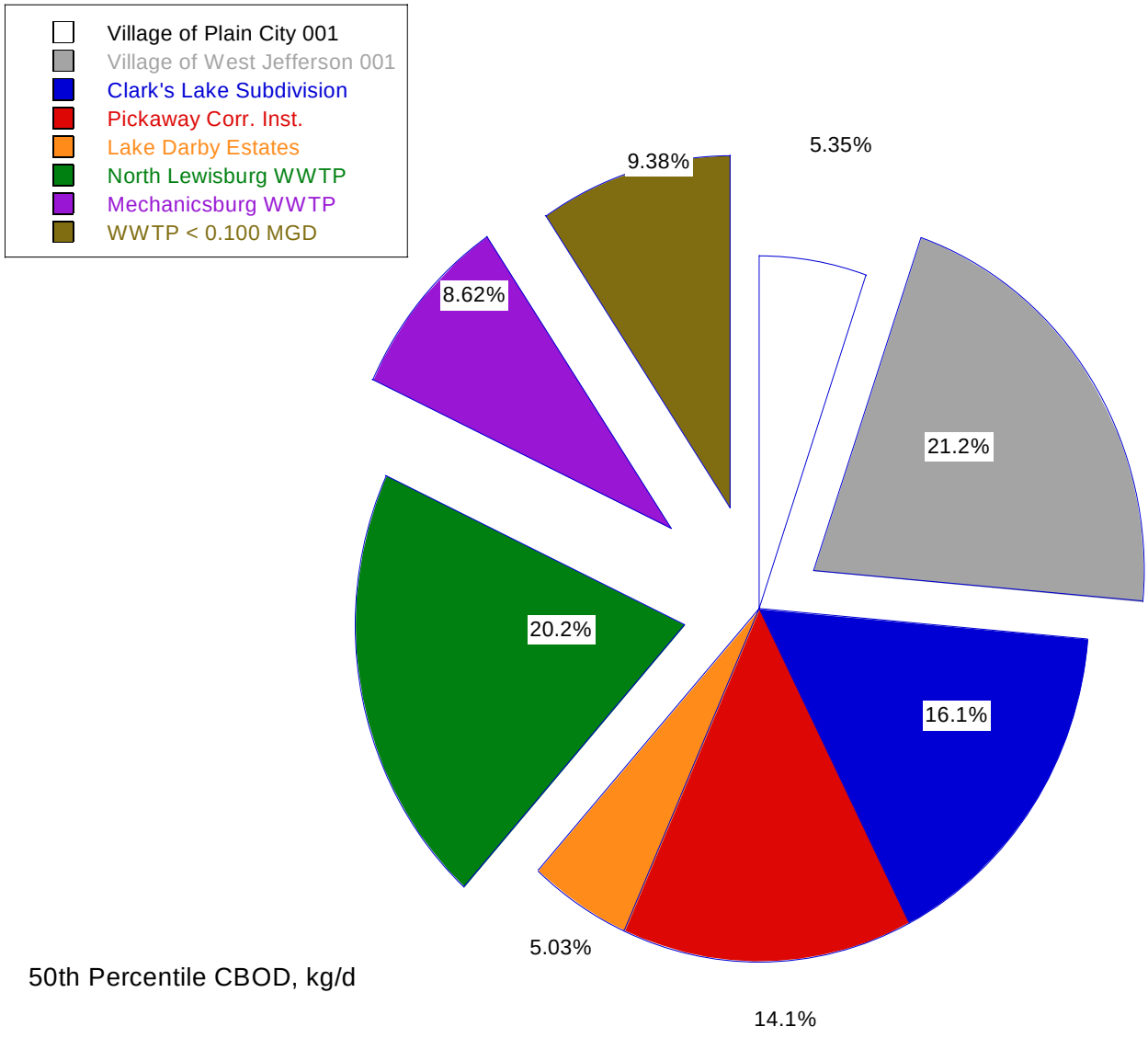


Figure B.1.4. Percent contributions from permitted Wastewater Treatment Plants to the 50th Percentile Effluent Flow in the Big Darby Creek watershed, 2001.

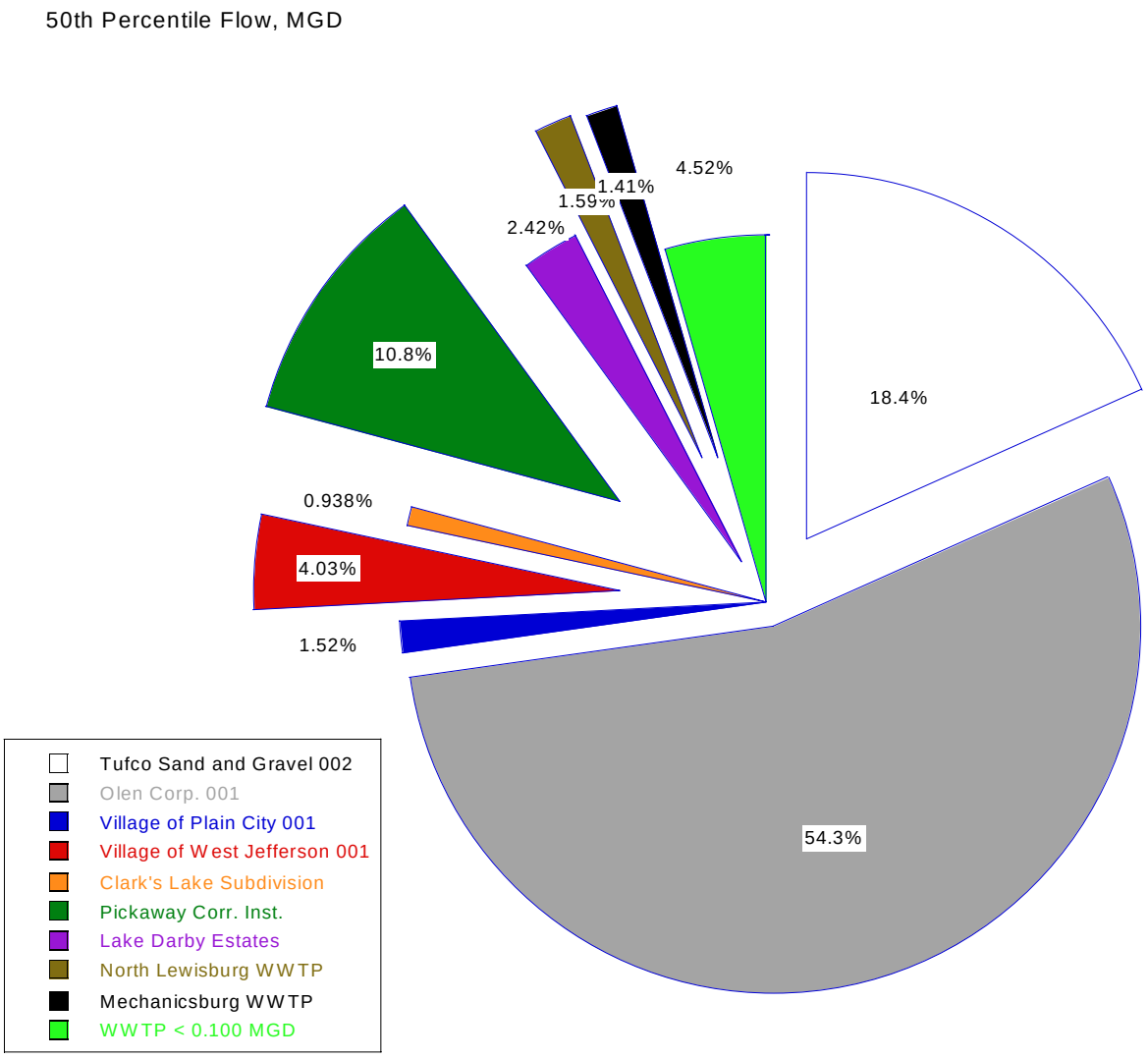


Figure B.1.5. Percent contributions of permitted Wastewater Treatment Plants to the 50th Percentile Loadings of ammonia (kg/da) in the Big Darby Creek watershed, 2001.

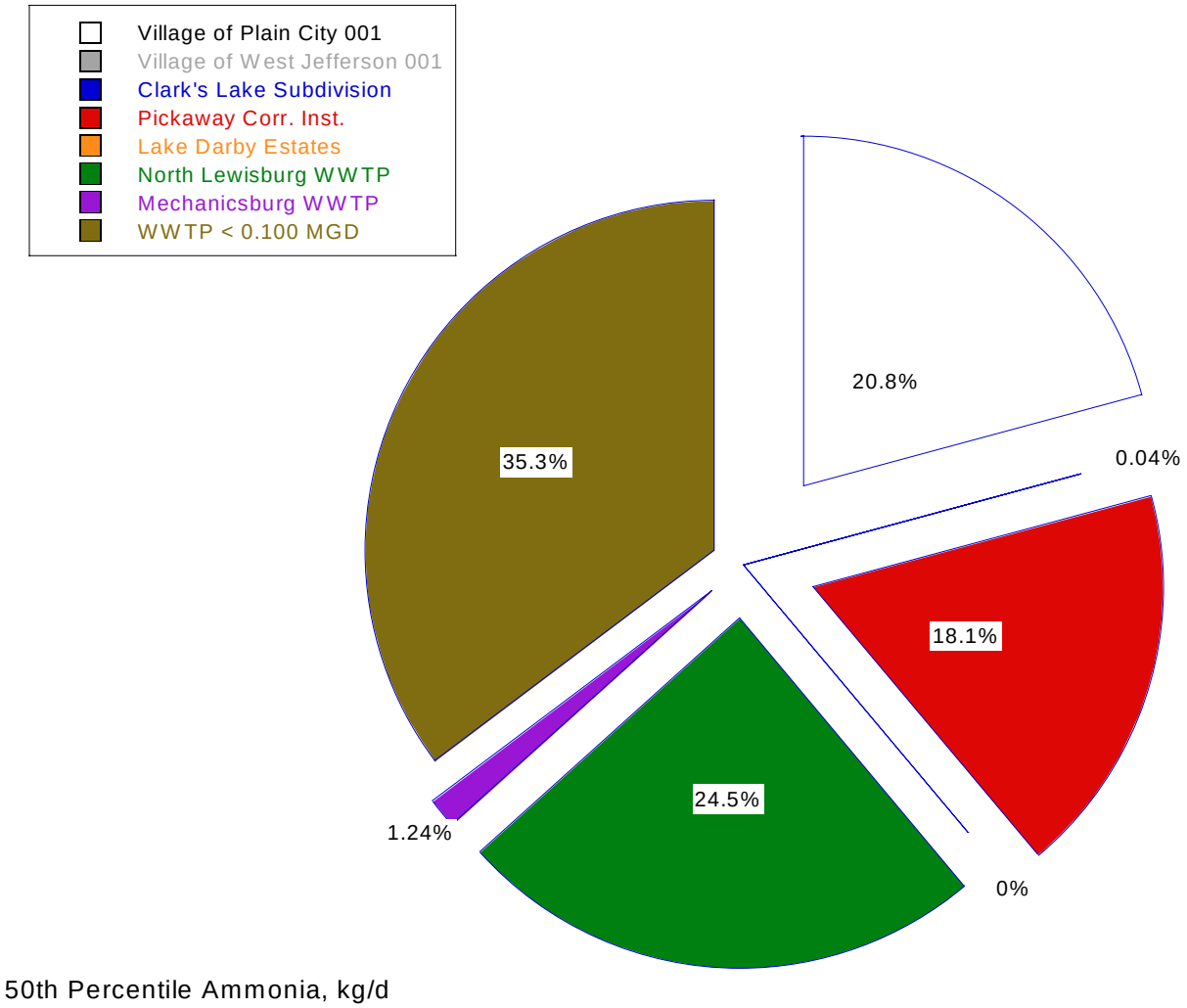
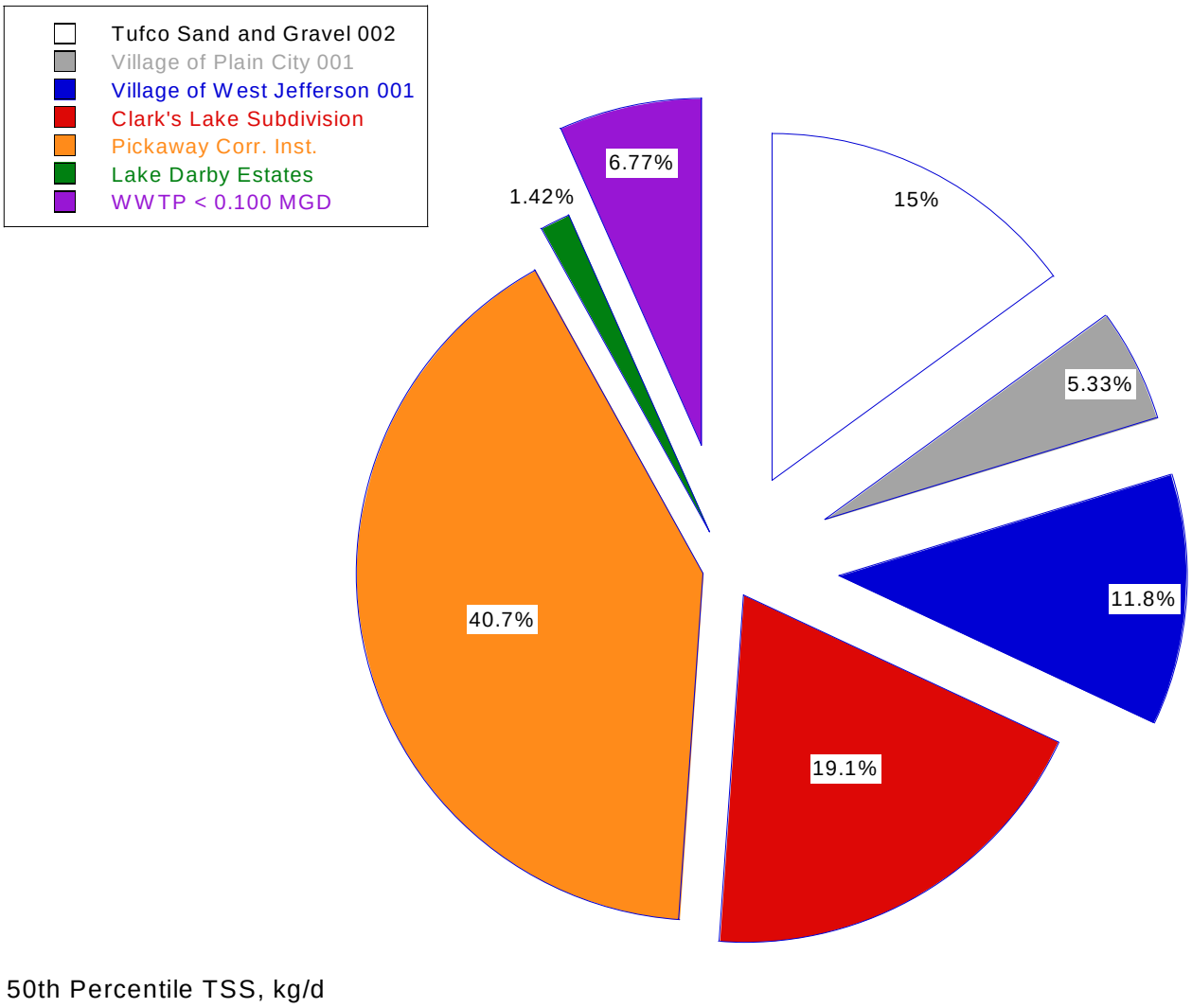


Figure B.1.6. Percent contributions of permitted Wastewater Treatment Plants to the 50th Percentile Loadings of Total Suspended Solids (kg/da) in the Big Darby Creek watershed, 2001.



50th Percentile TSS, kg/d

The Flat Branch WWTP treatment process consists of a lift station, pre-aeration, comminutor bar screen, a flow equalization basin, extended aeration, clarification, rotating biological contactor (RBC), two fixed media clarifiers, rapid sand filter, chlorination and post aeration. The aeration tanks, clarifier and sludge holding tanks are enclosed in a fiberglass building reducing the potential for odor nuisance. The bypass channel around the RBCs was reported as being inoperable due to mechanical dysfunctions. The collection system contains to lift stations and is reported as having zero overflow structures; however, inflow and infiltration into the collection system have been problematic for the treatment plant. Flat Branch WWTP design flow rate is 0.1 MGD (100,000 GPD) with an average annual daily flow rate for the past three years of 0.062 MGD.

Ohio EPA has documented operational problems and numerous serious violations of the NPDES permit for the Flat Branch WWTP over the last 6 years. Poor plant operations were documented through an inspection performed in 1998, documenting that sludge wasting had not occurred at the wastewater facility in 15 years. In order to insure proper operation and treatment efficiency, a WWTP must remove or "waste" sludge (microfauna) periodically. This is done by removing settled sludge from the treatment train and sending it off for disposal. Continual "recycling" of the sludge without wasting leads to poor treatment of the wastes due to the excessive age of the microfauna and a buildup of sludge in the plant, allowing the possibility that sludge might escape from the plant during high flow events. Sludge loss from the Flat Branch WWTP to the Big Darby Creek may be inferred due to documented problems with I/I noted above and violations of total suspended solids concentrations and loadings in the effluent.

Percentile flows have remained fairly constant over time except during the period from 1999 through 2001 when it exceeded or approached the design flow. Monthly operating reports submitted by the Flat Branch WWTP indicate that the wastewater treatment plant has not met NPDES permitted effluent concentration and loading limits or sampling frequency requirements during much of the last 6 years. Violations for various parameters occur regularly over a monthly reporting period. Permit violations for the period of January 2000 through December 2003 have been documented for total residual chlorine (39%), fecal coliform bacteria (14%), pH (14%), total suspended solids (12%), ammonia (11%), and 5-day carbonaceous biochemical oxygen demand (2%) (Table B.1.2). Many of these permit violations were significant and are causing degradation instream. (See also Figures B.1.7 to B.1.10).

The volume and scope of NPDES permit violations noted for this facility indicate a lack of consistent and proper treatment of wastewater delivered to the Flat Branch WWTP that has negatively affected the biological communities downstream of the discharge point. Monitoring by the WWTP upstream and downstream of the discharge shows little change in chemical water quality (Figures B.1.11 and B.1.12). The frequency and quantity of instream monitoring should be closely examined to determine possible correlations with effluent violations (e.g., was instream monitoring completed on days where there were effluent violations of one kind or another). There is also the possibility that upstream point or nonpoint sources have increased loadings since the operations and treatment at the plant have not improved over time. Certainly, significant degradation to the biological communities in the upper Big Darby Creek exists downstream of the Flat Branch WWTP.

Table B.1.2. NPDES permit violations at the Flat Branch WWTP (1PP00006) from January 2000 through December 2003.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
TSS (mg/l)	2/Week	8 (7-d)	13	Jan. 2000
TSS (mg/l)	2/Week	12 (7-d)	32.4	Jan. 2000
TSS (kg/d)	2/Week	3.0 (30-d)	9.4	Jan. 2000
TSS (kg/d)	2/Week	4.5 (7-d)	39.9	Jan. 2000
CBOD5 (mg/l)	2/Week	3.0 (70d)	3.4	Jan. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.2	Jan. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.4 (2 days)	Jan. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.1	Jan. 2000
TSS (mg/l)	2/Week	12 (7-d)	12.4	Feb. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.3	Feb. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.2	Feb. 2000
pH (S.U.)	1/Day	6.5 (min.)	6.4 (4 days)	Feb. 2000
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	3280	May 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	2780	May 2000
CBOD5 (mg/l)	1/2Weeks	8.0 (7-d)	11.7	May 2000
CBOD5 (kg/dl)	1/2Weeks	3.0 (7-d)	6.6	May 2000
CBOD5 (kg/d)	1/2Weeks	1.9 (30-d)	2.0	May 2000
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	4628	June 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	8643	June 2000
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	1858	July 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	July 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	July 2000
D.O. (mg/l)	1/Day	6.0 (min.)	4.4	July 2000
TSS (kg/d)	2/Week	4.5 (7-d)	10.7	Aug. 2000
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	4207	Aug. 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	7000	Aug. 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	16000	Aug. 2000
NH3 (mg/l)	1/2Weeks	0.5 (30-d)	1.08	Sept. 2000
NH3 (mg/l)	1/2Weeks	0.8 (7-d)	2.1	Sept. 2000
NH3 (kg/d)	1/2Weeks	0.2 (30-d)	0.6	Sept. 2000
NH3 (kg/d)	1/2Weeks	0.3 (7-d)	1.2	Sept. 2000
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	3469	Sept. 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	5600	Sept. 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	3900	Sept. 2000
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	2575	Sept. 2000
D.O. (mg/l)	1/Day	6.0 (min.)	5.8	Oct. 2000

Continued

Table B.1.2. Continued.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
pH (S.U.)	1/Day	6.5 (min.)	6.4 (4 days)	Dec. 2000
TSS (mg/l)	2/Week	12 (7-d)	12.1	Dec. 2000
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	5.6	Dec. 2000
NH3 (mg/l)	1/2Weeks	1.5 (30-d)	2.98	Dec. 2000
NH3 (kg/d)	1/2Weeks	0.6 (30-d)	1.6	Dec. 2000
NH3 (kg/d)	1/2Weeks	0.9 (7-d)	3.2	Dec. 2000
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	2.7	Jan. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.4 (2 days)	Jan. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.2 (2 days)	Jan. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.4	Feb. 2001
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	3.4	March 2001
NH3 (mg/l)	1/2Weeks	0.5 (30-d)	0.9	May 2001
NH3 (mg/l)	1/2Weeks	0.8 (7-d)	0.88	May 2001
NH3 (mg/l)	1/2Weeks	0.8 (7-d)	1.4	May 2001
NH3 (kg/d)	1/2Weeks	0.2 (30-d)	0.36	May 2001
NH3 (kg/d)	1/2Weeks	0.3 (7-d)	0.79	May 2001
TSS (kg/d)	1/2Weeks	4.5 (7-d)	6.2	May 2001
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	May 2001
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	May 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.31	May 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.25	May 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.14	May 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.26	May 2001
D.O. (mg/l)	1/Day	6.0 (min.)	5.2	May 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.06	June 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.06	June 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.11	June 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.12	June 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.15	June 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.12	June 2001
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	July 2001
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	July 2001
D.O. (mg/l)	1/Day	6.0 (min.)	5.8	July 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.98	Aug. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.09	Aug. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.08	Aug. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.11	Aug. 2001

Continued.

Table B.1.2. Continued.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.14	Aug. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.2	Aug. 2001
F. Coliform (#/100 ml)	1/Week	1000 (7-d)	AK	Sept. 2001
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.066	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.083	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.082	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.074	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.0696	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.192	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.058	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.105	Sept. 2001
D.O. (mg/l)	1/Day	6.0 (min.)	5.8	Sept. 2001
D.O. (mg/l)	1/Day	6.0 (min.)	5.3	Sept. 2001
D.O. (mg/l)	1/Day	6.0 (min.)	5.6	Sept. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.152	Oct. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.175	Oct. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.202	Oct. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.326	Oct. 2001
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.067	Oct. 2001
TSS (mg/l)	2/Week	12 (7-d)	12.5	Oct. 2001
TSS (kg/d)	2/Week	4.5 (7-d)	6.7	Oct. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.4 (3 days)	Dec. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.2	Dec. 2001
pH (S.U.)	1/Day	6.5 (min.)	6.4 (2 days)	Feb. 2002
pH (S.U.)	1/Day	6.5 (min.)	6.3	Feb. 2002
pH (S.U.)	1/Day	6.5 (min.)	6.4 (3 days)	March 2002
pH (S.U.)	1/Day	6.5 (min.)	6.4	April 2002
TSS (mg/l)	2/Week	8.0 (30-d)	8.2	April 2002
pH (S.U.)	1/Day	6.5 (min.)	6.4	May 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	9808	May 2002
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	4639	May 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.06	May 2002
D.O. (mg/l)	1/Day	6.0 (min.)	5.4	June 2002
pH (S.U.)	1/Day	6.5 (min.)	6.4	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	5.08	June 2002

Continued.

Table B.1.2. Continued

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
Chlorine, (mg/l)	1/Day	0.021 (max.)	10.3	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.59	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.51	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.22	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.22	June 2002
TSS (mg/l)	2/Week	12.0 (7-d)	29.4	June 2002
TSS (mg/l)	2/Week	8.0 (30-d)	8.9	June 2002
TSS (kg/d)	2/Week	3.0 (30-d)	11.9	June 2002
TSS (kg/d)	2/Week	4.5 (7-d)	46.2	June 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	2600	June 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	June 2002
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	June 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.07	July 2002
pH(S.U.)	1/Day	6.5 (min.)	6.4	Aug. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.54	Aug. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	1.49	Aug. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.8	Aug. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.29	Aug. 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	Aug. 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	Aug. 2002
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	Aug. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.08	Sept. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.09	Sept. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.11	Sept. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.09	Sept. 2002
TSS (mg/l)	2/Week	12.0 (7-d)	13	Sept. 2002
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	17700	Sept. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.26	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.11	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.16	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.07	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.23	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.13	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.13	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.12	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.11	Oct. 2002
Chlorine, (mg/l)	1/Day	0.021 (max.)	0.10	Oct. 2002

Continued.

Table B.1.2. Continued.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	2294	Oct. 2002
NH3 (mg/l)	1/2Weeks	1.5 (30-d)	3.3	Jan. 2003
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	5.9	Jan. 2003
pH (S.U.)	1/Day	6.5 (min.)	6.0 and 6.0	Jan. 2003
TSS (mg/l)	2/Week	8.0 (30-d)	9.4	Feb. 2003
NH3 (mg/l)	1/2Weeks	1.5 (30-d)	2.17	Feb. 2003
NH3 (kg/d)	1/2Weeks	0.6 (30-d)	0.65	Feb. 2003
NH3 (kg/d)	1/2Weeks	0.9 (7-d)	1.5	Feb. 2003
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	3.6	Feb. 2003
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	3.0	Feb. 2003
pH (S.U.)	1/Day	6.5 (min.)	6.4	Feb. 2003
TSS (mg/l)	2/Week	8.0 (30-d)	10.3	March 2003
TSS (kg/d)	2/Week	3.0 (30-d)	4.1	March 2003
TSS (kg/d)	2/Week	4.5 (7-d)	5.4	March 2003
pH (S.U.)	1/Day	6.5 (min.)	6.4	March 2003
TSS (mg/l)	2/Week	8.0 (30-d)	11.7	April 2003
TSS (mg/l)	2/Week	12.0 (7-d)	14.3	April 2003
TSS (mg/l)	2/Week	12.0 (7-d)	15.4	April 2003
TSS (mg/l)	2/Week	8.0 (30-d)	13.9	May 2003
TSS (kg/d)	2/Week	4.5 (7-d)	7.4	May 2003
TSS (kg/d)	2/Week	3.0 (30-d)	3.97	May 2003
TSS (mg/l)	2/Week	12.0 (7-d)	23.1	May 2003
TSS (mg/l)	2/Week	12.0 (7-d)	14.8	May 2003
TSS (kg/d)	2/Week	4.5 (7-d)	4.6	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.22	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.22	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.23	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.19	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.12	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.14	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	May 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.09	May 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.2	May 2003
D.O. (mg/l)	1/Day	6.0 (min)	4.5	May 2003
TSS (kg/d)	2/Week	3.0 (30-d)	5.5	June 2003
TSS (kg/d)	2/Week	4.5 (7-d)	15.8	June 2003

Continued.

Table B.1.2. Continued.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
NH3 (mg/l)	1/2Weeks	0.5 (30-d)	0.84	June 2003
NH3 (kg/d)	1/2Weeks	0.2 (30-d)	0.29	June 2003
NH3 (mg/l)	1/2Weeks	0.8 (7-d)	1.6	June 2003
NH3 (kg/dl)	1/2Weeks	0.3 (7-d)	0.6	June 2003
CBOD5 (mg/l)	1/2Weeks	8.0 (7-d)	8.8	June 2003
CBOD5 (kg/d)	1/2Weeks	3.0 (7-d)	4.4	June 2003
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	June 2003
F. Coliform (#/100 ml)	1/Week	1200 (7-d)	AK	June 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.0	June 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.1	June 2003
D.O. (mg/l)	1/Day	6.0 (min)	4.8	June 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.7	June 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.5	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	1.03	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.38	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.09	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.08	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.17	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.18	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.21	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.08	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.1	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.08	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.14	June 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.08	June 2003
TSS (kg/d)	2/Week	4.5 (7-d)	4.7	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.22	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.1	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.23	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.12	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.09	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.07	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.08	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.05	July 2003
D.O. (mg/l)	1/Day	6.0 (min)	5.0	July 2003

Continued.

Table B.1.2. Continued.

EFFLUENT LIMIT VIOLATIONS FOR OUTFALL 001

PARAMETER	FREQUENCY	PERMIT LIMIT VALUE	REPORTED	DATE
D.O. (mg/l)	1/Day	6.0 (min)	5.8	July 2003
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	July 2003
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	July 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.18	Aug. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.12	Aug. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.16	Aug. 2003
pH (S.U.)	1/Day	6.5 (min.)	6.45	Aug. 2003
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	5500	Aug. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.18	Sept. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.21	Sept. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.12	Sept. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	Sept. 2003
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	AK	Sept. 2003
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	5140	Sept. 2003
F. Coliform (#/100 ml)	1/Week	1000 (30-d)	AK	Sept. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.05	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.11	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.13	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.11	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.06	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.32	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.11	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.19	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.21	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.21	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.32	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.12	Oct. 2003
Chlorine (mg/l)	1/Day	0.021 (max.)	0.13	Oct. 2003
F. Coliform (#/100 ml)	1/Week	2000 (7-d)	2420	Oct. 2003
NH3 (mg/l)	1/2Weeks	1.5 (30-d)	3.04	Nov. 2003
NH3 (kg/d)	1/2Weeks	0.6 (30-d)	0.86	Nov. 2003
NH3 (mg/l)	1/2Weeks	2.3 (7-d)	5.9	Nov. 2003
NH3 (kg/d)	1/2Weeks	0.9 (7-d)	1.7	Nov. 2003
TSS (mg/l)	1/Week	12 (7-d)	14.4	Dec. 2003

Figure B.1.7. Flat Branch WWTP 50th and 90th Percentile Total Suspended Solids Effluent Concentrations for the period 1980 to 2001.

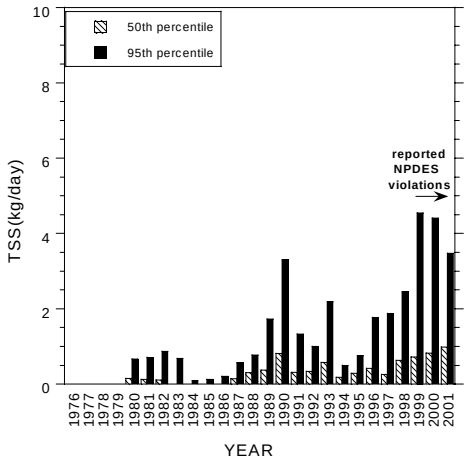


Figure B.1.8. Flat Branch WWTP 50th and 90th Percentile Ammonia Effluent Concentrations for the period 1980 to 2001.

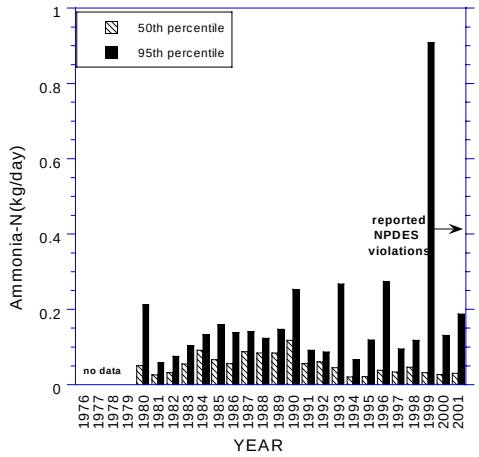


Figure B.1.9. Flat Branch WWTP 50th and 90th Percentile cBOD5 Effluent Concentrations for the period 1980 to 2001.

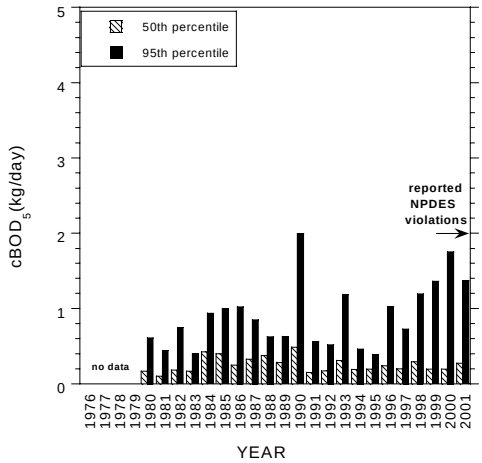


Figure B.1.10. Median and 95th percentile conduit flow (MGD) from the Flat Branch WWTP from 1976 through 2001.

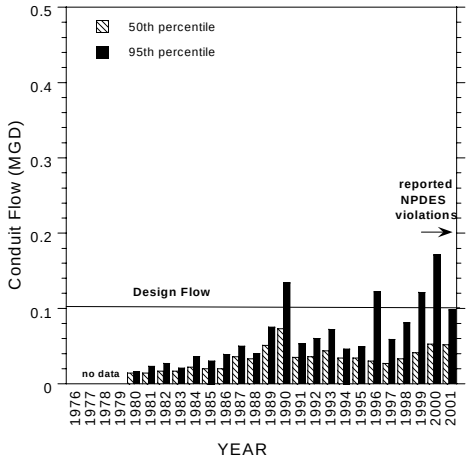


Figure B.1.11. Median Ambient Ammonia Concentrations in Big Darby Creek up and downstream from the Flat Branch WWTP during the period 1980 to 2001.

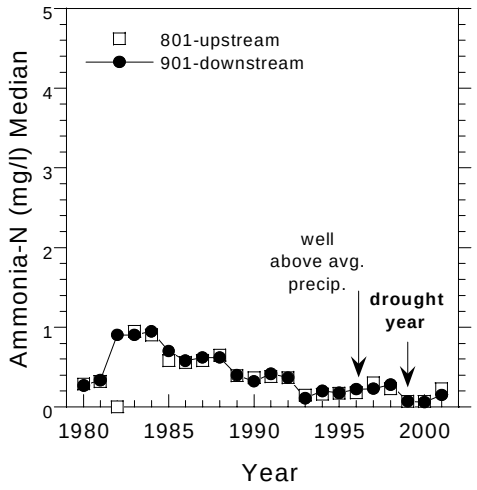
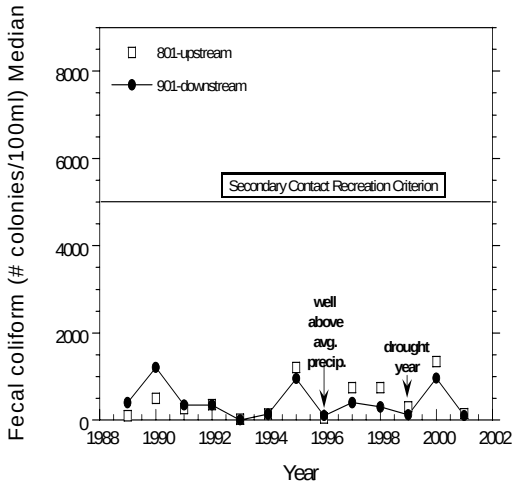


Figure B.1.12. Median Fecal Coliform Counts in Big Darby Creek up and downstream from the Flat Branch WWTP during the period 1980 to 2001.



Honda Water Treatment and Surface Water Ditches

Honda East Liberty Auto Plant Water Treatment Plant - (formerly TRC)-001 and 002 (RM 4.80, Flat Branch via Unnamed Tributary)

The East Liberty Auto Plant Water Treatment Plant (ELPWTP) is located at 11000 SR 347, East Liberty, Ohio in Logan County. Raw water is drawn from five wells, at a daily production rate of 1.2 MGD, followed by clarification, filtration, and disinfection. Wastewater from treatment is discharged through two outfalls, 001 and 002.

The treatment processes used at the water treatment plant are clarification (via polymers and hydrated lime), re-carbonation, sand filtration, chlorination and lime sedimentation. Honda East Liberty WTP utilizes conventional water treatment processes to treat groundwater and yield potable water for both personal and industrial usage. Influent groundwater is mixed with polymer and lime to raise pH, precipitate metals, and enhance settling.

Due to the high quality of the groundwater, soda ash is not required in the treatment process. The chemical mixing and sludge settling is accomplished using an upflow clarifier system. The facility discharges lagoon overflow through two outfalls that discharge to a 1000' long unnamed tributary (swale) of Flat Branch. The final outfall (outfall 001) conveys supernatant from the southwest lime sludge lagoon. Outfall 002 carries overflow from the northeast lime sludge lagoon. The swale is then picked up by a ten acre storm water retention basin that also receives runoff from the buildings downspouts and parking lot. The storm water retention basin then

discharges from a single location to Flat Branch. The average daily discharge flow in 2000 was 12,300 gpd.

The clarifier and other process tanks are generally drained and cleaned out once per year with the wash water discharging to the lime sludge settling lagoon. Dewatered lime sludge is disposed of in accordance with an approved Sludge Management Plan (SMP). Sludge that accumulates in the settling lagoon is applied to agricultural land located on Honda property which is farmed under a cooperative agreement with Honda.

A total of 2,860 acres of Honda-owned agricultural land is available to receive lime sludge which is applied at a maximum rate of six dry tons per acre. Isolation distances, topography, seasonal variations, and flood plains are considered when siting for land application of the sludge in order to minimize the potential for runoff into nearby waterways.

On numerous occasions in 2001, Ohio EPA field personnel noted a chalky white appearance to the unnamed tributary prior to discharge into Flat Branch. The whitish plume was also apparent in Flat Branch and Big Darby Creek. The origin of the chalky plume appeared to be one of the lime settling lagoons. As indicated by the field report, this particular event was not judged to be related to a storm event. Flow conditions were not documented during this sampling event. Honda is investigating the causes and sources of the gray-white material and corrective measures that might be taken to eliminate this problem prior to water reaching Flat Branch. A preliminary report indicated a drainage problem. Honda has significantly increased the amount of impervious surfaces on their property; the impacts associated with the increased rate of storm water run-off may be an issue. A final report detailing corrective measures outlines additional water quality monitoring proposed in Flat Branch. Re-vegetation of stream and ditch banks, further conservation methods on agricultural fields owned by Honda, and improvements to storm water controls including construction of erosion control BMPs were some of the measures proposed to deal with this documented problem.

Limited conduit flow data for both outfall 001 and 002 demonstrated unpredictable and irregular flows for both outfalls likely linked to industry process peak demand, lagoon capacity and storm events.

Honda - Benton Road Water Treatment Plant (RM 2.21, Flat Branch via Unnamed Tributary)

The Honda-Benton Road Water Treatment Plant (WTP) is located in Union County on Benton Road, north of Pottersburg and east of Middleburg between SR 33 and SR 739. The first wastewater discharge permit Ohio EPA issued for the Honda-Benton Road WTP was in 1988. The Honda-Benton Road WTP permit was recently reissued in July 2000 with limits for pH between 6.5 and 11.0 S.U. and total suspended solids (TSS) at 30 mg/l for a 30-day average and 45 mg/l for the daily maximum value. The Honda-Benton Road WTP utilizes lime-soda softening, sand filtration, and chlorination to produce between 0.60 and 1.70 MGD of potable water.

Wastewater discharges through two outfalls, 001 and 002, to the unnamed tributary. Honda-Benton Road's average daily discharge flow during 2000 was 12,300 gpd. Raw water drawn for treatment is supplied by five primary wells and two backup wells. Flow seems to fluctuate monthly according to Monthly Operating Reports (MORs) and is likely due to precipitation and evaporation rates and production demand rates.

Dewatered lime sludge is usually disposed of on site in accordance with an approved Sludge Management Plan (SMP). Isolation distances, topography, seasonal variations, and flood plains are considered when siting for land application of the sludge in order to minimize the potential for runoff into nearby waterways.

Limited data available for conduit flow demonstrates an increasing trend in quantity with fairly consistent percentile variance. Total suspended solids (TSS) trends demonstrated no discernable pattern from 1994 to 2001. This pattern is likely tied to production and inflow rates, as well as sampling timing and technique, all of which have the potential to suspend solids of various concentrations.

North Lewisburg WWTP (RM 1.50, Spain Creek)

The Village of North Lewisburg WWTP is located in Champaign County at 9984 SR 245 in North Lewisburg. The village began treating wastewater in the early 1970s in response to population growth and to address public health concerns associated with failing on-site systems. A lagoon wastewater treatment process was constructed in 1970 utilizing two 0.10 MGD stabilization lagoons with a grit chamber, an inflow/outflow structure, and a final outfall headwall. This type of treatment system was unable to consistently comply with its NPDES permit limits resulting in degradation of Spain Creek. The village's population is currently estimated at 1,800 with the population projected to grow to 2,000 within five to ten years.

In 1989, the Village of North Lewisburg was referred to the State of Ohio Attorney General's Office for failure to comply with the July 1, 1988 directive to meet secondary wastewater treatment criteria. North Lewisburg was required to construct a treatment facility to negate further degradation of Spain Creek and to conform to the secondary treatment technology mandate. By 1990, North Lewisburg administrators received a federal construction grant for an overhaul of the WWTP. The abandonment of the stabilization lagoon system occurred in 1991 when the village completed its installation of the Sequencing Batch Reactor (SBR) Treatment System.

The North Lewisburg WWTP currently has a design capacity of 0.170 MGD. Full capacity is expected to be reached by the year 2010. In addition, the Village of North Lewisburg has a current agreement with the Village of Woodstock to accept wastewater flow of approximately 0.0267 MGD. The current wastewater treatment process includes a sewage grinder, grit removal system, lift station, a three cell equalization tank, SBR, four rapid sand filters, chlorination system, tablet dechlorination system, and post aeration followed by a final effluent flow meter. Sludge is handled via aerobic digesters and a sludge holding tank. Power failures at the

treatment facility are handled by an emergency power generator which can provide power for the entire plant.

The collection system is a gravity flow system of approximately 29,000 linear feet of 8" to 12" diameter pipe. The entire sanitary collection system consists of separate sewers, with all of the village sewered. Inflow and infiltration are problematic in the collection system.

In 1996, an Ohio EPA inspection report of the North Lewisburg Treatment Plant and their effluent quality described the wastewater as dark green in color and noted the depletion of the supply of chlorine used for disinfection. During most of 1995 and a portion of 1996, Monthly Operating Reports (MORs) were not submitted to Ohio EPA, a violation of their discharge permit. Additional permit violations for North Lewisburg continued throughout the 1990s.

An inspection by Ohio EPA personnel in June of 2001 revealed solids and sludge on the streambed of Spain Creek, downstream from the final outfall (001). In addition, a significant quantity of foam was also documented downstream from the WWTP. Records indicate the Village of North Lewisburg has completed a Sludge Management Plan (SMP) and received approval in 2001 for land application on nearby cropland.

The village is also currently working with an environmental consultant on a plan to provide for treatment plant upgrades brought about by the inflow and infiltration problems, necessary repairs and general housekeeping practices. The wastewater treatment plant has been re-rated for a Class II Operator, requiring the present operator to pursue a Class II Operator Certification while North Lewisburg's consultant oversees operations of the wastewater plant.

Wastewater treatment improved prior to the expansion completed in 1991 for most wastewater constituents with the exception of ammonia-N, which remained variable throughout the years evaluated (Figures B.1.13 to B.1.16). Loads of $cBOD_5$ and TSS notably decreased after the 1989 referral to the Ohio Attorney General's Office. Prior to the requirement to meet secondary standards, peak flows, as represented by the 95th percentile, consistently exceeded design flow of 0.10 MGD.

Monitoring stations upstream and downstream of the WWTP outfall yielded similar ammonia values. Insufficient reporting of data for fecal coliform prevented an accurate evaluation of any differences over the same period.

Records indicate a total of 235 NPDES permit violations for the North Lewisburg WWTP from February 1999 through December of 2001. Permit limit violations decreased annually from 112 violations in 1999 to 52 violations in 2001. Most of the violations occurred in May and July of the respective years, suggesting seasonal influences. The most frequent parameters reported in violation listed in decreasing order of frequency were ammonia-N, TSS and $cBOD_5$.

Figure B.1.13. North Lewisburg WWTP 50th and 90th Percentile Loadings of Total Suspended Solids to Big Darby Creek during the period from 1976 to 2001.

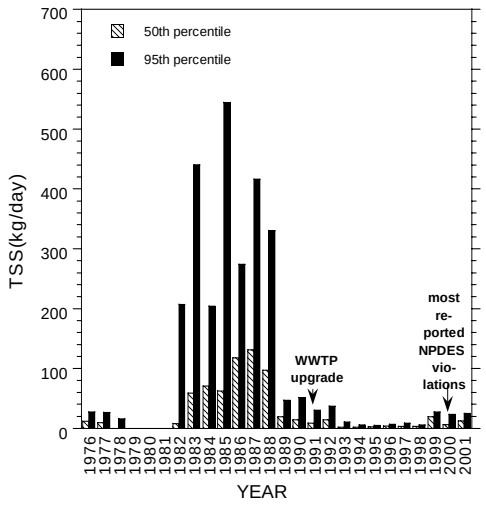


Figure B.1.14. North Lewisburg WWTP 50th and 90th Percentile Loadings of Ammonia to Big Darby Creek during the period from 1976 to 2001.

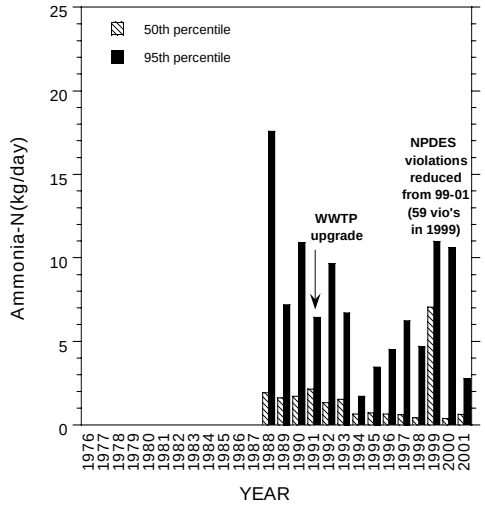


Figure B.1.15. North Lewisburg WWTP 50th and 90th Percentile Loadings of carbonaceous Biochemical Oxygen Demand to Big Darby Creek during the period from 1976 to 2001.

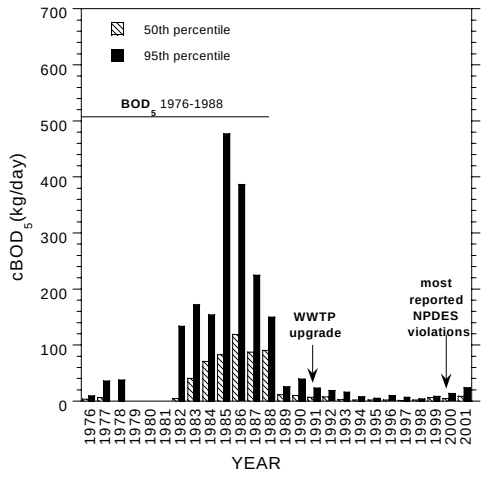
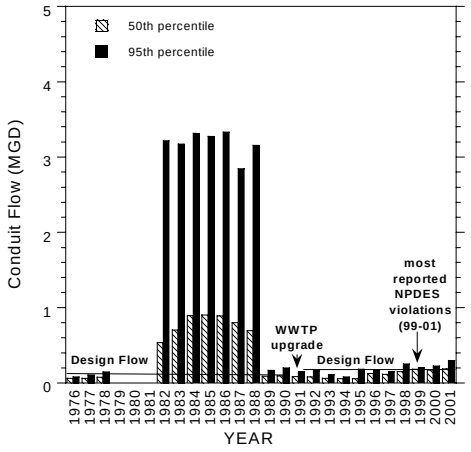


Figure B.1.16. North Lewisburg WWTP 50th and 90th Percentile Conduit Flow to Big Darby Creek during the period from 1976 to 2001.



The Village of North Lewisburg WWTP contributes approximately 1.6% of the total point source flow to the Darby watershed. The village also adds 20.2% of the $cBOD_5$ loading and 24.5% of the ammonia loading to the watershed. Loadings of suspended solids were negligible.

Reflections Subdivision (RM 8.00, Buck Run via Unnamed Tributary)
The Reflections Subdivision operates a wastewater treatment system which treats wastewater via a wetland. Wastewater is pumped to the wetland from submerged piping underneath the wetland. Once treatment is completed, wastewater is conveyed to two ponds, overflow from which intermittently discharges to an unnamed tributary to Buck Run. This system consistently meets NPDES permit limits. Inspections have revealed that adequate maintenance is provided.

Darby Creek Golf Course (RM 64.00, Big Darby Creek)
The Darby Creek Golf Course operates a 7,580 gpd capacity package WWTP. The WWTP consistently meets its permit limits. Inspections revealed marginal operation and maintenance practices.

Fairbanks School (RM 63.74, Big Darby Creek)
Fairbanks School operates an unpermitted, 15,000 gpd capacity package WWTP which operates year-round. The school houses the Union County Board of Education offices. Ohio EPA has received an NPDES permit application for this facility. The plant appears to be operated properly.

Ranco Corporation (RM 54.00, Big Darby Creek)
Ranco Corporation operates a 39,000 gpd design combined non-contact cooling water and package WWTP. Inspections revealed good operation and maintenance practices.

Discharge data shows a decrease in flow and loadings of pollutants to Big Darby Creek (Figures B.1.17 and B.1.18). This is primarily due to reduced levels of production at the company. Whole effluent toxicity testing in November 2001 and March 2002 confirmed acute toxicity of the effluent to the invertebrate *Ceriodaphnia dubia* at an LC50 of 44.1% (Ohio EPA Bioassay Report 02-2600-C), consistent with reports in 1992 and 1997. Toxicity was not apparent in the mixing zone.

Figure B.1.17. 50th and 95th Percentile Discharge Flow from the Ranco Inc. 001 outfall, 1976-2000.

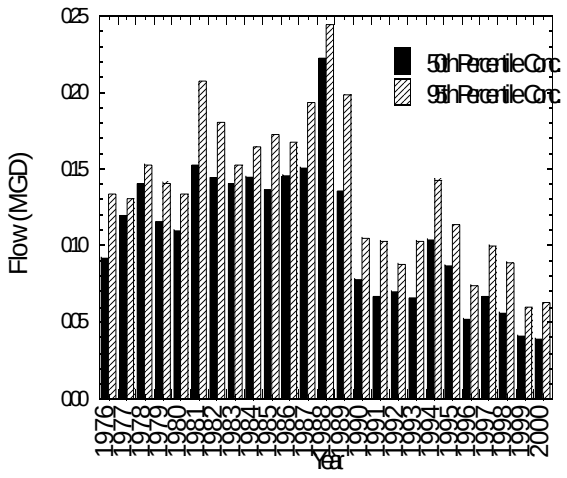
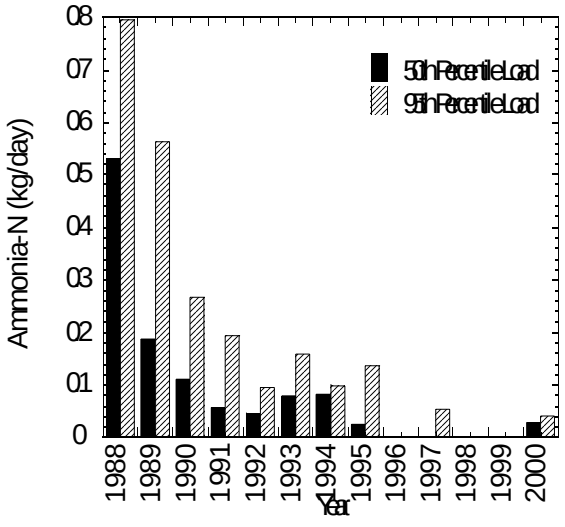


Figure B.1.18. 50th and 95th Loadings for ammonia from the Ranco Inc. 001 outfall, 1976-2000.



St. Johns Evangelical Lutheran Church (RM 8.04, Robinson Run via Unnamed Tributary)
St. Johns Church operates a 3,500 gpd package WWTP that consistently meets NPDES permit limits. Inspections have revealed marginal operation and maintenance practices at this facility.

Darby Meadows (RM 0.42, Robinson Run via ditch)
Darby Meadows subdivision operates a 10,000 gpd capacity package WWTP which consistently meets NPDES permit limits. Inspections reveal marginal operation and maintenance practices. Effluent chemistry suggests stable operation of the plant, although disinfection may be insufficient at times (Figures B.1.19 to B.1.22).

Figure B.1.19. Darby Meadows WWTP 50th and 90th Percentile Loadings of BOD5 and CBOD5 to Robinson Run for the period 1976 to 2001.

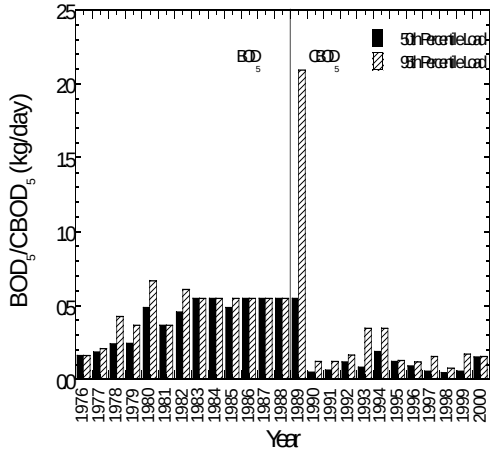


Figure B.1.20. Darby Meadows WWTP 50th and 90th Percentile Loadings of Total Suspended Solids to Robinson Run for the period 1976 to 2001.

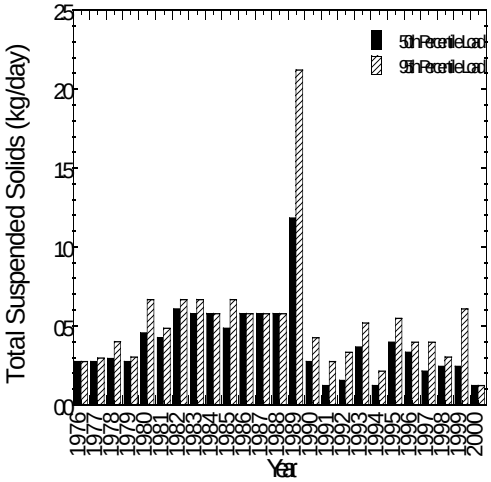


Figure B.1.21. Darby Meadows WWTP 50th and 90th Percentile Loadings of BOD5 and CBOD5 to Robinson Run for the period 1976 to 2001.

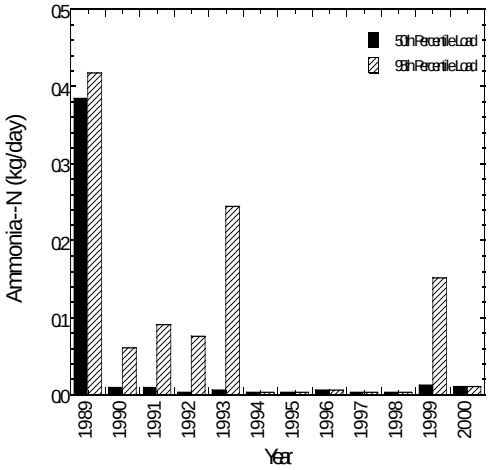
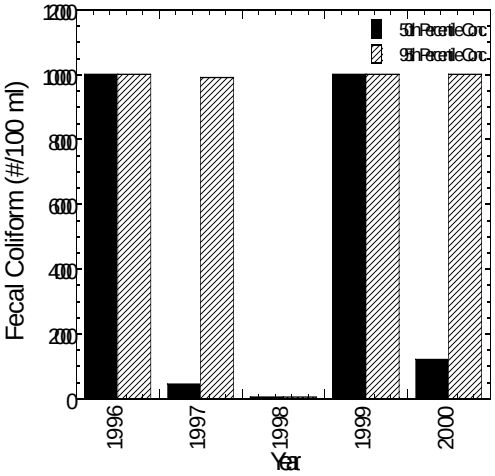


Figure B.1.22. Darby Meadows WWTP 50th and 90th Percentile Count of Fecal Coliform colonies/100ml. to Robinson Run for the period 1996 to 2001.



Tuffco Sand and Gravel (RM 52.40, Big Darby Creek)

This quarrying operation produces an intermittent overflow to the creek from solids settling ponds. Flow data shows a regular discharge of approximately 2.1 MGD (Figure B.1.23). The system consistently meets NPDES permit limits. Inspections have revealed that maintenance is provided for this treatment system. This facility is one of the two largest contributors of wastewater flow to the Big Darby watershed. Tuffco Sand and Gravel contributes 18.4% of the flow and 15% of the loading of suspended solids to the watershed from known point sources (Figures B.1.24 and B.1.25).

Figure B.1.23. Tuffco Sand and Gravel Co. 50th and 90th Percentile Effluent Flow to Big Darby Creek for the period 1994 to 2000.

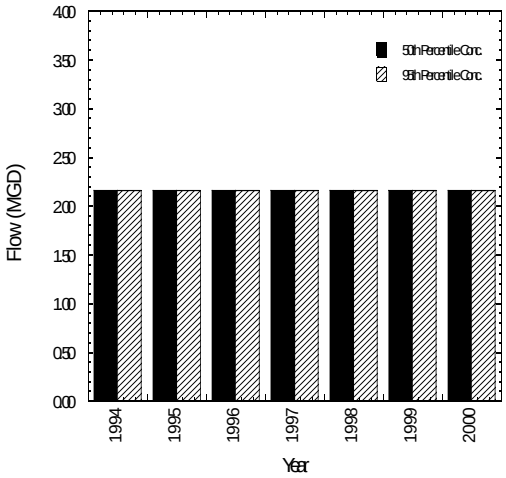


Figure B.1.24. Tuffco Sand and Gravel Co. Total Suspended Solids to Big Darby Creek for the period 1994 to 2000.

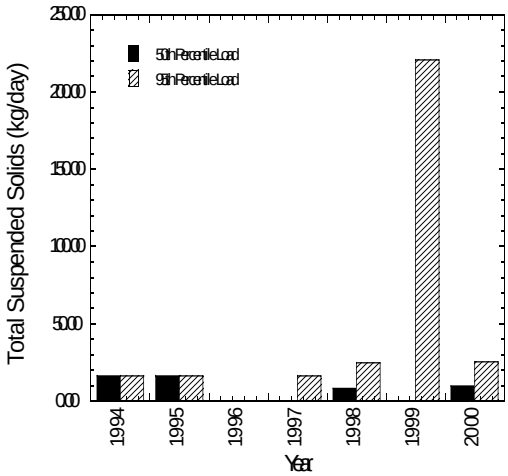
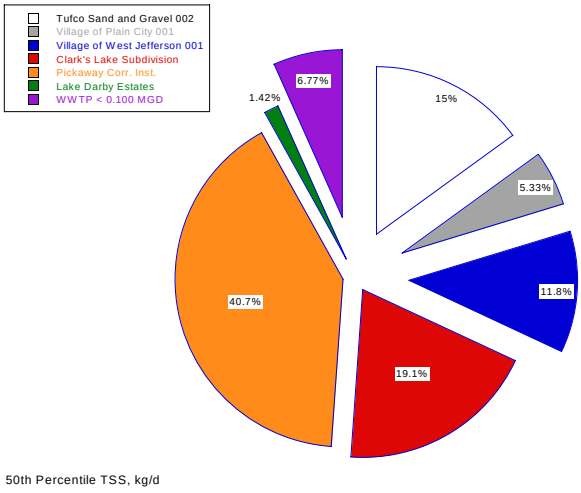


Figure B.1.25. Percent contributions of dischargers loadings of Total Suspended Solids to Big Darby Creek during 2001.



Plain City WWTP (RM 52.05, Big Darby Creek)

The Village of Plain City owns and operates a 0.50 MGD capacity WWTP. The treatment train consists of two "race track" oxidation ditches, two clarifiers, a chlorine contact tank and post aeration. This facility has consistently met its NPDES permit limits for the last 5 years. However, numerous complaints had documented that the total suspended solids limits in the permit allowed for the degradation of Big Darby Creek downstream of the outfall due to the deposition of excess biosolids on the streambed. This violated Ohio WQS (OAC 3745-1-04) that apply to all surface waters in that they be "free from suspended solids or other substances that enter the waters as a result of human activity and that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life."

Therefore, the NPDES permit was modified to reduce suspended solids reaching the creek. The mayor and village council of Plain City have since adjudicated this NPDES permit modification and the issue has gone to legal proceedings for resolution. In the meantime, the village Utilities Director and WWTP Superintendent have been investigating the addition of another oxidation ditch and rapid sand filtration to meet the new permit limits. Inspections revealed good operation and maintenance practices at this facility.

Historical loadings data from the WWTP show highly variable values for TSS and $cBOD_5$ when comparing median to 95th percentile values (Figures B.1.26 and B.1.27). Loadings for these parameters, however, are trending lower. Instream monitoring up and downstream of the outfall by the Village shows little impact from the WWTP for dissolved oxygen, $cBOD_5$, fecal coliform, or ammonia. Analysis for TSS was not part of the instream monitoring requirements until the 2002 permit renewal, so no comparisons can be made for this parameter.

The Village of Plain City WWTP contributes only 1.5% of the total wastewater flow to the Darby watershed. However, this plant adds over 5.3% of the $cBOD_5$, 20.8% of the ammonia, and over 5.3% of the suspended solids loadings to the watershed from known point sources.

Suburbans Mobile Home Park (RM 49.80, Big Darby Creek)

The Suburbans Mobile Home Park operates a 44,000 gpd package WWTP that complies with its NPDES permit limits about half the time. This is primarily due to excessive inflow and infiltration (I/I) causing loss of biosolids to the stream during rain events. Inspections have revealed good operation and maintenance practices at this WWTP. An I/I reduction program is in place and has helped reduce solids loss. The facility may also pursue flow equalization.

Dutch Kitchen (Ballenger-Jones Ditch via Unnamed Tributary at RM 0.70)

The Dutch Kitchen restaurant operates an 8,000 gpd capacity package WWTP that is usually in compliance with its NPDES permit. Inspection reports revealed marginal operation and maintenance practices.

Figure B.1.26. Plain City WWTP 50th and 90th Percentile Total Suspended Solids Loadings to Big Darby Creek during the period 1977 to 2000.

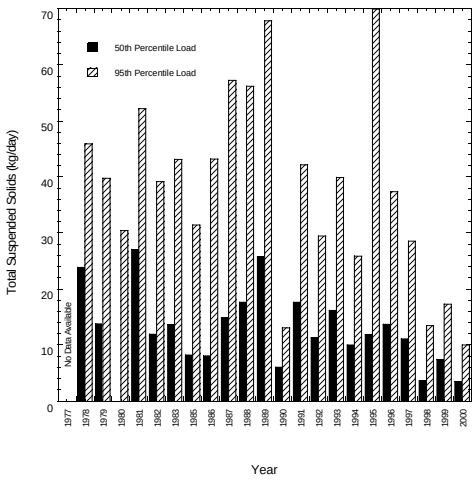
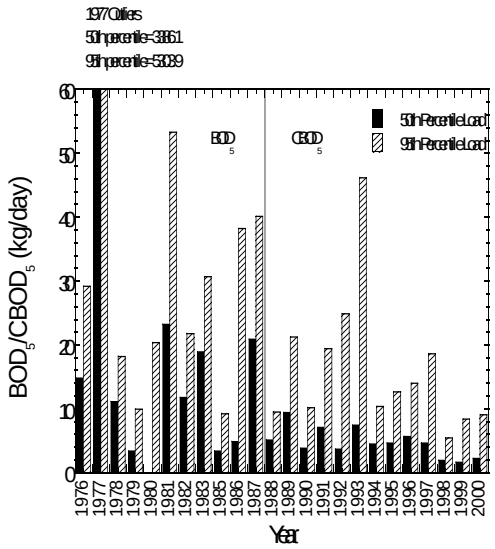


Figure B.1.27. Plain City WWTP BOD5/CBOD5 Loadings to Big Darby Creek during the period 1977 to 2000.



Jonathan Alder High School (RM 2.55, Ballenger-Jones Ditch)
This school operates a 5000 gallon per day package wastewater treatment plant that is overloaded and no longer appears to operate. Inspections reveal a history of marginal operation and maintenance. A NPDES permit was issued September 18, 2003, and a new plant will be constructed to handle the Canaan Elementary School flow and the high school flows in the summer of 2004.

COJV School District, aka Tolles Technical School (RM 2.68, Powell Ditch)
This vocational education school operates a 20,000 gpd capacity package WWTP that consistently meets its permit limits. The majority of the inspections revealed adequate operation and maintenance. The discharge is continuous as the school is operated year-round.

Canaan Elementary (RM 2.25, Yutzy Ditch)
This school operates an unpermitted 3,000 gpd capacity package WWTP. The sampling performed to complete the NPDES permit application indicates that the WWTP does not provide adequate treatment. The WWTP fails to perform even secondary treatment. Inspection of the plant indicated that maintenance provided was inadequate with respect to replacing worn and faulty equipment. No discharge occurs during the summer months of June to September when school is out of session. This school flow will be redirected to the high school's new wastewater plant in the summer of 2004.

Wisslohican Sanitary Sewer District (RM 45.00, Big Darby Creek)
This sewer district operates a 4,400 gpd package WWTP that consistently meets its permit limits. Recent inspections have revealed good operation and maintenance practices at the WWTP. Monitoring of sites immediately up and downstream of the outfall reveal little to no impact on Big Darby Creek (Figures B.1.28 to B.1.31).

Canaan Community Mobile Home Park (RM 1.40, Fitzgerald Ditch)
This mobile home park operates a 35,000 gpd capacity package WWTP that is in compliance with its NPDES permit the majority of the time. Inspections revealed that the WWTP will require replacement within 5 years due to deteriorating tankage and piping.

Olen Corporation (Big Darby Creek RM 43.60)
This sand and gravel quarrying operation was a batch discharger, discharging only at night from settling ponds. The discharge was limited to surface water run-off, recycled process-generated wastewater and non-process generated wastewater. Calculated flows indicated discharges from 0 gallons to 100,000 gallons per day. Olen ceased operations in 2003, eliminating the point source discharge. They have sold their property to the Franklin County Metro Park system to be incorporated into the Prairie Oaks Metropark.

Battelle Memorial Institute (RM 40.55, Big Darby Creek)
This facility operates a 20,000 gpd capacity package WWTP that has a continuous discharge of treated sewage (outfall 001) along with an intermittent discharge of up to 13,000 gpd of non-contact cooling water (outfalls 002 and 003). This facility consistently complies with its NPDES permit requirements and limits. Inspection reports indicated good operation and maintenance practices. The intermittent cooling water discharge is located within 200 feet of the continuous WWTP discharge point on the Big Darby Creek. Median flow from the 001 discharge has averaged between 20,000 and 30,000 gpd over the last 5 years of record (Figure B.1.32). Median loadings of ammonia, suspended solids, and $cBOD_5$ have shown slight decreases over the same time period (Figures B.1.33, B.1.34, and B.1.36). Median discharge from the 002 and 003 outfalls are approximately 2000 gpd and 5000 gpd, respectively (Figures B.1.35 and B.1.37).

Figure B.1.28. Dissolved Oxygen Concentrations upstream from the the Wisslohican Sewer District in Big Darby Creek during the period 1979-2000.

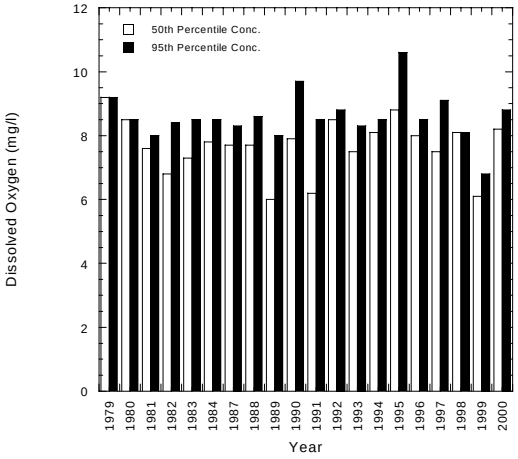


Figure B.1.29 Dissolved Oxygen Concentrations downstream from the the Wisslohican Sewer District in Big Darby Creek during the period 1979-2000.

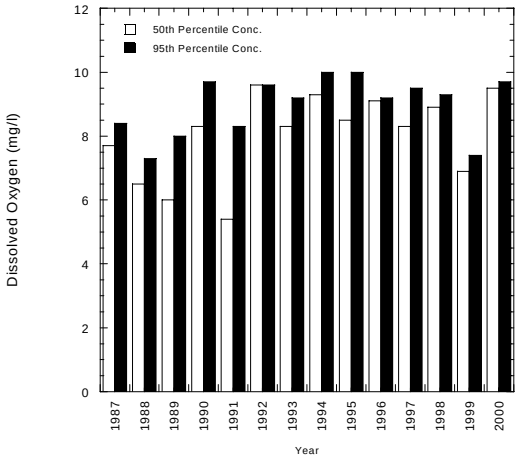


Figure B.1.30. Un-ionized Ammonia Concentrations upstream from the Wisslohican Sewer District in Big Darby Creek during the period 1979-2000.

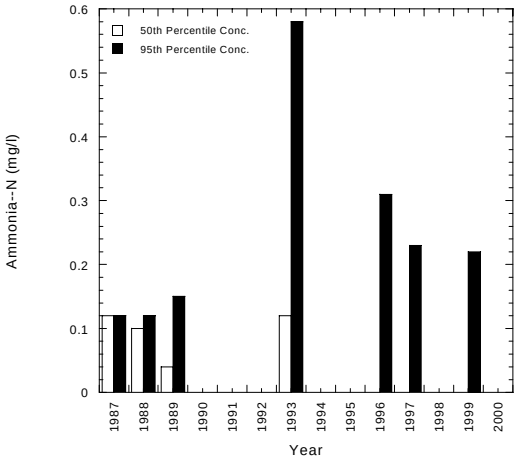


Figure B.1.31. Un-ionized Ammonia Concentrations downstream from the Wisslohican Sewer District in Big Darby Creek during the period 1979-2000.

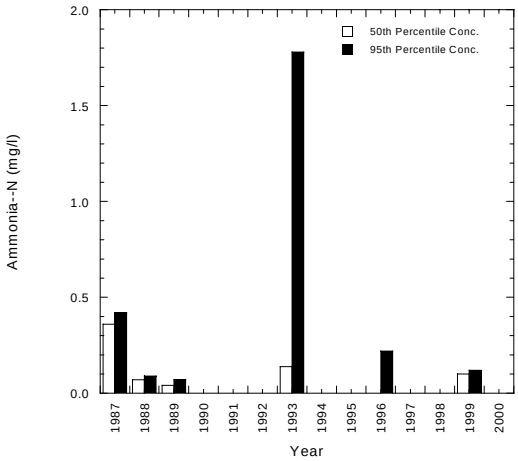


Figure B.1.32. Battelle Memorial Institute 001 50th and 90th Percentile Flow Contribution to Big Darby Creek during the period 1976 to 2000.

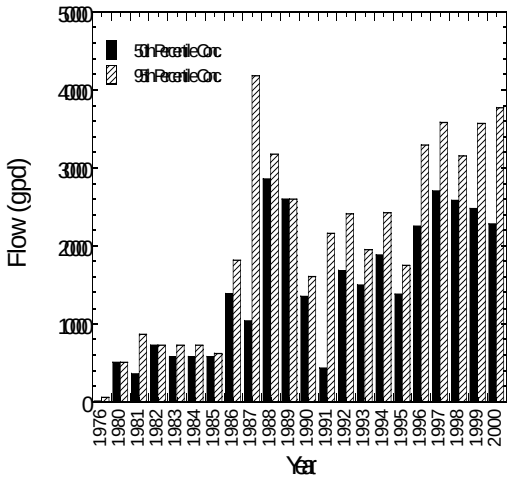


Figure B.1.33. Battelle Memorial Institute 50th and 90th Percentile Ammonia Loadings to Big Darby Creek during the period 1976 to 2000.

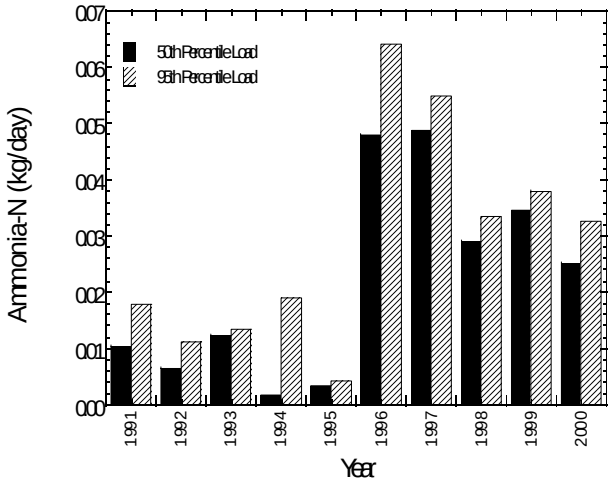


Figure B.1.34. Battelle Memorial Institute 50th and 90th Total Suspended Solids Loadings to Big Darby Creek during the period 1976 to 2000.

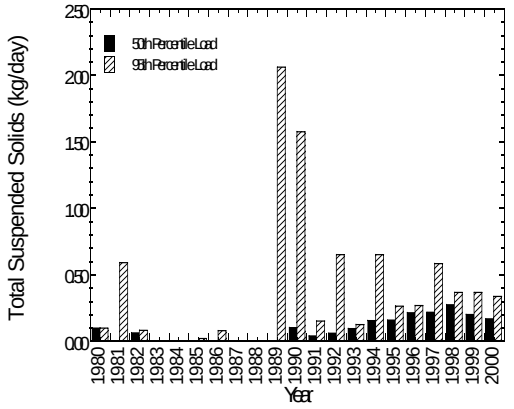


Figure B.1.35. Battelle Memorial Institute 002 Flow Contribution to Big Darby Creek during the period 1992 to 2000.

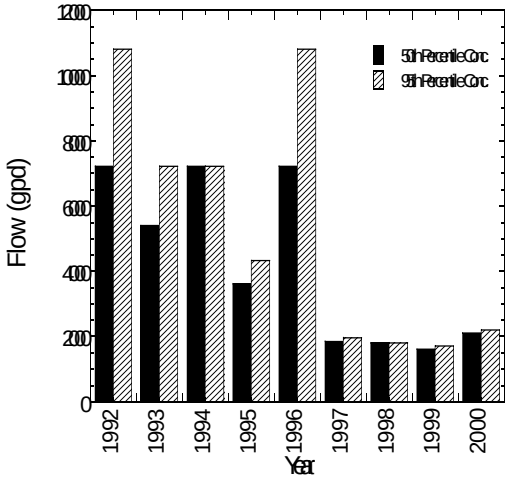


Figure B.1.36. Battelle Memorial Institute 50th and 90th Carbonaceous Biochemical Oxygen Demand Loadings to Big Darby Creek during the period 1976 to 2000.

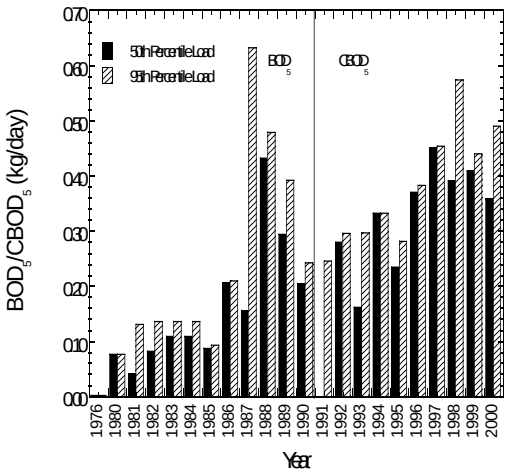
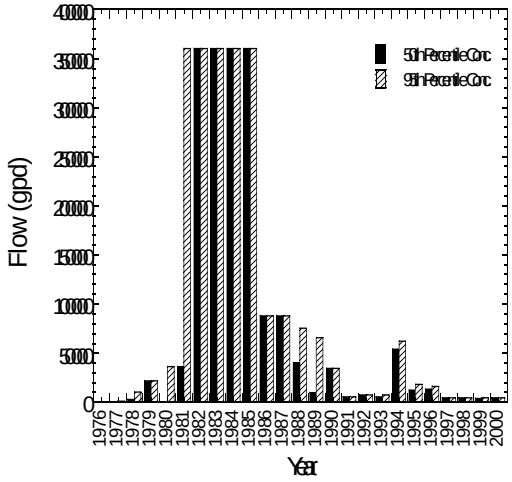


Figure B.1.37. Battelle Memorial Institute 003 Flow Contribution to Big Darby Creek during the period 1992 to 2000.



Lake Darby Estates WWTP (RM 40.00, Big Darby Creek)

American Water, Inc. operates a 500,000 gpd (0.50 MGD) WWTP for this subdivision. The plant consists of extended aeration tanks (rectangular tanks), rectangular clarifiers, a chlorine contact tank, and rapid sand filters. This WWTP consistently meets its permit limits in spite of the fact that significant inflow and infiltration plague the collection system during wet weather. Inspections revealed good operation and maintenance practices. Median loadings of suspended solids and ammonia have been low over the last 10 years (Figures B.1.38 and B.1.39). Fecal coliform concentrations also showed some variability within that time frame, including some elevated values indicating some problems with inflow/infiltration and/or disinfection (Figure B.1.40). Comparisons of instream conditions both up and downstream of the WWTP show no significant differences (Figures B.1.41 to B.1.48). Lake Darby Estates WWTP contributes just over 2.4% of the known point source wastewater flow to the Darby watershed. Loadings of $cBOD_5$, ammonia, and suspended solids are just over 5%, less than 1%, and 1.4%, respectively, of known point sources (Figures B.1.3, B.1.4, B.1.5, and B.1.6).

Greentree Mobile Home Park (RM 39.00, Big Darby Creek via ditch)

The Greentree Mobile Home Park operates a 16,000 gpd design package WWTP that consistently meets its NPDES permit limits. Inspections revealed marginal operation and maintenance practices.

Figure B.1.38. Lake Darby Estates 50th and 90th Percentile Loadings to Big Darby Creek of Total Suspended Solids for the period from 1981 to 2000.

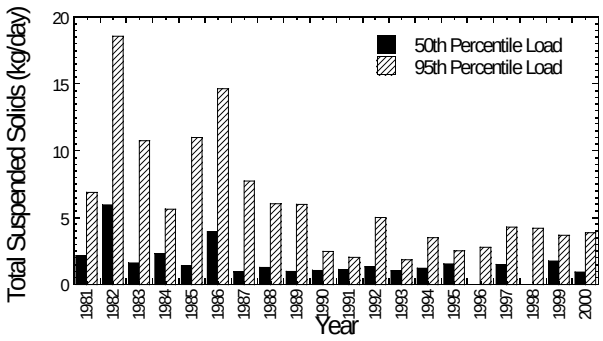


Figure B.1.39. Lake Darby Estates 50th and 90th Percentile Loadings to Big Darby Creek of Ammonia for the period from 1981 to 2000.

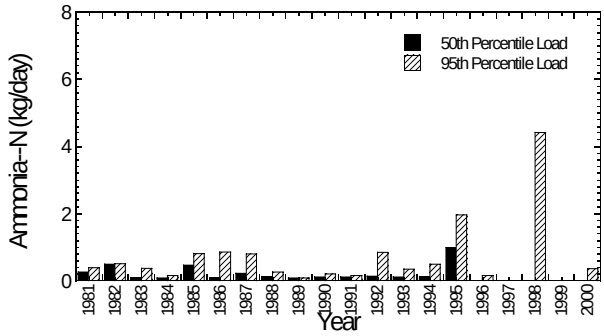


Figure B.1.40. Lake Darby Estates 50th and 90th Percentile Loadings to Big Darby Creek of Fecal coliform bacteria for the period from 1981 to 2000.

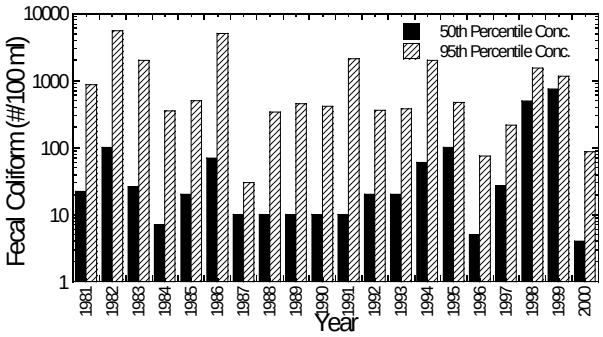


Figure B.1.41. 50th and 90th Percentile Concentrations of BOD5 and CBOD5 to Big Darby Creek upstream from the Lake Darby Estates WWTP, 1981-2000.

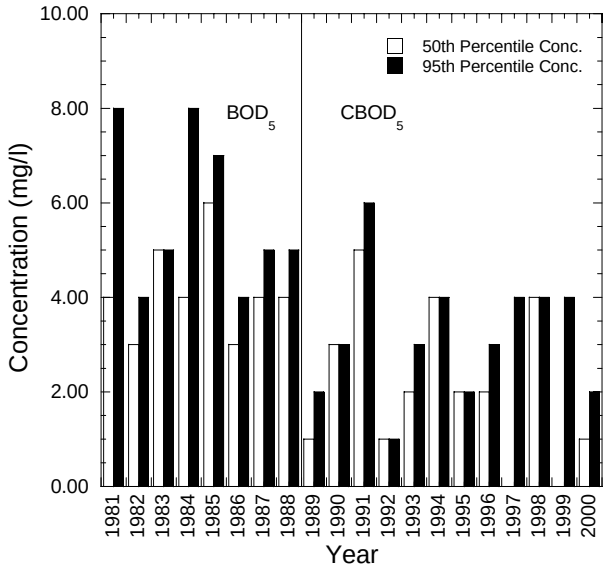


Figure B.1.42. 50th and 90th Percentile Concentrations of BOD5 and CBOD5 to Big Darby Creek downstream from the Lake Darby Estates WWTP, 1981-2000.

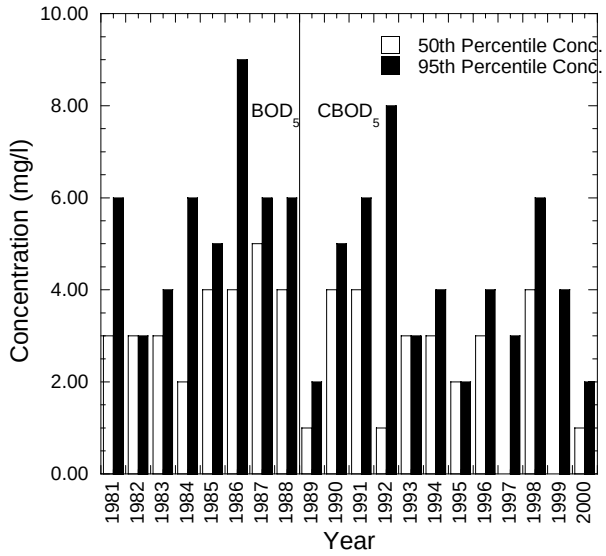


Figure B.1.43. 50th and 90th Percentile Concentrations of Dissolved Oxygen to Big Darby Creek upstream from the Lake Darby Estates WWTP, 1981-2000.

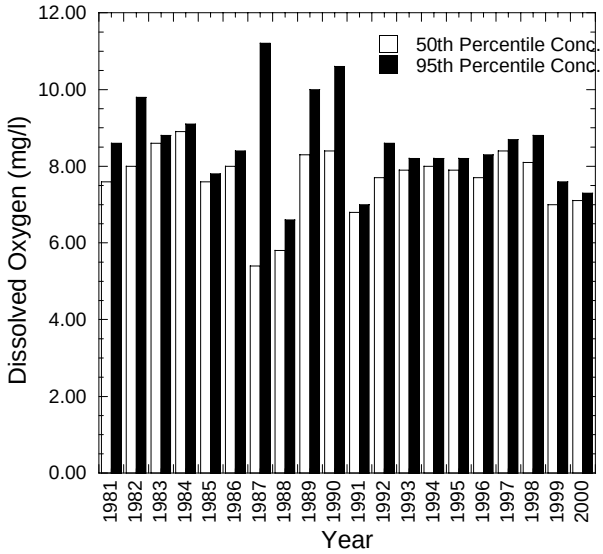


Figure B.1.44. 50th and 90th Percentile Concentrations of Dissolved Oxygen to Big Darby Creek downstream from the Lake Darby Estates WWTP, 1981-2000.

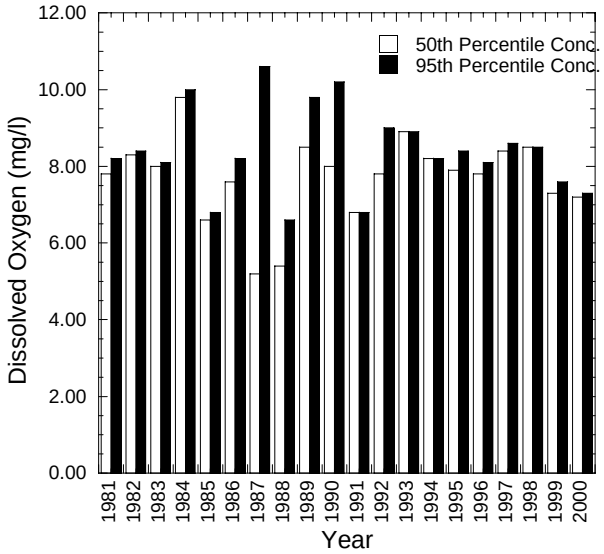


Figure B.1.45. 50th and 90th Percentile Concentrations of Fecal coliform bacteria to Big Darby Creek upstream from the Lake Darby Estates WWTP, 1981-2000.

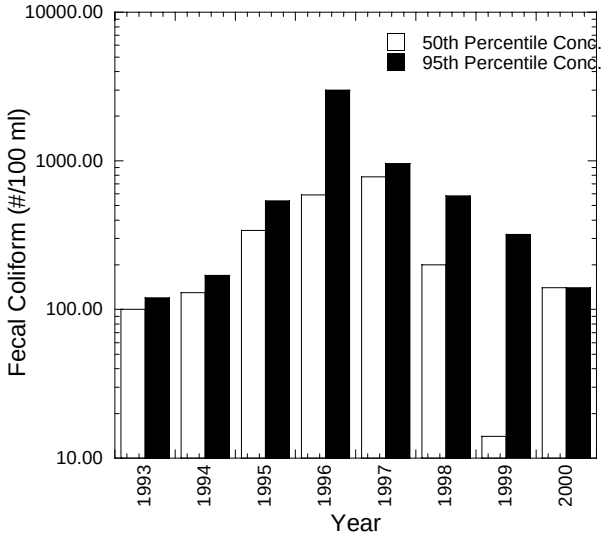


Figure B.1.46. 50th and 90th Percentile Concentrations of Fecal coliform bacteria to Big Darby Creek downstream from the Lake Darby Estates WWTP, 1981-2000.

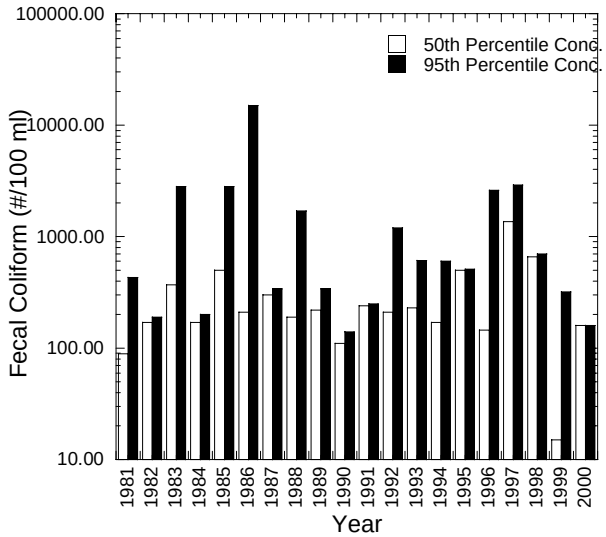


Figure B.1.47. 50th and 90th Percentile Concentrations of Ammonia to Big Darby Creek upstream from the Lake Darby Estates WWTP, 1981-2000.

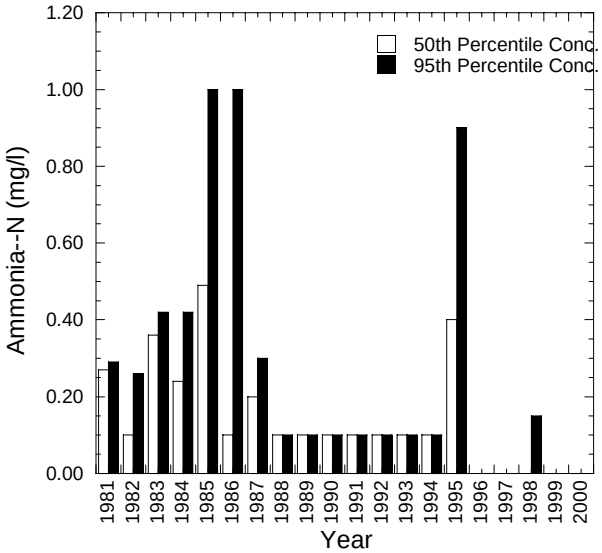
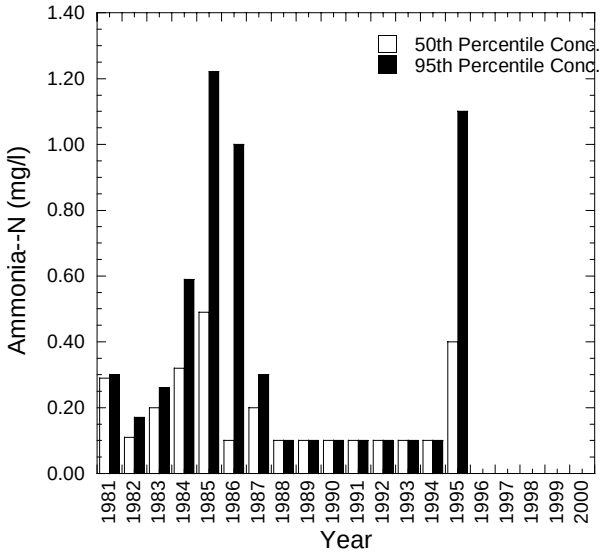


Figure B.1.48. 50th and 90th Percentile Concentrations of Ammonia to Big Darby Creek downstream from the Lake Darby Estates WWTP, 1981-2000.



Darby Dan Farms LLP (RM 36.70, Big Darby Creek)

Darby Dan Farms operates a 4,000 gpd capacity package WWTP which consistently violates its NPDES permit limits. The violations are caused by under-loading of the WWTP. Currently, the WWTP is undergoing modification to enable treatment of lower flows. Inspections revealed marginal operation and maintenance practices.

Mechanicsburg WWTP (RM 39.20, Little Darby Creek)

The Mechanicsburg WWTP is located in Champaign County at 18 N. Main Street in Mechanicsburg, Ohio. The facility was built in 1936, when wastewater treatment consisted solely of sand filters and chlorination, at a design flow of 0.16 MGD. Subsequent upgrades in 1971 and 1984 included the addition of aerated retention in treatment lagoons. A new Sequential Batch Reactor (SBR) treatment plant was constructed in 1990. The transition to a new treatment plant in 1990 included maintaining the original lagoon system for flow equalization during periods of peak flow. Land application of biosolids occurs at approved fields along State Route 4, approximately 0.3 mile east of the village. In 1980 the population served by the collection system was approximately 1,800. The service population is projected to be 2,780 by 2005.

The existing treatment train consists of a bar rack, comminutor with bar screen, SBR, chlorination and dechlorination with a SBR design capacity of 0.23 MGD and a hydraulic capacity of 0.72 MGD. Two lift stations are located at the intersection of Western Avenue and Railroad Street. The Railroad Street location was the original wastewater facility and the old bypass structure is currently sealed and inoperable. A private lift station serves the Tri County Jail. An additional connection of a two-inch force main was recently approved by Ohio EPA which will bring a church online in late 2002 adding an additional 300 gpd of sanitary sewage. Standby power is provided by portable generators for the treatment plant; however, incompatibility of the electrical connections at the lift stations leaves this area of the treatment system vulnerable to bypassing. A recent federal grant, matched by the Ohio Public Works Commission (OPWC), will provide funding for the Village of Mechanicsburg toward the construction of a new water storage tower. This tower will provide drinking water storage for the village and will be equipped with a generator providing backup power to the tower and to the wastewater lift stations in the event of a electrical power outage.

The 66 year old collection system consists of clay pipe with mortar joints. The collection system is totally separate from the storm water collection system with ninety-percent (90%) of the service area currently sewered. A USEPA grant in 1980 provided for an inflow and infiltration (I/I) evaluation of the collection system and treatment works. The investigation determined that the collection system was failing and there was inefficient solids removal at the wastewater treatment facility. Basement flooding and facility related bypassing historically occurred during storm events of 1.5 to 2 inches of rain. Consultants hired by the village recommended a Sewer System Evaluation Survey to identify specific locations of I/I problem areas. Based on those results, a 1982 Facility Planning Survey (FPS) recommended a complete sewer system rehabilitation along with the construction of additional oxidation ditches and the utilization of the existing lagoons for storm flow equalization. In 1988, a Consent Agreement was reached with Ohio EPA in response to numerous violations of the discharge limitations and monitoring

requirements of the Mechanicsburg discharge permit. The village agreed to eliminate discharges from overflows and bypasses from the sanitary sewer and to complete construction of the improvements to its WWTP by 1990. Indications are that bypass events continue to occur at manholes, influent pump stations, and at the treatment plant itself.

In 1994, the Village of Mechanicsburg filed for the Emergency Village Capital Improvement Special Account (EVCISA) for construction of the diversion station at the inlet works of the treatment plant whereby storm flow would be diverted to the lagoon at an estimated design of 0.23 mgd. In November of 1995 the village connected the equalization lagoons from the original plant to aid in equalizing flow in the influent chamber.

In July of 1998, Ohio EPA field personnel reported fish community impacts in Little Darby Creek downstream from the WWTPs discharge point. An Ohio EPA inspection in September of 2001 noted active discharge of raw sewage into Little Darby Creek at the Railroad Street lift station bypass. There is a limited amount of data on raw bypass quantities for this site; however, volumes of 450,000 gallons discharging to the Little Darby in July of 1992 and 100,000 gallons in June of 1995 are documented. Subsequent bypasses were reported in July of 1998 and October of 2000; however, these bypass events were not monitored so the total activity and associated quantities are unknown. This bypass location was permanently sealed on December 6, 2001. Field inspection sheets and observations by Ohio EPA water quality personnel also indicated a chronic loss of solids from the treatment plant as observed in the WWTP effluent and in Little Darby Creek downstream of the WWTP discharge pipe.

Annual peak flows consistently exceeded the design flow of 0.16 and 0.23 MGD throughout the period of record (since the 1970s) with peak flows approaching hydraulic design. Median percentile flows exceeded the original design of 0.16 MGD for the period of record and approached the increased design flow for the remainder of the record. This is indicative of the I/I problems that have plagued the collection system for many years. Loading percentile variance abruptly ended in 2001 when the majority of NPDES violations were reported, suggesting violations were correlated to operational controls as well as I/I influence.

Flow equalization completed in 1990 resulted in significant treatment improvements. Wastewater constituents (ammonia, suspended solids, $cBOD_5$) all declined notably following the inclusion of flow equalization, reacting inversely to flow behavior which graphically support reported events of frequent bypassing and substantial I/I problems. A steadily increasing trend in median discharge rate with the absence of new sewer extensions, substantiates the existence and impact of the archaic collection system.

Upstream and downstream (801 and 901) monitoring of the final outfall (001) is conducted by the city and reported quarterly to Ohio EPA. The upstream monitoring station (801) is located at the State Route 29 bridge north of Rosedale Road. The downstream monitoring station (901) is located at the Wing Road bridge. A pipe structure located under the bridge at Wing Road is described by the city as a storm sewer and is not configured to receive any effluent or influent for bypassing purposes.

Monitoring at stations 801 and 901 demonstrated that downstream concentrations of ammonia-N were commensurate with upstream values throughout the period of record. Fecal coliform values upstream clearly exceeded downstream concentrations from 1981-1987. Thereafter, approximately ten years of data for upstream concentrations was unreported.

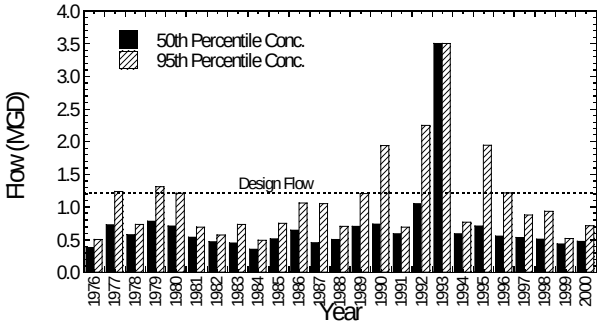
Fecal coliform violations accounted for nearly half of all NPDES violations documented from 1999 to 2002 with the majority of violations occurring in 2001. Between August of 1999 and January of 2002, a minimum of 47 NPDES permit violations were reported to Ohio EPA. All reported violations were typical constituents of treated domestic wastewater. The violations, in declining order of frequency, were: fecal coliform, TSS, pH, $cBOD_5$, ammonia-N and dissolved oxygen (D.O).

The Village of Mechanicsburg contributes approximately 1.4% of the total point source wastewater flow to the Darby watershed. Loadings of $cBOD_5$ and ammonia are 8.6% and 1.2% of the total respectively. Suspended solids comprised a negligible loading to the creek compared with other point sources.

Village of West Jefferson WWTP (RM 5.35, Little Darby Creek)

The Village of West Jefferson operates a 1.20 MGD WWTP which consists of two "race track" oxidation ditches followed by inter-channel clarifiers, a chlorine contact tank, and post aeration. Inspections of the WWTP revealed good operation and maintenance practices. However, the collection system for this facility is plagued by excessive inflow and infiltration causing excessive solids loss from the WWTP to the creek and loadings violations in the WWTP effluent during precipitation events. Historical flow data confirms the problems with I/I in the collection system (Figure B.1.49). The Village has been informed by Ohio EPA that construction of an equalization basin and a preliminary treatment system designed to handle the I/I problem, will be required as part of any permit-to-install applications submitted by the Village of West Jefferson. The Village initiated a NPDES permit renewal that contained a 12 month compliance schedule to construct an equalization basin and additional clarifiers to eliminate the solids loss due to their I/I problems. By September of 2004, West Jefferson will have completed construction. The Village of West Jefferson WWTP contributes just over 4% of the known point source wastewater flow to the Darby

Figure B.1.49. 50th and 90th Percentile Flows from the West Jefferson WWTP to Little Darby Creek, 1976 - 2000.



watershed along with over 21% of the $cBOD_5$, 11.8% of the suspended solids, and less than 1% of the ammonia loadings.

Triad Local School (RM ~ 7.00 Proctor Run [upstream of Brush Lake])
This WWTP is a typical package plant with a design capacity of 10,000 gpd. The discharge is to Proctor Run upstream of Brush Lake in the vicinity of RM 7.00. Brush Lake is located 6.6 river miles upstream of the Proctor Run confluence with Treacle Creek.

Monroe Elementary School (Spring Fork, unpermitted discharge)
The Jonathan Alder School District operates a 5000 gallon per day package wastewater treatment plant that is overloaded and inspections reveal that it does not appear to operate. Inspections reveal a history of marginal operation and maintenance. A NPDES permit was issued September 18, 2003, and a PTI was approved for the new plant. The wastewater treatment plant began operating in November 2003.

Green Meadows Mobile Home Park (RM 0.20, Spring Fork)
The Green Meadows Mobile Home Park operates an 81,000 gpd capacity package WWTP that meets its permit limits about half of the time. Inspections revealed marginal operation and maintenance practices. Effluent chemistry data indicated that there are 95th percentile loadings values of up to 2 kg/day of both $cBOD_5$ and TSS and fecal coliform median concentrations of nearly 1000 per 100 ml. These loadings are atypical of a facility this size and may be causing degradation to the stream. Ohio EPA personnel were not granted access to the stream by surrounding streamside landowners, so biological water quality data could not be obtained and the impact from this plant could not be evaluated.

Fisher Cast Steel (RM 14.00, Little Darby Creek via ditch)
Fisher Cast Steel operates a 1000 gpd intermittent discharge of non-contact cooling water. Recent inspections revealed good maintenance.

Jefferson Lodge Mobile Home Park (RM 9.00, Little Darby Creek)
This mobile home park operates a 40,000 gpd package WWTP that consistently meets NPDES permit limits. Inspections revealed marginal operation and maintenance practices.

Oakwood Acres Mobile Home Park (RM 8.00, Little Darby Creek via Unnamed Tributary)
This mobile home park owns a 10, 000 gpd capacity package WWTP that consistently violates its NPDES permit. Inspections have revealed problems with operation and maintenance practices with portions of the WWTP structure falling into the tributary. Ohio EPA is negotiating with the Village of West Jefferson to connect the MHP to its collection system following upgrades to the West Jefferson WWTP to allow for the abandonment of the malfunctioning Oakwood Acres WWTP.

B&B Motel (RM 7.00, Ditch to Little Darby Creek)
This motel operates a package WWTP (2,200 gpd design) that consistently violates its NPDES permit requirements and limits. Half of the inspections performed at this facility have revealed poor operation and maintenance practices. The discharge point is to an ephemeral ditch along U.S. Route 40 which flows into Little Darby Creek.

Oak Hills Mobile Home Park (RM 29.29, Big Darby Creek)
This mobile home park owns a 69,000 gpd capacity package WWTP that consistently violates its NPDES permit. Inspections revealed poor operation and maintenance practices as well as a severe inflow and infiltration problems. This WWTP receives as much as 5 times the design capacity during a precipitation event. Compliance sampling performed during dry conditions in August 2002 revealed that the plant was meeting NPDES permit limits for effluent quality. Ohio EPA plans to modify this NPDES permit by 2005 to require the abandonment of this WWTP and connection of the repaired collection system to the new Darbydale WWTP.

Darbydale Elementary (RM 29.00, Storm sewer discharge to Big Darby Creek)
The Darbydale Elementary School manages a 7,500 gpd capacity package WWTP that operates only while school is in session (9 months out of the year). The WWTP meets its NPDES permit limits about 2/3 of the time it is in operation. Inspections reveal good operation and maintenance practices. The NPDES permit will be modified by the year 2005 to require the school to abandon the WWTP and connect to the new Darbydale WWTP.

Pleasant Acres Mobile Home Park (Big Darby Creek via Unnamed Tributary at RM 1.00)
This mobile home park operates a 39,000 gpd design package WWTP that complies with NPDES permit limits the majority of the time. Inspections have revealed marginal operation and maintenance practices. Compliance sampling performed during dry conditions in August 2002 revealed that the plant was meeting NPDES permit limits for effluent quality. The NPDES permit will be modified by 2005 to require abandonment of this facility and connection of the collection system to the new Darbydale WWTP.

Community Gardens Mobile Home Park (RM 1.00, Unnamed Tributary to Big Darby Creek)
This mobile home park operates a 30,000 gpd capacity package WWTP that regularly discharges approximately half this amount. Inspections revealed virtually no attention given to proper operation and maintenance, causing regular non-compliance with its NPDES permit. Compliance sampling performed during dry conditions in August 2002 revealed that the plant was meeting NPDES permit limits for effluent quality. This entity will be connected to the proposed Darbydale WWTP by the year 2005. The new Darbydale plant will be built on the site of this WWTP and will discharge at the confluence of the unnamed tributaries which currently carry effluent from the Community Gardens MHP and the Pleasant Acres MHP.

Alton Campground Mobile Home Park (RM 0.50, Hamilton Ditch)
This campground operates a package WWTP (3,200 gpd design). This entity is typically in compliance with NPDES permit requirements and limits. Inspections have revealed proper operation and maintenance practices. The discharge flows to an ephemeral ditch along U.S. Route 40 that flows into Hamilton Ditch near the mouth.

Thornapple Country Club (RM 2.65, Clover Groff Ditch)
The Thornapple Country Club operates a 2,000 gpd capacity package WWTP that consistently meets NPDES permit limits. Inspections have revealed good operation and maintenance practices at this facility.

Cypress Wesleyan School (RM 1.30, Clover Groff Ditch)
Cypress Wesleyan School operates a 2,000 gpd capacity package WWTP. The WWTP often discharges approximately double this flow. Inspections indicated that virtually no maintenance is performed on the plant. The NPDES permit contains a compliance schedule which requires the school to connect to the City of Columbus sanitary sewer within 12 months and to abandon its WWTP.

Oakhurst Knolls (RM 5.80, Hellbranch Run)
Franklin County operates the 10,000 gpd capacity Oakhurst Knolls WWTP. The treatment train consists of an equalization tank split to an oxidation (orbal) ditch, two clarifiers, a rapid sand filter and a chlorine contact tank. The plant meets permit limits consistently during dry weather. Heavy precipitation (e.g., greater than 1 inch of rain) produces severe inflow and infiltration problems within the collection system. The WWTP can receive as much as 4 times the designed plant capacity during a precipitation event, causing a disruption to proper treatment. Flow and loadings information does not reveal much in the way of trends other than to confirm inspection results (Figures B.1.50, B.1.51, B.1.52, and B.1.53). Inspections have revealed good operation and maintenance practices at the WWTP.

Comparisons of up and downstream monitoring stations in Hellbranch Run reveal discharge of additional loadings of bacteria and ammonia to the stream from the WWTP (Figures B.1.54, B.1.55, B.1.56, and B.1.57). Instream dissolved oxygen concentrations seem unaffected by the discharge (Figures B.1.58 and B.1.59).

Figure B.1.50. 50th and 90th Percentile Flows from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

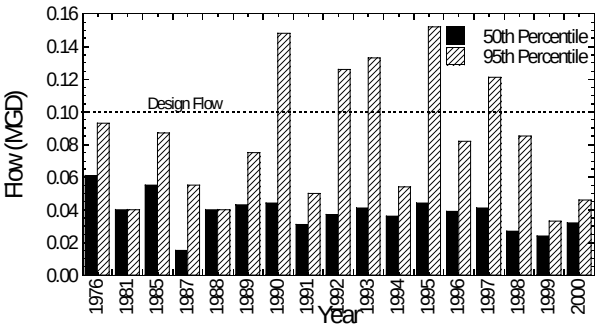


Figure B.1.51. 50th and 90th Percentile Total Suspended Solids Loadings from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

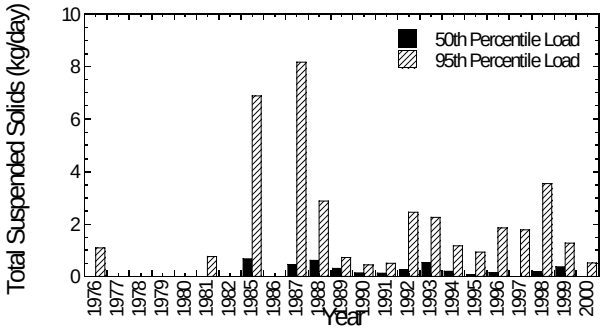


Figure B.1.52. 50th and 90th Percentile Ammonia Loadings from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

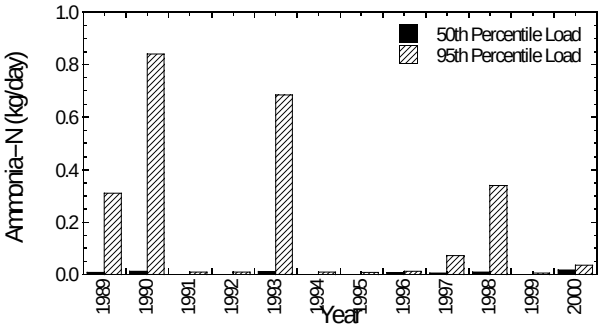


Figure B.1.53. 50th and 90th Percentile CBOD5 Loadings from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

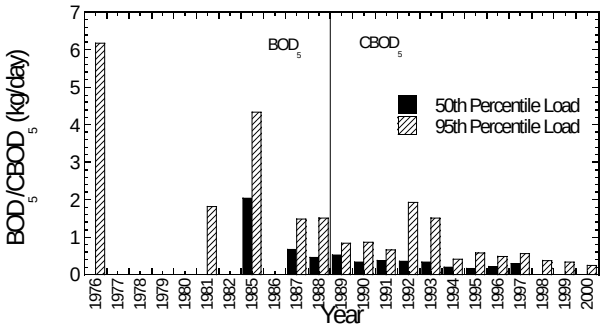


Figure B.1.54. 50th and 90th Percentile Concentrations of Fecal coliform bacteria upstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

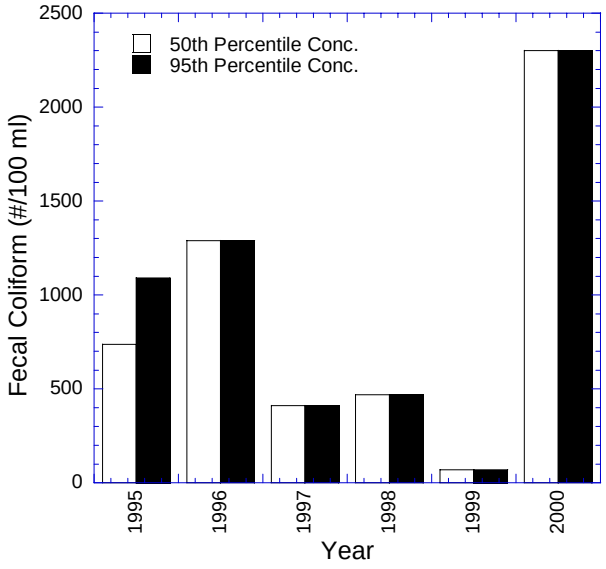


Figure B.1.55. 50th and 90th Percentile Concentrations of Fecal coliform bacteria downstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

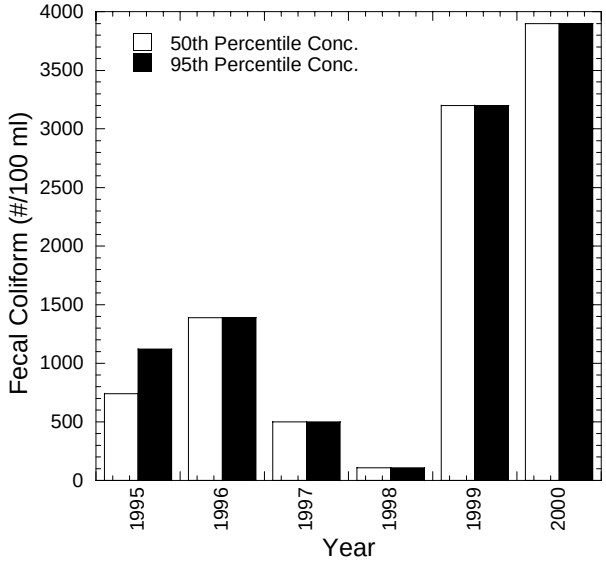


Figure B.1.56. 50th and 90th Percentile Concentrations of Ammonia upstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

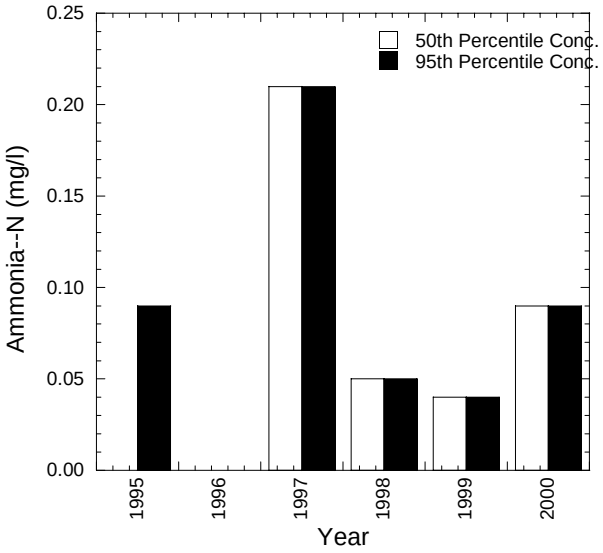


Figure B.1.57. 50th and 90th Percentile Concentrations of Ammonia downstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

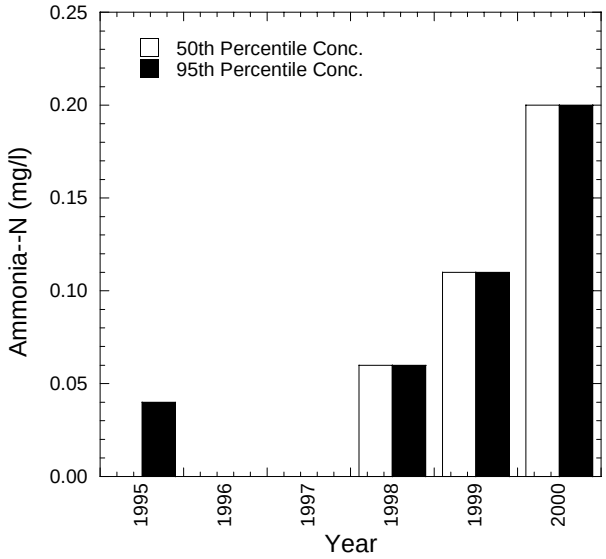


Figure B.1.58. 50th and 90th Percentile Concentrations of Dissolved Oxygen upstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.

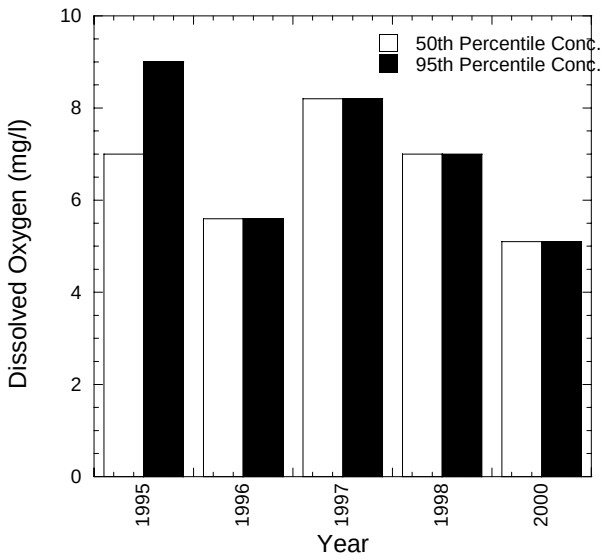
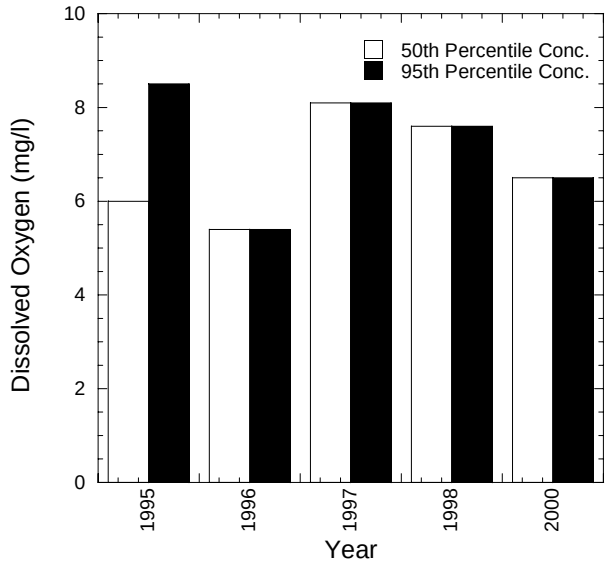


Figure B.1.59. 50th and 90th Percentile Concentrations of Dissolved Oxygen downstream from the Oakhurst Knolls WWTP to Hellbranch Run, 1976 - 2000.



Pleasantview School (RM 1.14, Hellbranch Run)

This school operates a 20,000 gpd capacity package WWTP plant that complies with NPDES permit limits most of the time. This facility only discharges while school is in session, generally about 9 months out of the year. Inspections revealed marginal operation and maintenance practices. Loadings from this outfall are not significant.

Timberlake Subdivision (RM 0.50, Hellbranch Run)

Lakeland Utilities operates the Timberlake subdivision 50,000 gpd package WWTP. This WWTP violates NPDES permit limits during rain events due to inflow and infiltration problems in the collection system. At times, large “blankets” of biosolids were evident in Hellbranch Run downstream of the outfall during stream sampling events by Ohio EPA. Inspections have revealed a number of problems, including inadequate maintenance funds and faulty and broken equipment. Due to the long history and severity of the violations, the Director of Ohio EPA issued orders to force Timberlake Subdivision to abandon the WWTP and connect to the Darbydale WWTP via force main by 2005.

Dot-Mar Mobile Home Park (RM 23.77, Big Darby Creek via ditch)

The Dot-Mar Mobile Home Park operates a 4,000 gpd capacity package WWTP. The WWTP is typically out of compliance with assigned NPDES permit requirements and limits. Inspections show a history of operations and maintenance problems. The NPDES permit for this entity will be modified by to require abandonment of the WWTP and connection to the force main supplying ODRC-Pickaway Correctional Institute WWTP.

ODRC - Pickaway County Correctional Institute (RM 22.92, Big Darby Creek)

The State of Ohio operates this 2.34 MGD capacity WWTP (expanded from 1.40 MGD in 2003). The treatment train consists of two "race track" oxidation ditches (extended aeration), two final clarifiers, and a chlorine contact tank. The expansion will allow this WWTP to become a regional facility eventually servicing the unsewered Village of Derby and forcing the abandonment of the following facilities: Clark's Lake Subdivision WWTP, Foxlair MHP WWTP, Vantage Point MHP WWTP, and Dot-Mar MHP WWTP following their connection to the expanded WWTP. This WWTP has future plans for expansion capped at 3.0 MGD due to antidegradation issues. Recent inspections revealed good operation and maintenance practices.

Beginning in 1988, ODRC-PCI WWTP began operating at or above its designed flow with regularity (Figure B.1.60). In the last 10 years, loadings of $cBOD_5$, and TSS peaked in 1998 and have declined since (Figures B.1.61 and B.1.62). NPDES permit limits for total suspended solids were typically violated during precipitation events (e.g., more than 2 inches of rain). Ammonia removal has also become more reliable and less variable (Figure B.1.63). Directors Final Findings and Orders were issued in March 2000, resulting in upgraded facilities which include a new sludge management plan and a contractor to haul the sludge, the addition of a new clarifier with a distribution splitter box, new aerators in the two oxidation ditches, a new flow meter and process improvements suggested by Ohio EPA. Upstream and downstream monitoring in Big Darby Creek indicated little recent impact to the stream from the WWTP. Previous instances of solids losses and poor treatment at this facility appear to have dissipated during the recent sampling. Whole effluent toxicity testing at the WWTP in October 2001 and May 2002 revealed no acute toxicity.

ODRC-PCI WWTP contributes 10.8% of the total, known point source wastewater flow to Big Darby Creek (Figure B.1.4) . Loadings of other pollutants are as follows: suspended solids 40.7%, $cBOD_5$ 14.1%, and 18.1% of the ammonia (Figures B.1.6, B.1.3, and B.1.5). With planned expansion of this facility and the elimination of several package plants and diversion of their sewage to PCI, loadings from the plant are expected to increase, but overall loadings to the watershed should decrease due to the elimination of package WWTPs with performance problems.

Foxlair Farms Mobile Home Park (RM 22.50, Big Darby Creek via ditch)

Foxlair Farms Mobile Home Park operates a 50,000 gpd design package WWTP that meets its NPDES permit limits about half of the time. Inspections indicated that marginal operation and maintenance has been performed. Compliance sampling performed during dry conditions in August 2002 revealed that the plant was not meeting NPDES permit limits for $CBOD_5$, ammonia, and suspended solids. The NPDES permit for this facility has been modified to require abandonment of this WWTP with connection of the collection system to the Pickaway

Figure B.1.60. 50th and 90th Percentile Discharge Flow from the Pickaway Correctional Institute WWTP, 1980 - 2000.

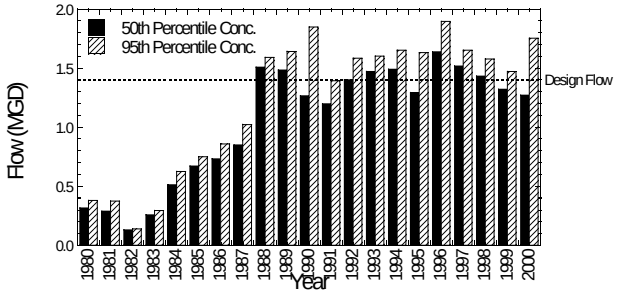


Figure B.1.61. 50th and 90th Percentile Loadings of BOD5 and CBOD5 from the Pickaway Correctional Institute WWTP, 1980 - 2000.

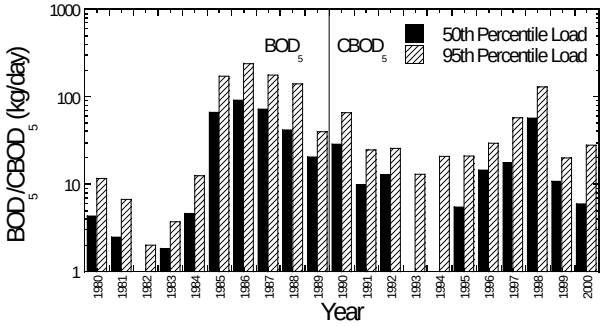


Figure B.1.62. 50th and 90th Percentile Loadings of Total Suspended Solids from the Pickaway Correctional Institute WWTP, 1980 - 2000.

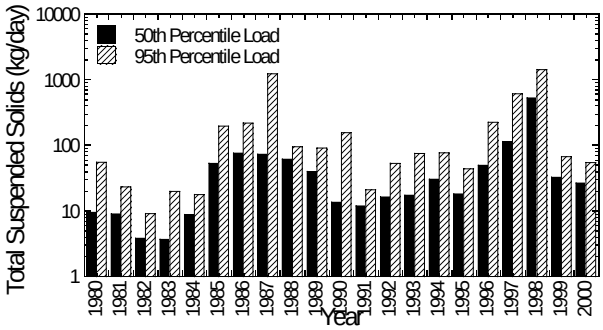
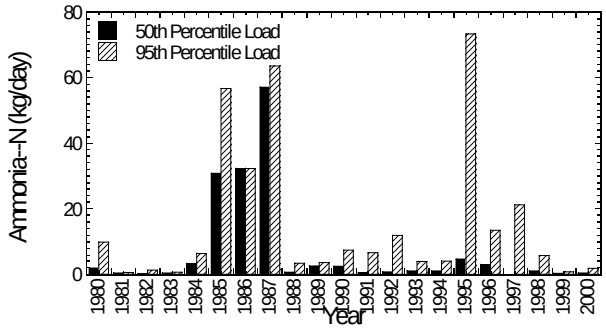


Figure B.1.63. 50th and 90th Percentile Loadings of Ammonia from the Pickaway Correctional Institute WWTP, 1980 - 2000.



County Board of Commissioners force main which supplies the ODRC Pickaway Correctional Institute WWTP.

Clark's Lake Subdivision (Big Darby Creek via Unnamed Tributary at RM 1.54 [aka Clarks Lake Tributary])

This subdivision operates a 100,000 gpd capacity, three lagoon, wastewater treatment system that consistently violates its NPDES permit limits. All of the inspections revealed poor operation and maintenance as well as excessive inflow and infiltration from the collection system. The sewage from this subdivision will be pumped to an expanded Ohio Department of Rehabilitation and Corrections (ODRC) Pickaway Correctional Institute wastewater treatment plant and the existing lagoons will be abandoned. Currently, this WWTP contributes just 0.9% of the known point source wastewater flow, under 1% of the ammonia loadings, over 16% of the $cBOD_5$, and 19.1% of the suspended solids loadings to the watershed (Figures B.1.4, B.1.5, B.1.3, and B.1.6).

B.2 Spills and Wild Animal Kills in the Big Darby Creek Watershed: 1979-2002

Lists of spills and wild animal kills can be useful to explain measured instream biological impacts that are not correlated with documented water chemistry problems or degraded instream habitat. However, as a recent report points out, the source of pollution causing many fish kills is never discovered and spills and fish kills are frequently not reported by the person or entity causing the problem. Therefore, many events go unnoticed for hours, days, or altogether, particularly if occurring during inclement weather (OEC, 2003).

A search of pollution investigation reports for the time period of 1979 to 2002 revealed 22 incidents where a total of 147,587 fish were killed within the basin (Table B.2.1). The two largest kills of 52, 134 and 36,767 animals resulted from spills of ammonia and liquid fertilizer, respectively. Both of these kills resulted from spills at an agribusiness in Mechanicsburg that drained into the Little Darby Creek in the middle 1980s. Half of the spills were directly attributable to agricultural sources which resulted in 96% (i.e., 142,748 fish) of the total body count. Virtually all of the counties in the watershed were represented (Figures B.2.1, B.2.5 and B.2.6). An additional twenty spills were reported that on-site investigations revealed no observable dead animals. Fertilizer was the most frequent reason for these investigations, followed by unknown causes.

Table B.2.1. Summary of fish kills reported in Water Pollution, Fish Kill, & Stream Litter Investigations 1979 - 2002, ODNR.

Date	County	Waterbody (RM)	# Killed	Suspected Pollutant	Operation
03/31/01	Pickaway	UT Greenbrier Cr.(@RM 1.2)	196	fertilizer	agriculture
02/01/01	Logan	UT to BDC (@ RM 72.56)	15	petroleum	petroleum
07/17/00	Union	Big Darby Cr.(RM 66)	>24,000	fermenting grain	feed mill
05/25/94	Franklin	Big Darby Cr. (RM>38.9)	304	"Natural"or low D.O.	hypolimn. H_20 or WWTP
07/21/93	Union	Sugar Run (RM 3.5)	1,884	Fertilizer by-products	Agribusiness
07/06/92	Union	Sugar Run	102	Milk	Dairy Farming
08/04/91	Union	Buck Run	402	"Natural"	"Natural"
08/19/90	Union	Big Darby Cr.@ 64.32 via UT	518	Unknown	Unknown
08/31/90	Franklin	Hellbranch Run	33	Sewage	Sewerage system
07/18/88	Madison	Spring Fork nr. mouth	54	sewage, algae	Unknown
12/17/87	Champaign	Little Darby Cr.(RM 39.6)	36,767	Liquid fertilizer	Agribusiness
08/31/87	Franklin	Hellbranch Run	33	sewage	Unknown
05/11/86	Madison	Bales Ditch	1,913	Unknown	Unknown
05/02/86	Union	Little Darby Creek	3,360	Herbicides	Gen. Farming
04/21/85	Mad./Un.	Little Darby Creek	743	Unknown	Unknown
08/11/84	Madison	Bales Ditch	794	Unknown	Unknown
07/09/84	Madison	Spring Fork	30	Unknown	Unknown
09/05/83	Champaign	Little Darby Cr.(RM 39.6)	52,134	Ammonia	Agribusiness
03/05/83	Pickaway	Greenbrier Creek	22,161	28% nitrogen feet.	Agriculture
07/23/82	Champaign	Little Darby Creek	222	Liquid fertilizer	Agribusiness
04/18/82	Union	Trib. Sugar Run	1,847	Cow manure	Animal husbandry
05/29/79	Madison	Trib. L. Darby Creek	75	Liquid fertilizer	Agribusiness

Figure B.2.1. Fish and Wildlife Kills documented in the Big Darby Creek Watershed by ODNR, 1983 -2003

A total of 31 fish kills were reported to ODNR between 1983-2003. Numbers of fish killed ranged between zero (unknown) to 52,134 fish. Specific location information was only available for 22 sites, which are mapped at right. The nine unmapped sites were located as follows: two along Big Darby Creek in Union County (1984 and 1990), three along Little Darby Creek (two in Madison County (1985 and 1987) and one in Union County (1986)), two along Sugar Run in Union County (1983 and 1984), one in Spring Fork in Madison County (1984), and one along a tributary to Big Darby Creek in Pickaway County (1983).

1983 - 1985, 5 of 11 mapped
1986 - 1989, 4 of 6 mapped
1990 - 1995, 4 of 5 mapped
1996 - 1999, all 5 mapped
2000 - 2001, all 4 mapped

A review was conducted of discharges and spills in the Big Darby Creek basin for the time period 1989 -2001 as reported by the Ohio EPA Division of Emergency and Remedial Response R.S.-2000 database and the Ohio Department of Natural Resources (ODNR) Division of Wildlife Pollution Investigation Reports. Results of that review are presented in Tables B.2.2 and B.2.3.

Table B.2.2. Summary of fish kills reported with no kills discovered, as listed in "Water Pollution, Fish Kill & Stream Litter Investigations 1979 -1990, ODNR"[a].

Date	County	Waterbody	Suspected Pollutant	Operation
04/12/02	Champaign	Big Darby Creek	Diesel fuel	Transportation
04/05/01	Pickaway	Greenbrier Creek	grain waste	Agribusiness
09/19/00	Champaign	Big Darby Trib	Manure	Unknown
11/09/98	Pickaway	Big Darby Creek	Sewage	WWTP
08/14/98	Pickaway	Greenbrier Creek	Sewage	Unknown
02/02/98	Pickaway	UT B. Darby Creek	Hog manure	Pig farm
11/07/97	Champaign	UT L. Darby Creek	Manure, milk house waste	Dairy farm
06/22/97	Madison	Else Ditch	milk	Dairy Farm
04/11/96	Madison	Big Darby Creek	Silt	Quarry
06/23/89	Union	Big Darby Creek	Septic tank wastes	Other
04/29/89	Franklin	Big Darby Creek	Diesel fuel	Trucking
03/05/86	Madison	Trib. L. Darby Creek	Gasoline	Oil & Gas Retailing
08/15/85	Champaign	Little Darby Creek	Cattle manure	Dairy Farming
05/11/84	Union	Sugar Run	Hog manure	Animal husbandry
04/03/84	Union	Big Darby Creek	Gasoline	Oil & Gas retailing
09/14/83	Pickaway	Trib. L. Darby Creek	Hog manure	Animal husbandry
01/28/83	Union	Sugar Run	Cattle manure	Animal husbandry
04/02/82	Pickaway	Trib. B. Darby Creek	Hog manure	Animal husbandry
03/26/82	Champaign	Little Darby Creek	Cattle manure	Dairy Farming
07/28/81	Pickaway	Trib. B. Darby Creek	Hog manure	General Farming

a Results from 1991 and 1992 not available at time of compilation.

Table B.2.3. Spills documented in the Big Darby Creek Watershed from the Ohio EPA Division of Emergency and Remedial Response R.S. - 2000 database, 1989-2002. (Spills arranged in reverse chronological order by county starting from the headwaters).

Date	County	Waterbody and RM (if known)	Suspected Pollutant	Amount Spilled	Operation
01/31/02	Logan	BDC trib.	Hydraulic fluid	Unknown	Transportation
02/22/01	Logan	BDC trib.	Fuel Oil	267 gal.	Fuel vendor
08/04/98	Logan	Flat Branch trib.(0.6) to Flat Branch @0.23 to BDC @78.48	Waste/Fertilizer	Unknown	Transportation/Agni.
04/12/02	Champ.	Big Darby Creek	Diesel fuel	25 gal.	Transportation
09/19/00	Champ.	Big Darby trib.	Manure	Unknown	Unknown
11/07/97	Champ.	LDC @ 36.85 via LDC trib(1.2)	Manure, milk waste	Unknown	Dairy farm
06/10/94	Champ.	Little Darby Creek (39.6)	Unknown	Unknown	Transportation
04/05/91	Champ.	Little Darby Creek (39.6)	Unknown	Unknown	Transportation
01/03/01	Union	BDC	Diesel Fuel	300 gal	Industry
07/26/00	Union	Trib BDC	Unknown	Unknown	Transportation
07/22/00	Union	BDC (66)	farm grain/molasses	>24,000 gal	Feed mill, agribusiness
09/30/99	Union	Flat Branch	Hydraulic Oil	7.0 gal.	Industry
07/20/99	Union	BDC	Black material	Unknown	WWTP
05/19/99	Union	BDC	Liquid N fertilizer	1000 gal	Transportation
02/26/99	Union	BDC	Wastewater	Unknown	Wastewater
11/01/98	Union	BDC (52.4 from Union to Mad. Co.)	Sewer overflows	Unknown	Plain City WWTP
07/24/98	Union	BDC (63.7)	Tanks	2.0 IT	Tank storage
07/02/98	Union	BDC (63.8)	Unknown	Unknown	Conservation club
07/22/97	Union	Robinson Run (0.4) to BDC@ 53.69	Unknown	Unknown	Residential/Agni.?
06/06/97	Union	BDC (66.5) (Milford Center)	Raw Sewage	194,000 gal.	Marysville pump station
03/19/97	Union	Buck Run@ 7.15 via Buck R trib.(2.5)	Unknown cargo	Unknown	Transportation
02/08/96	Union	Flat Br.@ 2.21 via Flat Br trib.(1.0)	Public Water 001	Unknown	Auto plant water treatment
08/06/95	Union	Flat Br.@~RM 2 via Flat Br. trib.	Unknown	Unknown	Auto production plant
07/21/93	Union	Sugar Run (3.5)	Fertilizer by-prod.	Unknown	Agribusiness
04/12/91	Union	BDC (60) Middleburg-Pln. City Rd	Unknown	Unknown	Resident./Agriculture?
01/22/91	Union	BDC basin (Darby Township)	Unknown	Unknown	St. Rt. 38
08/19/90	Union	BDC via BDC trib. @ 64.32 (0.1)	Unknown	Unknown	Unknown resident
08/03/90	Union	Sugar Run@4.26 via Sugar R trib(0.7)	Unknown	Unknown	Resident./Agriculture?
07/23/90	Union	Sugar Run (8.3)	Unknown	Unknown	Construction company
05/31/90	Union	Sugar Run@2.98 via Sugar R trib(3.2)	Landfill contents	Unknown	Private landfill
04/30/90	Union	Sugar Run (5.4)	Fertilizer products	Unknown	Agni. fertilizer company
04/10/90	Union	BDC (54) Plain City	Chem./metals/waste	Unknown	Thermostat control co.
02/13/90	Union	BDC (54) Plain City	Chem./metals/waste	Unknown	Thermostat control co.
07/07/89	Union	BDC basin (Darby Township)	Unknown	Unknown	Unknown
06/23/89	Union	BDC ($\leq$63 to $\geq$55) Darby Twp.	Septic tank waste	Unknown	Septic pump/transport
04/10/89	Union	BDC via tile (53.4)	Oil products	Unknown	Service station
02/10/89	Union	BDC @ 63.74 via Buck Run (0.1)	wastewater	Unknown	High School STP
11/30/01	Mad.	BDC trib.	Gas		Transportation

Continued.

Table B.2.3. Continued.

Date	County	Waterbody and RM (if known)	Suspected Pollutant	Amount Spilled	Operation
02/04/01	Mad.	Sweeney Run to BDC @ 52.11	Oil	4.0 gal.	Utility
09/29/98	Mad.	Little Darby Creek (6.4) W. Jeff.	fluids	Unknown	Auto repair shop
09/04/98	Mad.	Little Darby Creek (20.5)	Asphalt	Unknown	Paving company
06/29/98	Mad.	Smith Ditch (5.8)	Unknown.	Unknown	Resident/farm
05/19/98	Mad.	BDC @ 49.45 via Bellinger D. (1.1)	Unknown	Unknown	Resident/agriculture?
04/15/98	Mad.	BDC @ 49.45 via Bellinger D. (1.1)	Unknown	Unknown	Resident/agriculture?
09/16/97	Mad.	BDC@50.92 via Sugar R.&trib@0.2 (0.2)	Unknown	Unknown	LP Gas facility
08/28/97	Mad.	BDC (51.1)	Hydraulic oil	2.0 gal.	Transportation
06/30/97	Mad.	BDC (43.7)	Resident/agri.prod.	Unknown	Residential/farm?
06/22/97	Mad.	Else D. to Sweeney Run (0.3)	milk	Unknown	Dairy operation
06/09/97	Mad.	LDC@12 via Monroe Bidwell D. (0.3) to LDC trib.@1.05	Resident/agri.prod.	Unknown	Residential/farm?
06/02/97	Mad.	BDC@50.92 via Sugar R.&trib@0.2 (0.2)	Unknown	Unknown	LP Gas facility
06/02/97	Mad.	BDC (40.5)	Wastewater	Unknown	Research facility
12/23/96	Mad.	BDC	Asphalt	3 cyd.	Transportation
10/21/96	Mad.	Sugar Run (0.5)	Unknown	Unknown	Unknown
04/10/96	Mad.	BDC @52.11 via Sweeney Run(0.7)	Unknown	Unknown	Transportation
02/21/96	Mad.	Little Darby Creek (6.4)	Unknown	Unknown	Transportation
02/02/96	Mad.	BDC trib.	Fluorescein dye	500 gal.	Municipality
10/14/95	Mad.	BDC trib.	Diesel Fuel	70 gal.	Transportation
08/24/95	Mad.	BDC via BDC trib@ 43.14 (0.7)	Auto fluids	Unknown	Junk/Wrecking yard
04/04/95	Mad.	BDC@52.11via sewer&Sweeney R.(0.7)	Unknown	Unknown	Unknown
02/04/95	Mad.	BDC @41.84 via Hedrick D. (1.1)	Unknown	Unknown	Transportation
03/31/94	Mad.	BDC	Used oil	Unknown	Unknown drums
07/26/93	Mad.	BDC via BDC trib. @ 41.5 (0.3)	Oil	Unknown	Private residence
02/08/93	Mad.	BDC@41.84 via Hedrick D.(0.6)	Fuel/fluids	Unknown	Boat transport
08/26/92	Mad.	BDC via BDC trib@ 43.14 (0.7)	Auto fluids	Unknown	Junk/Wrecking yard
01/16/92	Mad.	BDC @52.11 via Sweeney Run(0.3)	Drink. H2O by-prod.	Unknown	Plain City Water Plant
06/12/91	Mad.	L. Darby Cr. (6.4) via sewer (W. Jeff)	Unknown	Unknown	Business
05/21/91	Mad.	Smith Ditch (5.0) adj. Lilly Chapel	Residential Chem./oil	Unknown	Private residence
05/20/91	Mad.	BDC@50.62 via Worthington D.(0.2)	Unknown	Unknown	Transport. Or agni?
03/17/91	Mad.	BDC via sewer (52.4) Plain City	Unknown	Unknown	Resident/business?
03/13/91	Mad.	BDC via sewer (52.4) Plain City	Unknown	Unknown	Resident/business?
01/12/91	Mad.	BDC@52.11via sewer/Sweeney R(0.7)	Oil products	Unknown	Oil company
12/03/90	Mad.	LDC@10.33 via LDC trib. (0.4)	Unknown	Unknown	Transportation
10/09/90	Mad.	BDC @41.84 via Hedrick D. (1.1)	Unknown	Unknown	Transportation
04/05/90	Mad.	BDC@42.08 via Bridenstine D. (2.2)	Residential/Agni.	Unknown	Resident/Farm
04/04/90	Mad.	LDC@14.65 via LDC trib. (0.7)	Unknown	Unknown	Transportation
12/06/89	Mad.	BDC via sewer (52.4) Plain City	Unknown	Unknown	Transportation
06/22/89	Mad.	BDC (Plain City)	Oil products	Unknown	Oil distribution
06/14/89	Mad.	Little Darby Creek (West Jeff.)	Unknown	Unknown	Transportation
06/11/89	Mad.	BDC (52.1) Plain City	Waste/solids	Unknown	Plain City WWTP
05/23/89	Mad.	Little Darby Cr. (6.5) via ditch/sewer	Fuel	Unknown	Gas Station (W. Jeff.)

Continued.

Table B.2.3. Continued.

Date	County	Waterbody and RM (if known)	Suspected Pollutant	Amount Spilled	Operation
05/01/89	Mad.	L. Darby Cr. basin (Monroe Twp)	Unknown	Unknown	Unknown
04/25/89	Mad.	Little Darby Creek (38.3-37.3)	Agri.products/chem.	Unknown	Agriculture
04/19/89	Mad.	L. Darby Cr. via trib. @14.65 (Deer Cr./Jefferson Twp. line)	Unknown	Unknown	Transportation
02/22/89	Mad.	L. Darby Cr. basin (Jefferson Twp)	Unknown	Unknown	Transportation
08/19/02	Frank.	BDC trib.	Unknown	Unknown	Unknown
07/16/01	Frank.	BDC	Quarry material	Unknown	Quarry
08/07/00	Frank.	BDC trib.	Diesel Fuel	35 gal.	Transportation
05/07/0	Frank.	Big Darby Creek	Sewage	Unknown	WWTP
06/15/99	Frank.	BDC trib.	Diesel Fuel	20 gal.	Transportation
10/13/98	Frank.	Little Darby Creek (1.0) via trib.	Unknown	Unknown	Resident/Agni.?
08/11/98	Frank.	BDC (25.2) at SR 62 bridge	Unknown	Unknown	Prison, Transportation
05/15/98	Frank.	BDC trib. @ 38.9 (0.6)	Termiticide	2.0 gal.	Extermination service
03/07/98	Frank.	Big Darby Creek	Unknown	Unknown	Unknown drums
07/24/97	Frank.	Big Darby Cr. via sewer (29.2)	liquid	Unknown	Mini grocer/gas station
06/09/97	Frank.	Hellbranch Run (0.9)	Resident chem./oil	Unknown	Private residence
12/03/96	Frank.	BDC trib.	Hydraulic oil	50 gal.	Transportation
10/18/96	Frank.	Big Darby Creek (29.2)	Sewage	Unknown	Mobile home park
05/01/96	Frank.	Big Darby Creek via ditch	Diesel fuel	200 gal.	Transportation fac.
01/17/96	Frank.	Clover Groff D.(0.2) via road ditch	Resident chem./oil	Unknown	Private residence
08/11/95	Frank.	Little Darby Cr.@0.2 via trib.(0.2)	Paving products	Unknown	Paving company
08/08/95	Frank.	Clover Groff D. (0.2) via drain/ditch	Resident chem./oil	Unknown	Private residence
04/28/95	Frank.	Clover Groff Ditch (7.1)	Unknown	Unknown	Residential or nursery
04/09/95	Frank.	Hellbranch Run@7.56 via trib.(0.3)	Resident chem./oil	Unknown	Private residence
11/30/94	Frank.	Hellbranch Run (10.3)	Resident chem./oil	Unknown	Private residence
08/29/94	Frank.	BDC trib.@ 27.93 (2.1) to BDC	Resident chem./oil	Unknown	Private residence
07/07/94	Frank.	Clover Groff Ditch (3.6)	Resident chem./oil	Unknown	Suburban residential
07/19/93	Frank.	Hellbranch R.@8.1via ditch/sewer	Unknown	Unknown	Unknown, Transport.
05/07/93	Frank.	Big Darby Creek (30.2)	Chem./waste	Unknown	Mobile home park
07/29/92	Frank.	BDC trib. @ 40.2 (0.4)	Resident.waste/chem.	Unknown	Plumbing co.@ residence
04/21/92	Frank.	Hellbranch Run (10.1)	Resident chem./oil	Unknown	Private residence
09/12/91	Frank.	Big Darby Creek(29.2) Darbydale	Chem./waste	Unknown	Mobile home park
07/21/90	Frank.	BDC @ 25.21 via BDC trib. (1.3)	Fuel storage spill	Unknown	Service Station
06/27/90	Frank.	Hellbranch R.@8.1via ditch/sewer	Unknown	Unknown	Unknown, Transport.
04/02/90	Frank.	Big Darby Creek (30.2) SR 665	Unknown	Unknown	Unknown
03/09/90	Frank.	Clover Groff Ditch (2.9)	Unknown cargo	Unknown	Transportation
11/13/89	Frank.	Hellbranch Run (7.6)	Resident chem./oil	Unknown	Private residence
04/29/89	Frank.	Big Darby Creek (29.2) Darbydale	Diesel fuel	Unknown	Transportation
08/17/99	Pick.	BDC trib.	Blue material	Unknown	Natural phenomenon
			Copper sulfate	Unknown	
			Low D.O.	Unknown	
10/20/98	Pick.	BDC (22.9)	Waste/solids	Unknown	Prison
08/31/98	Pick.	BDC (22.9)	Sludge	100 gal.	Prison

Continued.

Table B.2.3. Continued.

Date	County	Waterbody and RM (if known)	Suspected Pollutant	Amount Spilled	Operation
07/24/98	Pick.	BDC via drainage tile (22.9)	waste	Unknown	Prison
02/27/97	Pick.	Greenbrier Cr. via storm sewer	Residential/Agni.	Unknown	Residential/Farm
12/12/95	Pick.	BDC via ditch	Diesel Fuel	175 gal.	Transportation
09/08/95	Pick.	BDC trib. to BDC (22.9)	Used oil	32 gal.	Prison
03/29/95	Pick.	BDC from sewer (22.9) Orient	Unknown	Unknown	Prison
08/08/92	Pick.	BDC (8.5)	Manure	Unknown	Agriculture
08/02/92	Pic.	BDC (10.8)	Emuls. Asphalt	Unknown	Spray operations
02/11/92	Pick.	Springwater Run (2.4) to BDC@ 25.30	Oils	Unknown	Transportation
12/21/89	Pick.	Big Darby Cr. (24.4) via sewer	Resident chem./oil	Unknown	Municipal residence

A total of 129 spills were recorded during the 1989 through 2002 time frame with one third of that total since 1995. Unfortunately, it was not possible to determine the quantity of materials spilled in the majority of the incidents. However, in the cases where the quantity was estimated the total amounted to 220,789 gallons. Most of the incidents reported were for spills amounts of 300 gallons or less of material. Petrochemicals, particularly diesel fuel, were the most commonly reported spilled materials accounting for 1187 gallons. One spill of ammonia released approximately 1000 gallons of material. However, the largest spill was 194,000 gallons of sewage which came from the village of Milford Center in 1997. This small, previously unsewered village has now been sewered and tied into the Marysville WWTP.

The second largest release of material in the watershed also emanated from Milford Center. A mixture of fermenting grain and molasses (~24,000 gal) was pumped from the basement of a custom-blend feed mill into Big Darby Creek via a storm drain. This decaying material stripped the dissolved oxygen out of the water for several miles downstream for approximately one week, killing an estimated 24,000 fish and other aquatic organisms (Figure B.2.2). This is probably a conservative estimate of the damage associated with this spill because the spill was not reported until four days after the initial pumping. Some of the organisms killed during the early pumping likely would have washed downstream uncounted. Additionally, the stream segment impacted was host to a diverse and abundant community of bivalve molluscs including at least one Ohio Species of Special Concern, the wavy-rayed lampmussel *(Lampsilis fasciola)*.

Figure B.2.2. Fish kill in Big Darby Creek downstream from Milford Center, July 17, 2000.

Since bivalve molluscs burrow into the stream bed not all of the dead would have been counted. Additionally the juveniles are difficult to detect. However, Ohio State Museum of Biological Diversity staff were allowed to salvage dead mussel shells from the spill zone during and after the low dissolved oxygen period (Tetzloff, 2001). Surviving mussels were noted and survival estimates were made (Table B.2.4).

Table B.2.4. Estimated survival rates for various unionid species following a low oxygen event from a spill in Milford Center into Big Darby Creek, Union County, Ohio, 7/19/2000.

Common Name	Scientific Name	Abundance at Spill Site	Est. survival after 3 weeks
paper pondshell	Utterbackia imbecillis	uncommon	15 percent
giant floater	Pyganodon grandis	fairly common	70-80 percent
cylindrical papershell	Anodontoides ferussacianus	rare*	50 percent
squawfoot	Strophitus undulatus	common	50 percent
slippershell	Alasmidonta viridis	rare*	none observed
elktoe	Alasmidonta marginata	rare*	50 percent
fluted shell	Lasmigona costata	common	90 percent
creek heelsplitter	Lasmigona compressa	uncommon	80 percent
threeridge	Amblema plicata	very common	near 100 percent
Wabash pigtoe	Fusconaia flava	fairly common	100 percent
spike	Elliptio dilatata	abundant	50 percent
kidneyshell	Ptychobranchus fasciolaris	abundant	less than 5
fragile papershell	Leptodea fragilis	rare*	12.5 percent
rainbow	Villosa iris	common	50 percent
fat mucket	Lampsilis radiata luteola	abundant	33 percent
plain pocketbook	Lampsilis ventricosa	common	30 percent
wavy-rayed lampmussel	Lampsilis fasciola	very common	5 percent

*sample less than 10 individuals

Pool species and adult specimens survived better than riffle species with juveniles particularly affected (Tetzloff, 2001). This pattern of species - selective kills may explain why this reach of Big Darby Creek does not support some of the more rare and sensitive unionids living elsewhere in the Darby watershed (e.g., the northern riffleshell, *Epioblasma rangiana*, snuffbox, *E. triquetra*, and rabbitsfoot, *Quadrula cylindrica*) (Appendix C.3). It may be several years before the full impact of this spill can be determined.

Additional evidence of the long term impact associated with this spill is the lag in repopulation of this segment by fish. Although a systematic survey of this segment has not been conducted since the spill, fish tissue sampling was conducted upstream from Buck Run in 2002. At that time the sampling crew noted that it was very difficult to secure the target species particularly in the larger size ranges desired. Additionally, it was noted that non-target species were much

smaller than had previously been encountered at that location during previous pre-spill sampling events. This segment should be subject to follow-up sampling to determine the rate and success of re-population.

Figure B.2.3. Efforts by volunteers to re-oxygenate water in Big Darby Creek to reduce impact from a spill in Milford Center, 2000.

The impact of this spill might have been worse if not for the concerted efforts of a number of dedicated volunteers that worked around the clock to retard the movement of the contaminated slug of water downstream and came up with some innovative ways to re-aerate the water in the pooled area of Big Darby Creek in Milford Center prior to releasing it to flow downstream (Figure B.2.3).

In a more recent example on May 30, 2003, a large spill of approximately 2000 gallons of diesel fuel from a storage tank at an agricultural operation occurred. The diesel fuel migrated through the agricultural tile drainage system to Little Darby Creek (Figure B.2.4). This spill occurred at approximately 9 AM, but it was not reported for nearly 10 hours. Had this spill been promptly reported, and responded to, the extensive damage to the drainage system, and the impacts of diesel fuel to Little Darby Creek could likely have been minimized.

In many cases these spills were preventable, particularly the larger events. Given the great harm that can and has resulted to this high quality resource in a short period of time, every effort should be made to determine how to avoid spills, prepare emergency response plans for quickly reacting to spills when they do take place, and develop education and outreach tools to convey these plans to stakeholders in the watershed. The first step should be to conduct a survey of potential hazards within the watershed which can be developed into a map. Then an action plan should be developed for either eliminating the potential sources or designing containment measures to ensure that releases do not reach surface or ground water. Finally, a response plan with pre-identified areas for

Figure B.2.4. Diesel fuel spill to Little Darby Creek, RM 12.9, May 30, 2003.

treatment and diking if spills do occur. This last step would be necessary to deal with spills associated with transportation-caused spills. If funding is not currently available for these projects hazard rankings should be developed and priorities assigned for pursuit of funding. A standing committee of a watershed group could be tasked to pursue grants and donations. Other ideas to be considered would be developing a spill fund that would permit immediate hiring and deployment of a spill response team, placing a spill response firm on retainer and developing a volunteer spill response team.

Spills should be reported to the Ohio EPA at (800) 282-9378 and (614) 224-0946 (available 24 hours a day). Fish kills can be reported to individual county Wildlife Officers whose phone numbers can be secured at (800) 945-3543.

Figure B.2.5. Spills reported to the Ohio EPA Division of Emergency and Remedial Response during the period 1989 to 2000.

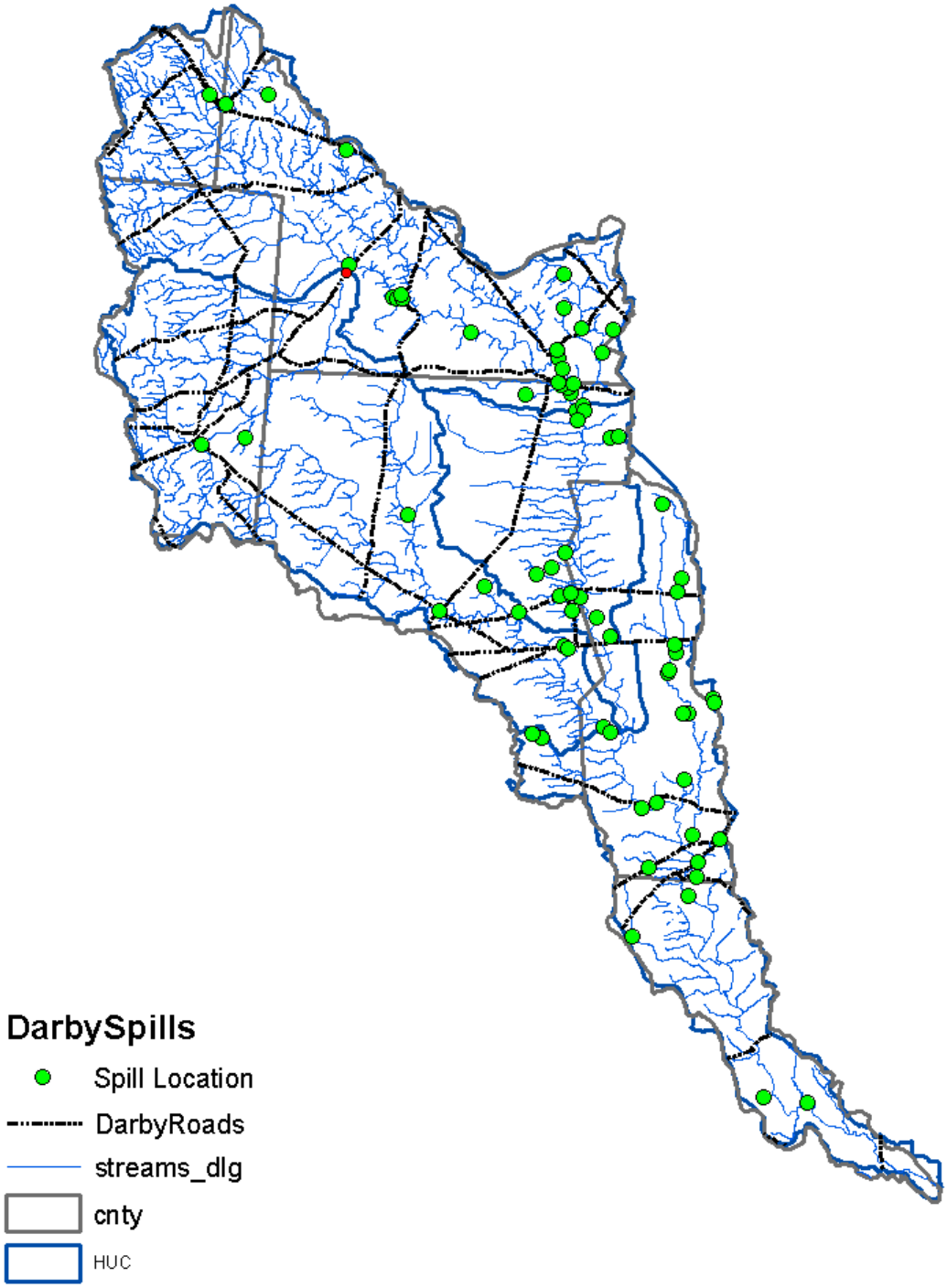
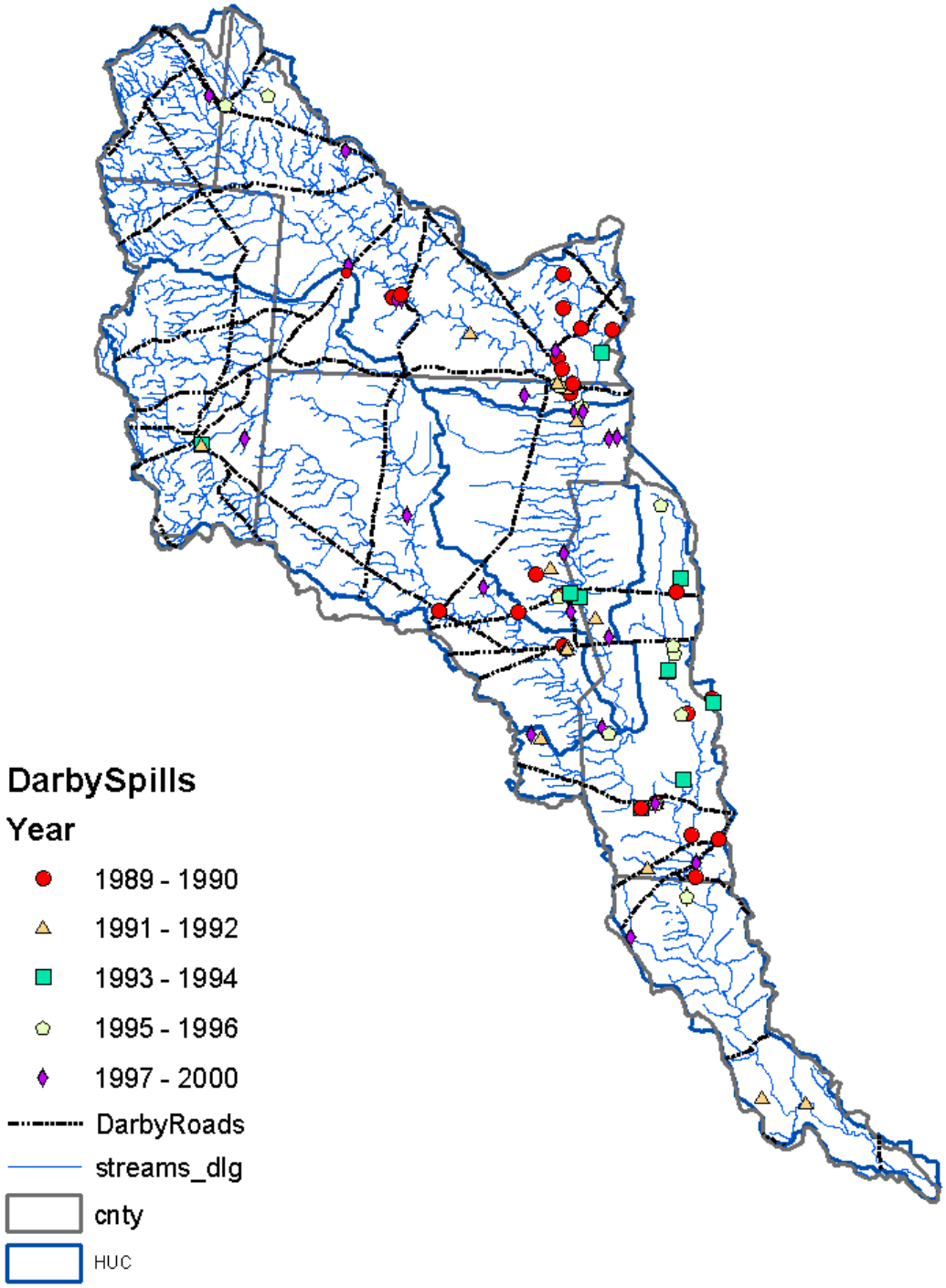


Figure B.2.6. Spills reported to the Ohio EPA Division of Emergency and Remedial Response during the period 1989 to 2000 presented by time interval.



B.3 Chemical Water Quality

Upper Big Darby Creek, Including Tributaries
(Headwaters to Plain City ~ RM 82.5 - 52.10)

Chemical water quality sampling in Upper Big Darby Creek extended from the headwaters at RM 82.50 to RM 52.10 just upstream of the Village of Plain City WWTP outfall. Tributaries included in this sampling effort included Flat Branch and tributary, Little Darby Creek (Logan County), two different unnamed tributaries, Spain Creek, Pleasant Run, Hay Run, Buck Run, Robinson Run, and Sweeney Run.

Mainstem
Chemical water quality sampling occurred in upper Big Darby Creek five times during the 2001 survey period. There were no violations of WQS found in upper Big Darby Creek (Table B.3.1).

Some *E. coli* and fecal coliform sample results appear elevated in the upper Big Darby Creek mainstem when compared with WQS benchmarks (Figures B.3.1 and B.3.2).

Dissolved oxygen concentrations in the upper Darby watershed exhibited areas with moderately depressed oxygen concentrations. Mean dissolved oxygen concentrations in the Big Darby Creek decreased downstream of the confluences of both Flat Branch and Buck Run with the site just downstream of Buck Run nearly in non-attainment for mean D.O. (Figure B.3.3). Mean concentrations increased again prior to reaching the Village of Plain City WWTP outfall at RM 52.05 (Figure B.3.3).

Total suspended solids concentrations varied throughout the upper watershed. All values examined in the WWH section of the upper Darby (RMs 82.50 and 79.20), upstream of the confluence with Flat Branch were greater than ECBP background median concentrations with half of these values in excess of the 75th percentile (Table B.3.2). Comparison of these segments with others of similar drainage area showed medians well above the comparison group (Figures B.3.5 and B.3.6).

Table B.3.1. Exceedences of Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH) water quality criteria (OAC 3745-1) for chemical/physical parameters in the Big Darby Creek study area, 2001. Plain text river miles indicate Warmwater Habitat, boldface river miles are designated Exceptional Warmwater Habitat, effluent discharges are in italic print, undesignated streams have a letter U following the river mile, and areas designated Modified Warmwater Habitat are underlined (Units are #/100 ml for bacteria, °C for temperature, µg/l for metals, cyanide and pesticides, mg/l for all other chemical parameters and square miles for drainage area).

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
Big Darby Creek		52/NA	68.0	82.50	1.5		
		48/NA	64.5	79.20	5.6		
	Flat Branch WWTP			*78.48*	No effluent samples taken during survey.		
		37.3/NA	63.5	**78.40**	19.4		
		43/NA	73.5	**76.60**	32		
		52/9.24	70.5	**69.40**	70		
	Darby Creek Golf Course WWTP			*64.00*	No effluent samples taken during survey.		
		49/8.18	80.5	**63.80**	89		
	Fairbanks School WWTP			*63.74*	No effluent samples taken during survey.		
		47/7.52	83.5	**62.50**	121		
		53/9.23	83.5	**54.20**	138		
	Ranco, Inc.			*54.00*	No effluent samples taken during survey.		
		52/9.35	93.0	**53.90**	136		
	Tuffco Sand and Gravel			*52.40*	No effluent samples taken during survey.		
		51/9.08		**52.10**	150		
	Plain City WWTP			*52.05*		F. coliform	(22982)✪
		43/8.78	81.0	**52.00**	150		
	Suburbans MHP WWTP			*49.68*	No effluent samples taken during survey.		
		48/8.3	76.0	**49.50**	177		
	Wisslohican Sanitary Sewer Dist. WWTP			*45.00*	No effluent samples taken during survey.		
		55/9.87	81.5	**42.00**	240		
	Battelle Memorial Institute WWTP			*40.55*	No effluent samples taken during survey.		

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
	Lake Darby Estates WWTP			*40.00*	No effluent samples taken during survey.		
	Greentree MHP WWTP			*39.00*	No effluent samples taken during survey.		
	Darby Dan Farms WWTP			*36.70*	No effluent samples taken during survey.		
		55/10.14	93.5	**34.10**	253		
	Oak Hills MHP WWTP			*29.29*	No effluent samples taken during survey.		
	Darbydale Elementary WWTP			*29.00*	No effluent samples taken during survey.		
				27.00	453		
		55/10.2	87.5	**23.80**	498		
	Dot-Mar MHP WWTP			*23.77*	No effluent samples taken during survey.		
	Pickaway Correctional Inst. WWTP			*22.92*			
		53/11.36	84.5	**22.80**	505		
		52/10.53	85.0	**19.10**	513		
		52/10.82	85.5	**13.40**	534		
		54/11.02	82.0	**3.10**	552		
-Flat Branch (RM 78.48)	Honda E. Liberty WTP			*4.80*	No effluent samples taken during survey.		
		26/NA	25.5	3.20	3.3	Temp.	(28.1)*
	Honda Benton Road WTP			*2.21*	No effluent samples taken during survey.		
				2.20	9.3	Copper-T	(81)***
		28/NA	36.5	0.80	13.9		
--Unnamed Trib. to Flat Branch (RM 1.50)				0.10 U	3.5		
-Little Darby Creek (RM 78.34, Logan Co.)		55/NA	71.5	3.50 U	2.4	Copper-T	(46)**
		50/NA	68.0	0.40 U	7.0		
-Unnamed Trib. to Big Darby Creek (RM74.91)		50/NA	62.5	0.20 U	3.9		

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
-Spain Creek (RM 74.30)		44/NA	66.0	5.70	3.5		
		56/NA	72.0	3.70			
	North Lewisburg WWTP			*1.50*	No effluent samples taken during survey.		
		53/NA	76.0	0.10	9.1		
-Pleasant Run (RM 72.01)		54/NA	72.0	**4.10**	4.9		
		58/NA	59.5	**0.50**	8.5		
-Unnamed Trib. to Big Darby Creek (RM 69.40)		50/NA	64.5	0.40 U	4.6		
-Hay Run (RM 67.60)		54/NA	52.5	0.20	5.8		
-Buck Run (RM 63.74)		26/NA	40.0	10.40	5.1		
		28/NA	55.5	7.80	9.2	D.O.	(3.69)‡‡
				5.00	18.1	D.O.	(3.52)‡‡
		44/7.14	70.5	0.10	29.8		
-Robinson Run (RM 53.69)	St. Johns Church WWTP			*8.04*	No effluent samples taken during survey.		
	Darby Meadows WWTP			*5.23*	No effluent samples taken during survey.		
		30/NA	64.0	2.10	8.4		
		30/NA	70.0	0.70			
-Sweeny Run (RM 52.11)		46/NA	58.0	0.10 U	4.0		
-Sugar Run (RM 50.92)		26/NA	31.0	7.50	4.1		
		26/NA	29.5	7.00		D.O.	(2.88)‡‡
		34/NA	38.5	5.40			
		40/NA	65.5	0.50	19.4		
-Worthington Ditch (RM 50.62)		24/NA		0.20 U	4.4		
-Ballenger-Jones Ditch (RM 49.68)	Jonathan Alder School WWTP			*2.55*	No effluent samples taken during survey.		
		40/NA	69.0	0.20 U	6.0		

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
Powell Ditch (RM 48.35)	COJV School District			*2.68*	No effluent samples taken during survey.		
-Yutzy Ditch (RM 47.10)	Canaan Elementary WWTP			*2.25*	No effluent samples taken during survey.		
				0.40 U	4.3		
-Fitzgerald Ditch (RM 44.96)	Canaan Community MHP WWTP			*1.40 U*	No effluent samples taken during survey.		
		32/NA	56.5	0.50 U	5.1		
-Little Darby Creek (RM 34.1)				**41.20**	3.3		
		44/NA		**39.60**	9.4		
	Mechanicsburg WWTP			*39.20*			
		38/NA		**38.80**	13.2		
		46/NA		**34.70**	25.9		
		44/8.40		**29.50**	70		
		54/9.07		**24.50**	83		
		58/9.91		**15.30**	151		
	Fisher Cast Steel			*14.00*	No effluent samples taken during survey.		
	Jefferson Lodge MHP WWTP			*9.00*	No effluent samples taken during survey.		
	Oakwood Acres WWTP			*8.00*	No effluent samples taken during survey.		
	B&B Motel WWTP			*7.00*	No effluent samples taken during survey.		
		58/9.10		**6.50**	163		
	West Jefferson WWTP			*5.35*			
		56/9.62		**4.10**	170		
		49/8.99	77.5	**0.70**	176		
--Clover Run (RM 39.80)		36/NA	60.0	**0.60**	2.0		
--Lake Run (RM 36.90)		42/NA	71.0	**0.90**	6.0		
---Jumping Run (RM 3.90)		30/NA	63.0	**0.30**	2.4		

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
--Treacle Creek (RM 31.30)		40/NA	67.5	**11.80**	5.7		
		52/NA		**8.30**	10.3		
		48/NA	66.5	**6.00**	17.0		
				0.80	38.1		
---Howard Run (RM 5.40)		52/NA	55.5	**0.60**	2.6		
---Proctor Run (RM 3.69)	Triad Schools			*7.00*	No effluent samples taken during survey.		
		42/NA	71.5	**4.90**	3.9		
		48/NA	65.0	**3.10**	9.1		
		52/NA	73.0	**1.60**	10.0		
--Barron Creek (RM 24.40)				**0.20**	6.3		
--Spring Fork (RM 17.46)		48/NA	60.5	**15.90**	4.3		
		54/NA	62.5	**13.40**	8.3		
		48/NA	54.5	**7.80**	19.3		
	Green Meadows MHP WWTP			*1.10*	No effluent samples taken during survey.		
				0.80	38.1		
---Bales Ditch (RM 3.64)		50/NA	70.0	0.40 U	5.2		
-Smith Ditch (RM 31.69)		52/NA	77.5	2.10 U	5.9		
-Unnamed Trib. to Big Darby Creek (27.93)	Pleasant Acres MHP			*1.00*	No effluent samples taken during survey.		
	Community Gardens MHP			*1.00*	No effluent samples taken during survey.		
--Unnamed Trib. to Smith Ditch (RM 0.06)		50/NA	67.0	0.10 U	0.9		

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
-Hellbranch Run (RM 26.10)		36/6.76	39.5	10.10			
		32/8.17	51.0	7.40			
	Oakhurst Knolls WWTP			*5.81*	No effluent samples taken during survey.		
		35/8.16	65.5	5.80			
		47/9.02	83.5	3.70			
	Pleasantview School WWTP			*1.14*	No effluent samples taken during survey.		
		49/9.18	84.5	0.90			
	Timberlake Subdivision WWTP			*0.51*	No effluent samples taken during survey.		
		41/9.07	83.5	0.50		D.O.	(3.60)‡‡
--Hamilton Ditch (RM 11.19)		16/NA	21.0	3.40	4.3		
	Alton Campground WWTP			0.50	No effluent samples taken during survey.		
		24/NA	36.5	0.50	10.2		
--Clover Groff Ditch (RM 11.19)		18/NA	22.0	4.70	4.5		
	Thorn Apple Country Club WWTP			*2.65*	No effluent samples taken during survey.		
	Cypress Wesleyan School WWTP			*1.30*	No effluent samples taken during survey.		
		28/NA	61.5	0.80	8.2		
-Springwater Run (RM 24.00)		50/NA	48.5	0.20	3.4		
-Unnamed Trib. to Big Darby Creek (aka Clark's Lake Outlet RM 20.20)	Foxlair Farms WWTP			*2.45*	No effluent samples taken during survey.		
	Clark's Lake Subdivision WWTP			*1.54*	No effluent samples taken during survey.		
		44/NA	77.5	0.80 U	4.3		
-Greenbrier Creek (RM 16.75)		40/NA	57.0	2.70	4.4	D.O.	(3.07)‡‡
		46/NA	74.5	1.30			

River/Stream	NPDES Discharge	IBI/MIWB	QHEI	River Mile	Drainage Area	Parameter	(Value) code
-Georges Run (RM 14.40)		46/NA	61.0	0.50	1.2		

❣ Water quality criteria identified for the warmwater habitat use designation apply to water bodies not assigned an aquatic life use designation. Primary Contact Recreation criteria are used for reference only.

✪ exceedence of NPDES permit limitation 30 day average.

* exceedence of numerical criteria for prevention of chronic toxicity [Chronic Aquatic Conc. (CAC)].

** exceedence of numerical criteria for prevention of acute toxicity [Acute Aquatic Conc. (AAC)].

*** exceedence of numerical criteria for prevention of acute toxicity inside the mixing zone [i.e., Final Acute Value (FAV)].

‡‡ exceedence of the minimum exceptional warmwater habitat or warmwater habitat dissolved oxygen criterion (EWH = 5.0 mg/l, WWH = 4.0 mg/l).

◊◊ exceedence of the maximum Primary Contact Recreation (PCR) criterion (E. coli 298/100 ml, Fecal coliform 2000/100mL).

◊◊◊ exceedence of the maximum Secondary Contact Recreation (SCR) criterion (E. coli 576/100 ml, Fecal coliform 5000/100 ml).

Table B.3.2. Comparison of background nutrient and demand parameter concentrations with those found in the Big Darby Creek study area, 2001. Comparisons are made to Eastern Corn Belt Plains (ECBP) ecoregion background 50th percentile (median), 75th, 90th, and 95th percentile values for headwaters, wadeable, and small river sites. Units are mg/l for all parameters. Plain text river miles indicate Warmwater Habitat, boldface river miles are designated Exceptional Warmwater Habitat, effluent discharges are in italic print, undesignated streams have a letter U following the river mile, and areas designated Modified Warmwater Habitat are underlined.

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
Big Darby Creek		68.0	82.50	1.5	TSS Ammonia Nitrite TKN TP	(*39*, *23*, *16*, 11, 7) (*0.077*) (0.074) (1.22, 0.47, 0.41) (**0.476**, 0.051)
		64.5	79.20	5.6	TSS Nitrite TKN TP	(**79**, *16*, 12, 8, 8) (*0.043*) (*0.61*, 0.45) (*0.092*)
	Flat Branch WWTP		*78.48*			
		63.5	**78.40**	19.4	TSS Nitrite TKN TP	(64, 63, *44*, *29*) (0.071, 0.051, 0.027, 0.022) (*0.74*, 0.53, 0.47, 0.42, 0.41) (*0.182*, *0.172*, *0.135*, *0.113*, 0.073)
		73.5	**76.60**	32	TSS Nitrate Nitrite TKN TP	(**105**, 56, 29, 24) (1.04, 1.02) (0.061, *0.024*) (1.00, *0.74*, *0.66*, *0.60*) (0.297, *0.157*)
		70.5	**69.40**	70	TSS Nitrate Nitrite TKN TP	(**89**, *44*, *41*, 19, 15) (*3.03*, 1.24, 0.85) (*0.029*, *0.027*) (0.52) (*0.196*, 0.077, 0.074)
	Darby Creek Golf Course WWTP		*64.00*			
		80.5	**63.80**	89	TSS Nitrate Nitrite TKN TP	(24, 23, 15) (**6.30**, 1.25, 0.98) (*0.044*) (0.56, 0.55, 0.55) (0.078)
	Fairbanks School WWTP		*63.74*			

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
		83.5	**62.50**	121	TSS Ammonia Nitrate Nitrite TKN	(25, 22, 19) (*0.054*) (*4.32*, 1.21, 1.02) (*0.038*, *0.022*) (0.60, 0.59, 0.52, 0.51)
		83.5	**54.20**	136	TSS Nitrate Nitrite TKN TP	(*41*, *34*, *33*, 24) (*4.11*, 1.72, 1.37) (*0.033*, *0.021*) (*0.66*, 0.58) (**1.75**, 0.088, 0.084)
	Ranco, Inc.		*54.00*			
		93.0	**53.90**	136	TSS Ammonia Nitrate Nitrite TKN TP	(40, 29, 27, 20) (*0.052*) (*4.05*, 1.72, 1.46, 1.03) (*0.035*, *0.024*) (*0.67*, 0.52) (0.124, 0.091)
	Tuffco Sand and Gravel		*52.40*			
			52.10	150	TSS Nitrate Nitrite TKN TP	(*42*, *36*, 23, 17, 17) (**6.13**, 1.74, 1.21, 1.10) (0.054, *0.022*) (*0.63*, *0.61*, 0.56, 0.52) (0.166, 0.141, 0.097, 0.092, 0.082)
	Plain City WWTP		*52.05*			
		81.0	**52.00**	150	TSS Ammonia Nitrate Nitrite TKN TP	(*43*, *30*, 29, 26, 15) (**1.54**, **0.329**, **0.314**, **0.227**, 0.131) (**7.6**, *3.61*, *3.32*, 2.45, 1.08) (**0.249**, **0.211**, 0.083, *0.044*, *0.035*) (**2.95**, **1.55**, **1.37**, **1.12**) (**1.65**, 0.226, *0.204*, *0.158*)
	Suburbans MHP WWTP		*49.68*			
		76.0	**49.50**	177	TSS Nitrate Nitrite TKN TP	(29, 23, 17, 16, 15) (*4.01*, 1.52, 1.03) (*0.024*) (0.59, 0.56, 0.55, 0.52) (*0.158*, *0.133*, 0.09, 0.071)
	Wisslohican Sanitary Sewer Dist. WWTP		*45.00*			

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
		81.5	**42.00**		Nitrate Nitrite	(*3.30*) (*0.025*)
	Battelle Memorial Institute WWTP		*40.55*			
	Lake Darby Estates WWTP		*40.00*			
	Greentree MHP WWTP		*39.00*			
	Darby Dan Farms WWTP		*36.70*			
		93.5	**34.10**	253	TSS Nitrate TKN	(29) (2.91, 1.98) (*0.85*, 0.66)
	Oak Hills MHP WWTP		*29.29*			
	Darbydale Elementary WWTP		*29.00*			
			27.00	453	Nitrate TKN	(*3.20*, 1.89) (*0.81*)
		87.5	**23.80**	498	Nitrate TP	(*3.14*, 1.85) (0.218)
	Dot-Mar MHP WWTP		*23.77*			
	Pickaway Correctional Inst. WWTP		*22.92*			
		84.5	**22.80**	505	Nitrite Nitrate TP	(0.021) (3.10, 1.92) (*0.294*, 0.216, 0.215, 0.157)
	Foxlair Farms MHP WWTP		*22.50*			
		85.0	**19.10**	513	Nitrate TP	(2.83, 2.00) (**0.556**, *0.29*, *0.255*, 0.238, 0.222)
		85.5	**13.40**	534	Nitrate Nitrite TP	(2.52, 2.1, 1.75) (0.022) (0.154)
		82.0	**3.10**	552	Nitrate TP	(2.52, 2.07, 1.99) (*0.292*, 0.155)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Flat Branch (RM 78.48)	Honda E. Liberty WTP		*4.80*			
		25.5	3.20	3.3	TSS Nitrite TKN TP	(**111**, *47*, *21*, *26*, *14*) (0.074, *0.037*, *0.030*, 0.022) (*0.91*, *0.79*, 0.56, 0.53, 0.50) (0.274, 0.051)
	Honda Benton Road WTP		*2.21*			
			2.20	9.3	TSS Ammonia Nitrite TKN TP	(**113**, *41*, *24*) (0.116, *0.056*) (**0.104**, *0.041*, *0.031*) (*0.69*, *0.66*, 0.58, 0.52) (0.21, *0.109*, *0.091*, 0.072, 0.07)
		36.5	0.80	13.9	TSS Ammonia Nitrite TKN TP	(**74**, 48, *46*, *42*, *41*) (*0.088*, *0.079*) (**0.106**, 0.053, *0.041*, 0.023) (*0.90*, *0.64*, *0.63*, 0.47, 0.42) (*0.138*, *0.091*, 0.076, 0.075, 0.07)
--Unnamed Trib. to Flat Branch (RM 1.50)			0.10 U	3.5	TSS Nitrite TKN TP	(50, *34*, *29*, *16*, 12) (0.069, 0.023) (1.18, *0.90*, 0.57, 0.55, 0.52) (*0.138*, *0.103*, *0.087*, 0.064)
-Little Darby Creek (RM 78.34, Logan Co.)		71.5	3.50 U	2.4	TSS Nitrate Nitrite TKN TP	(*20*, *20*, 7) (*3.39*, *2.80*, 2.22, 1.61) (0.070, *0.036*) (1.02) (*0.177*, *0.106*)
		68.0	0.40 U	7.0	TSS Nitrate Nitrite TKN TP	(43) (1.83, 1.45, 1.03) (*0.046*, 0.025) (*0.78*) (0.254, 0.223)
-Unnamed Trib. to Big Darby Creek (RM 74.91)		62.5	0.20 U	3.9	TSS Nitrate Nitrite TKN TP	(*18*, 10, 9) (5.47, 4.76, *4.24*, *4.02*, *3.41*) (0.029, 0.023) (*0.81*) (0.313, 0.059)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Spain Creek (RM 74.30)		66.0	5.70	3.5	TSS Nitrate Nitrite TKN TP	(**205**, 10) (*2.42*) (0.07) (*0.75*) (*0.142*)
		72.0	3.70		TSS Ammonia Nitrate Nitrite TKN TP	(**56**, *21*, 7) (**0.208**) (1.92, 1.05) (0.022, 0.022) (0.58) (*0.128*)
	North Lewisburg WWTP		*1.50*			
		76.0	0.10	9.1	TSS Ammonia Nitrate Nitrite TKN TP	(*27*) (**0.269**, 0.123) (1.64, 1.21, 1.18) (**0.104**, 0.082, *0.048*, *0.041*) (*0.80*, *0.70*, *0.68*, 0.51) (0.211, 0.210, *0.151*, *0.140*, *0.085*)
-Pleasant Run (RM 72.01)		72.0	**4.10**	4.9	Nitrate Nitrite	(1.03, 1.00) (*0.038*)
		59.5	**0.50**	8.5	TSS Nitrate Nitrite TKN	(*16*) (*3.55*) (*0.042*) (0.42)
-Unnamed Trib. to Big Darby Creek (RM 69.40)		64.5	0.40 U	4.6	TSS Nitrate Nitrite TKN TP	(9, 9, 7) (**11.0**, 4.53, *2.70*) (*0.039*, *0.038*, 0.025) (*0.72*, 0.53) (0.321, *0.086*)
-Hay Run (RM 67.60)		52.5	0.20	5.8	TSS Nitrate Nitrite TKN TP	(7) (**12.4**, *2.73*, 2.18) (*0.039*, 0.024, 0.022) (0.52, 0.45, 0.41) (0.054)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Buck Run (RM 63.74)		40.0	10.40	5.1	TSS	(**81**, 56, 56, *24*, *22*)
					Ammonia	(*0.091*)
					Nitrite	(0.082, *0.047*, 0.027, 0.025)
					TKN	(*0.96*, *0.86*, *0.68*, *0.65*, *0.65*)
					TP	(*0.148*, *0.11*, 0.056)
		55.5	7.80	9.2	TSS	(50, *32*, *31*, *26*, *18*)
					Ammonia	(**0.31**, 0.123, *0.079*, *0.075*)
					Nitrite	(**0.114**, 0.025)
					TKN	(1.05, *0.97*, *0.92*, *0.89*, *0.86*)
					TP	(0.25, 0.066, 0.065, 0.051)
			5.00	18.1	TSS	(59, 52, 49, *28*, *17*)
					Ammonia	(*0.076*, *0.054*)
					Nitrite	(*0.043*, 0.021)
					TKN	(**1.30**, *0.74*, *0.69*, 0.54, 0.50)
					TP	(0.26, 0.052, 0.051)
		70.5	0.10	29.8	TSS	(*33*, *32*, *27*, *21*, *19*)
					Ammonia	(0.107, *0.084*, *0.072*)
					Nitrate	(1.75)
					Nitrite	(*0.031*, *0.021*)
					TKN	(**1.17**, 1.08, 0.96, *0.71*, *0.63*)
					TP	(0.085, 0.073, 0.072)
-Robinson Run (RM 53.69)	St. Johns Church WWTP		*8.04*			
	Darby Meadows WWTP		*5.23*			
		64.0	2.10	8.4	TSS	(*29*, 12, 7)
					Ammonia	(0.112, *0.083*, *0.063*)
					Nitrate	(**6.01**, 1.15)
					Nitrite	(**0.14**, 0.024)
					TKN	(1.34, 1.20, 1.16, 1.12, 0.90)
					TP	(*0.142*, *0.12*, *0.083*, 0.077, 0.06)
		70.0	0.70	11.5	TSS	(65, 10)
					Ammonia	(*0.064*)
					Nitrate	(1.54, 1.32)
					Nitrite	(0.08, 0.022)
					TKN	(1.11, 1.10, *0.90*, *0.85*, *0.83*)
					TP	(*0.115*, *0.111*, *0.083*, *0.08*, 0.059)
-Sweeney Run (RM 52.11)		58.0	0.10 U	4.0	TSS	(11, 9)
					Ammonia	(**2.55**, *0.053*)
					Nitrate	(**11.2**, 4.66, *2.39*)
					Nitrite	(0.071, *0.039*, 0.029, 0.022)
					TKN	(**3.95**, 1.19, *0.7*, *0.62*, 0.54)
					TP	(**0.76**, 0.222, 0.217, *0.129*, *0.08*)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Sugar Run (RM 50.92)		31.0	7.50	4.1	TSS	(**75**)
					Ammonia	(*0.08*, *0.057*)
					Nitrate	(4.72)
					Nitrite	(*0.036*)
					TKN	(**1.77**, **1.59**, **1.50**, **1.47**, *0.76*)
					TP	(0.313, 0.31, 0.25, *0.139*, *0.093*)
		29.5	7.00	9.5	TSS	(**72**, *34*, *20*, 12, 11)
					Ammonia	(0.111, *0.074*)
					Nitrate	(**8.34**)
					Nitrite	(0.057, *0.036*)
					TKN	(**1.51**, **1.50**, 1.27, *1.01*, *0.98*)
					TP	(0.238, *0.131*, *0.10*, *0.10*, 0.07)
		38.5	5.40	11.0	TSS	(*31*, *27*, *20*, 10, 9)
					Ammonia	(**0.194**, *0.095*, *0.09*, *0.089*, *0.066*)
					Nitrate	(**6.66**)
					Nitrite	(0.074, *0.042*, 0.025, 0.022, 0.021)
					TKN	(**1.42**, 1.33, 1.20, 1.10, *0.66*)
					TP	(*0.188*, *0.136*, *0.134*, *0.123*, *0.11*)
		65.5	0.50	19.4	TSS	(*31*, *21*, *15*, 12, 8)
					Ammonia	(*0.08*, *0.056*)
					Nitrate	(4.81)
					Nitrite	(0.057)
					TKN	(1.15, *0.97*, *0.92*, *0.68*, *0.64*)
					TP	(**0.58**, *0.11*, *0.102*, 0.067, 0.061)
-Worthington Ditch (RM 50.62)			0.20 U	4.4	TSS	(*22*)
					Ammonia	(*0.059*)
					Nitrate	(**10.3**, 1.45, 1.27, 1.16)
					Nitrite	(*0.033*, 0.022)
					TKN	(*0.85*, *0.76*, *0.71*, *0.61*, 0.57)
					TP	(*0.182*, *0.151*, *0.128*, 0.074, 0.059)
-Ballenger-Jones Ditch (RM 49.68)	Jonathan Alder School WWTP		*2.55*			
		69.0	0.20 U	6.0	Nitrate	(**9.17**)
					Nitrite	(*0.036*)
					TKN	(*0.98*, *0.71*, *0.69*, 0.59, 0.57)
					TP	(*0.128*, *0.101*, *0.089*)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Powell Ditch (RM 48.35)	COJV School District WWTP		*2.68*			
-Yutzy Ditch (RM 47.10)	Cannan Elementary WWTP		*2.25*			
			0.40 U	4.3	Nitrate	(**13.0**)
					Nitrite	(*0.03*)
					TKN	(1.28, 1.08, *0.92*, *0.80*, *0.72*)
					TP	(*0.091*, 0.077, 0.064)
-Fitzgerald Ditch (RM 44.96)	Canaan Community MHP WWTP		*1.40*			
		56.5	0.50 U	5.1	TSS	(*15*, 13)
					Ammonia	(**0.215**, 0.10)
					Nitrate	(**11.4**, 4.66, *4.26*, *4.22*, *3.10*)
					Nitrite	(*0.033*, 0.021)
					TKN	(1.3, 1.2, *0.94*, *0.87*, *0.68*)
					TP	(**1.38**, **0.693**, **0.502**, 0.236, *0.111*)
-Little Darby Creek (RM 34.10)			**41.20**	3.3	Nitrate	(*3.81*, *3.74*, *3.69*, *3.67*)
			39.60	9.4	TSS	(*14*)
					Nitrate	(*2.70*, *2.52*, *2.47*, *2.42*, *2.3*)
	Mechanicsburg WWTP		*39.20*			
			38.80	13.2	TSS	(9)
					Ammonia	(*0.09*, *0.08*)
					Nitrate	(*2.48*, *2.27*, 2.17, 2.17, 2.14)
					TKN	(0.49, 0.43)
					TP	(*0.21*, *0.14*, *0.13*, *0.12*)
			34.70	25.9	TSS	(16, 14)
					Ammonia	(*0.08*, *0.07*, *0.07*)
					Nitrate	(2.75, 1.65, 1.28, 1.24, 1.23)
					TP	(0.07)
			29.50	70	TSS	(*30*, 15)
					Ammonia	(*0.08*, *0.06*)
					Nitrate	(5.02, 1.73, 1.41)
					Nitrite	(*0.03*)
					TKN	(0.52)
			24.50	83	TSS	(*37*, 25, 23, 20)
					Ammonia	(0.11, *0.06*)
					Nitrate	(**6.04**, 2.07, 1.55)
					TKN	(0.54, 0.52)
					TP	(*0.14*, 0.07)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
			15.30	151	TSS Nitrate TKN TP	(14) (**6.07**, 2.48, 1.40) (*0.75*, 0.51) (0.11, 0.07, 0.07)
	Fisher Cast Steel		*14.00*			
	Jefferson Lodge MHP WWTP		*9.00*			
	Oakwood Acres WWTP		*8.00*			
	B&B Motel WWTP		*7.00*			
			6.50	163	TSS Nitrate TKN TP	(14) (5.97, 2.19, 1.53) (*0.65*, 0.53, 0.50) (*0.14*, 0.10, 0.08)
	West Jefferson WWTP		*5.35*			
			4.10	170	Nitrate TKN TP	(5.38, 2.53, 2.1, 1.08, 1.07) (0.57, 0.51) (*0.14*, *0.13*, 0.11, 0.10)
		77.5	**0.70**	176	Nitrate TKN TP	(4.55, 2.44, 2.37, 1.18, 1.08) (0.59, 0.58, 0.54, 0.54) (*0.14*, *0.13*, 0.10, 0.09)
--Clover Run (RM 39.80)		60.0	**0.60**	2.0	TSS Nitrate TKN TP	(7, 7) (1.86, 1.46) (0.42) (*0.08*, 0.07)
--Lake Run (RM 36.90)		71.0	**0.90**	6.0	TSS Ammonia Nitrate TKN	(8) (0.10, *0.08*, *0.07*, *0.07*) (2.12, 1.04) (0.51, 0.43, 0.41, 0.40)
---Jumping Run (RM 3.90)		63.0	**0.30**	2.4	TSS Nitrate TKN	(7) (*3.81*, *2.66*, 1.95) (0.44)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
--Treacle Creek (RM 31.30)		67.5	**11.80**	5.7	TSS	(12, 9, 6)
					Ammonia	(**0.76**, **0.30**, *0.06*)
					Nitrate	(*3.42*, 1.10, 1.04)
					Nitrite	(**0.15**, 0.07, *0.03*, *0.03*)
					TKN	(**1.86**, *0.88*, 0.48, 0.44)
					TP	(*0.08*, *0.08*, 0.06)
			8.30	10.3	TSS	(13)
					Nitrate	(*3.12*, *2.58*, 2.07, 1.29, 1.05)
					TKN	(0.45, 0.45)
					TP	(**0.52**)
		66.5	**6.00**	17.0	TSS	(**134**, *33*, 12)
					Nitrate	(*3.73*, *2.86*, 1.87, 1.25)
					TKN	(*0.60*, 0.43)
			0.80	38.1	TSS	(*43*, *33*, *29*, 20)
					Ammonia	(0.13, 0.10, 0.10)
					Nitrate	(5.64, 1.74, 1.58, 1.11)
					Nitrite	(*0.03*, *0.03*)
					TKN	(*0.68*, 0.58)
					TP	(0.09, 0.07)
---Howard Run (RM 5.40)		55.5	**0.60**	2.6	TSS	(12, 9)
					Nitrate	(4.76, 2.16)
					Nitrite	(*0.03*)
					TKN	(*0.61*, 0.41)
---Proctor Run (RM 3.69)	Triad Schools		*7.00*			
		71.5	**4.90**	3.9	TSS	(*31*, *21*, 13, 9)
					Ammonia	(0.10, *0.07*)
					Nitrate	(1.55)
					TKN	(0.51, 0.44)
					TP	(*0.11*)
		65.0	**3.10**	9.1	TSS	(10)
					Nitrate	(*4.54*, 2.88, 1.03)
					Nitrite	(*0.03*)
					TKN	(*0.62*, 0.49, 0.44)
		73.0	**1.60**	10.0	Nitrate	(*3.94*, 2.11, 1.02)
					TKN	(0.53, 0.46, 0.44, 0.42)
--Barron Creek (RM 24.40)		44.5	**0.20**	6.3	TSS	(58, *20*, 12, 10)
					Ammonia	(*0.08*, *0.06*, *0.06*)
					Nitrate	(*4.56*)
					Nitrite	(*0.04*, *0.03*, *0.03*)
					TKN	(0.91, *0.73*, *0.70*, 0.58, 0.52)
					TP	(*0.16*, *0.11*)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
--Spring Fork (RM 17.46)		60.5	**15.90**	4.3	TSS Nitrate Nitrite TKN TP	(*21*) (*3.91*, *3.76*, 1.81, 1.77) (*0.04*, *0.03*) (1.06, *0.72*, 0.44, 0.43, 0.42) (*0.15*)
		62.5	**13.40**	8.3	TSS Nitrate Nitrite TKN TP	(*21*) (*2.99*, 1.86) (*0.04*) (1.00, *0.68*) (*0.17*)
		54.5	**7.80**	19.3	TSS Nitrate Nitrite TKN TP	(*32*, 8) (5.06, 2.15, 1.80) (*0.04*) (*0.71*, 0.54, 0.53, 0.51, 0.47) (0.07)
	Green Meadows MHP WWTP		*1.10*			
			0.80	38.1	TSS Ammonia Nitrate Nitrite TKN TP	(24) (*0.09*, *0.07*, *0.06*) (5.34, *2.88*, 2.29, 1.72, 1.10) (0.05, *0.04*, *0.03*, *0.03*) (*0.72*, *0.70*, *0.64*, 0.57) (*0.17*, *0.13*, 0.10, 0.07)
---Bales Ditch (RM 3.64)		70.0	0.40 U	5.2	TSS Nitrate Nitrite TKN TP	(*16*) (**8.28**, *3.04*) (*0.04*, *0.04*) (*0.76*, *0.62*, *0.62*, 0.59, 0.57) (0.08, 0.06)
-Smith Ditch (RM 31.69)		77.5	2.10 U	5.9	TSS Nitrate TKN TP	(10) (2.54, 2.02) (0.41) (0.236, 0.054)
-Unnamed Trib. To Big Darby Creek (RM 27.39)	Pleasant Acres MHP WWTP		*1.00*			
	Community Gardens WWTP		*1.00*			
--Unnamed Trib. to Smith Ditch (RM 0.06)		67.0	0.10 U	0.9	Nitrate TP	(1.93) (0.055)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Hellbranch Run (RM 26.10)		39.5	10.10	23	TSS Ammonia Nitrate Nitrite TKN TP	(*41*, *31*, 19, 16, 16) (*0.084*, *0.084*) (1.75) (*0.024*, *0.023*, *0.021*) (1.02, *0.78*, *0.67*, *0.62*) (0.259, *0.209*, *0.134*, 0.104, 0.092)
		51.0	7.40	27	Nitrite TKN TP	(2.01, 0.89) (*0.77*, *0.75*, *0.66*, 0.56, 0.54) (0.122, 0.114, 0.102, 0.085, 0.081)
	Oakhurst Knolls WWTP		*5.81*			
		65.5	5.80	30	Nitrate Nitrite TKN TP	(2.16, 2.16, 1.53, 1.17) (*0.025*) (*0.86*, *0.80*, *0.78*, *0.76*, *0.67*) (**0.307**, *0.215*, *0.15*, *0.147*, *0.137*)
		83.5	3.70	32	Ammonia Nitrate TKN TP	(*0.06*) (2.12, 1.20, 1.09) (0.95, *0.80*, *0.79*, *0.69*, 0.59) (*0.144*, *0.135*, 0.115, 0.111, 0.103)
	Pleasantville School WWTP		*1.14*			
		84.5	0.90	35	Nitrate TKN TP	(1.83, 1.24) (*0.63*, *0.62*) (0.117, 0.087, 0.078)
	Timberlake Subdivision WWTP		*0.51*			
		83.5	0.50	35	TSS Ammonia Nitrate Nitrite TKN TP	(14) (**0.257**, **0.24**, *0.079*) (1.82, 1.63, 1.36, 1.18) (*0.047*, *0.041*, *0.031*) (0.98, 0.93, *0.80*, 0.58, 0.52) (**0.372**, **0.356**, 0.296, *0.21*, *0.192*)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
--Hamilton Ditch (RM 11.19)		21.0	3.40	4.3	TSS Ammonia Nitrate Nitrite TKN TP	(**150**, **96**, *20*, *17*) (**0.40**, *0.075*, *0.073*, *0.058*, *0.053*) (1.90, 1.21, 0.99) (0.059, 0.05, *0.047*, *0.04*, *0.037*) (**1.61**, *0.91*, *0.76*, *0.65*, *0.64*) (**0.443**, 0.281, 0.249, 0.227, 0.226)
	Alton Campground WWTP		*0.50*			
		36.5	0.50	10.2	TSS Ammonia Nitrate Nitrite TKN TP	(13, 9, 8, 8) (0.142, *0.073*, *0.068*, *0.059*) (*3.43*, 0.99) (*0.043*, *0.037*, *0.03*, 0.028) (1.34, *0.94*, *0.78*, *0.64*, 0.58) (0.269, 0.237, 0.226, *0.197*, *0.137*)
--Clover Groff Ditch (RM 11.19)		22.0	4.70	4.5	TSS Ammonia Nitrite TKN TP	(*21*, 11, 9) (**0.278**, 0.162, 0.149, 0.10, *0.097*) (0.05, *0.031*, 0.029 0.026) (*0.85*, *0.83*, *0.75*, 0.54) (**0.912**, 0.08, 0.067)
	Thornapple Country Club WWTP		*2.65*			
	Cypress Wesleyan School WWTP		*1.30*			
		61.5	0.80	8.2	TSS Ammonia Nitrite TKN TP	(8, 8) (0.105, *0.082*) (*0.044*, *0.035*, *0.034*, 0.024) (*0.88*, *0.79*, *0.78*, 0.57, 0.48) (0.35, *0.137*, *0.10*, *0.095*, 0.077)
-Springwater Run (RM 24.00)		48.5	0.20	3.4	Nitrate TKN TP	(*2.94*, *2.62*, 1.50, 1.39, 1.02) (*0.99*, *0.75*, *0.71*, 0.57) (0.22, *0.197*, *0.19*, *0.174*, *0.174*)

River/Stream (River Mile of Tributary)	NPDES Discharge	QHEI	River Mile	Drainage Area	Parameter	(Value) code mg/l
-Unnamed Trib. to Big Darby Creek (aka Clark's Lake Outlet, RM 20.20)	Foxlair Farms WWTP		*2.45*			
	Clark's Lake Subdivision WWTP		*1.54*			
		77.5	0.80 U	4.3	TSS	(7)
					Ammonia	(**0.529**)
					Nitrate	(1.68, 1.65, 1.38, 1.22)
					Nitrite	(**0.228**, *0.042*, 0.027)
					TKN	(<u>1.16</u>, *0.74*, *0.68*, 0.55, 0.52)
					TP	(<u>0.208</u>, <u>0.207</u>, *0.197*, *0.157*, *0.115*)
-Greenbrier Creek (RM 16.75)		57.0	2.70	4.4	TSS	(8)
					Ammonia	(*0.067*)
					Nitrate	(**7.57**, *4.23*, 1.25)
					TKN	(*0.78*, *0.63*, 0.52, 0.42)
					TP	(<u>0.216</u>, *0.143*, *0.119*, *0.114*, *0.094*)
		74.5	1.30	7.0	TSS	(*18*)
					Nitrate	(*3.75*, *3.67*)
					TKN	(0.40)
					TP	(*0.125*, *0.095*)
-Georges Run (RM 14.40)		61.0	0.50	1.2	Nitrate	(1.25)
					TKN	(0.44)
					TP	(0.055)

TSS = Total Suspended Solids, TKN = Total Kjeldahl Nitrogen, TP = Total Phosphorus
Normal print values exceed the 50th percentile background
Italic print values exceed the *75th* percentile background
<u>Underlined</u> values exceed the <u>90th</u> percentile background
Boldfaced values exceed the **95th** percentile background

Figure B.3.1 Number of *E. coli* colonies/100 ml. from samples collected in the upper Big Darby Creek mainstem, 2001.

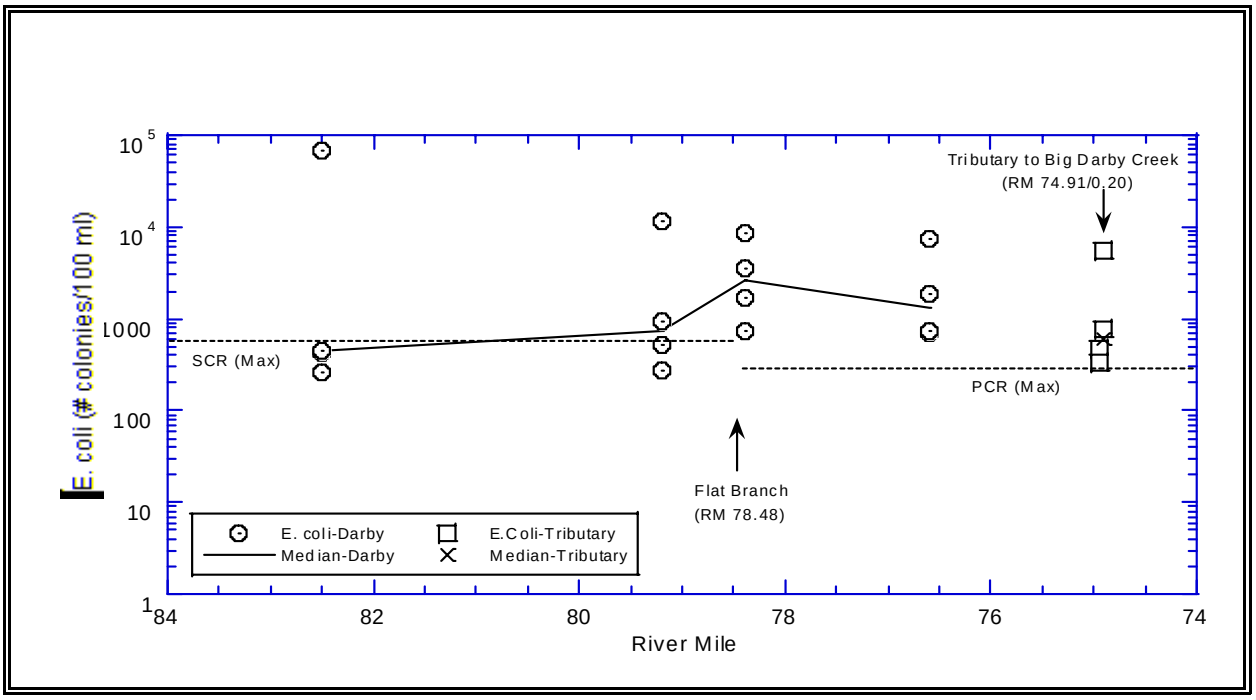


Figure B.3.2. Number of Fecal Coliform colonies/100 ml. from samples collected in the upper Big Darby Creek mainstem, 2001.

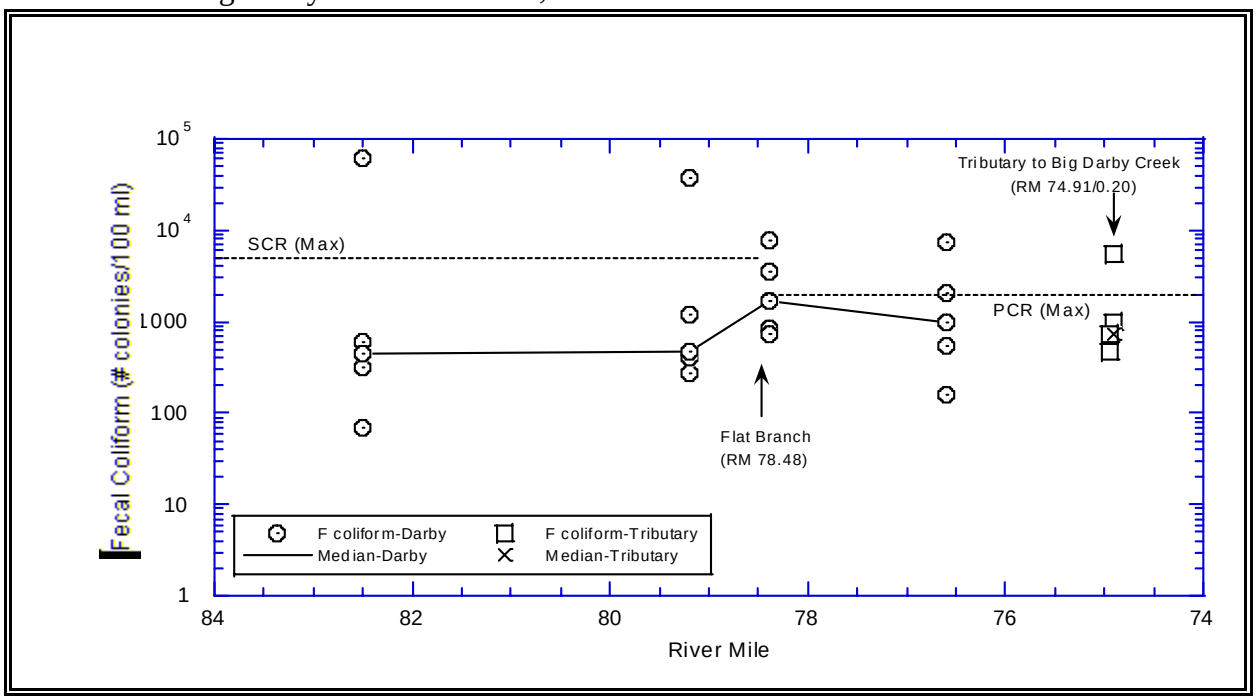
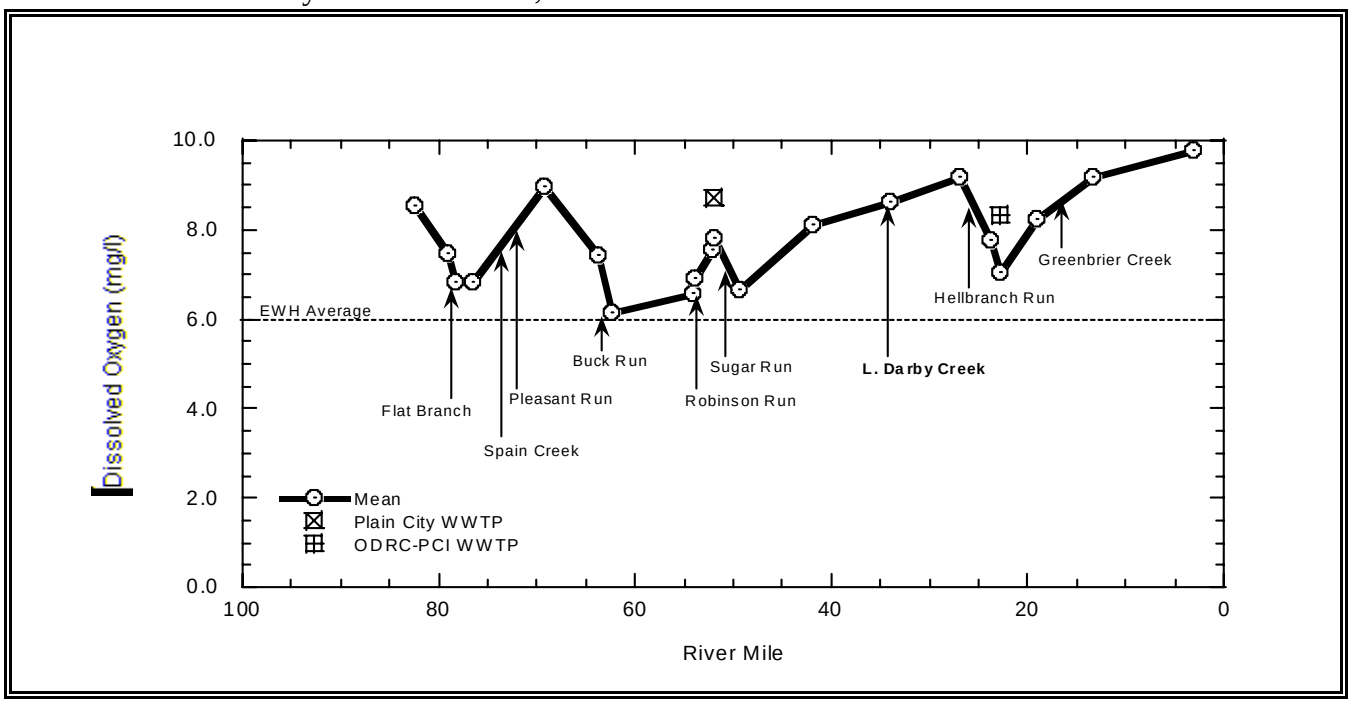


Figure B.3.3. Longitudinal trend in mean Dissolved Oxygen concentrations measured in the Big Darby Creek mainstem, 2002.



Mean total suspended solids in Big Darby Creek increased markedly downstream of the confluence with Flat Branch. Flat Branch was a major source of total suspended solids loading to Big Darby Creek as documented by sample results and photographs (Figure B.3.4). Drainage from the Honda property could be the source, as discussed in the following section on Flat Branch. The pollution influence from Flat Branch extended well downstream and was augmented by suspended solids loadings from the Flat Branch WWTP and Buck Run. Fully 80% of the samples taken at the eight sites between RM 78.40 and 52.10 inclusive were greater than the background median for total suspended solids with 32.5% of the total larger than the 75th percentile (Table B.3.2). Comparison of suspended solids concentrations among stream segments of like drainage areas revealed that most upper Big Darby EWH sites exhibited total suspended solids concentrations significantly above those found in comparable sized streams (Figures B.3.7 and B.3.8).

Figure B.3.4. Confluence of Big Darby Creek (left) and Flat Branch (right) documenting turbidity emanating from Flat Branch, 2002.

Figure B.3.5. Box and whisker plot of Total Suspended Solids concentrations at sites having a drainage area of 0 to 2 square miles in drainage area within the Big Darby Creek watershed, 2001.

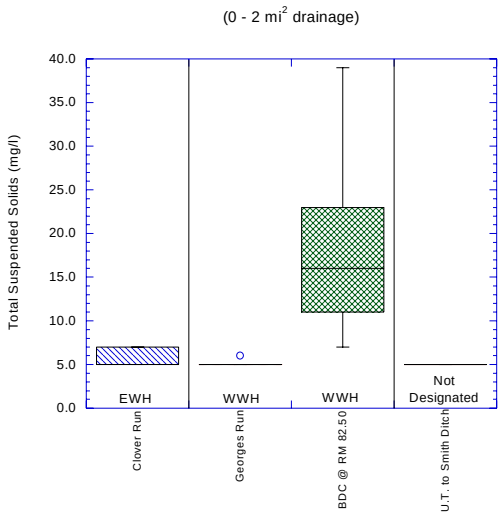


Figure B.3.6. Box and whisker plots of Total Suspended Solids concentrations at sites having a drainage area of 4-8 square miles in drainage area within the Big Darby Creek watershed, 2001.

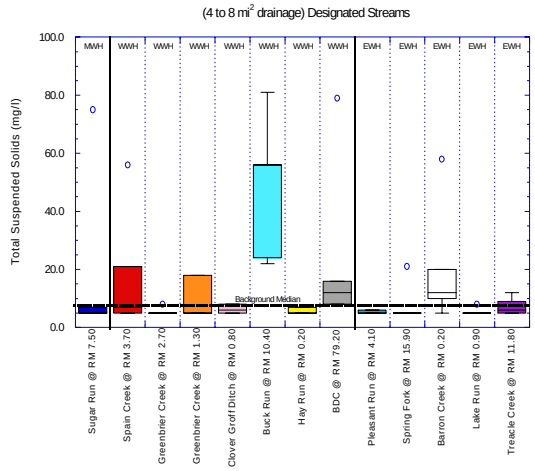


Figure B.3.7. Box and whisker plot of Total Suspended Solids concentrations measured at sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

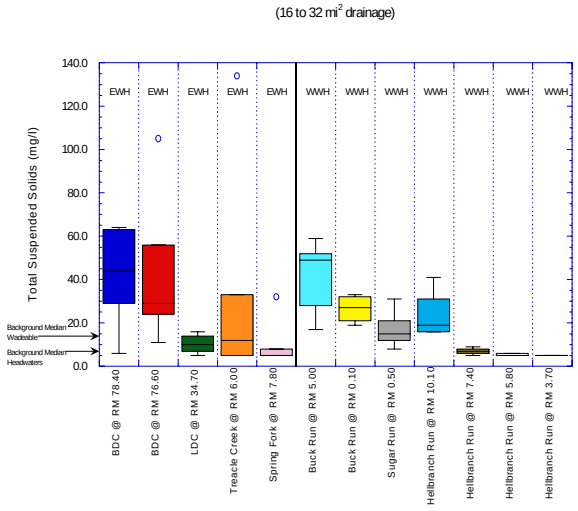
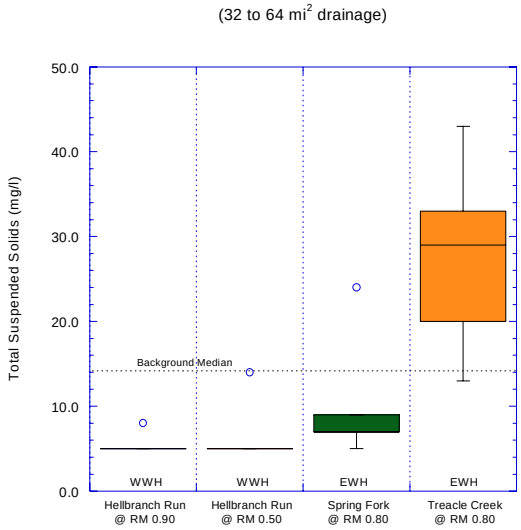


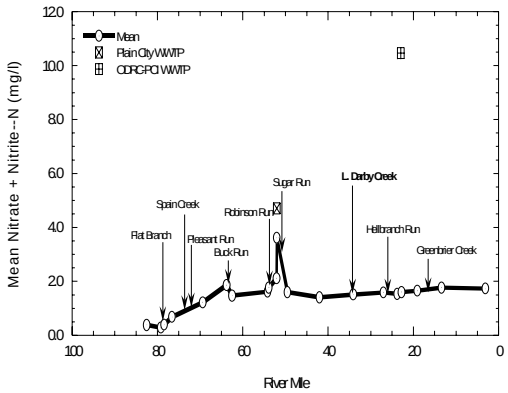
Figure B.3.8. Box and whisker plot of Total Suspended Solids concentrations measured at sampling sites with a drainage area of 64-128 mi^2 in the Big Darby Creek watershed, 2001.



Nutrient concentrations were also somewhat variable in the upper watershed. Nitrate+nitrite displayed a fairly steady increase over the entire range of the upper Big Darby Creek (Figure B.3.9). Forty four (44) percent of the samples analyzed for nitrate+nitrite in the upper Darby mainstem were found at concentrations greater than the background median (Table B.3.2). Organic nitrogen (TKN) showed a much more stable response with little variation and more consistent readings from site to site. Sixty percent of the samples analyzed for TKN showed concentrations greater than the background median (Table B.3.2). Mean total phosphorus exhibited a more variable response hovering around 0.1 or 0.2 mg/l, peaking and falling again prior to the end of the segment. As with TKN, 60% of the samples exceeded the background median for total phosphorus (Table B.3.2). Flat Branch (stream) and Flat Branch WWTP both contributed significant amounts of phosphorus, nitrite, and organic nitrogen to the Big Darby mainstem as seen at RM 78.40. Although the mean data do not necessarily indicate an increase in nutrients in the mainstem, several tributary streams are contributing significant concentrations of nutrients to Big Darby Creek. Spain Creek (with North Lewisburg WWTP contributing), Buck Run, Robinson Run, and Sweeney Run are all included in this group.

Algal blooms in the upper mainstem, witnessed at various times during the 2001 field effort, were indicative of nutrient enrichment. Partial biological attainment in the mainstem beginning downstream of Flat Branch may be caused by degraded chemical water quality as evidenced by elevated suspended solids and nutrients.

Figure B.3.9. Mean Nitrite + Nitrate concentrations in the Big Darby Creek mainstem, 2001



Flat Branch (02-223) (RM 78.48) (MWH)
Chemical water quality was evaluated at three locations on Flat Branch. Flat Branch is currently designated as MWH, Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Secondary Contact Recreation (SCR). Water quality criteria were violated in two instances, for temperature at RM 3.20 and copper at RM 2.20 (Table B.3.1). The copper violation may be due to use of an algicide (Cutrine) by Honda of America in ponds directly drained by Flat Branch or its tributaries. Bacterial exceedences were also common at all three sampling locations (Table B.3.1).

Numerous other chemical water quality problems plagued Flat Branch during the survey period. Total suspended solids were found at concentrations that were consistently above the 75th percentile for background and exceeded the 95th percentile at times (Table B.3.2). The problem was traced to runoff from the Honda of America facility. A study was undertaken by the facility, and a plan to ameliorate the water quality problems was developed (Burgess and Niple 2002).

Concentrations of organic nitrogen (TKN), and phosphorus were also excessive (Table B.3.2), but comparable to MWH designated streams of similar drainage area (Figures B.3.11, B.3.12, B.3.16 and B.3.17). Nitrite concentrations in Flat Branch seemed excessive at times with 4 of 15 values greater than the 90th percentile of background. Sources of the nutrients are unknown.

Unnamed Tributary to Flat Branch (02-365) (RM 1.50) (Undesignated/MWH Recommended)
Water quality criteria for WWH apply to this stream even though it is currently undesignated. No chemical water quality criteria violations were noted during the survey period (Table B.3.1). This tributary, however, had some similar water quality problems as its receiving stream, Flat Branch. Suspended solids, organic nitrogen (TKN), and total phosphorus were all found at concentrations much like those found in Flat Branch itself.

Little Darby Creek (02-251) (RM 78.34) (Undesignated/EWH + CWH Recommended)
Chemical water quality sampling was conducted at two sites on Little Darby Creek. Water quality criteria for WWH apply to this stream even though it is currently undesignated. Chemical water quality criteria violations were found at RM 3.50 for copper. Chemical water quality was fairly typical of other streams of the same drainage area (Figures B.3.13, B.3.12, B.3.11, B.3.14, B.3.14', B.3.15 and B.3.18 to B.3.21). Fecal coliform bacterial concentrations also compared favorably with other streams (Figures B.3.22 and B.3.23). *E. coli* concentrations were lower and had a narrow range at the upstream site when compared to similar streams; however, this was not true of the downstream site where values were much wider-ranging with a higher maximum (Figure B.3.24). Comparison of the *E. coli* values with PCR criteria indicated possible bacterial contamination at both sites (Table B.3.1).

Unnamed Tributary to Big Darby Creek (02-361) (RM 74.91) (Undesignated/EWH Recommended)

Chemical water quality sampling was conducted at a single site on this unnamed tributary of Big Darby Creek located southeast of Middleburg. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No chemical water quality criteria violations were noted during the survey period (Table B.3.1).

Nutrient enrichment was apparent with nitrate plus nitrite concentrations exceeding the 75th percentile for background in every sample with 2 of these in excess of the 90th percentile (Table B.3.1). Comparison of this stream with others of the same drainage area also indicated that these concentrations of nitrate plus nitrite were excessive as were *E. coli* bacteria counts (Figures B.3.14 and B.3.24) whereas the presence of other nutrients, suspended solids, and fecal coliform bacteria were at or below the values found in similar streams (Figures B.3.10 to B.3.13 and B.3.22). Dissolved oxygen concentrations varied within a narrow range, suggesting little supersaturation and, therefore, a stable algal community (Figure B.3.15).

Figure B.3.10. Box and whisker plot of Total Suspended Solids concentrations measured at sampling sites with a 2 to 4 mi^2 drainage area in the Big Darby Creek watershed, 2001.

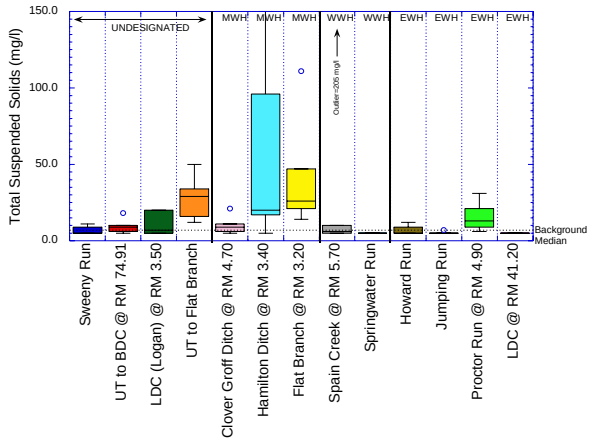


Figure B.3.11. Box and whisker plot for concentrations of Total Kjeldahl Nitrogen in sampling sites having a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

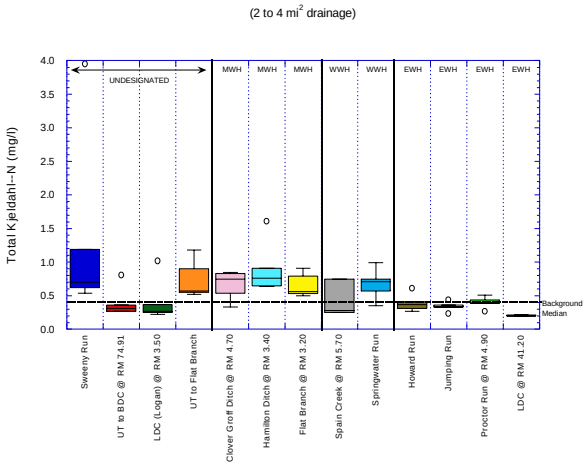


Figure B.3.12. Box and whisker plot for concentrations of Total Phosphorus at sampling sites having a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

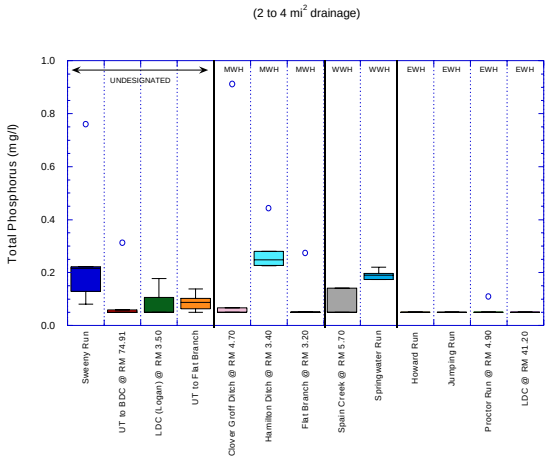


Figure B.3.13. Box and whisker plot of concentrations of Ammonia measured at sampling sites with a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

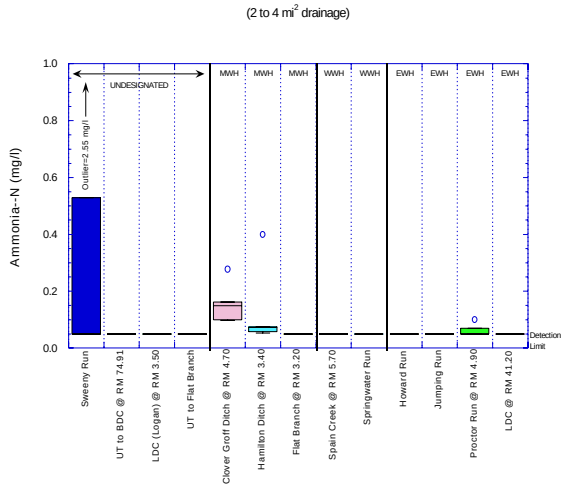


Figure B.3.14. Box and whisker plot of concentrations of Nitrite+Nitrate measured at sampling sites with a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

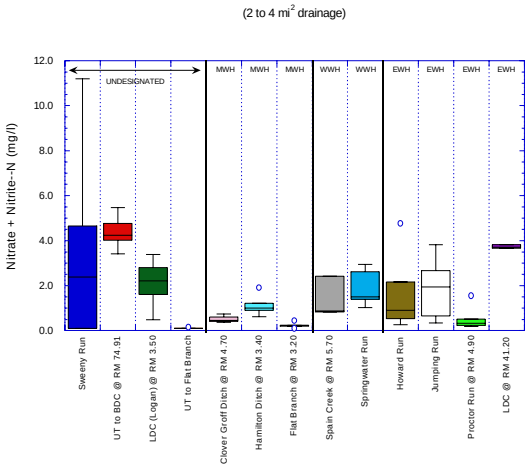


Figure B.3.14'. Box and whisker plot for Total Phosphorus at sites with drainage areas of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

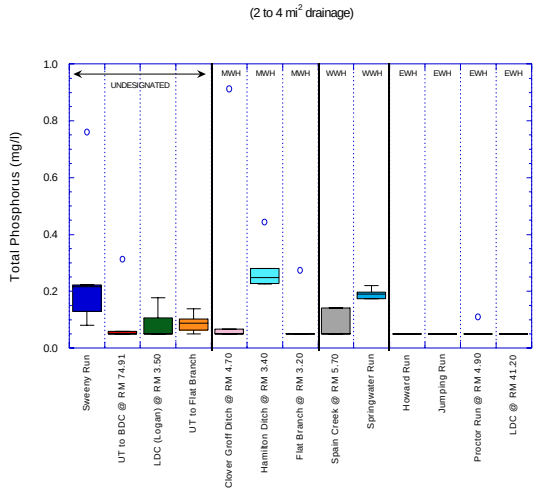


Figure B.3.15. Box and whisker plot for Dissolved Oxygen concentrations at sites with a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

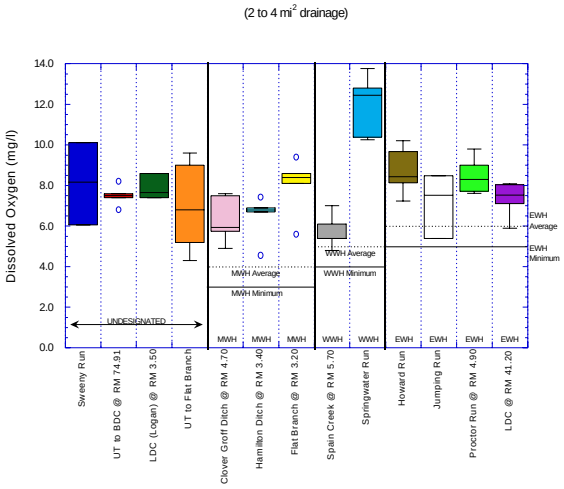


Figure B.3.16. Box and whisker plot for concentrations of Total Kjeldahl Nitrogen at sampling sites having a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

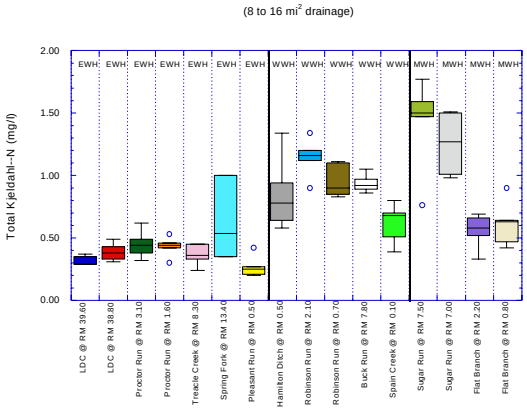


Figure B.3.17. Box and whisker plot for concentrations of Total Phosphorus at sampling sites having a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

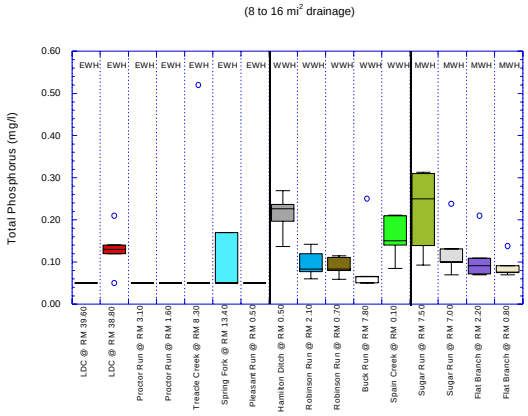


Figure B.3.18. Box and whisker plot for concentrations of Ammonia measured at undesignated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

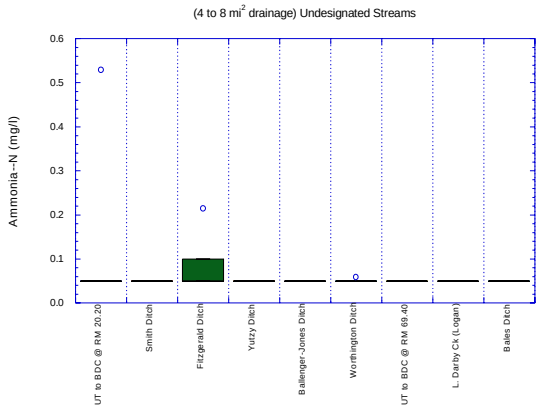


Figure B.3.19. Box and whisker plot for concentrations of Nitrite+Nitrate measured from undesignated sampling sites with a drainage of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

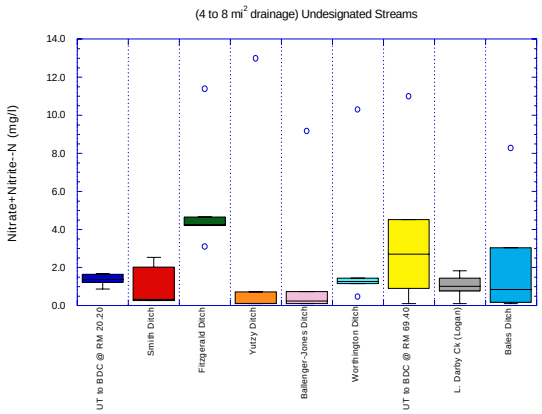


Figure B.3.20. Box and whisker plot of Phosphorus concentrations at undesignated sampling sites with drainage areas of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

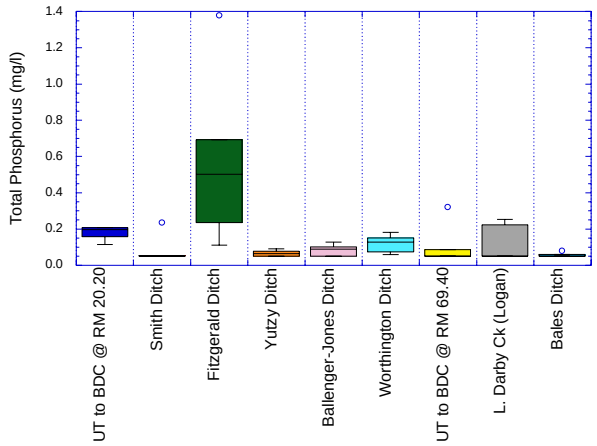


Figure B.3.21. Box and whisker plot of Dissolved Oxygen concentrations at undesignated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

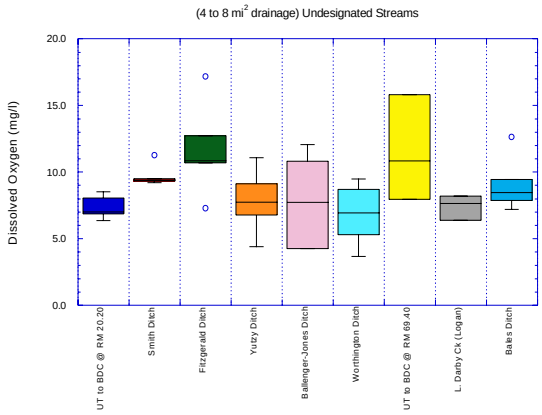


Figure B.3.22. Box and whisker plot for the number Fecal Coliform colonies/100 ml. at sites with a drainage area of 2-4 mi^2 in the Big Darby Creek watershed, 2001.

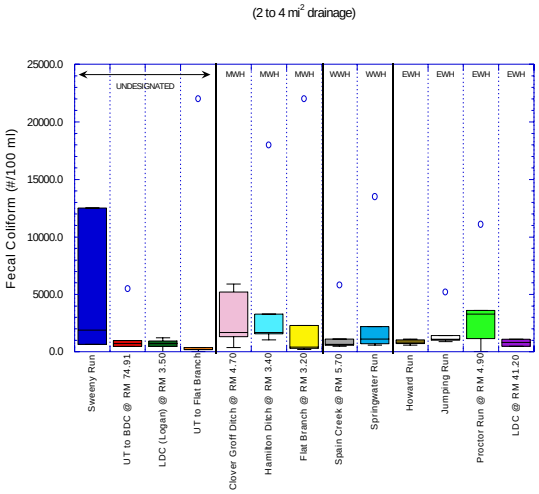


Figure B.3.23. Box and whisker plot for the number Fecal Coliform colonies/100 ml. at undesignated sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

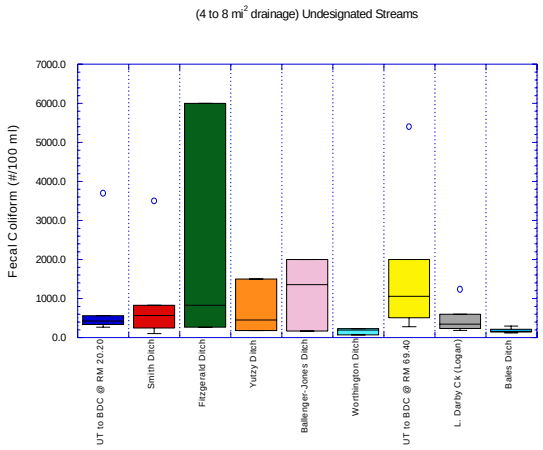
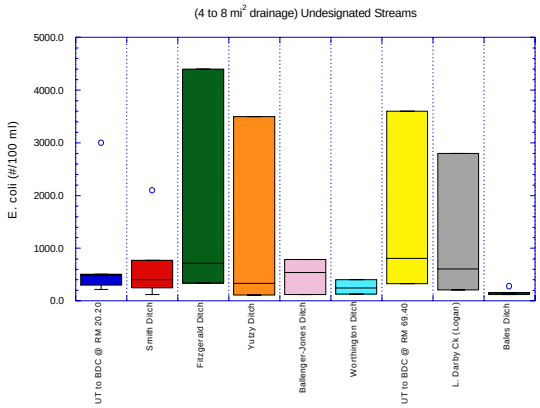


Figure B.3.24. Box and whisker plots of *E. coli* colonies/100 ml. at undesignated sampling sites with drainage areas of 4-8 mi^2 in the Big Darby Creek watershed, 2001.



<u>Spain Creek</u> (02-222) (RM 74.30) (WWH/WWH+CWH Recommended >RM 5.0, EWH+CWH Recommended <RM 5.0)
Chemical water quality was examined at three different sites in the Spain Creek watershed. Spain Creek is currently designated WWH, AWS, IWS, SCR. There were no chemical water quality criteria violations in Spain Creek during the survey period.

Total suspended solids concentrations exceeded the 95th percentile of background at 2 sites on Spain Creek, RM 5.70 and 3.70. The upper watershed seemed to exhibit more of a negative impact from suspended solids than the lower reaches. Median values of suspended solids in Spain Creek were comparable with other streams with similar drainage areas and WWH designations (Figures B.3.10, B.3.25 and B.3.26).

Nutrient concentrations increased incrementally downstream, indicating that the upper part of the Spain Creek watershed was not causing significant nutrient enrichment. Undoubtedly, the North Lewisburg WWTP contributed to the enrichment of the lower section of the creek, downstream of the discharge point, especially for organic nitrogen (TKN), nitrite, total phosphorus and, to some extent, ammonia (Table B.3.2).

<u>Pleasant Run</u> (02-221) (RM 72.01) (EWH)
Pleasant Run was evaluated for chemical water quality at two sites, RM 4.10 and RM 0.50. There were no violations of the chemical water quality criteria for the EWH designation although elevated levels of *E. coli* and fecal coliform bacteria were noted in many of the samples

and were in the middle range of comparably sized streams (Figures B.3.29 to B.3.32). Dissolved oxygen concentrations were in a narrow range at both sites and well in excess of the EWH minimum and average criteria indicating a stable D.O. regime instream and confirming low nutrient values (Figures B.3.27 and B.3.28). Nutrient concentrations were indeed very low with few values exceeding the respective background median (Table B.3.2). In comparison with other streams of similar drainage area, Pleasant Run had some of the lowest ranges of suspended solids and nutrient concentrations and some of the most stable dissolved oxygen readings (Figures B.3.33 to B.3.41) indicating little negative impact from chemical pollutants.

Unnamed Tributary to Big Darby Creek (02-360) (RM 69.40) (Undesignated/WWH Recommended)

This small tributary was evaluated for chemical water quality at one location. Water quality criteria for WWH apply to this stream even though it is currently undesignated. There were no violations of water quality criteria detected in the stream. This tributary showed indications of nutrient enrichment with a median D.O. saturation of approximately 120% (e.g., D.O. concentrations above 15 mg/l) as well as higher median nitrate concentrations than similar-sized streams (Figures B.3.19, B.3.21 and B.3.42).

Figure B.3.25. Box and whisker plot of Total Suspended Solids concentrations at designated sites with a drainage area of 4-8 mi^2 in Big Darby Creek watershed, 2001.

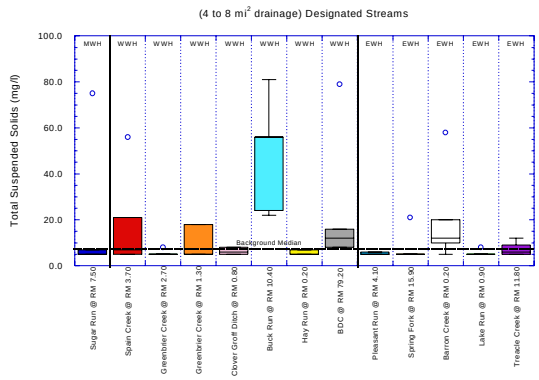


Figure B.3.26. Box and whisker plot of Total Suspended Solids concentrations at designated sites with a drainage area of 8-16 mi^2 in Big Darby Creek watershed, 2001.

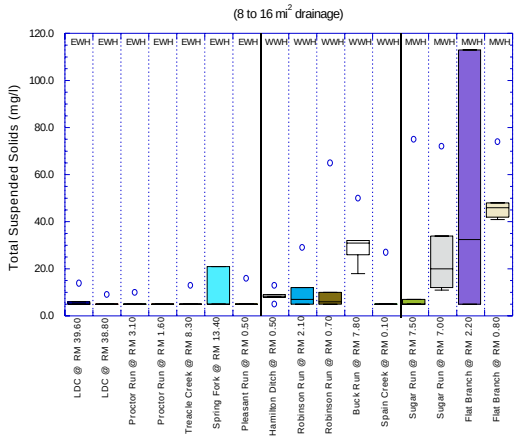


Figure B.3.27. Box and whisker plot of Dissolved Oxygen concentrations at designated sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

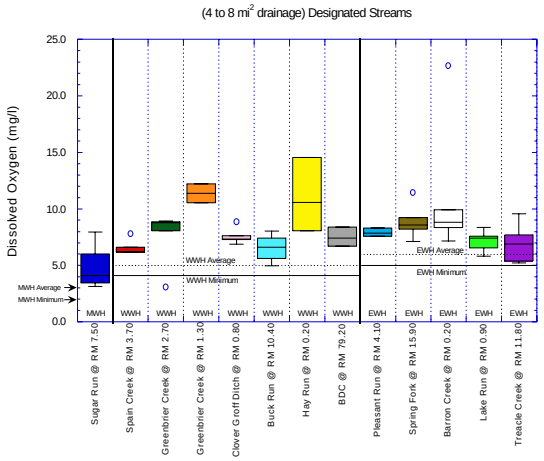


Figure B.3.28. Box and whisker plot of Dissolved Oxygen concentrations at sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

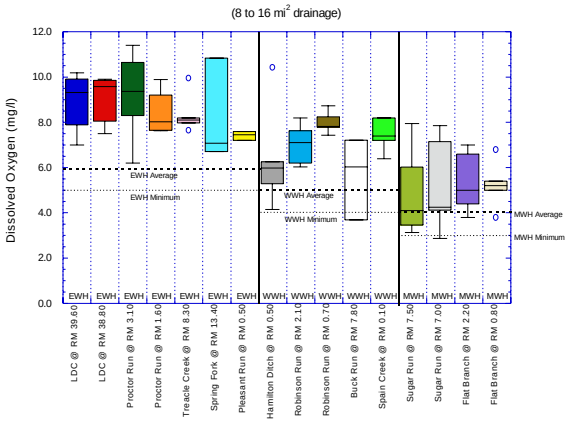


Figure B.3.29. Box and whisker plot of *E. coli* colonies/100 ml. at designated sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

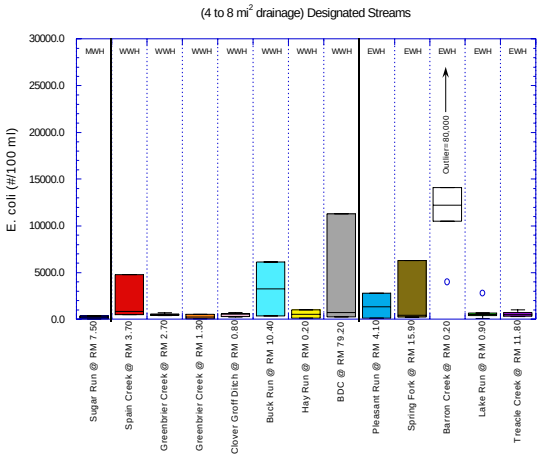


Figure B.3.30. Box and whisker plot of Fecal Coliform colonies/100 ml. at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

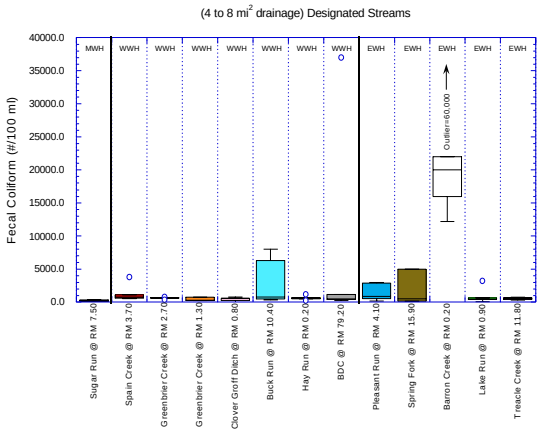


Figure B.3.31. Box and whisker plot of *E. coli* colonies/100 ml. at designated sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

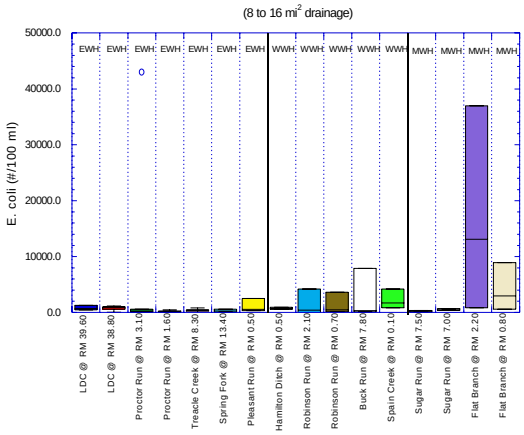


Figure B.3.32. Box and whisker plot of Fecal Coliform colonies/100 ml. at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

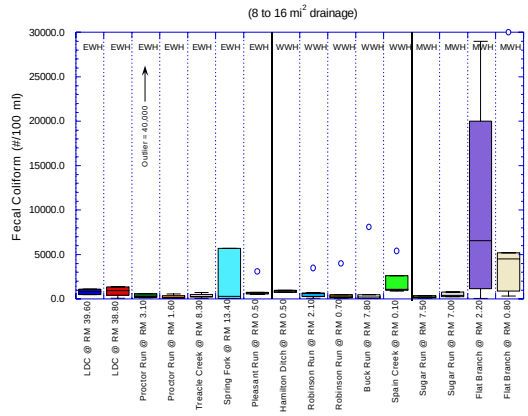


Figure B.3.33. Box and whisker plot for Total Suspended Solid concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

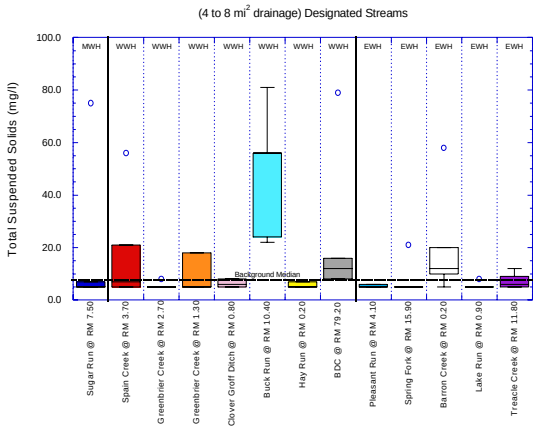


Figure B.3.34. Box and whisker plot for Ammonia concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

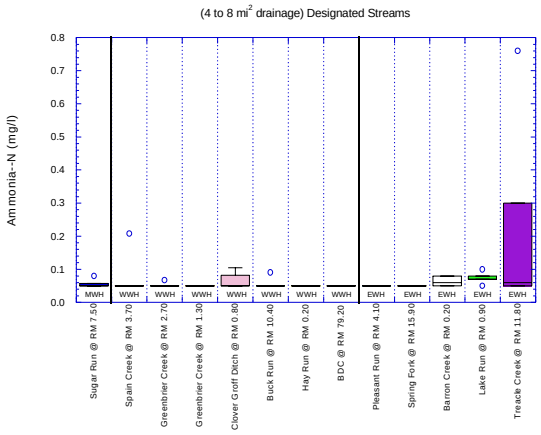


Figure B.3.35. Box and whisker plot for Nitrate+Nitrite concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

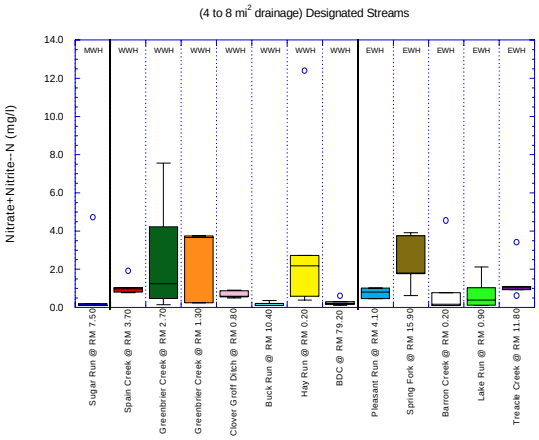


Figure B.3.36. Box and whisker plot for Total Kjeldahl Nitrogen concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

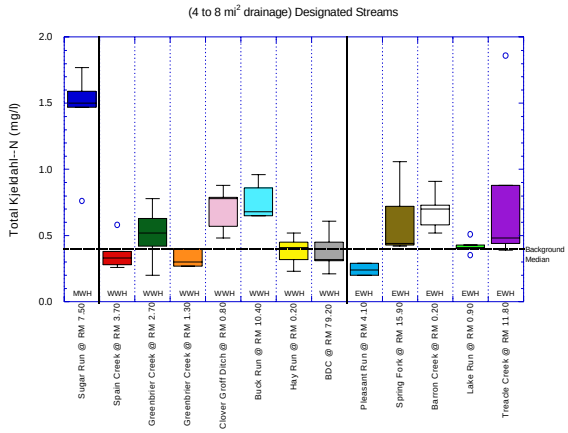


Figure B.3.37. Box and whisker plot for Total Phosphorus concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

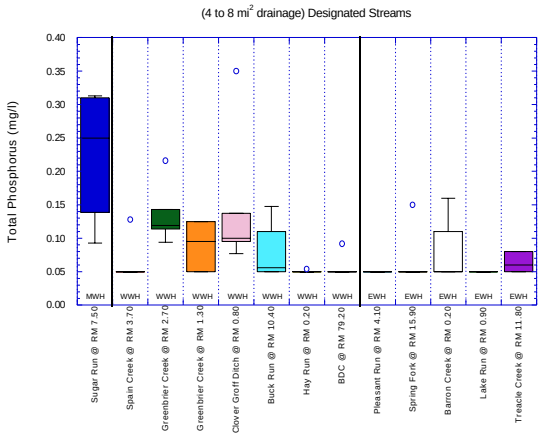


Figure B.3.38. Box and whisker plot for Dissolved Oxygen concentrations at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

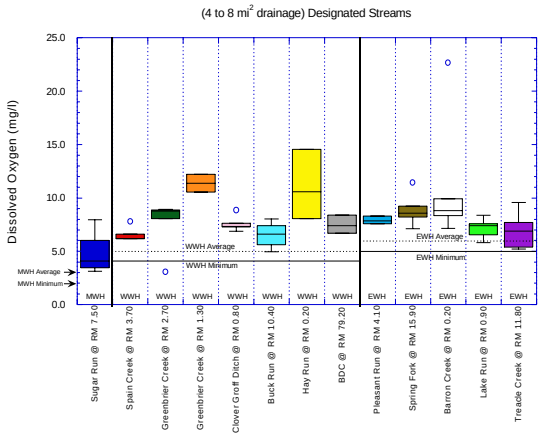


Figure B.3.39. Box and whisker plot for Ammonia concentrations at designated sampling sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

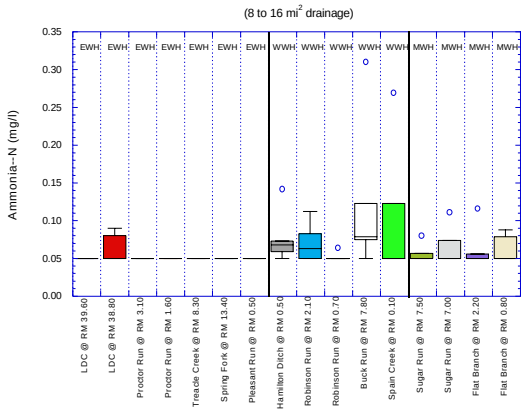


Figure B.3.40. Box and whisker plot for Nitrate+Nitrite concentrations at designated sampling sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

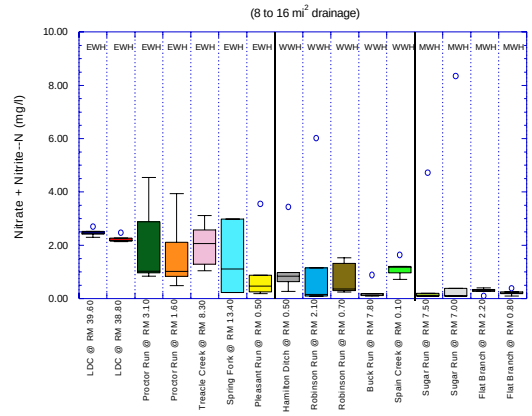


Figure B.3.41. Box and whisker plot of Dissolved Oxygen concentrations at sampling sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

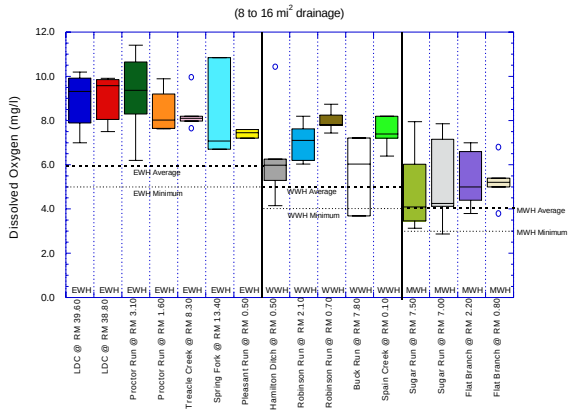
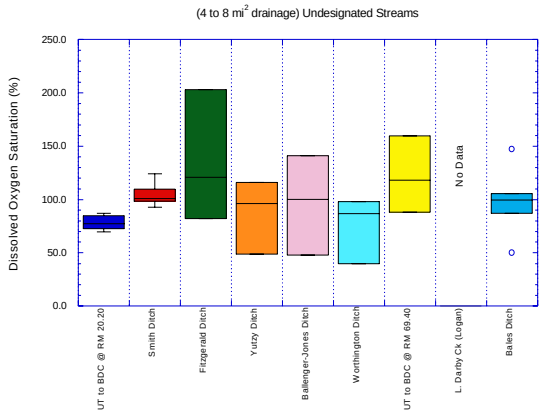


Figure B.3.42. Box and whisker plot of Percent Dissolved Oxygen saturation at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.



<u>Hay Run</u> (02-220) (RM 67.6) (WWH/EWH Recommended)
Chemical water quality was evaluated at one location on Hay Run. There were no violations of water quality criteria detected in the stream. Nitrates were found at concentrations in excess of the median background concentration in 3 of 5 samples (Table B.3.2), with one of these in excess of the 75th percentile and another exceeding the 95th percentile.

Comparisons of Hay Run with similar-sized streams in the watershed showed that Hay Run was comparable to most creeks of the same drainage area except for dissolved oxygen and nitrate. Dissolved oxygen values were wider ranging (into supersaturated conditions), more than other streams of the same drainage area (Figures B.3.42 and B.3.43). Nitrate showed the second highest median concentration and the highest actual concentration of all WWH streams in the 4 to 8 square mile drainage category (Figure B.3.35). These chemical data and visual observations of large algal blooms instream suggest that Hay Run suffers from significant nutrient enrichment.

<u>Prairie Run</u> (02-219) (RM 63.84) (Undesignated/LRW Recommended)
No chemical data taken.

<u>Buck Run</u> (02-209) (RM63.74) (WWH)
Chemical water quality was evaluated at four locations in the Buck Run watershed. Water quality criteria violations of the WWH minimum dissolved oxygen criteria occurred twice during

the survey (Table B.3.1) and the mean values for D.O. in Buck Run were slightly greater than the WWH average D.O. criterion of 5 mg/l at RM 7.80, 5.00, and 0.10.

Total suspended solids concentrations were greater than the 75th percentile of background in every sample taken in Buck Run, even exceeding the 90th percentile 7 times out of 20. Additionally, nutrient concentrations were excessive in many samples. Moderate to elevated concentrations of organic nitrogen (TKN) and total phosphorus were apparent followed by significant appearances of ammonia.

Comparison of Buck Run sampling sites with other sampling stations on streams of similar drainage confirmed that Buck Run was indeed impaired by insufficient dissolved oxygen and elevated concentrations of suspended solids, bacteria, and nutrients (Figures B.3.38, B.3.41, B.3.45 (D.O.), B.3.25, B.3.26, B.3.7 (TSS), B.3.29, B.3.30, B.3.31, B.3.46, B.3.47 (bacteria), B.3.36, B.3.16 (TKN), B.3.37, B.3.44, B.3.48 (P), B.3.34, B.3.39, B.3.49 (ammonia)). Biological community results also confirm this (Table A.15).

Figure B.3.43. Box and whisker plot of Percent Dissolved Oxygen saturation at designated sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

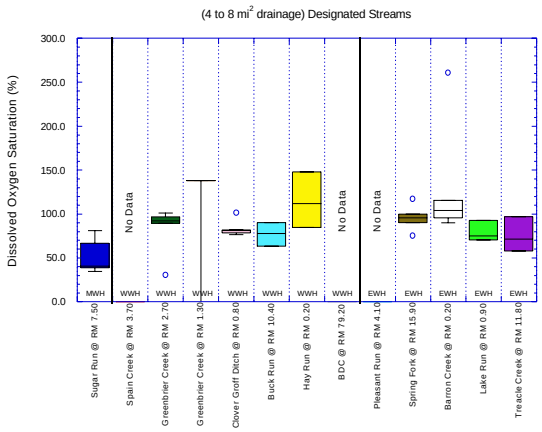


Figure B.3.44. Box and whisker plot of Total Phosphorus concentrations at sampling sites with a drainage area of 8-16 mi^2 in the Big Darby Creek watershed, 2001.

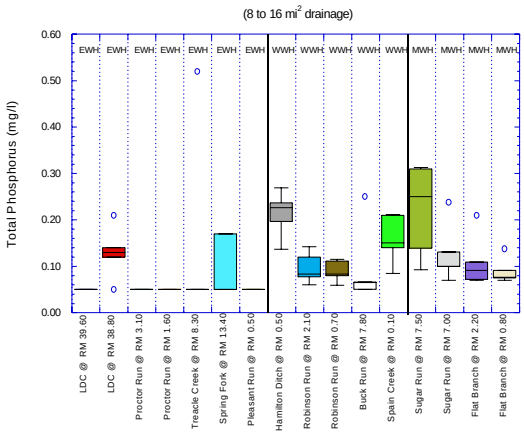


Figure B.3.45. Box and whisker plot of Dissolved Oxygen concentrations at sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

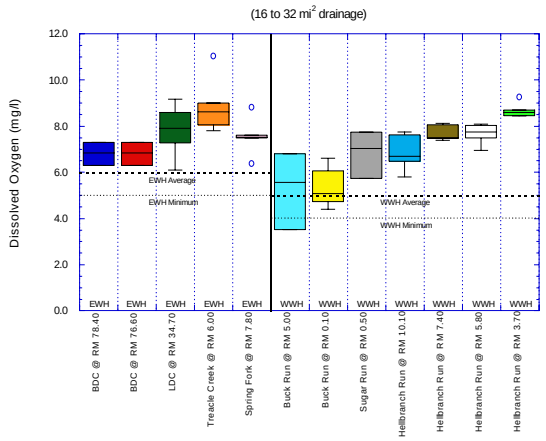


Figure B.3.46. Box and whisker plot of Fecal Coliform colonies/100 ml. at designated sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

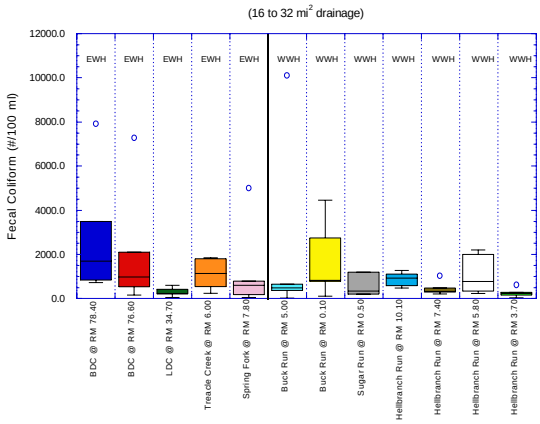


Figure B.3.47. Box and whisker plot of *E. coli* colonies/100 ml. at designated sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

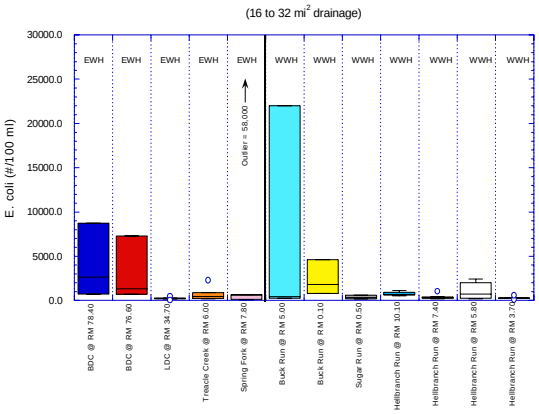


Figure B.3.48. Box and whisker plot of Total Phosphorus concentrations at designated sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

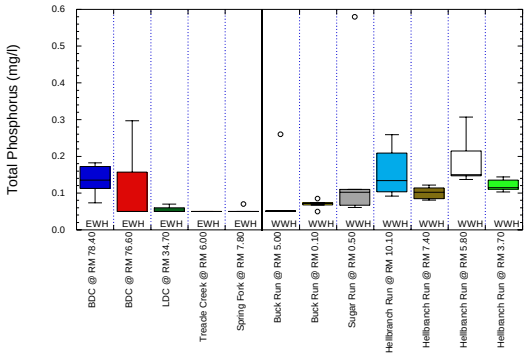
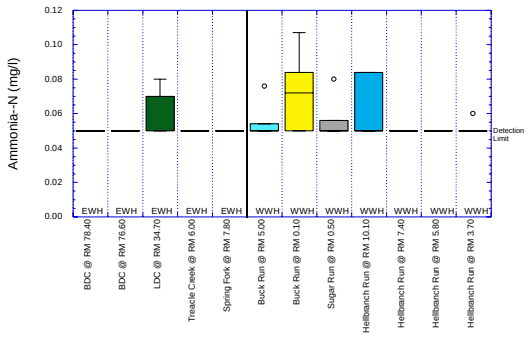


Figure B.3.49. Box and whisker plot of Ammonia concentrations at designated sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.



Robinson Run (02-207) (RM 53.69) (WWH)

Robinson Run is designated WWH, AWS, IWS, and PCR. There were no violations of chemical water quality criteria in Robinson Run during the survey. Dissolved oxygen concentrations were well above WWH criteria (Figure B.3.28). Nitrogen (TKN) concentrations were well above the background 75th percentile in all cases with many values exceeding the 90th percentile (Table B.3.2). Total phosphorus was also greater than the background 75th percentile in 70% of the samples taken in Robinson Run (Table B.3.2). Concentrations of suspended solids, nitrate, nitrite, and ammonia were also noticeable.

Comparison of Robinson Run with streams of similar drainage area yielded little difference for nutrients. All of the WWH streams in this drainage range seemed impaired by nutrients (Figures B.3.16, B.3.44 and B.3.39). The WWTPs in the upper portion of the watershed did not appear to be causing this nutrient enrichment.

Sweeney Run (02-357) (RM 52.11) (Undesignated/WWH Recommended)

Chemical water quality sampling in Sweeny Run included a single sampling location within the Village of Plain City. Water quality criteria for WWH apply to this stream even though it is currently undesignated. Nutrient enrichment was apparent via the observation of large algal blooms instream coupled with excessive concentrations of ammonia, nitrate, organic nitrogen, and total phosphorus (Table B.3.2).

Comparison of Sweeney Run with other streams of similar drainage area showed a narrow range of values for TSS clustered very close to the background median (Figure B.3.10); widely variable results for nitrates, including some values elevated above the 90th percentile of background; and wide-ranging concentrations of fecal coliform bacteria (Table B.3.2, Figures B.3.14 and B.3.22). Organic nitrogen, ammonia and total phosphorus were also present in significantly higher concentrations when compared with similar streams (Figures B.3.11 to B.3.13)

Middle Big Darby Creek, Including Tributaries

(Plain City to confluence with Little Darby Creek)

Chemical water quality sampling in Middle Big Darby Creek extended from just downstream of the Village of Plain City WWTP outfall (RM 52.00) to the confluence with Little Darby Creek at RM 34.10 (4 sampling stations). Tributaries included in this sampling effort included Sugar Run (4 sampling stations), Worthington Ditch (1 sampling station), Ballenger-Jones Ditch (1 sampling station), Yutzy Ditch (1 sampling station), and Fitzgerald Ditch (1 sampling station).

Mainstem

Chemical water quality sampling occurred in middle Big Darby Creek five times during the 2001 survey period. There were no violations of water quality criteria found in the middle Big Darby Creek mainstem (Table B.3.1). Effluent sampling at the Village of Plain City WWTP outfall revealed a single violation of the fecal coliform limit in the NPDES permit issued to the village (Table B.3.1). Biosolids deposits were witnessed immediately downstream of the outfall, in violation of the “free froms” in the WQS. Significant increases in bacterial and nutrient concentrations in Big Darby Creek immediately downstream of the Plain City WWTP outfall were observed. The NPDES permit limits have been adjusted to eliminate these violations (see discussion of Plain City WWTP in Section B.1).

The Village of Plain City WWTP was the main cause of degradation and partial biological attainment in this segment of stream. Nutrient concentrations immediately downstream of the outfall were always greater than the background median and often greater than the 95th percentile of background (Table B.3.2). Concentrations of suspended solids, nitrate+nitrite, TKN, and total phosphorus remained elevated downstream to RM 49.50 and were likely due to the residual effects of the Plain City WWTP discharge (Table B.3.2). Chemical water quality and biological attainment were not compromised at RM 42.00 and RM 34.10. The numerous small WWTPs scattered along this stretch of river did not appear to impair chemical water quality or the biota.

Sugar Run (02-206) (RM 50.92) (WWH/MWH Recommended > RM7.0, WWH<RM 7.0)

Sugar Run was sampled for chemical water quality at four different sites along its length. Chemical water quality criteria in Sugar Run were violated by a few instances of low dissolved oxygen (Table B.3.1). Mean dissolved oxygen concentrations were less than 1.0 mg/l above the standard of 4.0 mg/l for modified streams (Figure B.3.50). Dissolved oxygen concentrations in Sugar Run were similar to those found in streams of the same drainage area (Figures B.3.41 and

B.3.45). *E. coli* bacteria concentrations were excessive on only a few occasions and were mild in comparison with area streams of similar drainage and designation (Figures B.3.31 and B.3.47).

Mean total suspended solids were consistently at or above 18 mg/l in Sugar Run. Total suspended solids concentrations were found in excess of at least the background median concentration on every sampling occasion at the three lowermost sampling sites (Table B.3.2). The uppermost site at RM 7.50 showed only one instance of this during a rain event, when the sample exceeded the 95th percentile for background (Table B.3.2). Comparison of Sugar Run sampling locations with similarly-sized drainage areas indicated that the upper site at RM 7.50 was much like other sites as was the site at RM 7.0. Sugar Run at RM 5.4 and RM 0.5 exhibited modestly elevated suspended solids concentrations when compared with reaches of similar drainage.

Organic forms of nitrogen as measured by TKN and total phosphorus were well above the 75th percentile of background at all four sites (Table B.3.2). Mean concentrations of TKN were above 1 mg/l at all sites but the mouth (Figure B.3.51). Comparisons with stream reaches of similar drainage area and designation (MWH, WWH) showed that Sugar Run was suffering from gross nutrient enrichment in the modified section and moderate nutrient enrichment in the WWH portion (Figures B.3.36, B.3.16, B.3.60, B.3.37, B.3.44 and B.3.48). Ammonia concentrations were also found to be regularly above background conditions and certainly contribute to nutrient pollution along with nitrate+nitrite (Figure B.3.51).

Figure B.3.50. Mean concentrations of Dissolved Oxygen at sampling sites in Sugar Run, 2001.

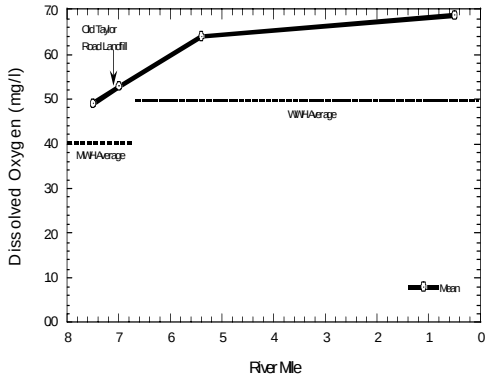
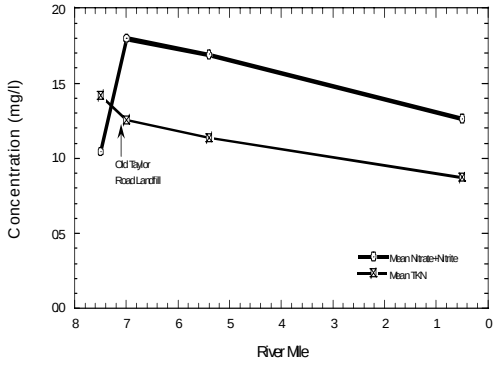


Figure B.3.51. Mean concentrations of Total Kjeldahl Nitrogen and Nitrate+Nitrite at sampling sites in Sugar Run, 2001.



These chemical water quality problems are caused by several conditions. First, the majority of the Sugar Run watershed is dominated by poor habitat including modified (channelized) sections and missing riparian corridor as evidenced by the poor QHEI scores. This modified habitat allows for more erosion with accompanying increases in suspended materials and siltation. Poor habitat also short-circuits proper nutrient cycling. Add to this the additional nutrient inputs from a golf course in the upper watershed, and widespread agricultural practices and the result is impaired chemical water quality. Since the majority of the watershed has degraded habitat, even the section at the mouth (which had better habitat and exhibited biological attainment) was nutrient enriched and negatively impacted by suspended solids, threatening biological attainment.

Worthington Ditch (02-02-356) (RM 50.62) (Undesignated/WWH Recommended)
This small headwater stream drains approximately 4.4 square miles. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of chemical water quality criteria were in evidence following testing (Table B.3.1). Nutrient concentrations in Worthington Ditch were significantly greater than median background conditions as shown by the concentrations of nitrates, TKN, and total phosphorus (Table B.3.2). Water chemistry in this stream compares favorably with others of the same drainage area exhibiting lower ammonia, suspended solids and bacterial concentrations as well as moderate to good oxygen saturation (Figures B.3.6, B.3.23, B.3.24 and B.3.42). However, TKN values were all found to be above the background median and well above those of some other small streams (Figure B.3.36).

Ballenger-Jones Ditch (02-355) (RM 49.68) (Undesignated/WWH Recommended)
This small headwater stream drains approximately 6.0 square miles. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of chemical water quality criteria were in evidence following testing (Table B.3.1). Elevated concentrations of TKN and phosphorus were also noted in this waterbody (Table B.3.2). These instances of bacterial contamination and nutrient enrichment are due in part to the discharge from the Jonathan Alder High School WWTP. Comparison with other streams of the same drainage area shows similar concentrations of ammonia, total suspended solids, phosphorus, and bacteria with moderately elevated concentrations of TKN (Figures B.3.18, B.3.6, B.3.20, B.3.23, B.3.24 and B.3.36).

Yutzy Ditch (02-364) (RM 47.10) (Undesignated/WWH Recommended)
This small headwater stream drains approximately 4.3 square miles. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of chemical water quality criteria were in evidence following testing (Table B.3.1). Elevated concentrations of nutrients were also noted and similar to those found in Ballenger-Jones Ditch (Table B.3.2). The Canaan Elementary School WWTP is found on this stream; however, no discharge was occurring during the summer sampling season because school was not in session.

Chemical water quality in Yutzy Ditch was comparable to other streams of similar drainage area for ammonia, phosphorus, total suspended solids and dissolved oxygen (Figures B.3.18, B.3.6

and B.3.20). Concentrations of both *E. coli* and TKN were wider in scope and higher than most other streams of the same size evaluated in the study (Figures B.3.24 and B.3.36).

Fitzgerald Ditch (02-272) (RM 44.96) (Undesignated/WWH Recommended)

This small headwater stream drains approximately 5.1 square miles. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of chemical water quality criteria were in evidence following testing (Table B.3.1). Nutrient concentrations were excessive in Fitzgerald Ditch with values for ammonia, nitrates, and total phosphorus all greater than the 75th percentile of background with some exceeding the 95th percentile (Table B.3.2). These instances of bacterial contamination and nutrient enrichment are due in part to the discharge from the poorly operated and maintained Canaan Community MHP WWTP, approximately a mile upstream.

Chemical water quality in Fitzgerald Ditch tended to be the most degraded when compared with other streams of similar drainage area. Elevated concentrations of bacteria as well as suspended solids, TKN, phosphorus, and ammonia were the norm as was dissolved oxygen supersaturation (Figures B.3.18, B.3.6, B.3.20, B.3.23, B.3.24, B.3.36 and B.3.42).

Little Darby Creek

Chemical water quality sampling in Little Darby Creek extended from the headwaters at RM 41.20 to RM 0.70 at the mouth (10 sampling stations). Tributaries included in this sampling effort included Clover Run (1 sampling station), Lake Run (1 sampling station), Jumping Run (1 sampling station), Treacle Creek (4 sampling stations), Howard Run (1 sampling station), Proctor Run (3 sampling stations), Barron Creek (1 sampling station), Spring Fork (4 sampling stations) and Bales Ditch (1 sampling station).

Mainstem

Chemical water quality sampling was conducted five times in Little Darby Creek during the 2001 survey. No violations of water quality criteria were discovered. Mean bacterial concentrations were high up and downstream of the Mechanicsburg WWTP apparently resulting from on-site waste treatment systems and the WWTP respectively (Figures B.3.52 and B.3.53). Bacterial concentrations dropped precipitously at the next downstream site (RM 34.70) and then increased again downstream of the confluence of Little Darby and Treacle Creek (RM 29.50). Following the spike at the Treacle Creek confluence, bacterial numbers decreased to insignificant levels moving toward the mouth (Figures B.3.52 and B.3.53). Dry weather flow from the West Jefferson WWTP did not appear to contribute to any bacterial degradation.

Mean dissolved oxygen concentrations in Little Darby Creek were all greater than the EWH average of 6 mg/l. The Mechanicsburg WWTP discharge appeared to promote a slight sag in dissolved oxygen downstream at RM 34.70, but nothing that violated water quality criteria. Dissolved oxygen concentrations became excessive at the mouth with mean saturation values over 150%. This was indicative of nutrient enrichment and poor riparian coverage as well a

Figure B.3.52. Mean number of colonies/100 ml. of Fecal Coliform bacteria at sampling sites on Little Darby Creek, 2001.

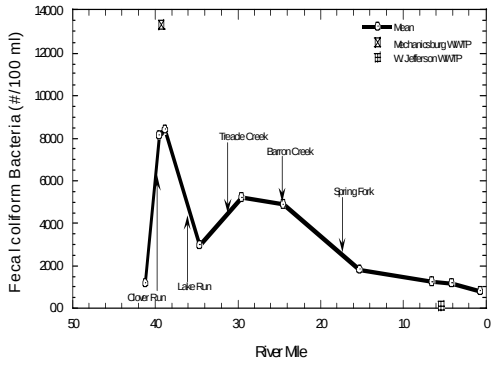
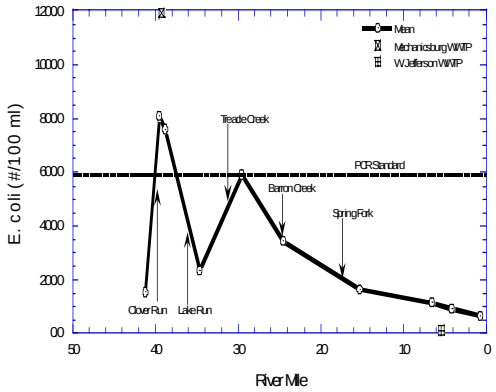


Figure B.3.53. Mean number of colonies/100 ml. of *E. coli* bacteria at sampling sites in Little Darby Creek, 2001.



modified stream channel with poor pool development.

Mean values of total suspended solids showed a marked increase downstream of Mechanicsburg (RM 34.70) to RM 24.50 (Figure B.3.54). Some of this increase was directly attributable to Treacle Creek and Barron Creek, both of which contributed large amounts of suspended solids to Little Darby Creek (see discussion of these creeks in the sections below) so that average values were well in excess of background median concentrations. Suspended solids mean concentrations decreased downstream of Spring Fork and remained below background median values down to the mouth (Figure B.3.54). Comparison of sites on Little Darby Creek with other EWH streams of similar drainage area revealed that the Little Darby Creek had relatively low suspended solids concentrations in most cases (Figures B.3.10, B.3.26, B.3.55 and B.3.56).

Mean concentrations of nitrate+nitrite exhibited a downward trend beginning at around 4 mg/l and leveling off around 2 mg/l just downstream of Lake Run and remaining relatively consistent down to the mouth (Figure B.3.57). Neither Mechanicsburg WWTP nor the West Jefferson WWTP seemed to create a significant increase in nitrate+nitrite concentrations instream. However, comparison of sites on Little Darby Creek with similar EWH sites of similar drainage area showed differences. Median nitrate+nitrite concentrations at most sites were among the highest detected for comparably-sized stream segments (Figures B.3.14, B.3.40, B.3.58 and B.3.59). Fully 74% of the samples analyzed for nitrate+nitrite in the Little Darby Creek were greater than the background median with 32% greater than the 75th percentile (Table B.3.2).

Other nutrients, including organic nitrogen (measured by TKN), ammonia, and total phosphorus were generally more consistent with their comparison stream segments. TKN concentrations were all comparable or lower than their counterparts (Figures B3.11, B.3.16, B.3.60, B.3.61 and B.3.62). Ammonia was typically undetected except in a few instances downstream of the Mechanicsburg WWTP and downstream of Treacle Creek at RM 29.50 and RM 24.50 (Figures B.3.13, B.3.39 and B.3.49). Mean total phosphorus showed notable peaks downstream of Mechanicsburg WWTP and West Jefferson WWTP as well as a gradual increase moving downstream (Figure B.3.63).

Storm water monitoring was performed at various times over a year's period for Little Darby Creek at Middle Pike (RM 7.35). This sampling station houses a USGS gauge which provided flow data for the calculation of different pollutant loadings. Total suspended solids and 3 nutrients were evaluated. Loadings of suspended solids, ammonia, nitrate+nitrite, and total phosphorus all increased with increasing flow volume, though not proportionally (Figures B.3.64 to B.3.67). For example, a storm event sampled on March 28, 2002 exhibited a flow of 25,734 liters/second (909 ft^3/s) with loadings of 115,617 kg/d of suspended solids, 25,792 kg/d of nitrate+nitrite, 145 kg/d of ammonia, and 238 kg/d of phosphorus whereas a storm event monitored on April 15, 2002 showed a flow of 46,428 liters/second (1640 ft^3/s) with loadings of 437,247 kg/d of suspended solids, 26,395 kg/d of nitrate+nitrite, 237 kg/d of ammonia, and 911 kg/d of phosphorus. Comparisons of the flows and loadings between these events shows increased flow (1.8 fold) with a 3.8 fold increase in suspended solids, a slightly increased loading of nitrate+nitrite, a 1.6 fold increase in ammonia loadings, and a 3.8 fold increase in phosphorus loadings.

Figure B.3.54. Mean Total Suspended Solids concentrations at sampling sites in Little Darby Creek, 2001.

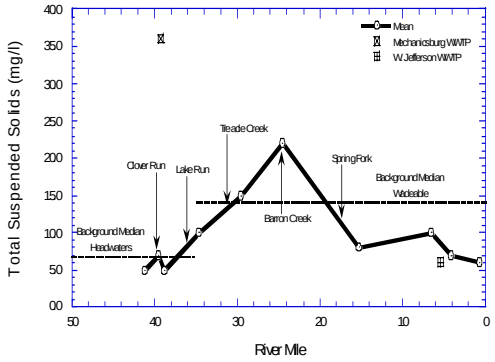


Figure B.3.55. Box and whisker plot of Total Suspended Solid concentrations at sampling sites with a drainage area of 64-128 mi^2 in the Big Darby Creek watershed, 2001.

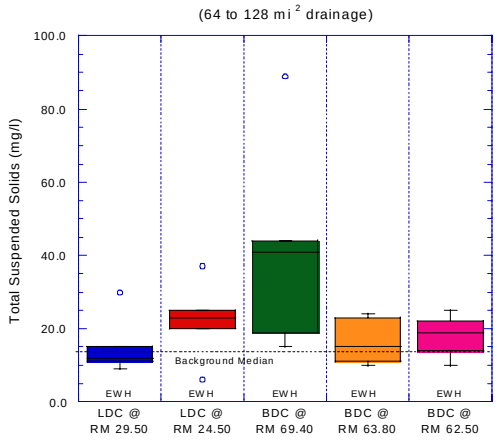


Figure B.3.56. Box and whisker plot of Total Suspended Solid concentrations at sampling sites with a drainage area of 128-256 mi^2 on the Big Darby Creek mainstem, 2001.

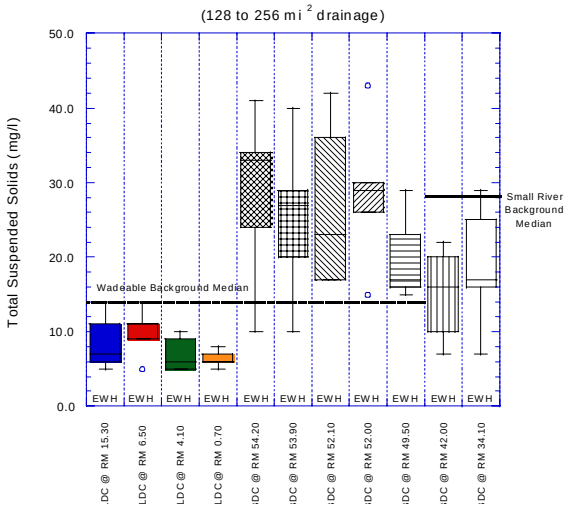


Figure B.3.57. Mean Nitrite+Nitrate concentrations at sampling sites in Little Darby Creek, 2001.

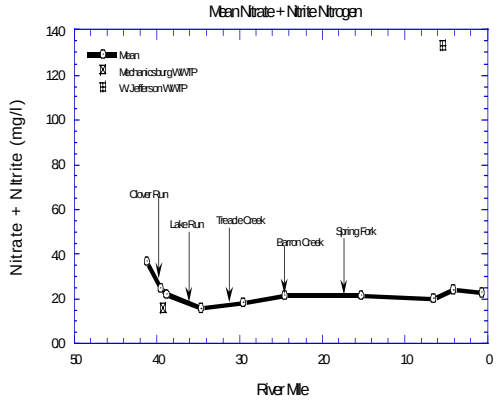


Figure B.3.58. Box and whisker plots of Nitrate+Nitrite concentrations at sampling sites with a drainage area of 64-128 mi^2 in the Big Darby Creek, 2001.

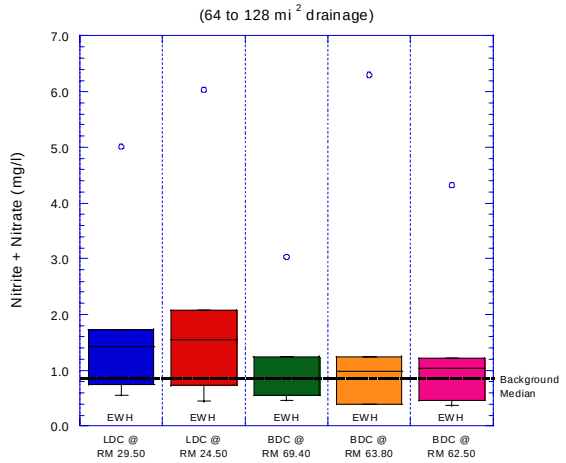


Figure B.3.59. Box and whisker plots of Nitrate+Nitrite concentrations at sampling sites with a drainage area of 128 -256 mi^2 in the Big Darby Creek, 2001.

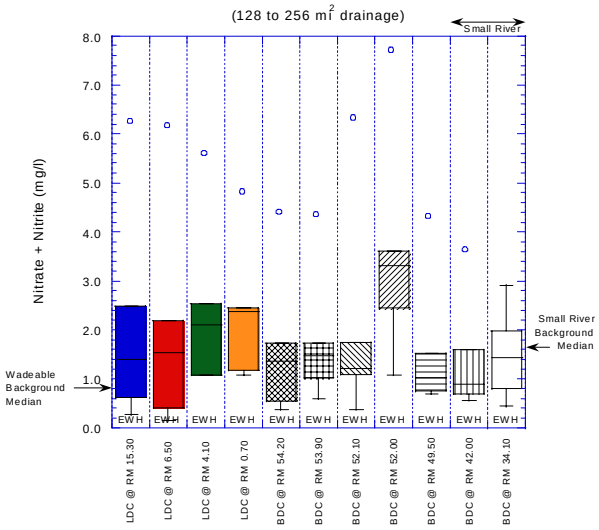


Figure B.3.60. Box and whisker plot of Total Kjeldahl Nitrogen concentrations at sampling sites with a drainage area of 16-32 mi^2 in the Big Darby Creek watershed, 2001.

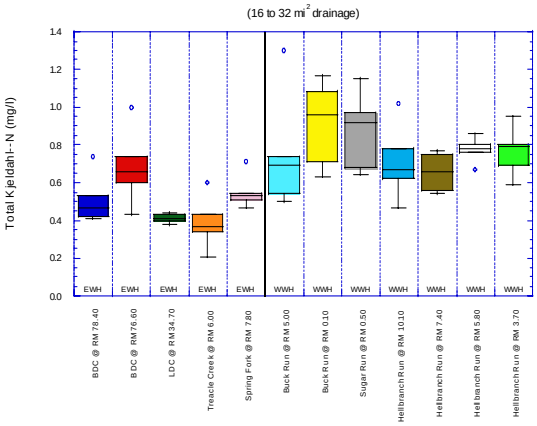


Figure B.3.61. Box and whisker plot of Total Kjeldahl Nitrogen concentrations at sampling sites with a drainage area of 64-128 mi^2 in the Big Darby Creek watershed, 2001.

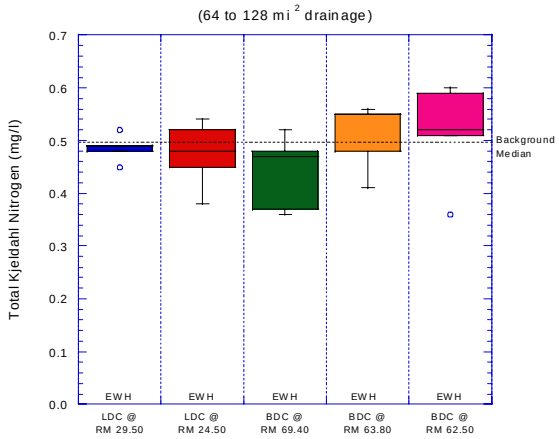


Figure B.3.62. Box and whisker plot of Total Kjeldahl Nitrogen concentrations at sampling sites with a drainage area of 128-256 mi^2 in the Big Darby Creek watershed, 2001.

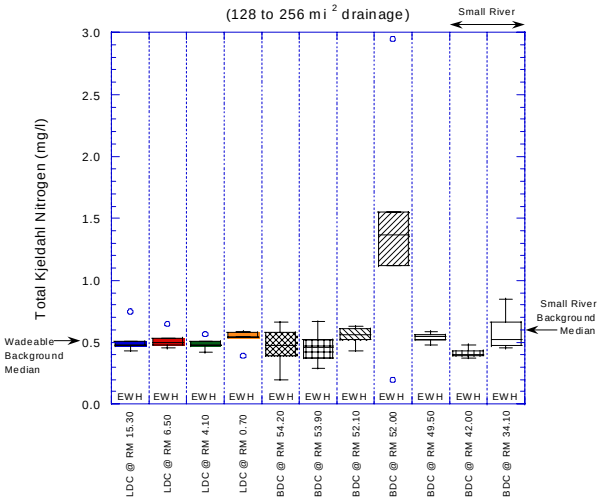


Figure B.3.63. Mean concentrations of Total Phosphorus at sampling sites in the mainstem of Little Darby Creek, 2001.

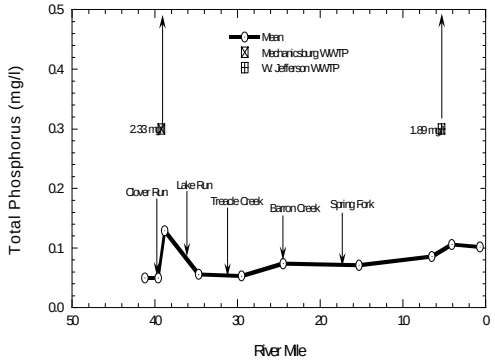


Figure B.3.64. Little Darby Creek storm event sampling - Mean Daily Flow vs. Total Suspended Solids Loadings based on sampling at the USGS Gaging Station at Middle Pike (RM 7.35) in Little Darby Creek, 2001.

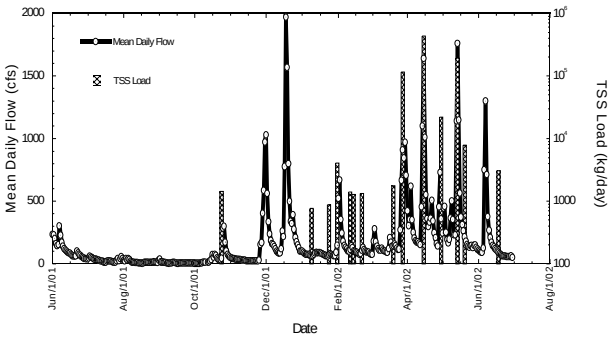


Figure B.3.65. Little Darby Creek storm event sampling - Mean Daily Flow vs. Nitrate+Nitrite Loadings based on sampling at the USGS Gaging Station at Middle Pike (RM 7.35) in Little Darby Creek, 2001.

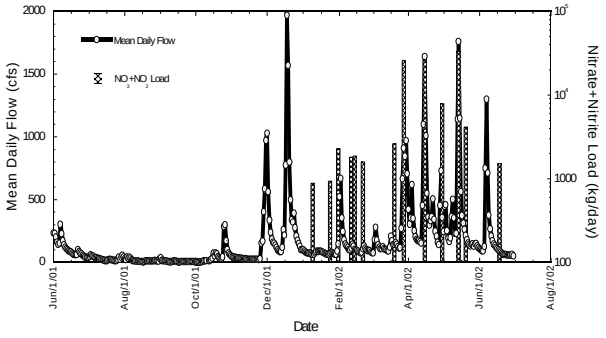


Figure B.3.66. Little Darby Creek storm event sampling - Mean Daily Flow vs. Ammonia Loadings based on sampling at the USGS Gaging Station at Middle Pike (RM 7.35) in Little Darby Creek, 2001.

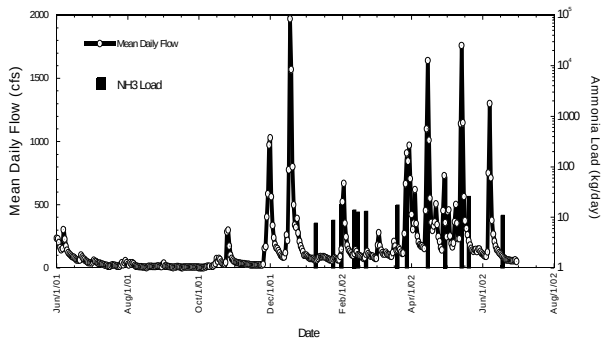
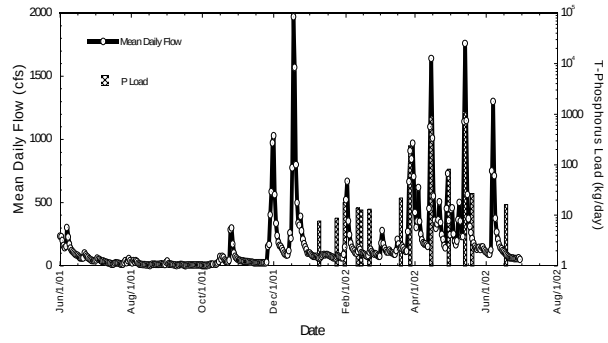


Figure B.3.67. Little Darby Creek storm event sampling - Mean Daily Flow vs. Total Phosphorus Loadings based on sampling at the USGS Gaging Station at Middle Pike (RM 7.35) in Little Darby Creek, 2001.



<u>Clover Run</u> (02-218) (RM 39.80) (EWH/WWH Recommended)
Water chemistry in Clover Run showed no violations of water quality criteria although bacterial contamination from *E. coli* was apparent in every sample taken in 2001 (Table B.3.1). Dissolved oxygen was found at acceptable concentrations with a median well above the average standard and no supersaturated conditions (Figures B.3.68 and B.3.69). Nutrient concentrations were not elevated with respect to background, nor were they found at median concentrations much different than other streams of similar size (comparison of Clover Run, an EWH stream was made to other WWH streams as there were no small EWH streams for comparison).

<u>Lake Run</u> (02-216) (RM 36.90) (EWH/EWH Deferred)
Chemical water quality in Lake Run exhibited no violations of water quality criteria (Table B.3.1). Dissolved oxygen concentrations compared well with stream segments of similar drainage area and were adequate and narrow-ranged showing nearly saturated conditions in most cases (Figures B.3.70 and B.3.71). Concentrations of nutrients, including ammonia and TKN were slightly elevated whereas phosphorus concentrations were below detection (Table B.3.1, Section C.1). Comparison of these values with EWH stream segments of similar drainage showed that ammonia values were indeed abnormal (Figure B.3.34) while organic nitrogen (TKN) was comparable with similar-sized locations (Figure B.3.36) even though most TKN values were in excess of the median for headwater streams. Nitrate+nitrite concentrations were similar to other stream segments (Figure B.3.35).

Figure B.3.68. Box and whisker plot of Dissolved Oxygen concentrations for sampling sites with a drainage area of 0-2 mi^2 in the Big Darby Creek watershed, 2001.

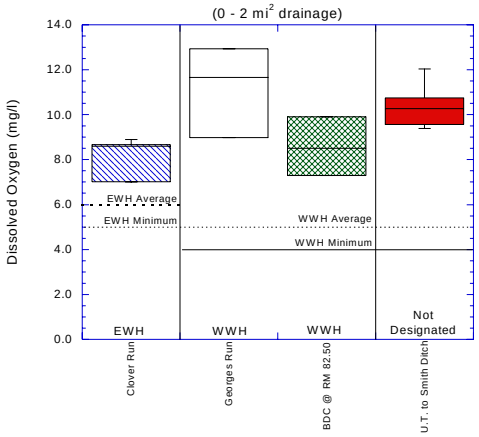


Figure B.3.69. Box and whisker plot of percent Dissolved Oxygen Saturation for sampling sites with a drainage area of 0-2 mi^2 in the Big Darby Creek watershed, 2001.

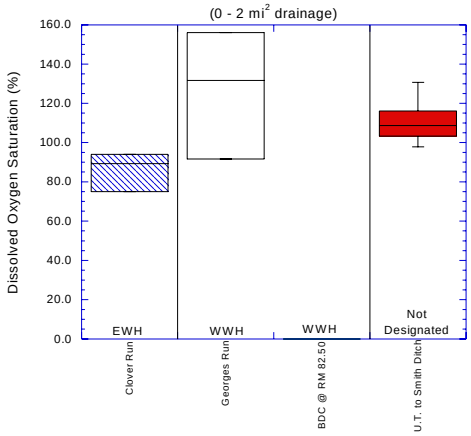


Figure B.3.70. Box and whisker plot of Dissolved Oxygen concentrations for sampling sites with a drainage area of 4-8 mi^2 in the Big Darby Creek watershed, 2001.

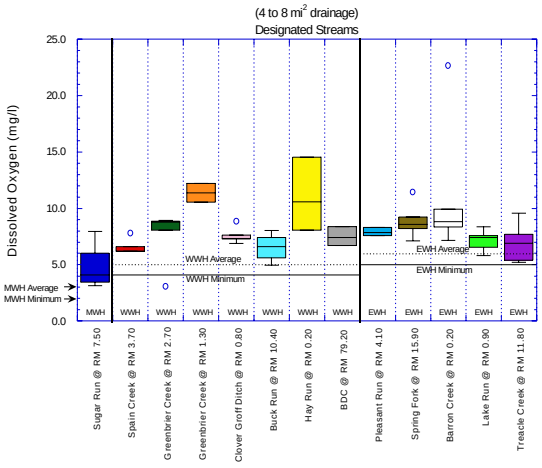
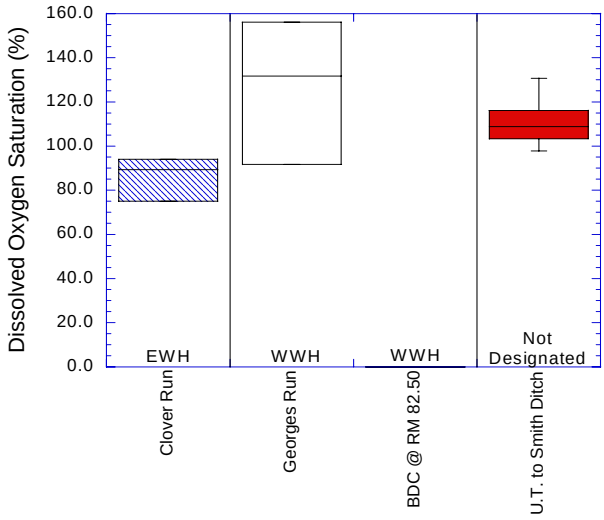


Figure B.3.71. Box and whisker plot of percent Dissolved Oxygen Saturation for sampling sites with a drainage area of 0-2 mi^2 in the Big Darby Creek watershed, 2001.



Jumping Run (02-217) (RM 3.90) (EWH/WWH Recommended)
Water quality sampling in Jumping Run in 2001 showed no violations of water quality criteria. Bacterial contamination from *E. coli* was evident in the majority of the samples, however (Table B.3.1). Dissolved oxygen concentrations did show some wider variability than other streams segments of similar drainage area, with the lower end of the range nearly at the EWH minimum of 5 mg/l (Figure B.3.15). This may be a sign of the beginning of chemical water quality problems. Nutrient concentrations in Jumping Run were comparable with other stream segments of similar drainage area (Figures B.3.11 to B.3.14) and suspended solids were some of the lowest in this category (Figure B.3.10).

Treacle Creek (02-213) (RM 31.30) (EWH)
Water quality sampling in Treacle Creek revealed no violations of water quality criteria. *E. coli* bacteria were found in the majority of the samples at elevated mean concentrations (Figure B.3.72).

Mean dissolved oxygen concentrations were well above the 6.0 mg/l standard for EWH streams (Figure B.3.73). However, dissolved oxygen ranges exhibited some disturbingly low values that were very near the minimum criteria of 5 mg/l at RM 11.80 and RM 0.80 (Section C.1). Generally, dissolved oxygen concentrations in Treacle Creek were comparable to other stream segments of similar drainage area (Figures B.3.27, B.3.28 and B.3.45).

Total suspended solids concentrations in Treacle Creek increased with distance downstream. Mean values increased more than 3-fold from RM 8.30 to RM 6.00 (Figure B.3.74) with half of the concentrations in excess of the 75th percentile of background at the lower 2 sites (Table B.3.2). Comparison of suspended solids concentrations at the lower site showed a large disparity between similarly-sized sites on Hellbranch Run (even though Hellbranch Run is only a WWH stream) and Spring Fork with Treacle Creek showing much greater values and a median concentration much higher than background.

Upper Treacle Creek (RM 11.80) exhibited some of the highest ammonia concentrations when compared with similarly sized stream segments; with two values topping the 95th percentile for background (Figure B.3.34, Table B.3.2). Organic nitrogen (TKN) and total phosphorus concentrations were also elevated in comparison with similar streams (Figures B.3.36 and B.3.37) and nitrate values that were analogous (Figure B.3.35).

The middle section of Treacle Creek (RM 8.30 and RM 6.00) showed no evidence of ammonia contamination or abnormal concentrations of TKN (Section C.1, Figures B.3.16 and B.3.60); however, mean nitrate+nitrite concentrations increased by about 33% compared with the upstream site (Figure B.3.75). Median nitrate+nitrite concentrations in middle Treacle Creek were among the highest of comparably-sized streams (Figure B.3.40).

Lower Treacle Creek exhibited slight increases in the mean concentrations of ammonia, nitrate+nitrite, and TKN compared with the middle section (Figure B.3.75). Sixty percent of the ammonia values were greater than the 75th percentile of background and 80 percent of the

Figure B.3.72. Mean number of colonies/100 ml. of *E. coli* bacteria at sampling sites in Treacle Creek, 2001.

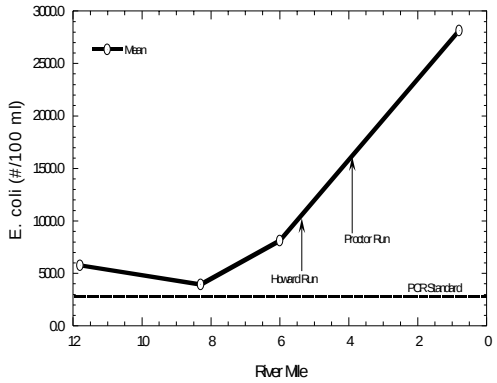


Figure B.3.73. Mean Dissolved Oxygen concentrations at sampling sites in Treacle Creek, 2001.

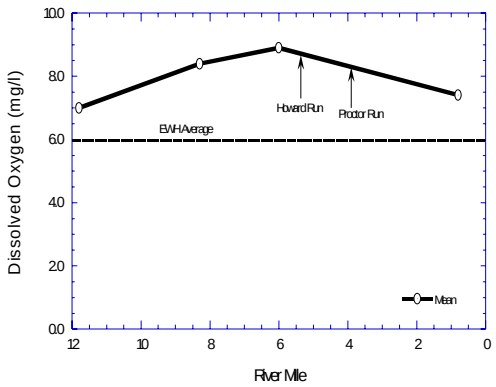


Figure B.3.74. Mean Total Suspended Solids concentrations at sampling sites in Treacle Creek, 2001.

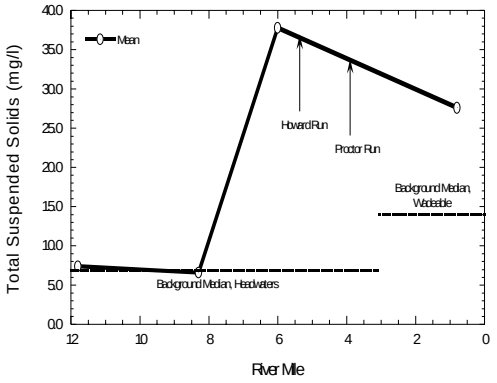
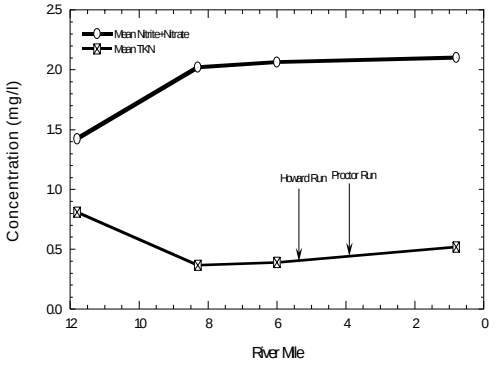


Figure B.3.75. Mean Nitrate+Nitrite and Total Kjeldahl Nitrogen concentrations at sampling sites in Treacle Creek, 2001.



nitrate+nitrite values were greater than the 50th percentile for background with one exceeding the 90th percentile (Table B.3.2).

Treacle Creek appears threatened by excessive numbers of *E. coli* bacteria over the entire stream channel along with high concentrations of suspended solids and immoderate nutrient concentrations in the upper and lower watersheds. This is likely due to contributions from multiple agricultural sources.

Howard Run (02-215) (RM 5.40) (EWH)

A single sampling location on Howard Run revealed no violations of water quality criteria during the 2001 survey. *E. coli* concentrations were, however, elevated in all samples (Table B.3.1). Dissolved oxygen concentrations and saturation were well within criteria and norms respectively and compared favorably to similarly sized streams (Figures B.3.68 and B.3.69). Phosphorus and ammonia were at or near detection levels in all samples with median TKN concentrations below background median. Nitrate+nitrite concentrations were more variable, but still comparable with similarly-sized stream segments (Figure B.3.14). Elevated concentrations of *E. coli* bacteria from Howard Run may contribute to bacterial contamination in Treacle Creek.

Proctor Run (02-214) (RM 3.69) (EWH)

Chemical water quality evaluation of Proctor Run revealed no violations of water quality criteria at any sampling site during the survey. However, numerous water quality problems were identified throughout this subwatershed.

Upper Proctor Run (RM 4.90) exhibited good dissolved oxygen concentrations with little to no supersaturation noted during instantaneous sampling (Figure B.3.15). Bacterial concentrations were noticeably higher than comparable stream segments (Figure B.3.22). Additionally, suspended solids concentrations were nearly all above the background median and generally greater than comparable EWH waterways (Figure B.3.10). Other nutrient concentrations were commensurate or minutely higher than comparison streams (total phosphorus, ammonia, TKN) or significantly lower (nitrate+nitrite).

Lower Proctor Run (RM 3.10 and RM 1.60) exhibited D.O. values similar to the upper reach although the site at RM 3.10 showed much wider variability. Comparison with stream reaches of similar size and drainage showed little difference, however (Figure B.3.41). Bacterial concentrations were lower possibly indicating attenuation from a source upstream. Mean values for suspended solids decreased from upstream values as did mean ammonia and phosphorus (Figures B.3.76 and B.3.77). Mean nitrate+nitrite increased by a factor of 4 before dropping slightly (Figure B.3.78) and mean TKN values remained steady. All nutrient concentrations in lower Proctor Run were commensurate with stream reaches of similar drainage area (Figures B.3.16, B.3.17, B.3.39 and B.3.40).

Figure B.3.76. Mean concentrations of Total Suspended Solids at sampling sites in Proctor Run, 2001.

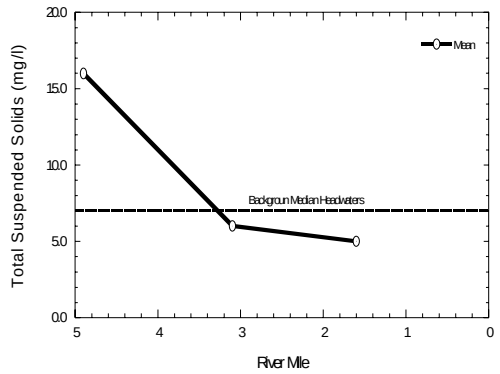


Figure B.3.77. Mean concentrations of Ammonia and Total Phosphorus at sampling sites in Proctor Run, 2001.

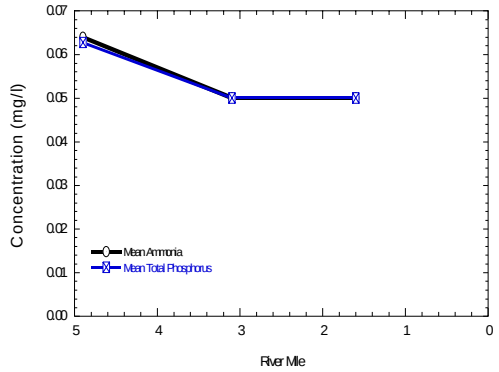
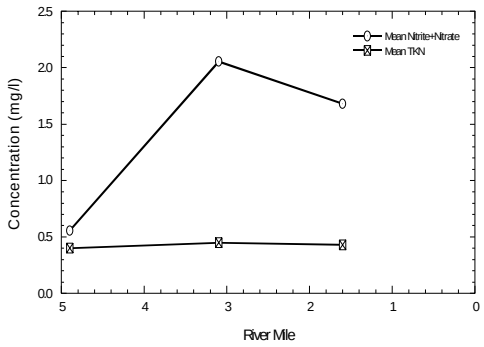


Figure B.3.78. Mean concentrations of Nitrate+Nitrite and Total Kjeldahl Nitrogen at sampling sites in Proctor Run, 2001.



Barron Creek (02-212) (RM 24.40) (EWH/WWH Recommended)
Chemical water quality monitoring in Barron Creek took place near the mouth at RM 0.20. There were no instances of water quality criteria violations noted during the sampling although serious chemical water quality problems were verified. Dissolved oxygen concentrations were generally within norms; however, one sample exhibited an extraordinary concentration of dissolved oxygen, greater than 20 mg/l with a saturation greater than 250% (extreme supersaturation). This could be indicative of a periodic pollution event.

Bacterial testing revealed contamination in every sample and with concentrations well above similar EWH streams (Figures B.3.30 and B.3.32) and indicative of a chronic contaminant source, perhaps poor manure management practices or another agricultural source.

Total suspended solids concentrations were all greater than the background median and higher than similarly sized streams (Figure B.3.25). Ammonia, organic nitrogen (TKN), and phosphorus were all present in concentrations that were in excess of other EWH streams of the same drainage area (Figures B.3.34, B.3.36 and B.3.37)). Concentrations of nitrate+nitrite were in the same range as comparison stream reaches (Figure B.3.35).

Spring Fork (02-211) (RM 17.46) (EWH)
Chemical water quality monitoring for Spring Fork occurred at four locations ranging from the headwaters to near the mouth. No water quality criteria violations were observed during the survey; however, some chemical water quality impairments were noted.

Dissolved oxygen mean concentrations were well over the EWH average found in the Ohio WQS. Dissolved oxygen saturation levels were between 80% and 100%. The site at RM 15.90 exhibited excellent oxygen concentrations and nearly saturated conditions during most of the survey (Section C.1). These values were comparable to other EWH stream segments of similar drainage (Figure B.3.27). The sampling location at RM 13.40 exhibited somewhat more variable dissolved oxygen concentrations and a wider range of saturation than similar EWH reaches, although median values for each were comparable to other sites (Figure B.3.41). Spring Fork at RM 7.80 also showed excellent dissolved oxygen concentrations (Figure B.3.45). Spring Fork at RM 0.80 displayed a more variable result for dissolved oxygen concentration and saturation. Saturation values were particularly disturbing with low and high values of around 62% and 130% respectively. This large variability in the data may be indicative of pollution caused by nutrient enrichment. Sources of nutrients to the stream in this area include the Green Meadows MHP WWTP and unrestricted access of livestock (many cattle were seen in the stream several times during the survey).

Both *E. coli* and fecal coliform bacteria results exhibited median values corresponding to EWH stream segments of similar size but the maximum values found were well in excess of these same locations in most cases (Figures B.3.30, B.3.32, B.3.79 and B.3.80).

Figure B.3.79. Mean number of colonies/100 ml. of *E. coli* bacteria from sampling sites in Spring Fork, 2001.

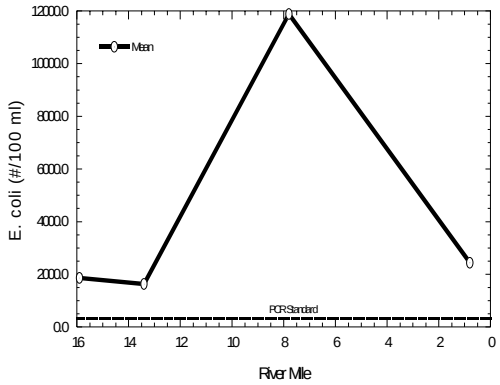
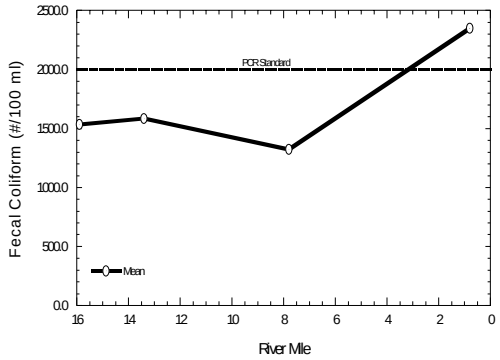


Figure B.3.80. Mean number of colonies/100 ml. of Fecal Coliform bacteria from sampling sites in Spring Fork, 2001.



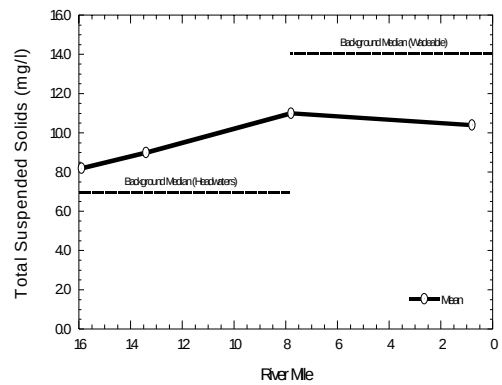
Spring Fork at RM 13.40 and RM 7.80 exhibited similar bacterial results compared to RM 15.40 (Figures B.3.31, B.3.46 and B.3.47). Sampling which occurred during a precipitation event produced the highest values while dry weather flow accounted for the rest. The problem is not completely precipitation-related, however. The site at RM 0.80 was atypical with median values much higher than comparably-sized stream reaches. Precipitation events did not seem to change the concentrations of bacteria noted at this site indicating a regular source of contamination (likely Green Meadows MHP WWTP and cattle in the creek).

Mean total suspended solids concentrations tended to rise slightly from RM 15.90 to RM 7.80 followed by a slight decrease at RM 0.80 (Figure B.3.81). Median values and ranges for suspended solids were much like those found in stream segments of similar EWH use designation and drainage area (Figures B.3.6, B.3.7 and B.3.26) although infrequently, elevated suspended solids concentrations were found in Spring Fork (Section C.1, Table B.3.2).

Nutrient concentrations were mixed with insignificant concentrations of ammonia and total phosphorus found in the upper part of the basin (RM 15.90 to RM 7.80). However, both ammonia and total phosphorus were detected with much more frequency and in higher concentrations at RM 0.80. Four out of 5 phosphorus concentrations were greater than the background median with 2 of these greater than the 75th percentile of background (Table B.3.2). Nitrate and TKN were present in the majority of samples taken at each site. At the upper site (RM 15.90) four out of 5 of the nitrate concentrations were greater than the background median with 2 of these greater than the 75th percentile of background (Table B.3.2). All samples

collected for organic nitrogen (TKN) were greater than the background median with one sample exceeding the 75th percentile and another exceeding the 90th percentile (Table B.3.2). The range of nitrate+nitrite concentrations at RM 15.90 was well above comparison stream segments (Figure B.3.35). Total Kjeldahl Nitrogen samples were comparable to most EWH segments in the 4 to 8 square mile drainage category but much higher than Pleasant Run (one of the higher quality streams noted in the survey, and an appropriate reference stream, see discussion on Pleasant Run above). Detections of nitrate+nitrite at RM 13.40 were fewer with an upper value of nearly 3 mg/l (Table B.3.2). The range and median of nitrate+nitrite values was commensurate with other EWH sites of similar drainage area, basically in the middle of the group (Figure B.3.40). The range of values measured for TKN was much wider than similar stream segments exhibiting the highest median value in the group (Figure B.3.16). Spring Fork at RM 7.80 exhibited results similar to the headwater location at RM 15.90. Most nitrate+nitrite values were greater than the background median as were concentrations of TKN (Table B.3.2). Comparison of this site with other EWH stream segments between 16 and 32 square miles revealed that median values were among the highest for both nitrate+nitrite and TKN (Figure B.3.60). Sampling performed at RM 0.80 exhibited concentrations of nitrate+nitrite that were all above median background concentrations and the highest median of all of the comparison stream reaches. Three of five TKN values exceeded the 75th percentile for background and comparison of these values to other stream reaches revealed that Spring Fork was second only to Hellbranch Run near the mouth.

Figure B.3.81. Mean concentration of Total Suspended Solids at sampling sites in Spring Fork, 2001.



Bales Fork (02-362) (RM 3.64) (Undesignated/WWH)

Chemical water quality monitoring in Bales Fork took place near the mouth at RM 0.40. There were no instances of water quality criteria violations noted during the sampling. Bacterial contamination was non-existent, which was an uncommon phenomenon for this study. Dissolved oxygen concentrations were certainly within the realm of an EWH stream (Figure B.3.21); however, a single instance of supersaturated conditions (nearly 150%) indicated sporadic nutrient enrichment (Section C.1). The regular presence of organic nitrogen (TKN) above the background median and the presence of nitrate+nitrite at concentrations above the 95th percentile of background is further proof of nutrient enrichment (Table B.3.2). Comparison of this reach with undesignated streams of similar drainage area revealed that Bales Ditch is about average in most categories except bacterial concentrations (Figures B.3.21, B.3.42, B.3.19 and B.3.20).

Lower Big Darby Creek, Including Tributaries

(Downstream of confluence with Little Darby Creek to the mouth)

Chemical water quality sampling in Lower Big Darby Creek extended from RM 27.00 downstream of the confluence with Little Darby Creek to RM 3.10 near the mouth (6 sampling stations). Tributaries included in this sampling effort included Smith Ditch (2 sampling stations), Hellbranch Run (6 sampling stations), Hamilton Ditch (2 sampling stations), Clover Groff Ditch (2 sampling stations), Springwater Run (1 sampling station), an unnamed tributary (1 sampling station), Greenbrier Creek (2 sampling stations), and Georges Run (1 sampling station).

Mainstem

Chemical water quality was evaluated in lower Big Darby Creek a total of five times during the 2001 field survey. No violations of water quality criteria were in evidence. Chemical water quality contributions from Little Darby Creek provided a positive influence on Big Darby Creek (e.g., increased dissolved oxygen concentrations and decreased total phosphorus concentrations were evident downstream of the confluence, Figures B.3.82 and B.3.83). Hellbranch Run seemed to negatively influence Big Darby Creek through increased concentrations of bacteria (Figures B.3.84 and B.3.85) and decreases in dissolved oxygen (Figure B.3.82). Mean bacterial concentrations continued a downward trend which began downstream of Sugar Run, until reaching Hellbranch Run and PCI-OCRC WWTP where there was an upward spike (Figures B.3.84 and B.3.85). Mean total suspended solids concentrations decreased downstream of Little Darby Creek and moderated at their lowest level in the entire mainstem, well below background median concentration (Figure B.3.86).

Nutrient concentrations in this section of Big Darby Creek were mixed in comparison to other parts of the basin. Nitrate+nitrite and TKN values were very consistent from the confluence with Little Darby Creek to the mouth (Figures B.3.87 and B.3.88). Mean total phosphorus concentrations rose throughout the same segment, increasing significantly downstream of Hellbranch Run and PCI-ODRC WWTP (Figure B.3.83). Elevated nutrient concentrations in the lower Big Darby Creek revealed nutrient enrichment threatens lower section of the mainstem. Nitrate+nitrite concentrations were found above the background median in nearly 47% of the samples whereas total phosphorus values exceeded the background median in over 43% of the samples (over a third of the total phosphorus values exceeded the 75th percentile for background, (Table B.3.2).

Figure B.3.82. Mean Dissolved Oxygen concentrations at sampling sites in the mainstem of Big Darby Creek, 2001.

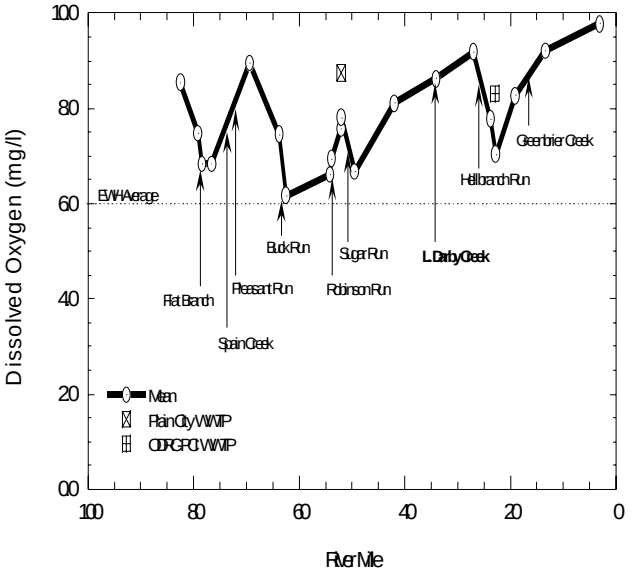


Figure B.3.83. Mean Total Phosphorus concentrations at sampling sites in the mainstem of Big Darby Creek, 2001.

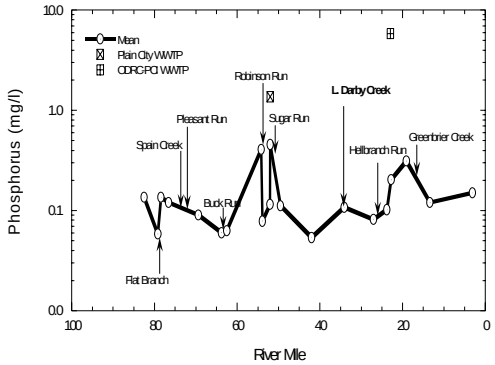


Figure B.3.84. Mean number of colonies of Fecal Coliform bacteria in the Big Darby Creek mainstem, 2001.

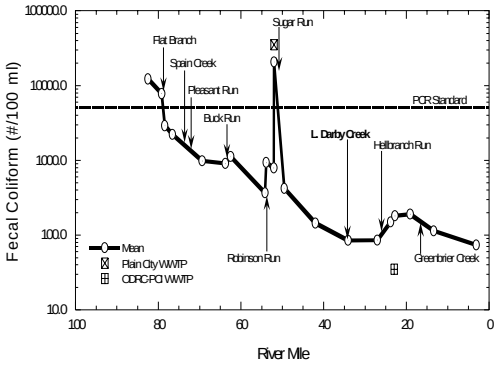


Figure B.3.85. Mean number of colonies of E. coli bacteria in the Big Darby Creek mainstem, 2001.

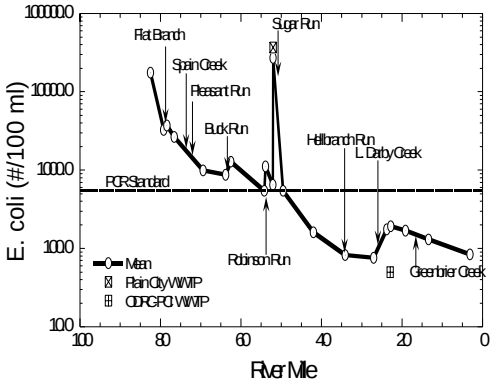


Figure B.3.86. Mean concentration of TSS at sampling sites in the Big Darby Creek mainstem, 2001.

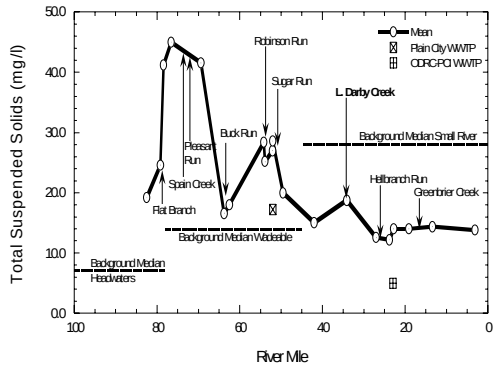


Figure B.3.87. Mean concentration of Nitrate+Nitrite at sampling sites in the Big Darby Creek mainstem, 2001.

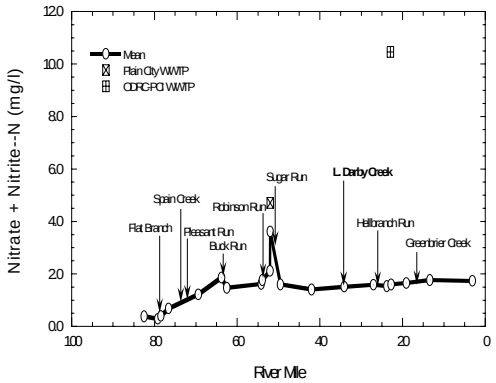
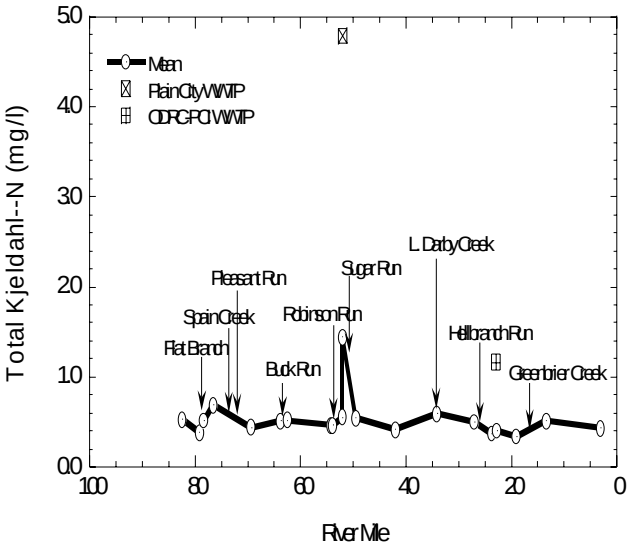


Figure B.3.88. Mean concentration of Total Kjeldahl Nitrogen at sampling sites in the Big Darby Creek mainstem, 2001.



Storm water monitoring was performed at various times over a year's period for Big Darby Creek at S.R. 316 near Darbyville (RM 13.40). This sampling station houses a USGS gauge which provided flow data which allowed for the calculation of different pollutant loadings. Total suspended solids and three nutrients were evaluated. Results similar to those found in Little Darby Creek were noted, that is, loadings increased with flow (Figures B.3.89 to B.3.92). For example, a storm event sampled on April 30, 2002 showed a flow of 32,557 liters/second (1150 ft^3/s) with loadings of 140,645 kg/d of suspended solids, 17,946 kg/d of nitrate+nitrite, 239 kg/d of ammonia, and 456 kg/d of phosphorus, whereas a storm event monitored on March 28, 2002 exhibited a flow of 66,528 liters/second (2,350 ft^3/s) with loadings of 482,840 kg/d of suspended solids, 49,836 kg/d of nitrate+nitrite, 420 kg/d of ammonia, and 770 kg/d of phosphorus. Comparisons of the flows and loadings between these events shows increased flow (2 fold) with a 3.4 fold increase in suspended solids, a 2.8 fold increase in loadings of nitrate+nitrite, a 1.8 fold increase in ammonia loadings, and a 1.7 fold increase in phosphorus loadings.

Generally, concentrations of pollutants tended to increase with flow. Graphs of flow versus concentration for ammonia, nitrate+nitrite, and total suspended solids show that concentrations increased with flow with good correlation (Figures B.3.89 to B.3.91). The relationship with total phosphorus did not show increased concentrations with flow (Figure B.3.92).

Smith Ditch (02-353) (RM 31.69) (Undesignated/EWH Recommended)
Smith Ditch was evaluated for chemical water quality at a single location at RM 2.10. Water quality criteria for WWH apply to this stream even though it is currently undesignated. Violations of water quality criteria were not found. Comparisons of bacterial values with similar undesignated stream segments revealed that Smith Ditch was average. Suspended solids and nutrient concentrations tended to be average (nitrate+nitrite, TSS) or lower (TKN, total phosphorus) than most comparison stream segments (Figures B.3.6, B.3.20 and B.3.19).

Unnamed Tributary to Smith Ditch (02-354) (RM0.06) (Undesignated/EWH Recommended)
This small tributary of Smith Ditch (0.9 square mile drainage area) contained consistent flow during the summer, likely due to groundwater input. Chemical water quality was evaluated just upstream of the confluence with Smith Ditch. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of water quality criteria were found for this stream. Dissolved oxygen concentrations were more than adequate to support an exceptional fauna, although moderately supersaturated conditions were noted (Figures B.3.68 and B.3.69). Suspended solids and nutrients were not a concern in this tributary and compared favorably with other streams of small drainage.

Gay Run (02-298) (RM 26.48) (Undesignated/WWH Recommended)
No chemical data taken.

Figure B.3.89. Big Darby Creek Storm Event Sampling: Mean Daily Flow vs. Total Suspended Solids Loadings based on USGS Gaging Station sampling at SR 316 near Darbyville (RM 13.4), 2001.

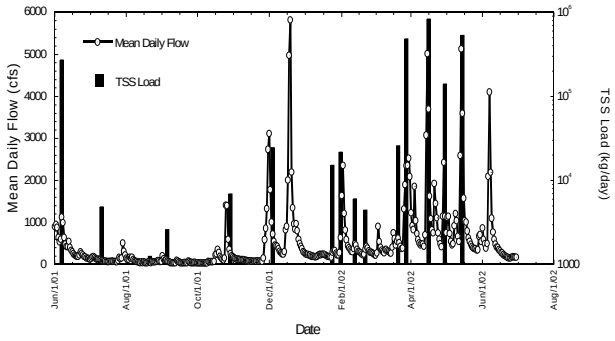


Figure B.3.90. Big Darby Creek Storm Event Sampling: Mean Daily Flow vs. Nitrate+Nitrite Loadings based on USGS Gaging Station sampling at SR 316 near Darbyville (RM 13.4), 2001.

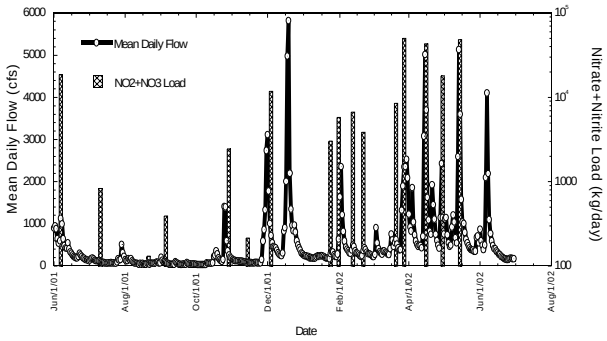


Figure B.3.91. Big Darby Creek Storm Event Sampling: Mean Daily Flow vs. Ammonia Loadings based on USGS Gaging Station sampling at SR 316 near Darbyville (RM 13.4), 2001.

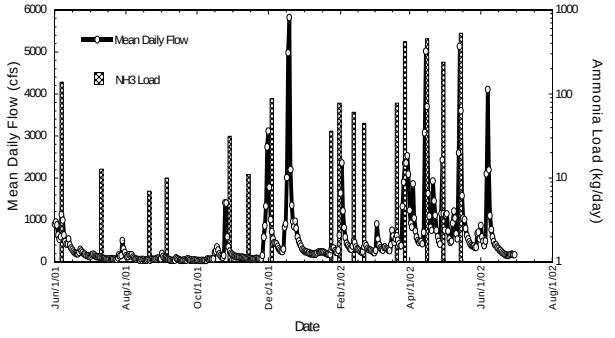
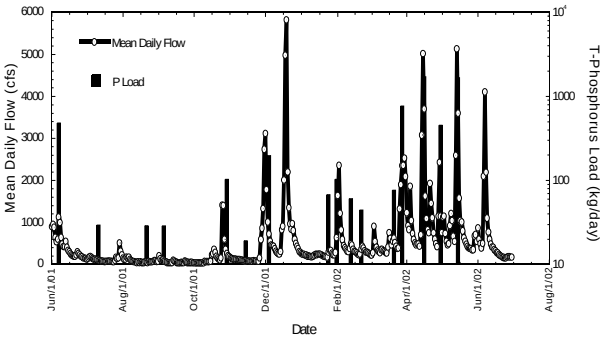


Figure B.3.92. Big Darby Creek Storm Event Sampling: Mean Daily Flow vs. Total Phosphorus Loadings based on USGS Gaging Station sampling at SR 316 near Darbyville (RM 13.4), 2001.



Hellbranch Run (02-204) (RM 26.1) (WWH)

Chemical water quality was evaluated in Hellbranch Run five times at six locations. There was only 1 water quality criteria violation during the sampling period. At RM 0.50, the dissolved oxygen minimum standard was violated (Table B.3.1). Mean concentrations of dissolved oxygen showed an upward trend in the subbasin which was well above the WWH average standard (Figure B.3.93). Mean oxygen concentrations then fell downstream of the Timberlake WWTP.

Total suspended solids values found in Hellbranch Run were highest at RM 10.10, just downstream of the confluence of Clover Groff and Hamilton Ditches. All suspended solids measurements at RM 10.10 were greater than the background median (Table B.3.2). These concentrations diminished downstream and stabilized at an average concentration of about 6 mg/l before increasing slightly downstream of the Timberlake WWTP (Figure B.3.94).

Hellbranch Run also experienced problems with nutrient enrichment. Seventy percent of the samples analyzed for organic nitrogen (TKN) showed values in excess of the 75th percentile for background with over 13 percent of the samples exceeding the 90th percentile (Table B.3.2). Samples analyzed for total phosphorus showed even larger values. Over 93 percent of the samples analyzed for total phosphorus transcended the background median with over 10 percent exceeding the 95th percentile (Table B.3.2). Both the Oakhurst Knolls WWTP and the Timberlake WWTP were responsible for some of the nutrient enrichment in the stream. Increases in TKN, total phosphorus, and nitrate+nitrite were all noted downstream of each WWTP (Figures B.3.95 to B.3.97).

Storm water monitoring was performed at various times over a year's period for Hellbranch Run at Lambert Road (RM 0.50). This sampling station is just downstream of a USGS gauge which provided flow data which allowed for the calculation of different pollutant loadings. Total suspended solids and 3 nutrients were evaluated. Again, increased flows generally corresponded to increased loadings of pollutants (Figures B.3.98 to B.3.102). For example, a storm event sampled on March 28, 2002 exhibited a flow of 4,303 liters/second (152 ft^3/s) with loadings of 12,269 kg/d of suspended solids, 1,985 kg/d of nitrate+nitrite, 25 kg/d of ammonia, and 54 kg/d of phosphorus whereas a storm event monitored on April 15, 2002 showed a flow of 11,352 liters/second (401 ft^3/s) with loadings of 96,123 kg/d of suspended solids, 3276 kg/d of nitrate+nitrite, 61 kg/d of ammonia, and 200 kg/d of phosphorus. Comparisons of the flows and loadings between these events showed increased flow (2.6 fold) with a 7.8 fold increase in suspended solids, (well above that found in Little and Big Darby Creeks and perhaps indicative of the high rate of development (i.e., disturbed landscape) in this watershed), a 1.7 fold increased loading of nitrate+nitrite, a 2.3 fold increase in ammonia loadings, and a 3.7 fold increase in phosphorus loadings.

Hamilton Ditch (02-259) (RM 11.19) (MWH, WWH)

Hamilton Ditch was evaluated for chemical water quality at two locations, RM 3.40 which is designated MWH (due to channel modification) and RM 0.50 which is designated WWH. There were no violations of chemical water quality criteria.

Figure B.3.93. Mean concentrations of Dissolved Oxygen at sampling sites in Hellbranch Run, 2001.

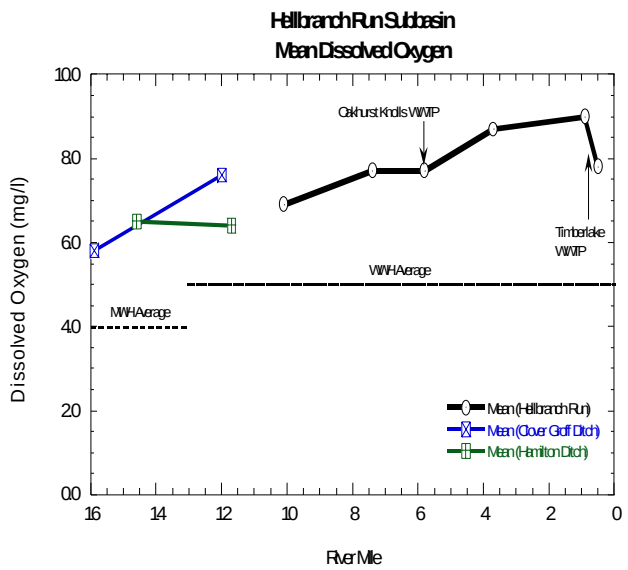


Figure B.3.94. Mean concentrations of Total Suspended Solids at sampling sites in Hellbranch Run, 2001.

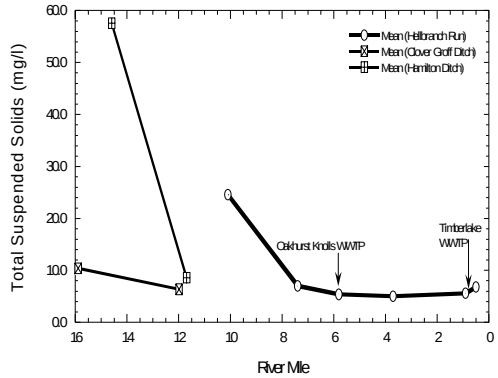


Figure B.3.95. Mean concentrations of Total Kjeldahl Nitrogen at sampling sites in Hellbranch Run, 2001.

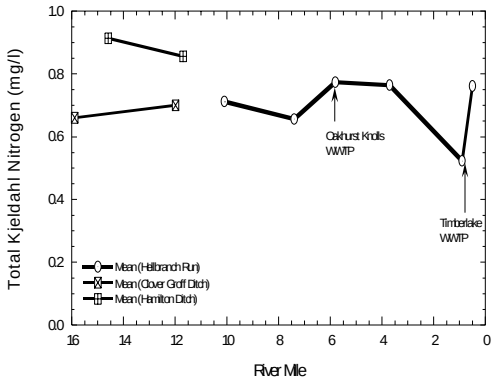


Figure B.3.96. Mean concentrations of Total Phosphorus at sampling sites in Hellbranch Run, 2001.

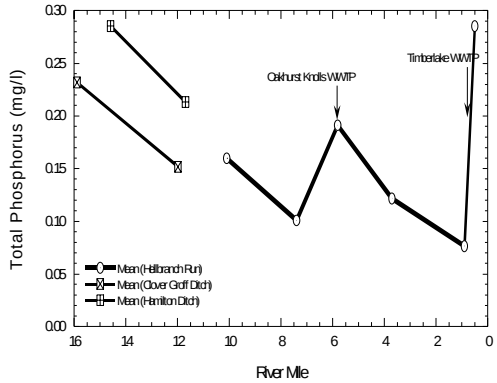


Figure B.3.97. Mean concentration of Nitrate+Nitrite at sampling sites in the Hellbranch Run subwatershed, 2001.

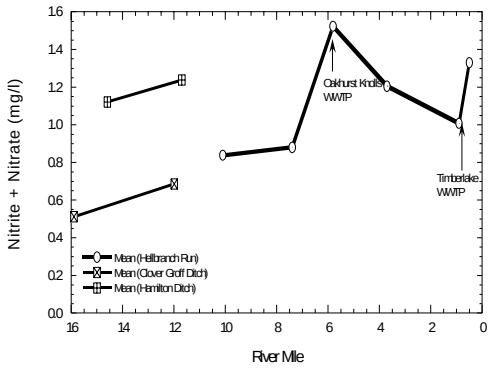


Figure B.3.98. Hellbranch Run Storm Event Sampling: Mean Daily Flow vs. Total Suspended Solids Loadings based on USGS Gaging Station sampling at Lambert Rd. (RM 0.5), 2001.

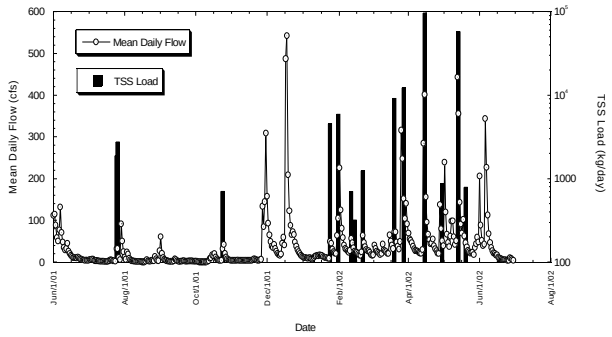


Figure B.3.99. Hellbranch Run Storm Event Sampling: Mean Daily Flow vs. Total Suspended Solids Loadings based on USGS Gaging Station sampling at Lambert Rd. (RM 0.5), 2001.

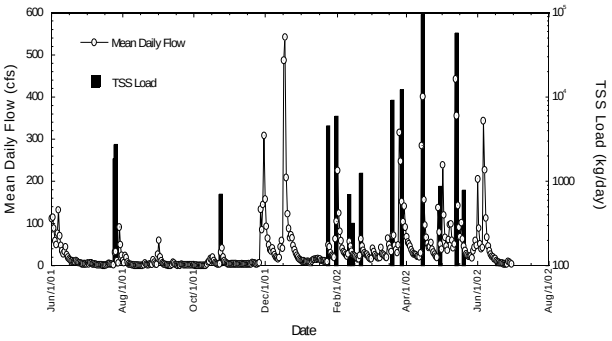


Figure B.3.100. Hellbranch Run Storm Event Sampling: Mean Daily Flow vs. Nitrate+Nitrite Loadings based on USGS Gaging Station sampling at Lambert Rd. (RM 0.5), 2001.

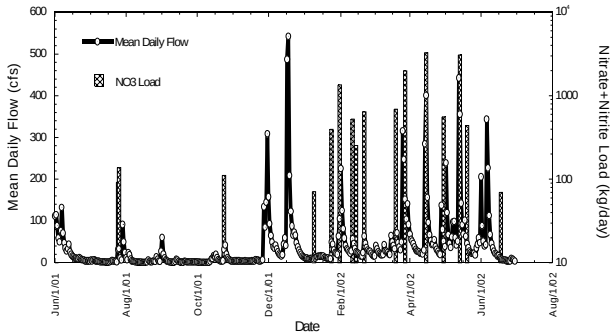


Figure B.3.101. Hellbranch Run Storm Event Sampling: Mean Daily Flow vs. Ammonia Loadings based on USGS Gaging Station sampling at Lambert Rd. (RM 0.5), 2001.

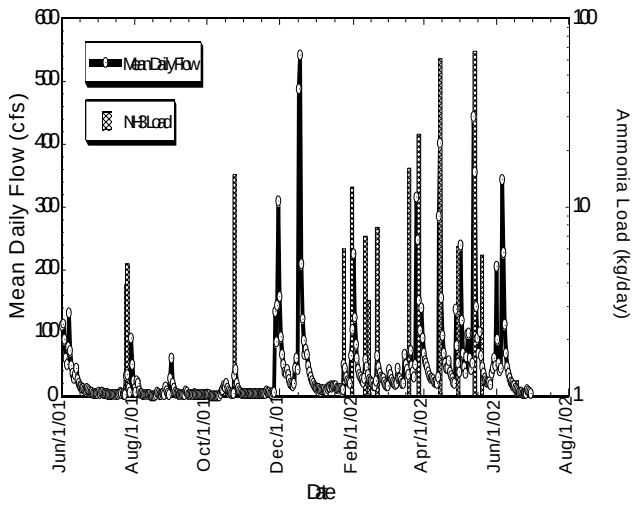
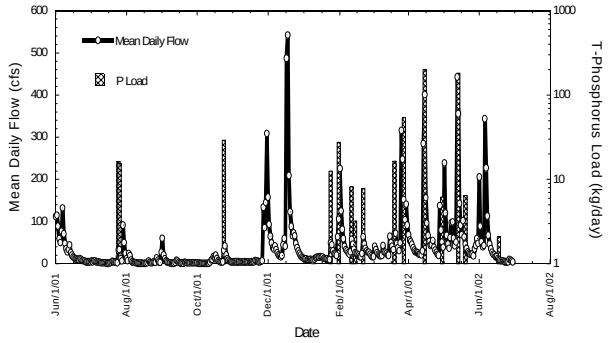


Figure B.3.102. Hellbranch Run Storm Event Sampling: Mean Daily Flow vs. Total Phosphorus Loadings based on USGS Gaging Station sampling at Lambert Rd. (RM 0.5), 2001.



Dissolved oxygen concentrations were more than adequate at the upstream site with small variation in the data; however, the WWH site exhibited highly variable dissolved oxygen concentrations, even though water quality criteria were not violated (Section C.1). The range of dissolved oxygen concentration and saturation was large (Figure B.3.41) indicative of environmental stress.

Total suspended solids concentrations at the upstream site were also highly variable with values exceeding the 95th percentile of background down to the detection level (Table B.3.2). Median values were typical for MWH sites (Figure B.3.10). Eighty percent of the TSS results taken from the downstream site were above the background median; however, none of the large variability found upstream, was encountered here. Total suspended solids concentrations at RM 0.50 were similar to other WWH sites of the same drainage area (Figure B.3.26).

Nutrient concentrations for RM 3.40 and RM 0.50 Hamilton Ditch were commensurate with those found at sites with similar drainage areas for nitrate+nitrite, TKN, and ammonia (Figures B.3.11, B.3.13, B.3.14, B.3.16, B.3.39 and B.3.40). Even though these were "typical" of modified sites, nutrient values were still much above background median concentrations, often above the 75th percentile values (Table B.3.2). Total phosphorus concentrations were noticeably higher than most other comparison locations for both sites (Figures B.3.12 and B.3.17) mostly exceeding the 90th percentile of background (Table B.3.2).

<u>Clover Groff Ditch</u> (02-245) (RM 11.19) (MWH, WWH)
Clover Groff Ditch was evaluated for chemical water quality at 2 locations, RM 4.70 which is

designated MWH (due to channel modification) and RM 0.80 which is designated WWH. There were no violations of chemical water quality criteria.

Both sites on Clover Groff Ditch exhibited adequate dissolved oxygen concentrations for their respective use designations (Figures B.3.15 and B.3.27). Dissolved oxygen saturation values were also adequate, although somewhat depressed.

Median total suspended solids concentrations were slightly above and below the background median value at RM 4.70 and RM 0.80 respectively. The wide ranges in values were absent here, compared with Hamilton Ditch and similar stream segments and were more representative of "normal" levels of suspended solids concentration (Figures B.3.10 and B.3.25).

Nitrate+nitrite was not detected above background median values in Clover Groff Ditch (Table B.3.2). Other nutrients were discovered at high concentrations at times during the survey. Most ammonia values found at RM 4.70 were in excess of the 90th percentile for background. Ammonia concentrations diminished at RM 0.80. TKN concentrations almost all exceeded the median background concentration for each site indicating the presence of excess organic nitrogen compounds. Comparison with similar stream segments showed that Clover Groff Ditch had "normal" concentrations of TKN at RM 4.70 and above average concentrations of TKN at RM 0.80 (Figures B.3.11 and B.3.36). Median total phosphorus concentrations at RM 4.70 were comparable to some of the EWH and WWH streams of similar drainage area although there was one value which spiked high (Figure B.3.12). However, total phosphorus was elevated at RM 0.80 in comparison with similar stream reaches, with most of the values above the 75th percentile of background.

The Thornapple Country Club WWTP and the Cypress Wesleyan School WWTP may be contributing to some of the nutrient enrichment noted at RM 0.80.

Springwater Run (02-203) (RM 24.0) (WWH)
Chemical water quality was evaluated in Springwater Run at one location near the mouth at RM 0.20. No violations of water quality criteria were noted in Springwater Run.

Dissolved oxygen concentrations and saturation were excessive with all samples exhibiting supersaturated conditions (Figure B.3.15). Supersaturated oxygen concentrations are often due to algal overpopulation exacerbated by nutrient enrichment and poor riparian cover. Nutrient concentrations found in Springwater Run do indeed confirm that the stream is nutrient enriched with all nitrate+nitrite values exceeding the background median, 60% of the TKN values above the 75th percentile for background, and all results for total phosphorus in excess of the 75th percentile for background. Suspended solids were not problematic in this stream. The unsewered community of Harrisburg could be contributing to the nutrient enrichment..

Unnamed Tributary to Big Darby Creek (02-352) (RM 23.77) (Undesignated/WWH Recommended)
No chemical data taken.

Unnamed Tributary to Big Darby Creek (02-270) (RM 20.2) (Undesignated/WWH Recommended)

Chemical water quality was evaluated on this unnamed tributary at RM 0.80. Water quality criteria for WWH apply to this stream even though it is currently undesignated. No violations of water quality criteria were noted in "Clark's Lake Outlet".

Dissolved oxygen concentrations and saturation levels were adequate for a warmwater stream and similar to many of the undesignated streams of the same drainage area (Figures B.3.21 and B.3.42). Total suspended solids concentrations were also low, similar to most comparison stream reaches.

Nutrient concentrations were variable for certain parameters and fairly consistent for others. Ammonia concentrations varied widely as did nitrite (Section C.1). Total phosphorus, nitrate+nitrite, and TKN concentrations were more consistent, but elevated, especially total phosphorus with all values exceeding the 75th percentile for background (Table B.3.2). Comparisons with similarly-sized, undesignated streams shows elevated TKN and "normal" concentrations of total phosphorus and nitrate+nitrite (Figures B.3.19 and B.3.20). Organic nitrogen concentrations may result from the Clark's Lake subdivision discharge.

Greenbrier Creek (02-202) (RM 16.75) (WWH)

Chemical water quality was evaluated on Greenbrier Creek at 2 locations, RM 2.70 and RM 1.30. A single water quality criteria violation was noted for dissolved oxygen at RM 2.70 (Table B.3.1).

Median concentrations of total suspended solids were less than the background median at both sites. Nutrient enrichment was a concern at RM 2.70. Nitrate+nitrite, TKN and total phosphorus concentrations were obviously elevated compared to other WWH streams of similar drainage area (Figures B.3.11, B.3.12 and B.3.14). All phosphorus concentrations measured at RM 2.70 were greater than the 75th percentile of background Table B.3.2. Total phosphorus and nitrate+nitrite also appeared elevated at RM 1.30 (Figures B.3.12 and B.3.14).

Georges Run (02-201) (RM 14.4) (WWH)

Water chemistry was examined in Georges Run at a single point (RM 1.20) during the 2001 survey. No violations of water quality criteria were discovered. Dissolved oxygen concentrations were variable but largely supersaturated, with a median value that was the highest of any 0-2 mile drainage stream (Figures B.3.68 and B.3.69). Supersaturated conditions generally result from nutrient enrichment and lack of riparian shading which promote algal overpopulation. Median nutrient concentrations were found to be comparable or less than streams with similar drainage areas. Few nutrient values exceeded the background median (Table B.3.2).

Diurnal Dissolved Oxygen Study-Big Darby Creek Watershed

Upper Watershed

Mainstem sites on Big Darby Creek in the upper watershed (headwaters to Plain City WWTP outfall) generally exhibited normal daily fluctuations in dissolved oxygen, although some sites showed supersaturated conditions of around 120% (Figures B.3.103 and B.3.104) which indicated nutrient enrichment and an open canopy. The only site which deviated from this pattern was found at RM 78.40, just downstream from the confluence with Flat Branch where dissolved oxygen concentrations fell below minimum criteria for EWH streams (Figure B.3.105). This area is influenced by the discharge from Flat Branch (Figures B.3.106 and B.3.107).

Tributary streams in this part of the watershed proved to be influenced in a variety of ways. Flat Branch showed wide fluctuations in dissolved oxygen concentrations/saturation in the upper and middle parts of the subbasin. Supersaturated conditions during the daylight hours result from nutrient enrichment and an open canopy (Figures B.3.108 to B.3.111). Poorly saturated conditions existed at the mouth at RM 0.80 during midsummer (Figures B.3.114 and B.3.115), likely influencing Big Darby Creek itself. Autumn conditions showed improvement in dissolved oxygen levels near the mouth (Figure B.3.112 and B.3.113). Little Darby Creek (Logan County), Robinson Run, and Buck Run all exhibited normal diurnal fluctuations for sites at the mouth and adequate to good concentrations and saturations (Figures B.3.114 to B.3.119). Robinson Run in the upper part of the stream showed similar diurnal variability, but without the smooth curves (Figures B.3.120 and B.3.121).

Figure B.3.103. Diel percent Dissolved Oxygen Saturation at RM 78.5 on the mainstem of Big Darby Creek, 2001.

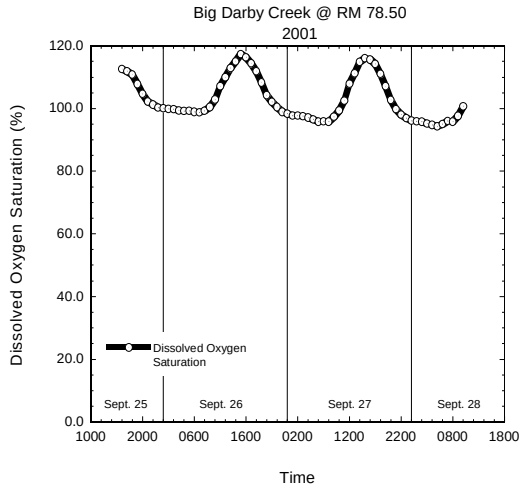


Figure B.3.104. Diel percent Dissolved Oxygen Saturation at RM 76.6 on the mainstem of Big Darby Creek, 2001.

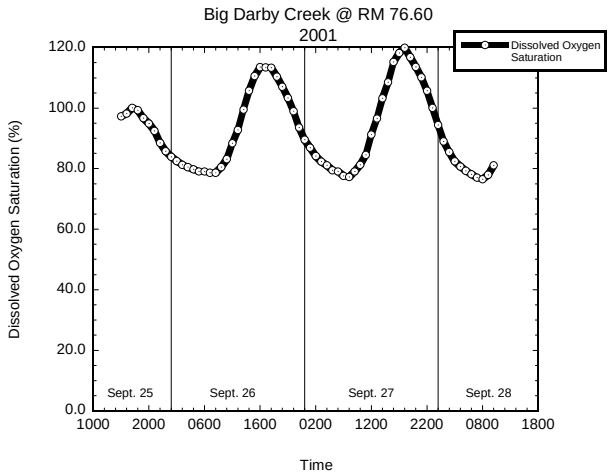


Figure B.3.105. Diel Dissolved Oxygen concentrations at RM 78.4 on the mainstem of Big Darby Creek, 2001.

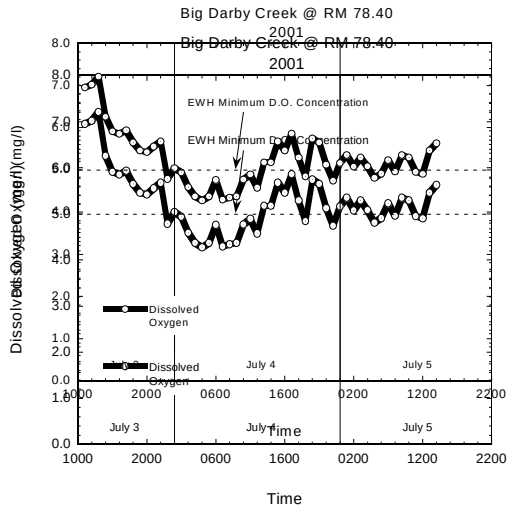


Figure B.3.106. Diel Dissolved Oxygen concentrations at RM 0.8 on Flat Branch, 2001.

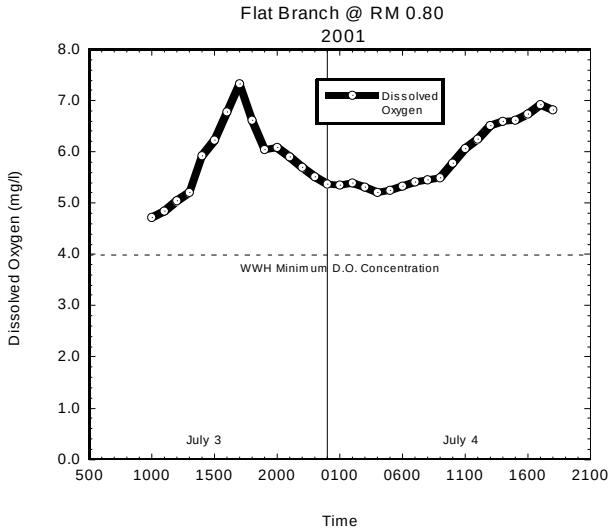


Figure B.3.107. Diel percent Dissolved Oxygen Saturation at RM 0.8 in Flat Branch, 2001.

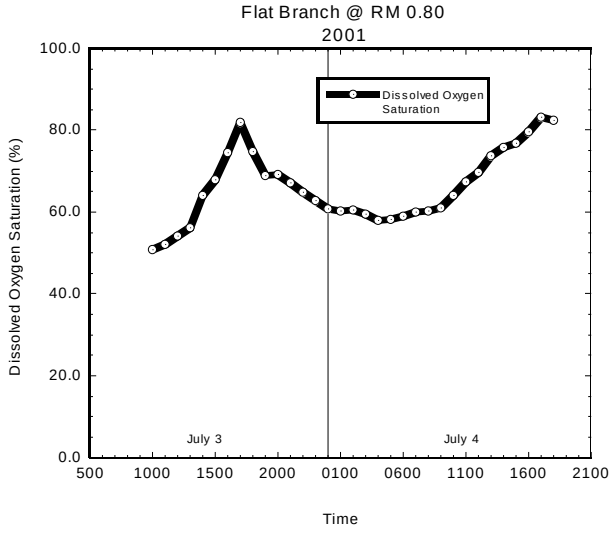


Figure B.3.108. Diel Dissolved Oxygen concentrations at RM 5.3 on Flat Branch, 2001.

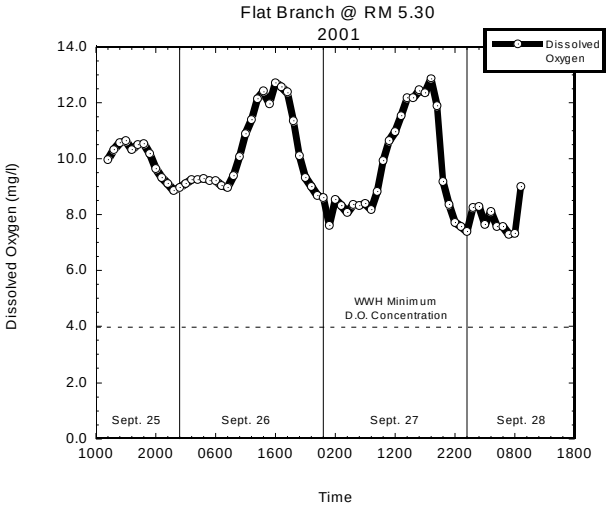


Figure B.3.109. Diel percent Dissolved Oxygen Saturation at RM 5.3 in Flat Branch, 2001.

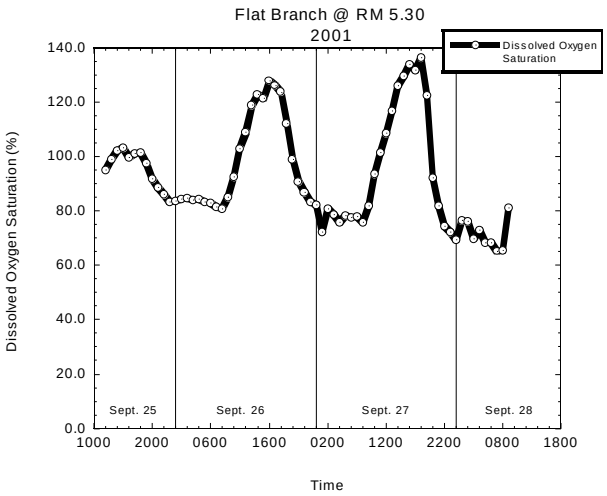


Figure B.3.110. Diel Dissolved Oxygen concentrations at RM 2.2 in Flat Branch, 2001.

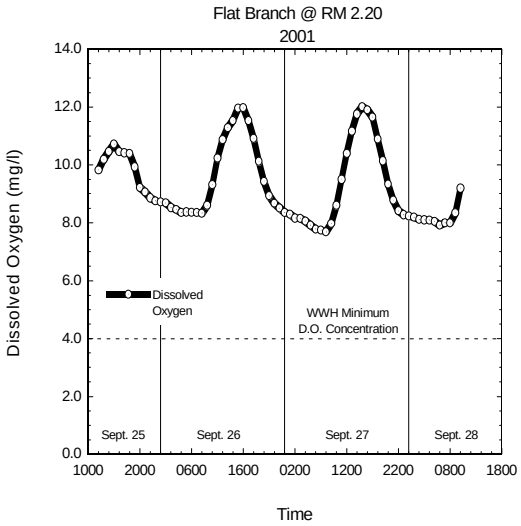


Figure B.3.111. Diel percent Dissolved Oxygen Saturation at RM 2.2 in Flat Branch, 2001.

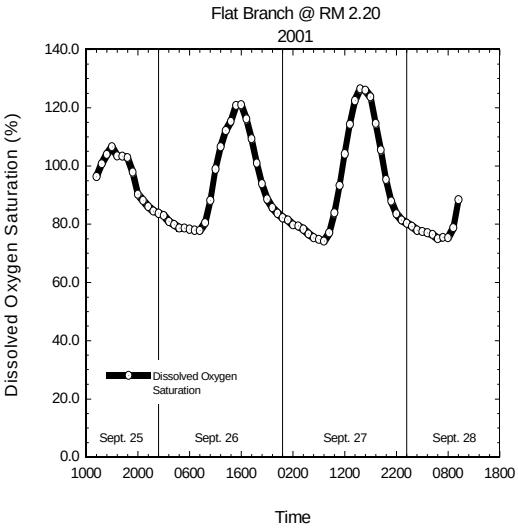


Figure B.3.112. Diel Dissolved Oxygen concentrations at RM 0.05 in Flat Branch, 2001.

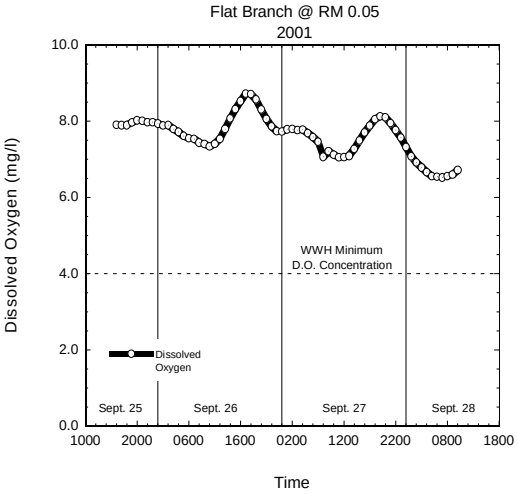


Figure B.3.113. Diel percent Dissolved Oxygen Saturation at RM 0.05 in Flat Branch, 2001.

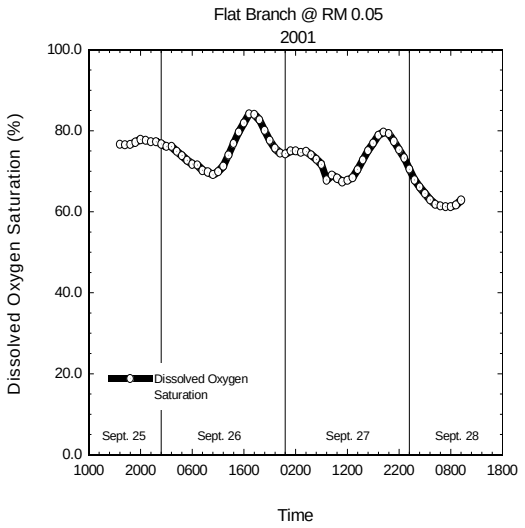


Figure B.3.114. Diel Dissolved Oxygen concentration at RM 0.4 in Little Darby Creek (Logan County), 2001.

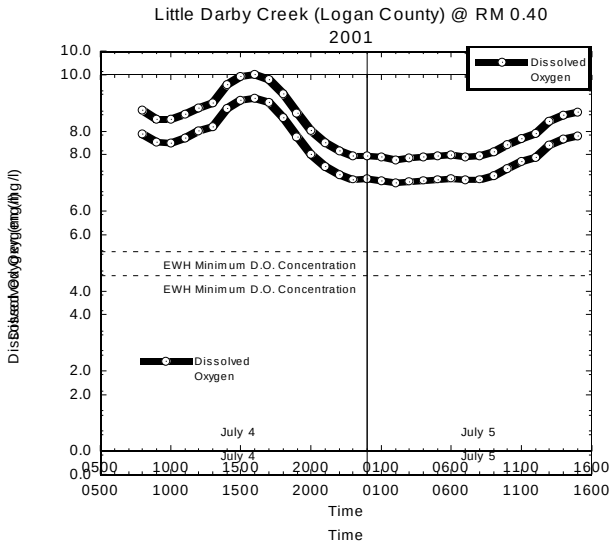


Figure B.3.115. Diel percent Dissolved Oxygen Saturation at RM 0.4 in Little Darby Creek (Logan County), 2001.

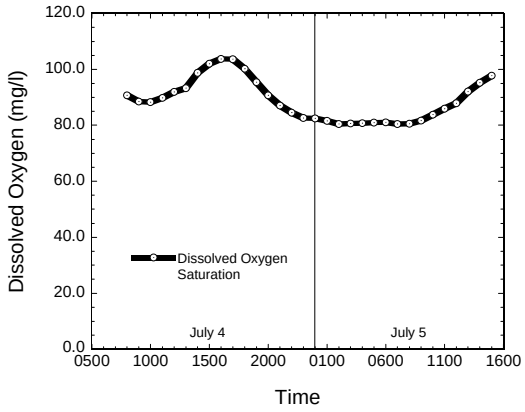


Figure B.3.116. Diel Dissolved Oxygen concentrations at RM 0.7 in Robinson Run, 2001.

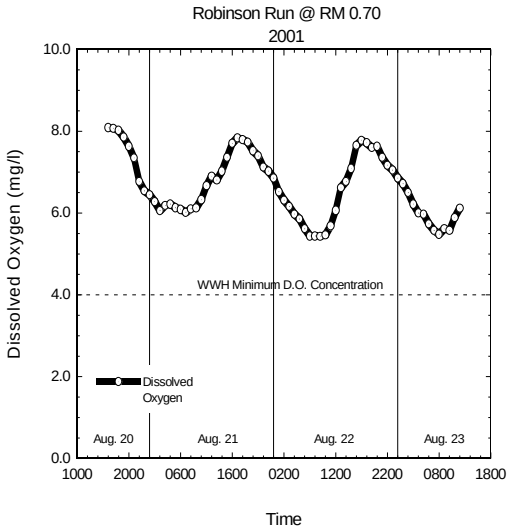


Figure B.3.117. Diel percent Dissolved Oxygen Saturation at RM 0.7 in Robinson Run, 2001.

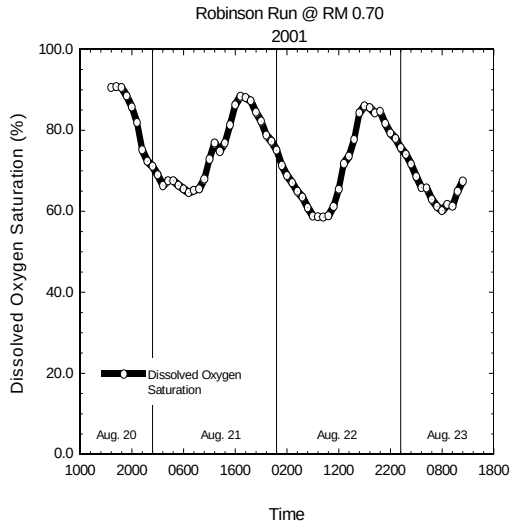


Figure B.3.118. Diel Dissolved Oxygen concentrations at RM 0.1 in Buck Run, 2001.

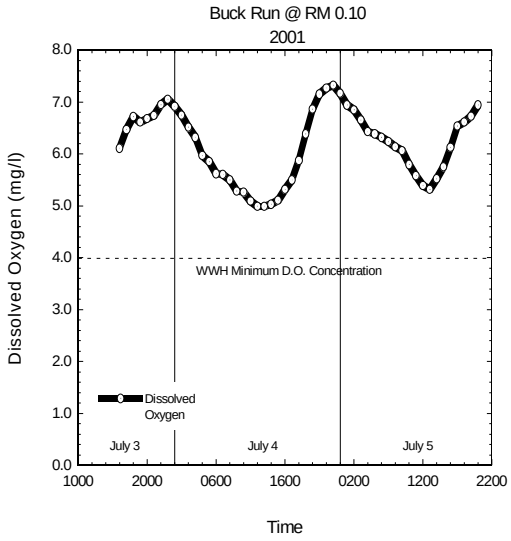


Figure B.3.119. Diel percent Dissolved Oxygen Saturation at RM 0.1 in Buck Run, 2001.

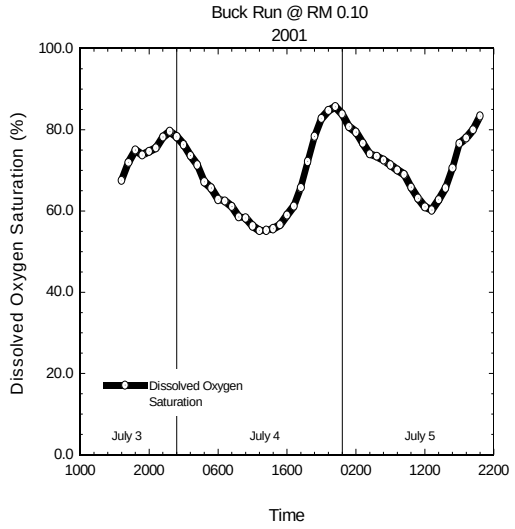


Figure B.3.120. Diel Dissolved Oxygen concentrations at RM 2.1 in Robinson Run, 2001.

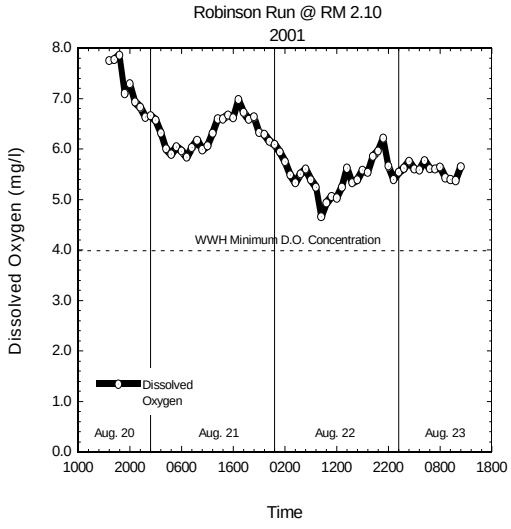
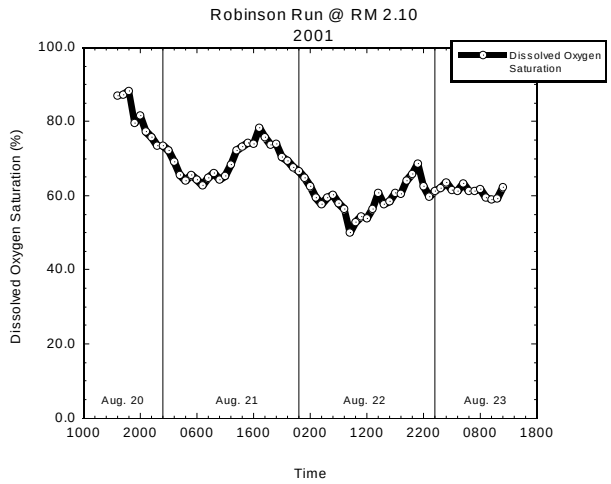


Figure B.3.121. Diel percent Dissolved Oxygen Saturation at RM 2.1 in Robinson Run, 2001.



Middle Watershed

Dissolved oxygen concentrations in this section of the Big Darby mainstem exhibited a variety of conditions. Directly downstream of the Plain City WWTP outfall, dissolved oxygen concentrations were adequate and exhibited a normal diurnal fluctuation (Figure B.3.122). However, further downstream, dissolved oxygen values were consistently below EWH minimum dissolved oxygen criteria with little or no normal diurnal fluctuation (Figure B.3.123). This site is likely located in the "oxygen sag" downstream of the Plain City WWTP. The site at the confluence with Little Darby Creek showed some supersaturated conditions early but moderated later (Figures B.3.124 and B.3.125). Sugar Run exhibited excellent concentrations of dissolved oxygen at the mouth, well above WWH criteria without harmful levels of supersaturation (Figures B.3.126 and B.3.127).

Little Darby Creek Watershed

Diel dissolved oxygen values found in the Little Darby Creek mainstem were all in normal ranges for concentration and saturation. The only area of concern was found downstream of the confluence with Treacle Creek at RM 29.50 (Figure B.3.128). Dissolved oxygen concentrations were found near the EWH minimum standard. Samples taken from the mouth of Treacle Creek (RM 0.80) confirmed that dissolved oxygen concentrations are not meeting EWH minimum criteria during early morning hours (Figure B.3.129). This has negatively influenced the dissolved oxygen values in Little Darby Creek and is likely due to organic enrichment arising from Treacle Creek. A tributary to Treacle Creek called Proctor Run exhibited a normal diel fluctuation for dissolved oxygen and oxygen saturation.

Lower Watershed

Diurnal dissolved oxygen concentrations in the lower Big Darby Creek watershed showed some variability. Normal diel fluctuations in concentration and saturation were noted at RM 28.00, just upstream of the Darbydale area. At RM 27.70, just downstream of the influence of Darbydale, dissolved oxygen concentrations were more irregular and dipped below the EWH minimum criteria. The Darbydale unsewered area likely contributes to organic enrichment here. Samples taken at locations throughout this section downstream of Darbydale exhibited some wide variability. Supersaturated conditions were common, often reaching and exceeding 120% (Figures B.3.130 and B.3.131). Concentrations often ranged widely during a 24 hour period, nearly 7 mg/l in some cases (Figure B.3.132). This wide variability seen in diurnal dissolved oxygen values provided evidence of nutrient enrichment and algal overproduction. Hellbranch Run exhibited excellent concentrations of dissolved oxygen at the mouth, well above WWH criteria without harmful levels of supersaturation (Figure B.3.133).

Figure B.3.122. Diel Dissolved Oxygen concentrations at RM 52.0 in Big Darby Creek, 2001.

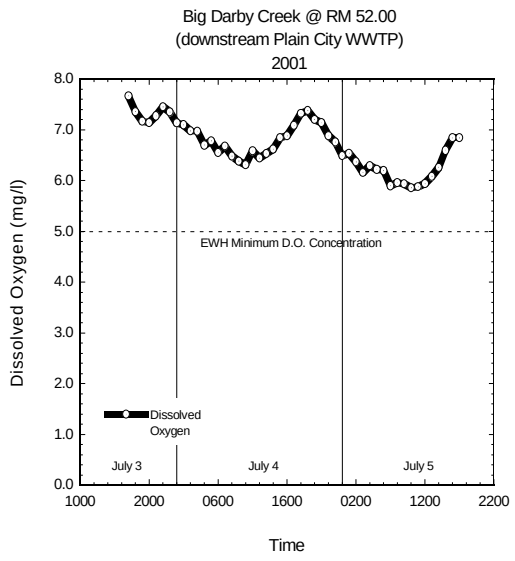


Figure B.3.123. Diel Dissolved Oxygen concentrations at RM 49.5 in Big Darby Creek, 2001.

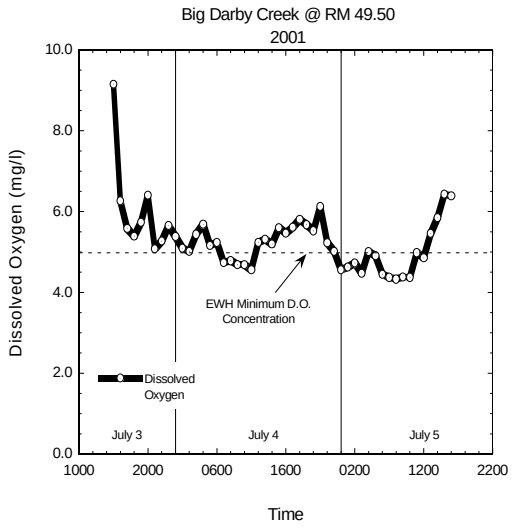


Figure B.3.124. Diel Dissolved Oxygen concentrations at RM 34.1 in Big Darby Creek, 2001.

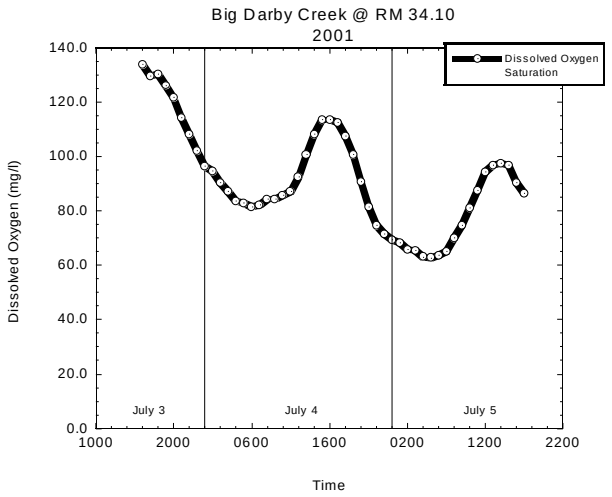


Figure B.3.125. Diel percent Dissolved Oxygen Saturation at RM 34.1 in Big Darby Creek, 2001.

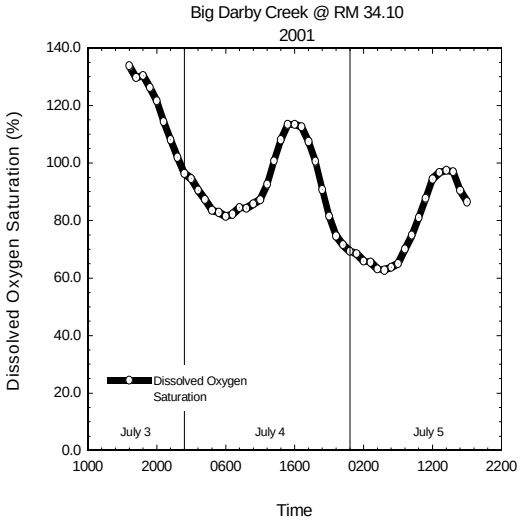


Figure B.3.126. Diel Dissolved Oxygen concentrations at RM 0.5 in Sugar Run, 2001.

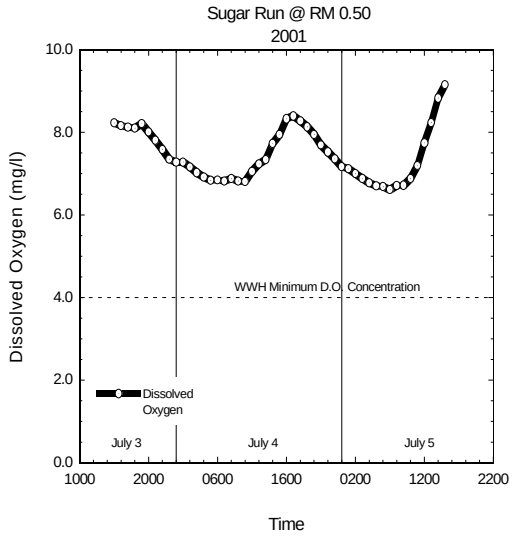


Figure B.3.127. Diel Dissolved Oxygen Saturation at RM 0.5 in Sugar Run, 2001.

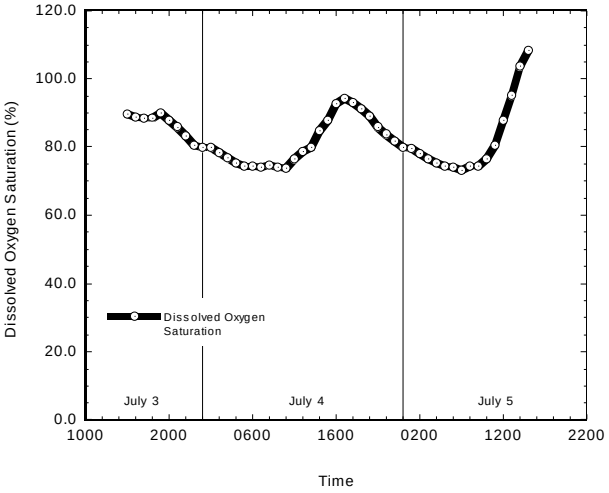


Figure B.3.128. Diel Dissolved Oxygen concentrations in Little Darby Creek at RM 29.5, 2001.

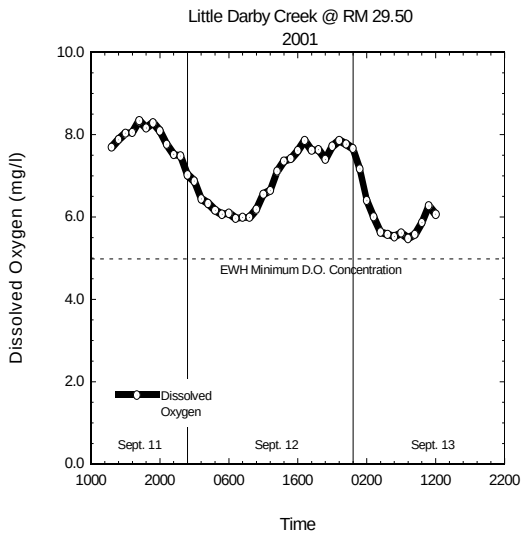


Figure B.3.129. Diel Dissolved Oxygen concentrations in Treacle Creek at RM 0.8, 2001.

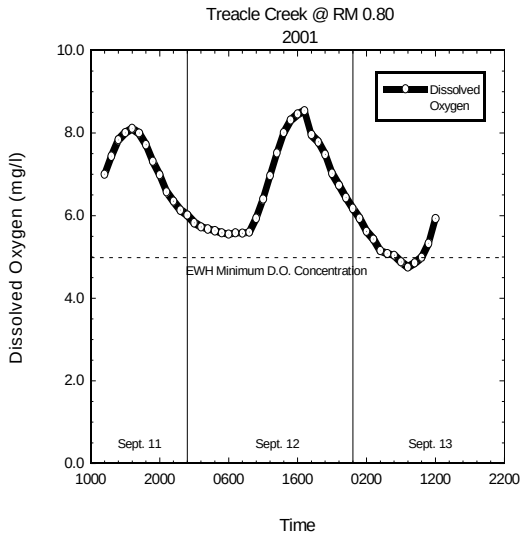


Figure B.3.130. Diel percent Dissolved Oxygen Saturation in Big Darby Creek at RM 23.8, 2001.

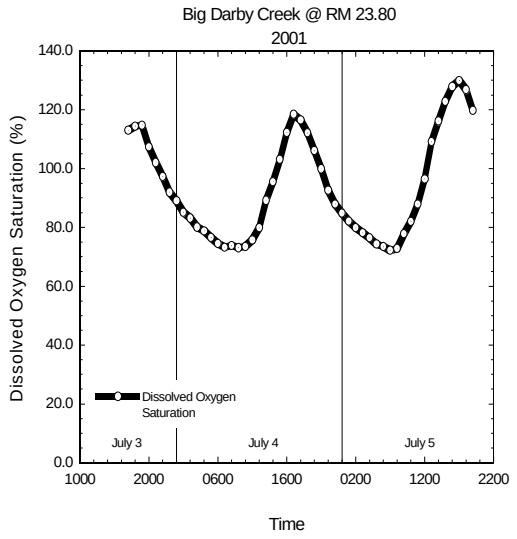


Figure B.3.131. Diel percent Dissolved Oxygen Saturation in Big Darby Creek at RM 12.9, 2002.

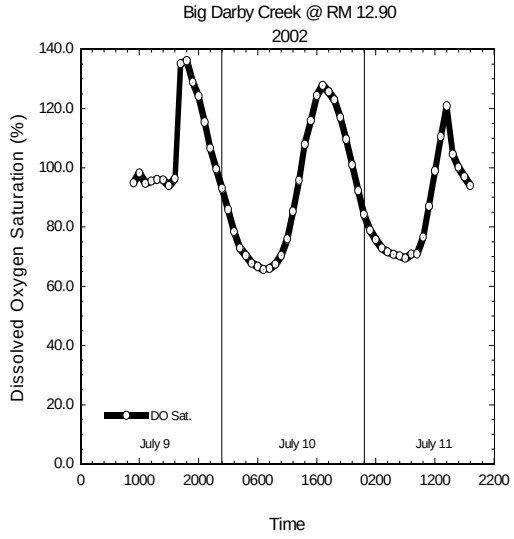


Figure B.3.132. Diel Dissolved Oxygen concentration in Big Darby Creek at RM 13.4, 2002.

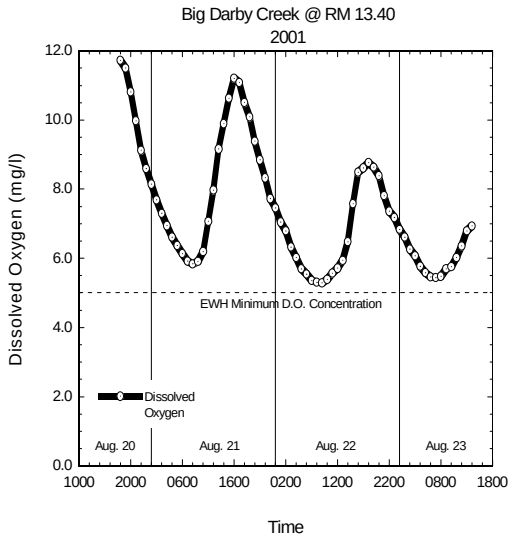
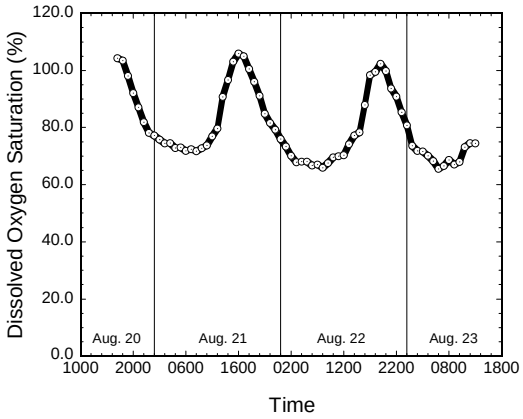


Figure B.3.133. Diel percent Dissolved Oxygen Saturation in Hellbranch Run at RM 0.9, 2001.



Water Column Organics: Big Darby Creek and Tributaries

Water samples were obtained for organic chemical analysis once during the survey period. Several different varieties of organic chemicals were sought, including volatile organic compounds (VOCs), base neutral and acid extractable compounds (BNAs), polychlorinated biphenyls (PCBs) and pesticides. Five sites on Big Darby Creek and 7 tributary sites (3 on Little Darby Creek plus the Mechanicsburg WWTP effluent) were evaluated.

VOCs were detected only in the Mechanicsburg WWTP effluent or in the area immediately downstream of the Timberlake WWTP outfall on Hellbranch Run (Table B.3.3). These VOCs were in the form of halogenated methanes. Halogenated methanes are often detected in the samples of WWTP effluent and are a result of reaction of chlorine disinfectant with organic material in the effluent. The presence of toluene (a component of gasolene) in the Mechanicsburg WWTP effluent is likely due to leakage of fuel into the collection system from a spill or leaking tank.

The plasticizer, bis (2-ethylhexyl) phthalate was also noted in several of the tributary streams as well as the Mechanicsburg WWTP effluent. This is a common organic contaminant and generally associated with towns, industrial areas, and/or disposal facilities (e.g., landfills).

Pesticides and their residues were the only organic chemicals detected in water samples taken from the Big Darby Creek mainstem. The majority of organic compounds detected in the tributaries were pesticides also. Lindane (γ-BHC) and/or its isomers (α-BHC, β-BHC, δ-BHC)

were detected in all samples in Big Darby Creek (Table B.3.4) and in numerous tributary streams (Table B.3.3) as well as the Mechanicsburg WWTP effluent. The presence of Lindane and its isomers in the effluent and in Little Darby Creek adjacent and downstream of Mechanicsburg (but not upstream) may be an artifact of runoff from the grain elevator/farm cooperative business in the center of town. Lindane is presently used as a seed and soil insect treatment for many grain crops; this use may explain why this chemical and its residues are so widespread.

Aldrin was detected at two upstream sites on Big Darby Creek (Table B.3.4) and at the mouth of Hellbranch Run (Table B.3.3). Aldrin is an organochlorine insecticide primarily used to control soil insects on farms and was used by professional pest control companies to treat building foundations for termites. Use of this pesticide in the United States has been prohibited for some time. The presence of this material in the water column may indicate a nearby source or use since it was not found in the sediments at this locale or any other in the survey area.

Atrazine was detected at all sites on Big Darby Creek downstream of RM 34.10 inclusive (Table B.3.4). Atrazine is currently used to control weeds year round for corn and other crops. Atrazine use instructions stipulate a buffer area between application sites and surface waters.

Metolachlor was also detected at the most upstream site on Big Darby Creek (Table B.3.4). Metolachlor is used as a preemergence and preplant weed control for corn, soybeans, potatoes, and pod crops (e.g., peas, beans).

Endosulfan is an insecticide and acaricide currently used on a wide variety of crops including grains, nuts, oil crops, fruits, and vegetables. It was detected in Robinson Run at RM 0.70.

Table B.3.3. Results of water quality organics sampling conducted in the Big Darby Creek study area during October, 2001. **HR** = Hellbranch Run at mouth (RM 0.50), **RR** = Robinson Run at U.S. 42 (RM 0.70), **LD1** = Little Darby Creek at Allison Road (RM 41.20), **LD2** = Little Darby Creek S.R.29 (RM 39.60). **LD3** = Little Darby Creek at Wing Road (RM 38.80), **M** = Mechanicsburg WWTP effluent, **SR** = Sugar Run at Taylor Road (RM 7.00). A blank cell means the compound was not detected in the sample.

Big Darby Creek Tributaries Water Column Organic Analysis									
Type	Analyte	Units	**HR**	**RR**	**LD1**	**LD2**	**LD3**	**M**	**SR**
Pesticides	Aldrin	mg/l	0.014						
	a-BHC	mg/l		0.021		0.012			
	b-BHC	mg/l		0.008					
	d-BHC	mg/l		0.014					0.011
	g-BHC (aka Lindane)	mg/l					0.010	0.087	
	Dieldrin	mg/l				0.008			
	Endosulfan I	mg/l		0.019					
	Heptachlor	mg/l							0.004
	Hexachlorobenzene	mg/l				0.005			
	Propachlor	mg/l	0.33						
Plasticizers	bis(2-Ethylhexyl) phthalate	mg/l		0.55		0.65		0.52	0.55
Volatiles	Bromodichloromethane	mg/l	5.31					3.38	
	Chloroform	mg/l	7.00					9.71	
	Dibromochloromethane	mg/l	1.59						
	Toluene	mg/l						32.5j	
j = estimated									

Table B.3.4. Results of chemical/physical water quality sampling conducted in the Big Darby Creek study area during October 2001. Blank spaces indicate that the compound was not detected in the sample. NA means the compound was not analyzed.

Big Darby Creek Mainstem Water Column Organic Analysis						
		River Mile				
Analyte	Units	54.20	53.90	34.10	23.80	22.80
Aldrin	mg/l	0.011	0.011			
Atrazine	mg/l		NA	0.25	0.24	0.25
a-BHC	mg/l	0.009	0.009	0.008	0.008	0.007
d-BHC	mg/l	0.010	0.010	0.006	0.007	0.006
4-4' DDE	mg/l			0.004		
Metolachlor	mg/l	0.50	NA			

Heptachlor is an organochlorine insecticide (a derivative of technical grade chlordane) that was used to treat seed and seed furrows to protect corn and other grains from pests. It was also used to control ants, cutworms, maggots, termites, and other pests in agriculture and in the home. Heptachlor is no longer sold and has extremely limited legal usage which does include uses to control termites around homes, although use is limited to stocks on hand since it has not been manufactured since the late 1980s. Heptachlor was detected in Sugar Run at RM 7.00. Sources of this contamination may include the old Taylor Road landfill.

Hexachlorobenzene was detected in Little Darby Creek at RM 39.60. This substance is a byproduct of the manufacture of many organic chemicals, including solvents and pesticides. It was used as a pesticide up until 1965. Currently, there are no allowable commercial uses for hexachlorobenzene. The presence of this material in the water column may indicate a nearby source (the agribusiness located in Mechanicsburg) or use since it was not found in the sediments at this locale or any other in the survey area.

Dieldrin was discovered in Little Darby Creek at RM 39.60. This organochlorine insecticide has been banned from manufacture and use in the United States for many years. Dieldrin is persistent and breaks down only slowly. The presence of this material in the water column may indicate a nearby source (perhaps the agribusiness located in Mechanicsburg) or use since it was not found in the sediments at this locale or any other in the survey area.

The pesticide residue 4-4' DDE was detected at RM 34.10 in Big Darby Creek. This residue is a direct breakdown product of the insecticide DDT which has been banned from use for many

years. The presence of this breakdown product in the water column may indicate a nearby source or use of the parent chemical since it was not found in the sediments at this locale or any other in the survey area.

The herbicide propachlor was detected in Hellbranch Run at the mouth (RM 0.50). Propachlor is used as a pre-emergence control for grasses and certain broadleaf weeds for field and seed corn and soybeans and is supposed to degrade rapidly in soils over several weeks. Application is limited to once per year. The presence of this material in the water column indicated a recent use since it degrades rather rapidly.

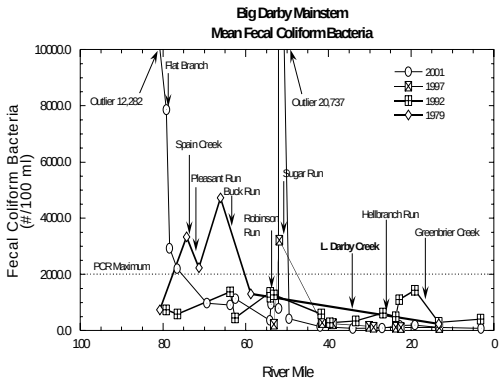
Row crop agriculture is the largest single land use in the Big Darby Creek watershed. Agribusinesses which provide support to this industry include sales of seed, fertilizers, and pesticides as well as equipment sales/rental and maintenance. Water pollution from these pesticides and/or their breakdown products most likely arose from wide-ranging uses revolving around application of these materials by agricultural interests either in the past or present, and subsequent migration into waterways from runoff events (application of pesticides also includes equipment preparation and cleaning before and after use as well as transport and mixing of chemicals). All of the pesticide compounds detected in the water column are/were listed for agricultural use as either seed/soil treatments or topical application for insect or weed control and about half are in current usage. Most of them do not have a water quality standard, not because they are nontoxic (many are toxic to fish and/or invertebrates like bees), but because no one has performed an assessment. Even so, these pesticides were found in low concentrations and do not appear to be the major cause of impairment. However, their presence is evidence that runoff does indeed carry chemicals of various types and concentrations to surrounding streams and rivers.

B.3.1 Chemical, Physical Water Quality Changes 1979-2001

Big Darby Creek Mainstem

Chemical water quality trends were evaluated on the Big Darby Creek mainstem using data from the years 1979, 1992, 1997, and 2001. Recent trends in fecal coliform bacteria indicated increased presence with higher mean concentrations in headwater areas falling to "normal" downstream of Spain Creek. A definite spike was also noted downstream of the Plain City WWTP, indicative of problems at the plant that were first noticed during the 1997 survey, but not before that (Figure B.3.1.1).

Figure B 3.1.1. Longitudinal and Temporal Trends in Mean number of colonies/100 ml. Fecal Coliform in the mainstem of Big Darby Creek, 1979, 1992, 1997 and 2001.



Dissolved oxygen values in 2001 seemed noticeably lower in certain areas of the mainstem although none of the values dropped below the WWH or EWH average. In particular, the areas downstream from Flat Branch and Buck Run exhibited lower mean concentrations than in previous years as did the areas downstream of Sugar Run, Little Darby Creek and Hellbranch Run. Even though these decreases seemed minor this may constitute a threat to the stream segments affected and to the watershed as a whole.

Mean total suspended solids concentrations generally exhibited decreases from those observed in previous surveys except in the upper watershed and downstream of Flat Branch and Spain Creek (Figure B.3.1.2). In this area, suspended solids concentrations showed increases over 1992 values and most 1979 values. This could be part of the cause for fish community impairment.

Trends in mean nutrient concentrations to the mainstem of Big Darby Creek showed decreases in mean nitrate+nitrite from previous surveys (Figure B.3.1.3). Organic nitrogen (measured via TKN) showed similar concentrations in the upper and lower watershed compared with survey results from 1992 and 1997 (Figure B.3.1.4). A pronounced peak was evident downstream of the Plain City WWTP in both 1997 and 2001 indicating worsening nutrient enrichment downstream of the plant. Survey results obtained in 1979 exhibited much higher concentrations of TKN than other survey years indicating improved chemical water quality conditions for this parameter except downstream of the Plain City WWTP. Mean total phosphorus concentrations showed very mixed trend results (Figure B.3.1.5). The upper watershed showed some slight increases compared with previous surveys especially downstream of Flat Branch. These concentrations

Figure B 3.1.2. Longitudinal and Temporal Trends in Mean Total Suspended Solids in the mainstem of Big Darby Creek, 1979, 1992, 1997 and 2001.

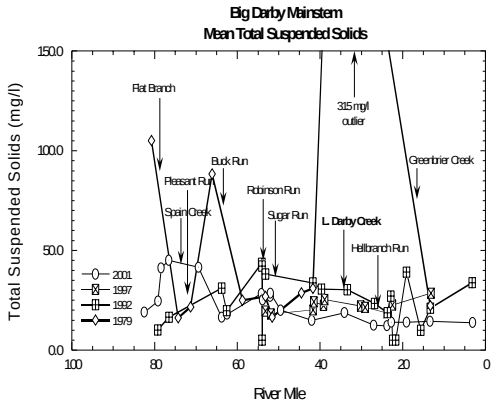


Figure B 3.1.3. Longitudinal and Temporal Trends in Mean Nitrate+Nitrite in the mainstem of Big Darby Creek, 1979, 1992, 1997 and 2001.

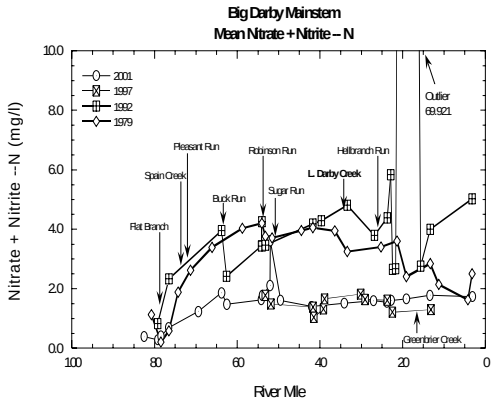


Figure B 3.1.4. Longitudinal and Temporal Trends in Total Kjeldahl Nitrogen in the mainstem of Big Darby Creek, 1979, 1992, 1997 and 2001.

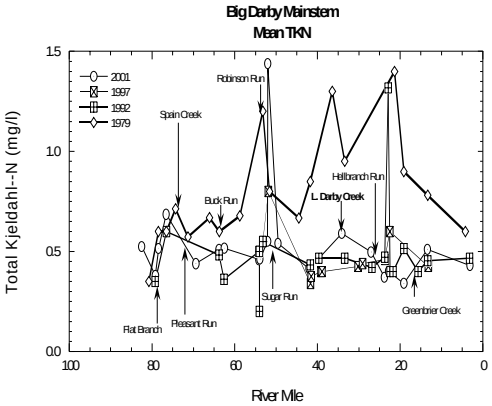
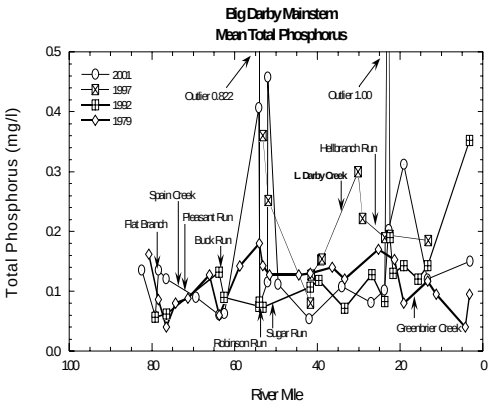


Figure B 3.1.5. Longitudinal and Temporal Trends in Total Phosphorus in the mainstem of Big Darby Creek, 1979, 1992, 1997 and 2001.



remained this way until downstream of Pleasant Run where they dipped below previous results. Phosphorus concentrations peaked in three other places on the mainstem, just upstream of Robinson Run, downstream of the Plain City WWTP, and downstream of the complex of wastewater treatment facilities including PCI-ODRC WWTP (RM 22.92), Clark's Lake Tributary (RM 20.20) and Foxlair Farms WWTP (RM 22.50).

Hellbranch Run (02-204) (RM 26.1) (WWH, EWH Recommended)
Chemical water quality trends were evaluated on the Hellbranch Run mainstem using data from the years 1992, 1997, and 2001. In most instances, average summer conditions on Hellbranch Run remained static and unchanging. Both mean ammonia and mean dissolved oxygen trends were similar until reaching the site downstream of the Timberlake WWTP outfall. There, ammonia spiked higher and dissolved oxygen drifted lower than noted in previous years (Figures B.3.1.6 and B.3.1.7). Mean total phosphorus concentrations were somewhat similar and just as variable as in previous years. Wastewater treatment plant influences seemed to provide the majority of nutrient spikes as in the past (Figure B.3.1.8). Mean nitrate+nitrite concentrations trended lower than in both 1992 and 1997 (Figure B.3.1.9). Mean bacterial values were found to be generally the same or lower than in the past except downstream of the Oakhurst Knolls WWTP. Mean total suspended solids concentrations were generally lower than historical values except in the headwaters. The negative influence from both Clover Groff and Hamilton ditches and the accelerating development in the upper watershed are contributing to these problems.

Little Darby Creek (02-210) (RM 34.1) (EWH)
Chemical water quality trends were evaluated on the Little Darby Creek mainstem using data from the years 1979, 1992, 1997, and 2001. Trends for both mean total suspended solids and mean fecal coliform bacteria were down from past evaluations as were concentrations of total phosphorus. Mean dissolved oxygen trends showed little change except for a slight drop at the headwaters and an increase around RM 15.30. Mean organic nitrogen concentrations trended higher downstream of Barron Creek to the mouth. Mean nitrate+nitrite concentrations were highest of any year at the headwaters falling to levels between those found in 1992 and 1997 (Figure B.3.1.10).

Treacle Creek (02-213) (RM 31.3) (EWH)
Chemical water quality trends were evaluated on Treacle Creek for the years 1992-95, 1997, and 2001. Trends evaluation could only be performed for the site at the mouth of the creek as there was no data for comparison at upstream sites. For total phosphorus and total suspended solids the 2001 data showed the lowest mean concentrations of any year (Figures B.3.1.11 and B.3.12). Mean dissolved oxygen concentrations were among the highest of any year (Figure B.3.1.13). Fecal coliform bacteria mean concentrations were midway between other years as were concentrations of nitrate+nitrite (Figures B.3.1.14 and B.3.1.15).

Figure B.3.1.6. Longitudinal and Temporal Trends in Ammonia in Hellbranch Run, 1992, 1997 and 2001.

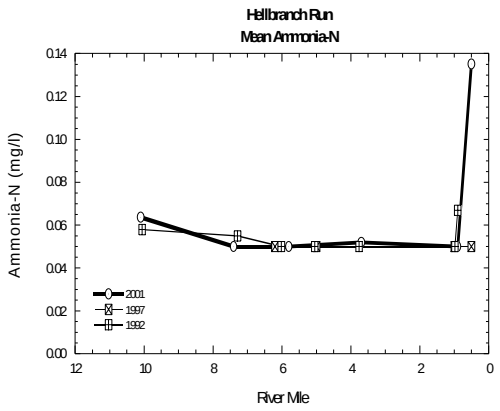


Figure B.3.1.7. Longitudinal and Temporal Trends in Dissolved Oxygen in Hellbranch Run, 1992, 1997 and 2001.

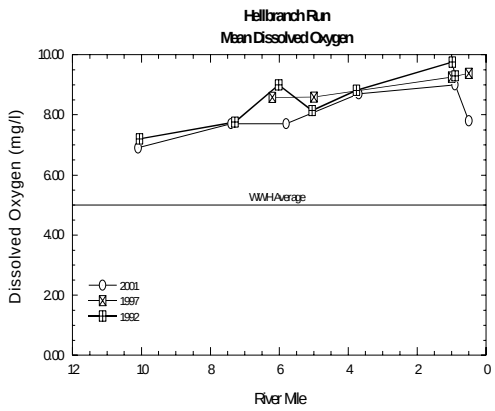


Figure B.3.1.8. Longitudinal and Temporal Trends in Total Phosphorus in Hellbranch Run, 1992, 1997 and 2001.

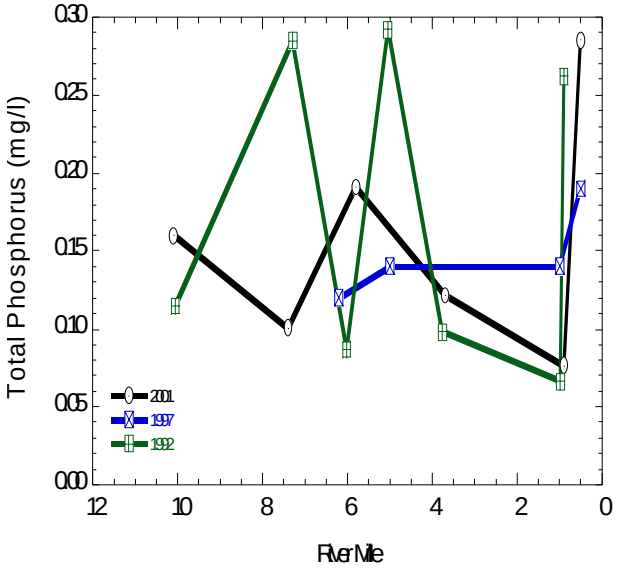


Figure B.3.1.9. Longitudinal and Temporal Trends in Nitrate - Nitrite in Hellbranch Run, 1992, 1997 and 2001.

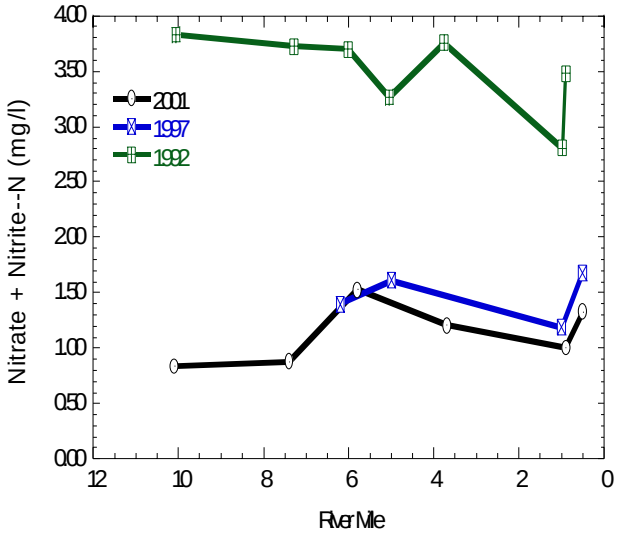


Figure B.3.1.10. Longitudinal and Temporal Trends in Nitrate+Nitrite in Little Darby Creek, 1979 1992, 1997 and 2001.

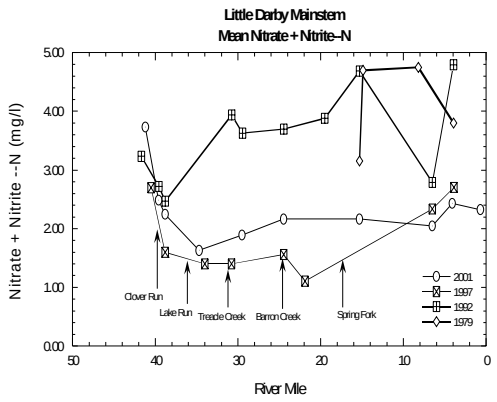


Figure B.3.1.11. Longitudinal and Temporal Trends in Total Phosphorus in Treacle Creek, 1992, 1993, 1994, 1995, 1997 and 2001.

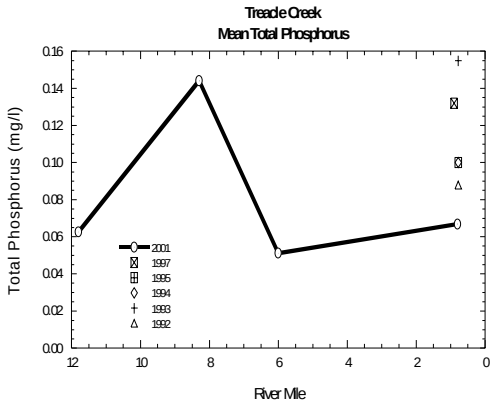


Figure B.3.1.12. Longitudinal and Temporal Trends in Total Suspended Solids in Treacle Creek, 1992, 1993, 1994, 1995, 1997 and 2001.

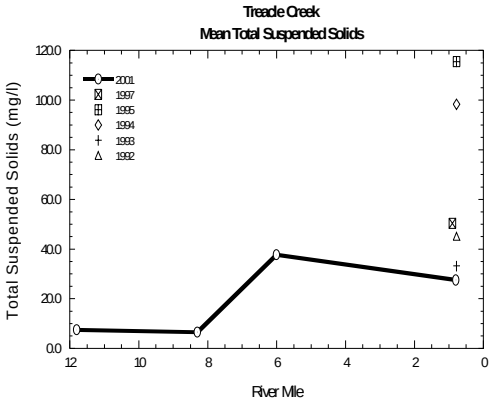


Figure B.3.1.13. Longitudinal and Temporal Trends in Dissolved Oxygen in Treacle Creek, 1992, 1993, 1994, 1995, 1997 and 2001.

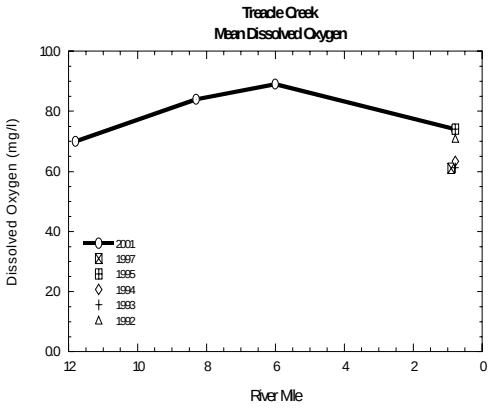


Figure B.3.1.14. Longitudinal and Temporal Trends in colonies/100 ml. of Fecal coliform bacteria in Treacle Creek, 1992, 1993, 1994, 1995, 1997 and 2001.

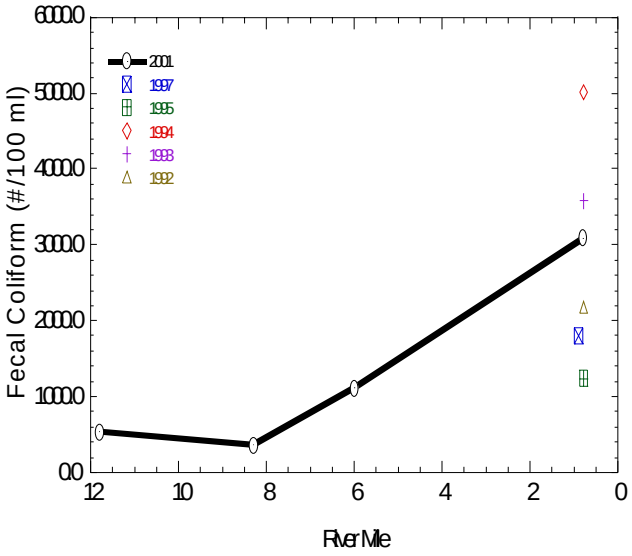
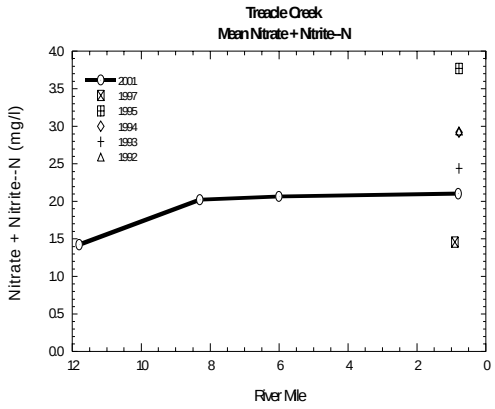


Figure B.3.1.15. Longitudinal and Temporal Trends in Mean Nitrate+Nitrite in Treacle Creek, 1992, 1993, 1994, 1995, 1997 and 2001.



B.4 Datasonde ™ Results (Short term continuous water quality monitoring)

Big Darby Creek Mainstem

Datasonde continuous monitoring units were deployed to record diel D.O. (dissolved oxygen), temperature, pH, and conductivity at various times during the summer of 2001 and 2002 at twenty seven locations between RM 78.6, upstream Flat Branch, to RM 3.1 at State Route 104 (Figures B.4.1 to B.4.7).

The results from diel sampling found most stations exhibiting the typical oscillating pattern of dissolved oxygen (through time) commonly associated with algal photosynthesis and respiration. Data collected from most of the stations indicated D.O. concentrations meeting or exceeding the minimum EWH standard of 5.0 mg/l with the exception of the stations located downstream from Flat Branch (RM 78.4, Figure B.4.1) and downstream from Plain City (RM 51.6, Figure B.4.1). These two sites, as well as the site downstream from Darbydale, exhibited mean dissolved oxygen that fell below the 6.0 mg/l EWH D.O. average criterion and, therefore, would constitute violations of that water quality standard. Additionally there are indications that there might be problems elsewhere in the watershed. Over half of the stations yielded values less than the 6.0 mg/l EWH D.O. average criterion. Most of the oxygen values that are below water quality stnadards were recorded at night when plants respire. Since these samples represent, in most cases, only a 96-hour period, it is likely that they do not represent the worst case scenario and values may well approach or exceed that criterion.

The stations where the average criterion violations occurred include the mainstem sites downstream from Flat Branch (RM 78.4, Figure B.4.1) and Buck Run (RM 62.5, Figure B.4.3), upstream and downstream from the Plain City WWTP (RMs 52.1, 52.0 Figure B.4.3), upstream from Little Darby Creek (RM 34.1, Figure B.4.2), downstream from Darbydale (RM 27.7, Figure B.4.2), downstream from Scioto Darby Road (RMs 18.45 and 18.1, B.4.6), adjacent Gulick Road (RM 15.7, Figure B.4.4), downstream from Georges Run (RM 14.8 Figure B.4.6), upstream from SR 316 (RM 13.5, Figure B.4.5), adjacent to Florence Chapel Road (RM 11.2, Figure B.4.6), and several sites in the lower mainstem at RMs 8.7 (Figure B.4.7), 7.9 (Figure B.4.4), and 5.4 (Figure B.4.7).

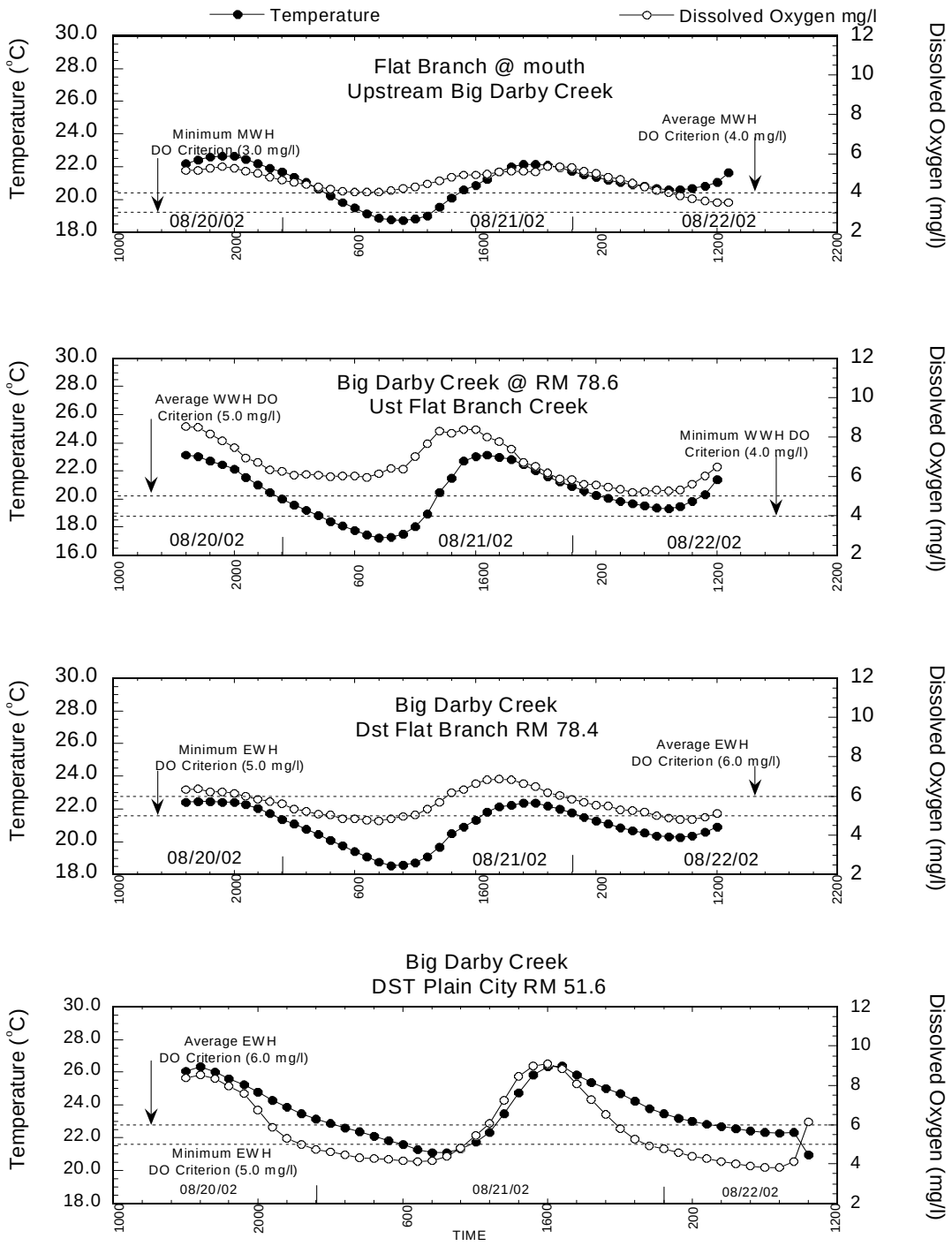


Figure B.4.1. Diel temperature and dissolved oxygen data collected with continuous monitoring units from Big Darby Creek and Flat Branch, September 2002.

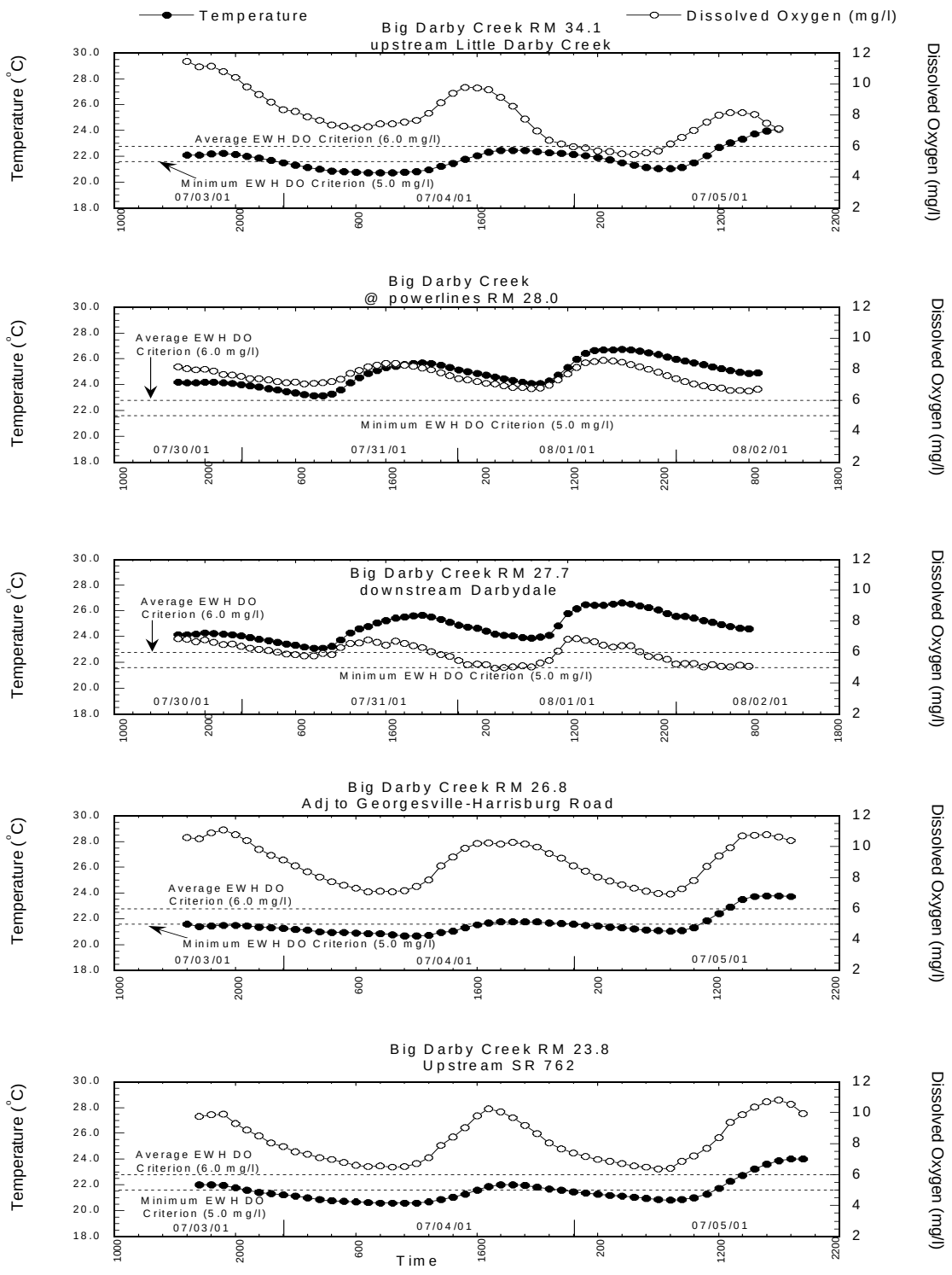


Figure B.4.2 Diel temperature and dissolved oxygen data collected with continuous monitoring units from the Big Darby Creek mainstem, July 2001.

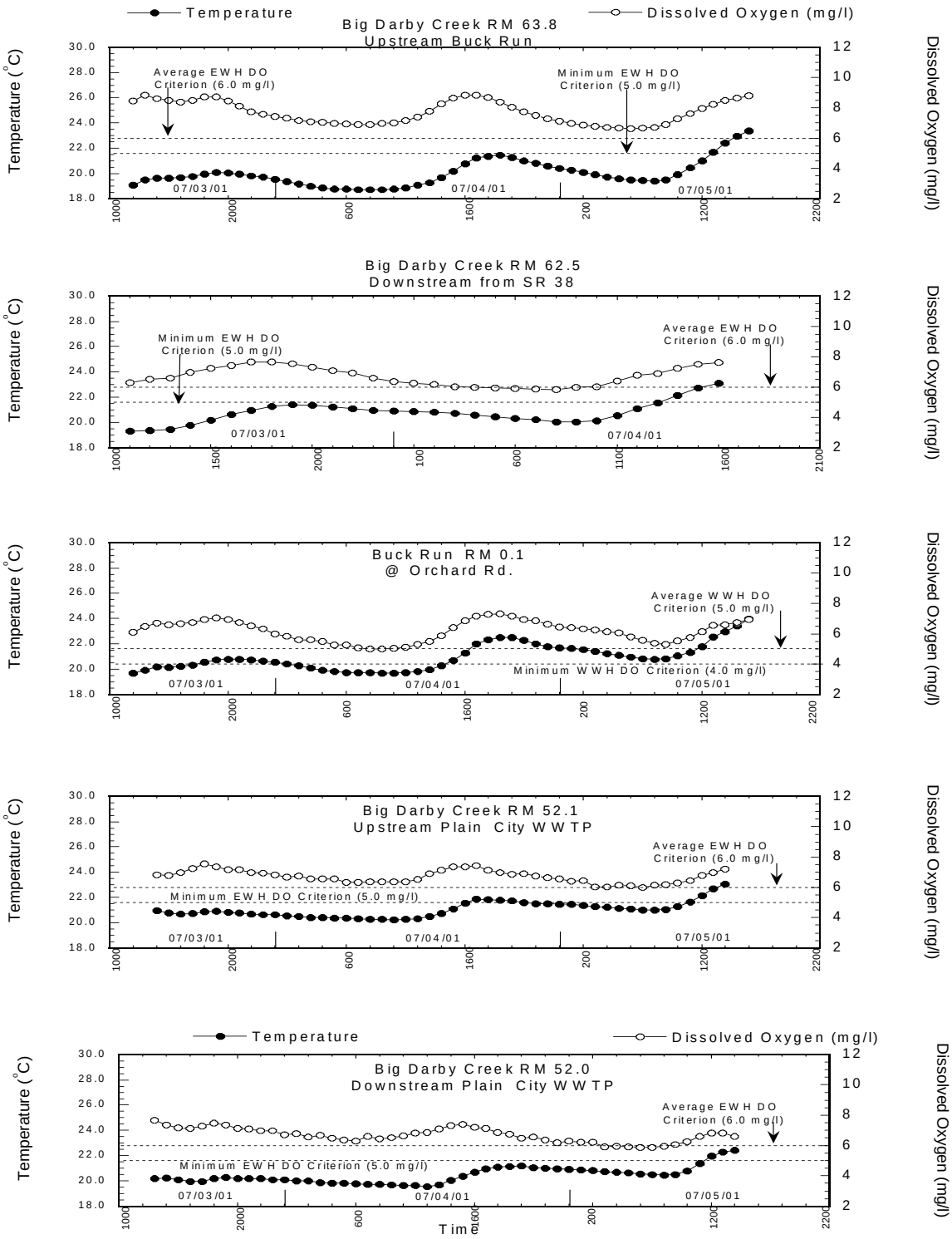


Figure B.4.3. Diel temperature and dissolved oxygen data collected with continuous monitoring units from Big Darby Creek and Buck Run, July 2001.

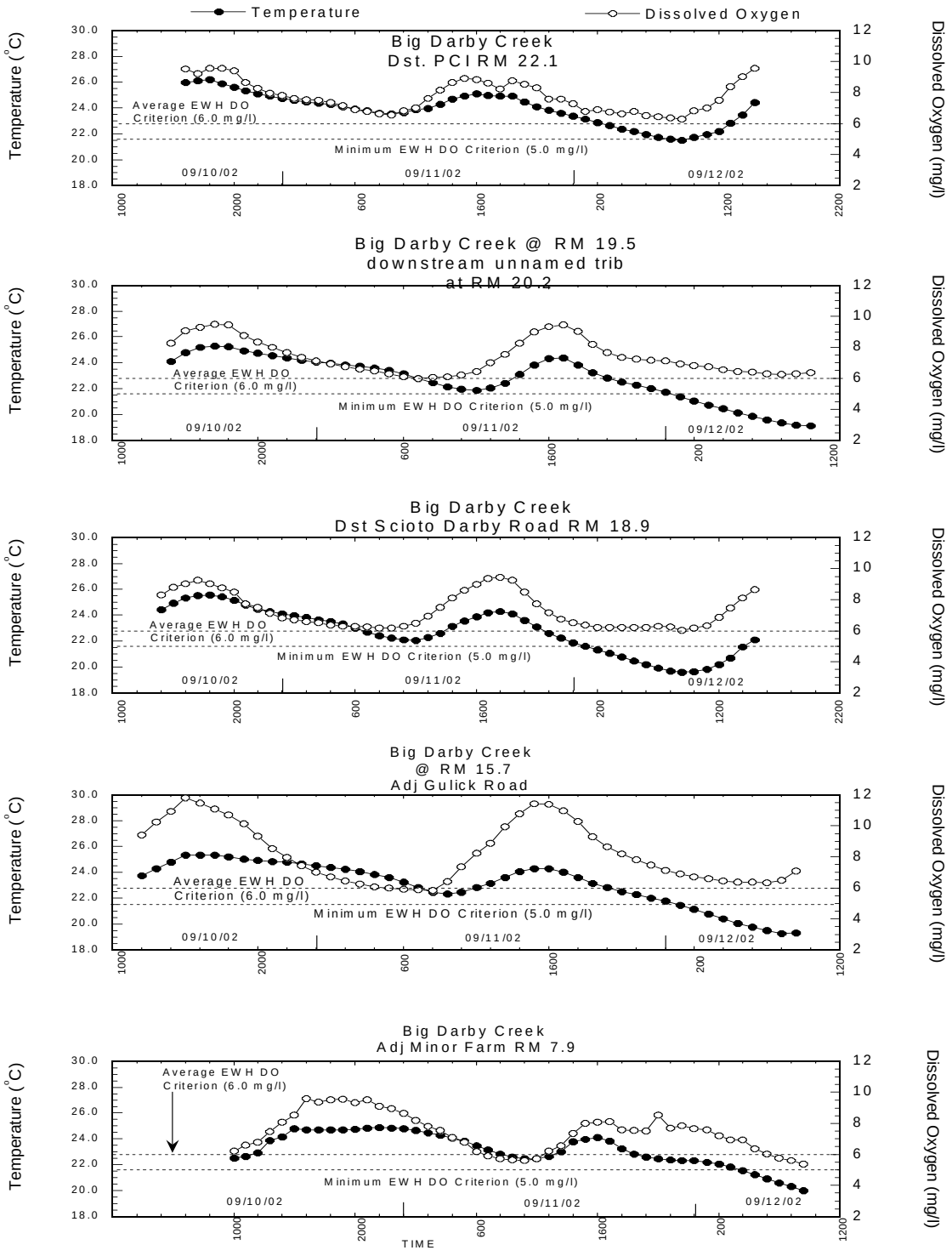


Figure B.4.4. Diel temperature and dissolved oxygen data collected with continuous monitoring units from the lower Big Darby Creek mainstem, September 2002.

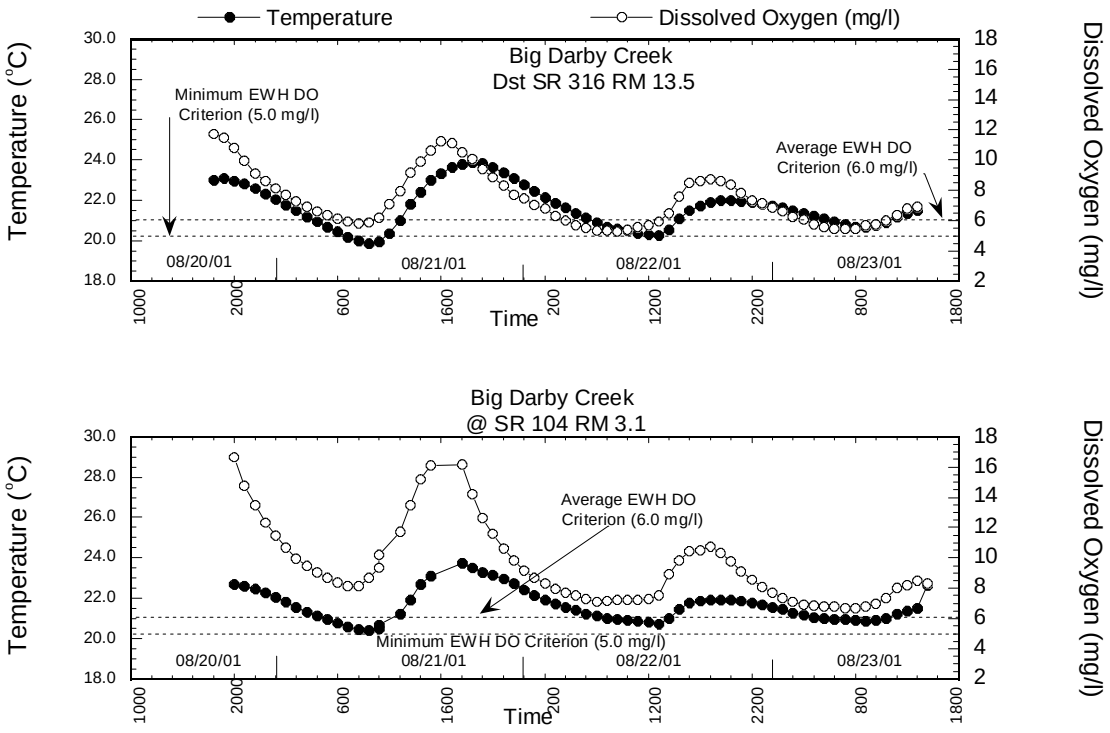


Figure B.4.5. Diel temperature and dissolved oxygen data collected with continuous monitoring units from the lower Big Darby Creek mainstem, September 2001.

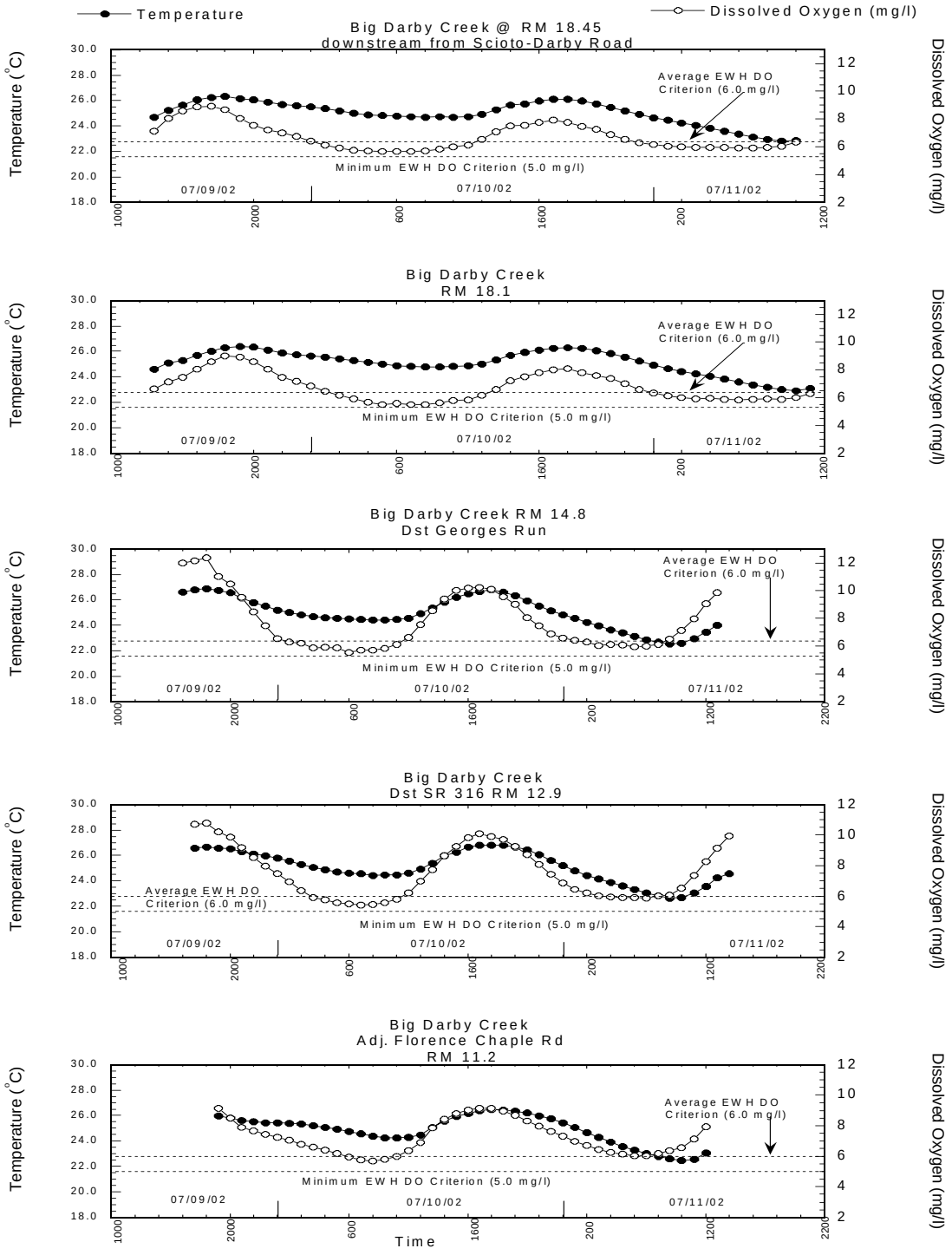


Figure B.4.6 Diel temperature and dissolved oxygen data collected with continuous monitoring units from the lower Big Darby Creek mainstem, July 2002.

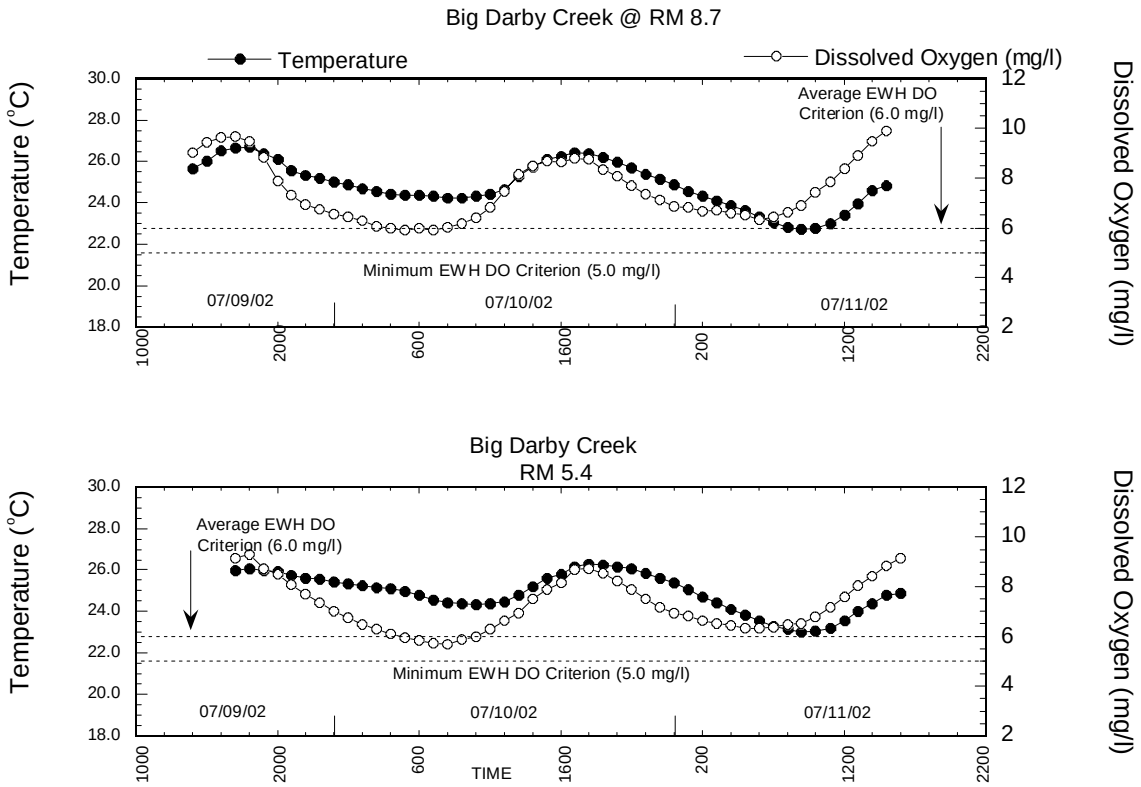


Figure B.4.7 Diel temperature and dissolved oxygen collected with continuous monitoring units from the lower Big Darby Creek, July 2002.

Little Darby Creek and Tributaries

Datasonde continuous monitoring units were deployed to record diel D.O., temperature, pH, and conductivity at various times during the summer of 2001 and 2002 at four locations on the Little Darby Creek mainstem between RM 39.6 to RM 15.3 (Figure B.4.8) and five tributaries to Little Darby Creek (Figure B.4.9).

The results from diel sampling found most stations exhibiting the typical oscillating pattern of dissolved oxygen through time commonly associated with algal photosynthesis and respiration. Data collected from all of the Little Darby Creek mainstem stations indicated D.O. concentrations meeting or exceeding the minimum EWH standard of 5.0 mg/l. One station at Axe Handle Road (RM 29.5) yielded a violation of the 6.0 mg/l EWH D.O. average criterion.

Dissolved oxygen concentrations from Treacle Creek (RM 0.75) yielded a violation of the 5.0 mg/l minimum EWH criteria (Figure B.4.9). A violation of the 6.0 mg/l EWH D.O. average criterion occurred in Spring Fork at Lafayette Plain City Road (Figure B.4.9, RM 0.75).

Dissolved oxygen concentrations from Proctor Run (designated EWH) met the EWH criteria (average and minimum criteria).

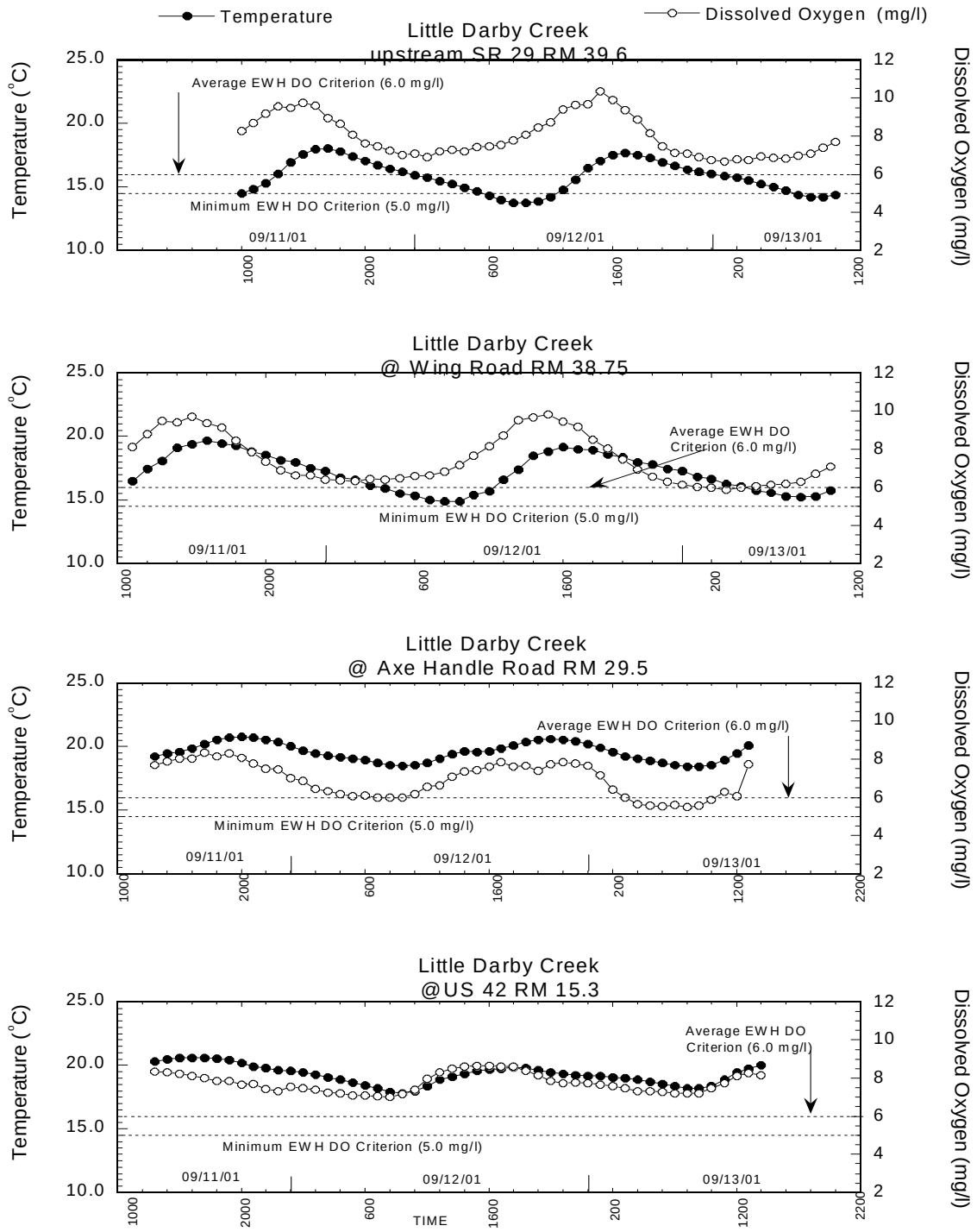


Figure B.4.8. Diel temperature and dissolved oxygen data collected with continuous monitoring units from the Little Darby Creek mainstem, September 2001.

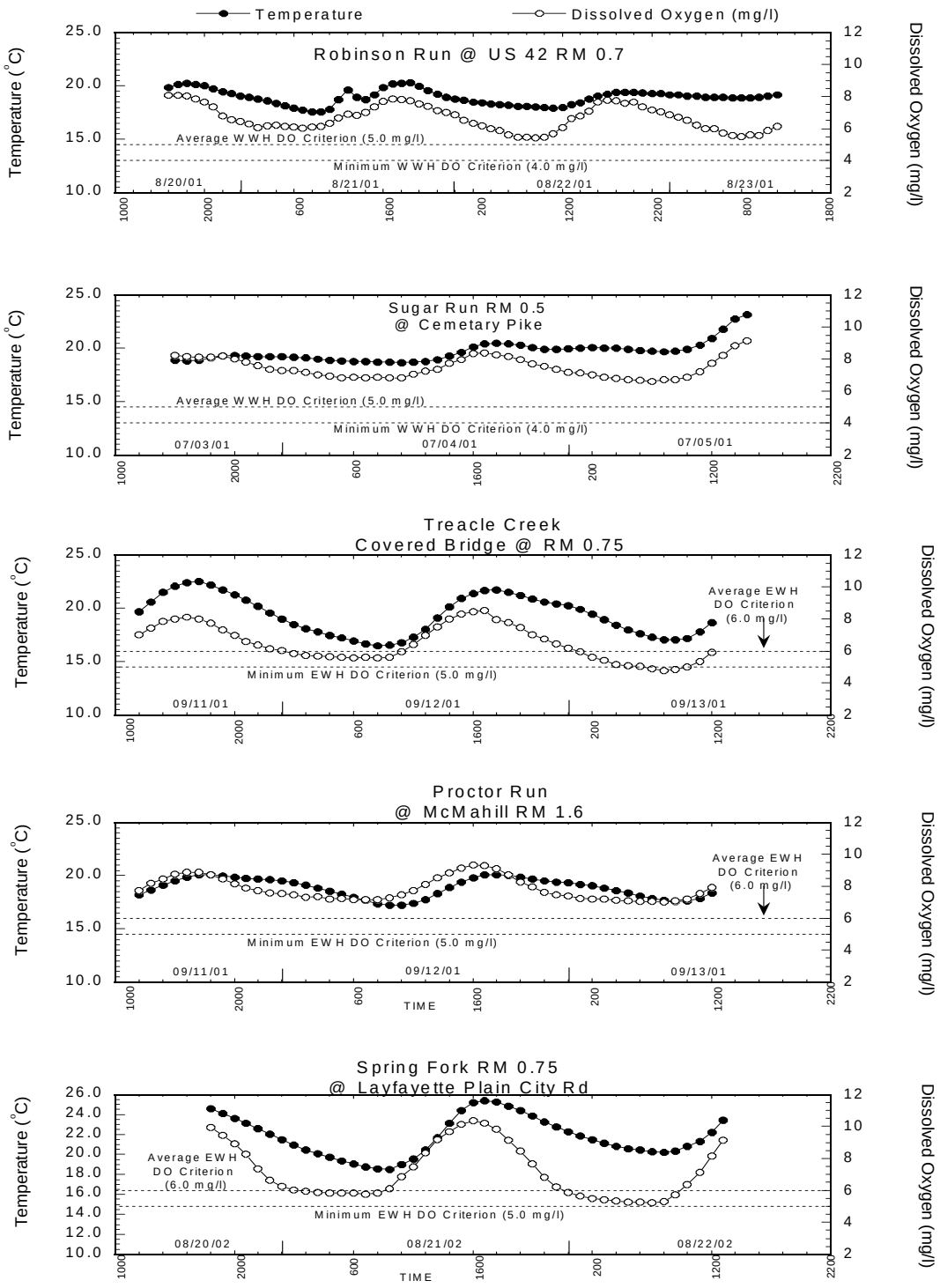


Figure B.4.9. Diel temperature and dissolved oxygen data collected with continuous monitoring units from various tributaries to Little Darby Creek, summer 2001 and 2002.

Big Darby Creek Upper Tributaries

Flat Branch (02-223) (RM 78.48)

Datasonde continuous monitoring units were deployed to record diel D.O., temperature, pH, and conductivity at three locations on Flat Branch during the summer of 2001 (Figure B.4.10). During the 2002 field season, Datasondes were also deployed upstream and downstream from Flat Branch on Big Darby Creek and at the mouth of Flat Branch to determine if Flat Branch was impacting Big Darby Creek (Figure B.4.10).

The results from diel sampling found most stations exhibiting the typical oscillating pattern of dissolved oxygen (through time) commonly associated with algal photosynthesis and respiration. Data collected in 2001 from all three Flat Branch mainstem stations (designated MWH) indicated D.O. concentrations fully met the minimum and average MWH criteria (Figure B.4.10). However, data collected from the 2002 field season indicated violations of the average MWH D.O. criteria of 4.0 mg/l at the mouth of Flat Branch. Dissolved oxygen concentrations upstream from Flat Branch in Big Darby Creek fully met the WWH criteria (minimum and average) but fell below the minimum EWH criterion of 5.0 mg/l downstream from Flat Branch. Big Darby Creek is currently designated WWH upstream from Flat Branch and EWH downstream from Flat Branch. The Datasonde results from the 2002 field season indicate that Flat Branch is causing a decrease in dissolved oxygen in the mainstem of Big Darby Creek.

Buck Run (02-209) (RM 63.74)

Datasonde continuous monitoring units were deployed to record diel D.O., temperature, pH, and conductivity at one location on Buck Run and upstream and downstream from Buck Run on Big Darby Creek during the summer of 2001 (Figure B.4.3). Two concentrations went below the average WWH D.O. criteria (5.0 mg/l) at the Buck Run location (RM 0.1 at Orchard Road). The Big Darby Creek location upstream from Buck Run fully met the EWH criterion for D.O. (average and minimum) but six concentrations went below the average EWH D.O. criterion (6.0 mg/l) at the Big Darby Creek location downstream from Buck Run. The results indicate that Buck Run may be causing decreased D.O. level in the mainstem of Big Darby Creek.

Robinson Run (02-207) (RM 53.69) and Sugar Run (02-206) (RM 50.92)

Dissolved oxygen concentrations from Robinson Run and Sugar Run, both designated WWH, met the WWH criteria (average and minimum criteria).

Unnamed Tributary to Big Darby Creek (02-270) (RM 20.2)

One Datasonde continuous monitoring unit was deployed to record diel D.O., temperature, pH, and conductivity just downstream from the Fox Lair Mobile Home Park on an unnamed tributary to Big Darby Creek at RM 20.2. Dissolved oxygen concentrations below the 4.0 mg/l WWH minimum standard were observed at all of the test cycles with the highest reading at 1.62 mg/l and the lowest at 0.52 mg/l (Figure B.4.11). The significant water quality violations are most likely caused by the discharge from the Fox Lair MHP but could also be a result of the dam release just upstream from the Fox Lair MHP.

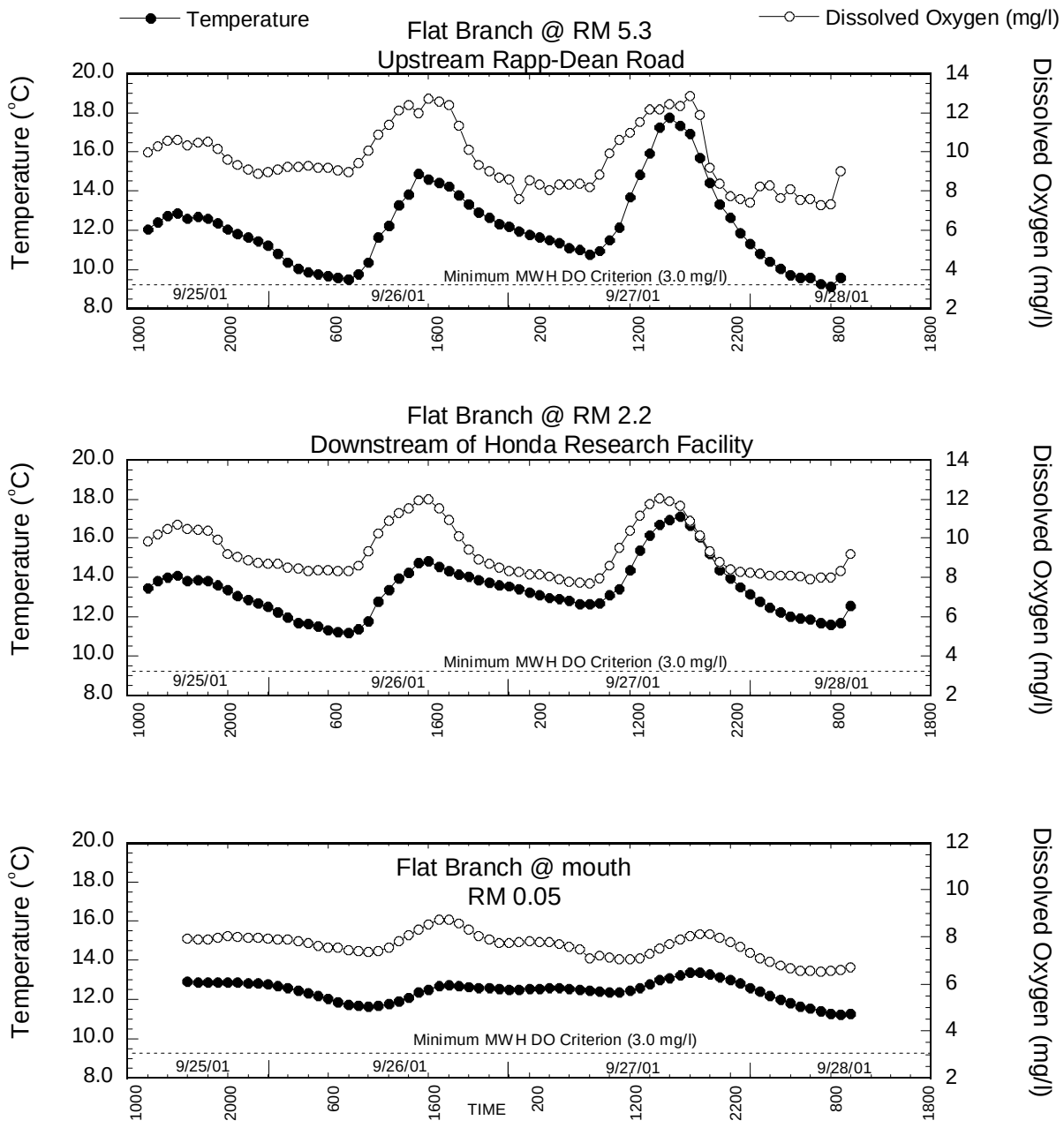


Figure B.4.10 Diel temperature and dissolved oxygen data collected with continuous monitoring units from Flat Branch, September 2001.

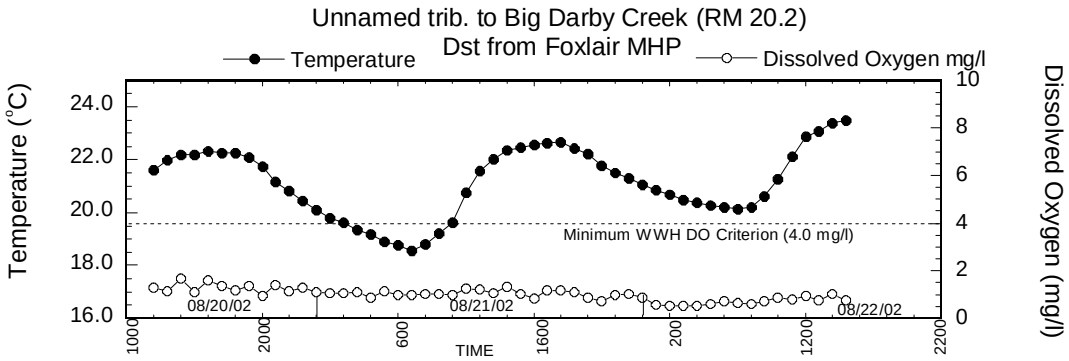


Figure B.4.11. Diel temperature and dissolved oxygen data collected with continuous monitoring units from an unnamed tributary to Big Darby Creek (RM 20.2) downstream from Foxlair MHP, September 2002.

B.5 Sediment Chemistry

The chemical quality of deposited sediments is important to evaluate since many pollutants adhere strongly to sediment particles and are persistent in the aquatic environment. The chemical and physical make-up of streambed sediments is largely a reflection of upstream and local geology, land use and surface run off. Some chemicals are attracted to the surface electrical charges associated with fine silts and clay suspended in the water column. Many persistent compounds are highly insoluble in water and have a high molecular weight and, therefore, settle out quickly where they will be incorporated with other settled materials, organic and inorganic in nature. The sediment - water interface is the most physically, chemically and biologically reactive layer of the streambed. It can be affected by currents, floods, sunlight, and burrowing benthic organisms. Analysis of the chemical make-up of this interface can be used to predict ecological impact.

Sediment sampling followed protocols detailed in Ohio EPA's Sediment Sampling Guide and Methodologies (Ohio EPA, 2001). Sediment samples were obtained from nine sites on Big Darby Creek and ten sites on tributary streams, four of which were from Little Darby Creek. Sediment samples were collected one time during the survey and evaluated for percent solids, total organic carbon, VOCs, BNAs, PCBs, pesticides, heavy metals, and nutrients. Not all samples received nutrient analysis.

Sediment contamination was evaluated by utilizing procedures detailed in peer reviewed literature (e.g., MacDonald, 2000; Persaud and Jaagumagi, 1994). Metal contamination was also compared with Ohio EPA statewide data (Ohio EPA 1996, 2003). The Ohio EPA Sediment Reference Values were based on data derived from ecoregional sediment reference sites. This Ohio EPA Sediment Reference Value (SRV), either ecoregion specific or a statewide value, was derived as a cutoff value, where a concentration above the SRV is considered an outlier and is judged to be elevated above the background concentration. The reference value is defined as the interquartile range (distance between the 25th and 75th percentile) multiplied by 1.5 and added to the upper quartile (75th percentile value). This value is consistent with the upper fence on a standard box plot. It is not a direct measure of toxicity. Guidelines for the Protection and Management of Aquatic Sediment in Ontario (Persaud et al., 1994) define two levels of ecotoxic effects, and are based on chronic, long-term effects of contaminants on benthic organisms. A Lowest Effect Level (LEL) is a level of sediment contamination that can be tolerated by the majority of benthic organisms. Contaminants at a Severe Effect Level (SEL) are expected to produce a significant disturbance of the sediment dwelling community. The potential for toxicity was also evaluated by the MacDonald guidelines which are consensus based using previously developed values. These guidelines predict that sediment below the threshold effect concentration (TEC) is not toxic and that concentrations greater than the probable effect concentration (PEC) in contrast are toxic.

Very few organic compounds were detected in the sediments sampled in the Big Darby Creek watershed. Only dieldrin (1 detection) and acetone (3 detections) were found (Tables B.5.1 and B.5.2). The detection of dieldrin, a pesticide, at RM 52.00 on Big Darby Creek, just downstream

from the Plain City WWTP, was sufficiently high to be greater than a threshold effect concentration (TEC, MacDonald, 2000). This concentration of dieldrin, an insecticide, may have contributed to the decline in the ICI, total EPT taxa and sensitive macroinvertebrate taxa documented downstream from Sweeney Run and the Plain City WWTP. Acetone was detected at 3 locations, RM 54.20 on Big Darby Creek, and RM 0.70 on Robinson Run, which were adjacent to and downstream from Ranco, Inc., respectively. Acetone was also found at RM 3.10, with no known source there. The acetone source(s) are unknown and did not seem to pose a threat to the stream or aquatic life.

Tributary Sediment Results

Nutrient analysis for sediments included both ammonia, total phosphorus, and total organic carbon. Ammonia concentrations were highest in Hellbranch Run near the mouth (i.e., 140 mg/kg) (Table B.5.4) and in Robinson Run (i.e., 94 mg/kg). Decreased fish community performance coincidently was observed at both of these sites. Both of these streams receive effluent from package WWTPs which may be contributing to sediment ammonia. The site with the next highest concentration (i.e., 57 mg/kg) was on Little Darby Creek at RM 15.3 (US Rt. 42) which is probably due to the Green Meadows MHP WWTP which discharges a short distance upstream to the mouth of Spring Fork. There has been a slight decrease in macroinvertebrate community quality here over time.

Total organic carbon was found in all tributary streams at concentrations above the lowest effect level (LEL, Persaud and Jaagumagi, 1993). Total organic carbon values in tributary streams (2.2 mg/kg - 5.1 mg/kg) were comparable to values documented in other ECBP tributary streams in central Ohio, such as Bokes Creek (2.5 mg/kg -3.5 mg/kg) and Olentangy River tributary streams (1.5 mg/kg - 9.4 mg/kg) (Ohio EPA 2000 and Ohio EPA 2001).

Sediment total phosphorus was evaluated at all sites (except two sites on Little Darby Creek) and all exceeded LEL concentrations. Total phosphorus concentrations in sediments were highest in Little Darby Creek (RM 15.3), Hellbranch Run at the mouth, Treacle Creek (RM 0.8), Robinson Run (RM 0.7) and Sugar Run (RM 0.7). The Green Meadows MHP WWTP is the logical source for the elevated total phosphorus value found at RM 15.30 in Little Darby Creek although NPS sources may have contributed to the problem. There has been a slight decline in macroinvertebrate community quality over time at this site. The majority of the responsibility for the Hellbranch Run value likely falls to the Timberlake WWTP which is just upstream and has experienced operational problems. A description of the problems associated with the Timberlake Subdivision WWTP is provided in the Pollution Loadings Section. Robinson Run has nonpoint source and WWTP inputs. Again, inadequate quality fish performance was observed at the Hellbranch Run and Robinson Run sites. Sugar Run and Treacle Creek sites had sedimentation, nutrient enrichment and low dissolved oxygen problems which yielded decreased biological community performance.

Mainstem Sediment Results

Nutrients found in Big Darby Creek followed the same pattern as the tributaries in most instances. Ammonia concentrations were not as elevated as some of those found in the tributaries; however, the three sites with higher concentrations have shown trends of decreasing quality. The highest concentrations were found at RM 3.10 (83 mg/kg) at RM 63.8 (68 mg/kg) and RM 53.9 (52 mg/kg) (Table B.5.3). All three areas have accumulated sediment from upstream NPS inputs (i.e., agriculture, tributaries and other sources). Sediment ammonia, along with other factors, likely contributed to decreased mussel diversity in these reaches (see Trends in Unionid Mussel Communities).

All sites exhibited total organic carbon concentrations greater than the lowest effect level (LEL, Persaud and Jaagumagi, 1993). The highest concentration was found at RM 53.9. Total organic carbon values in the Big Darby Creek mainstem (range 2.8 mg/kg - 7.2 mg/kg) compare favorably with those in other central Ohio waterbodies such as the Olentangy River (2.1 mg/kg - 9.0 mg/kg), Stillwater River (2.1 mg/kg - 9.1 mg/kg), and the middle Scioto River (1.5 mg/kg - 15.0 mg/kg) (Ohio EPA 2000 and Ohio EPA 2001).

All sites which received analysis for total phosphorus were also greater than the LEL (Ibid). Results for other ECBP streams show that the lower value of the Big Darby Creek sediment phosphorus concentration range (i.e., 971 mg/kg - 1700 mg/kg) was almost double to more than double the lower values from the Olentangy and Stillwater Rivers, respectively (Olentangy River - 527 mg/kg -1060 mg/kg, Stillwater River - 480 mg/kg - 1610 mg/kg). The upper end of the range in Big Darby Creek was 70% higher than the Olentangy River and less than 10% higher than the Stillwater River (both TSD cited). The three highest phosphorus concentrations were found at RM 3.1 (1700 mg/kg), RM 53.9 (1670 mg/kg), and RM 63.8 (1420 mg/kg). All three reaches have accumulated sediment as well as elevated sediment ammonia concentrations (see above). The elevated sediment phosphorus values at these sites likely contributed to the decreased mussel diversity in these reaches through time (see Trends in Unionid Mussel Communities).

In general, sediment nutrient values greater than the LEL indicate that the sediment is marginally to significantly polluted and that it will produce some toxicity concerns for benthic organisms living in them (Persaud and Jaagumagi, 1993). Sediment taken from an individual sampling location are chosen based on a qualitative evaluation of 2 observations. First, the material must be unconsolidated and freshly deposited, and second, the material should consist of mostly fine grained material (i.e., clays, silts, etc.) if available. The proportion of fine grained sediment in the segment will determine the magnitude of the toxicity associated with elevated concentrations of nutrients. If fines are a small proportion of the stream bed materials elevated concentrations of nutrients will not exacerbate enriched conditions in the water column. In contrast, nutrient enrichment may be a problem where substrates are dominated or embedded by fine-grained sediments.

Table B.5.1. Results of chemical/physical sediment quality sampling conducted on the Big Darby Creek mainstem during July-September, 2001. Blank spaces indicate that the compound was not detected in the sample. Parameters noted with underlining exceed the threshold effect concentration (TEC, MacDonald, 2000) and those in italics do not have data sufficient to produce an evaluation.

Big Darby Creek Mainstem Sediments										
		River Mile								
Analyte	Units	63.80	54.20	53.90	52.00	34.10	27.00	23.80	13.40	3.10
Solids	%	30.8	31.4	30.2	50.6	37.7	37.5	47.6	47.5	33.2
TOC	%	5.0	6.3	7.2	4.3	4.5	2.9	3.3	2.8	3.7
Acetone	mg/kg		*0.200*							*0.132*
Dieldrin	mg/kg				23.8					

Table B.5.2. Results of chemical/physical sediment quality sampling conducted in Big Darby Creek tributaries during July-September, 2001. **HR** = Hellbranch Run at mouth (RM 0.50), **BR** = Buck Run at mouth (RM 0.10), **TC** = Treacle Creek at mouth (RM 0.80), **PR** = Proctor Run at McMahill Road (RM 1.60), **RR** = Robinson Run at U.S. 42 (RM 0.70), **LD1** = Little Darby Creek at Allison Road (RM 41.20), **LD2** = Little Darby Creek at Rosedale-Plain City Road (RM 24.50). **LD3** = Little Darby Creek at U.S. 42 (RM 15.30), **LD4** = Little Darby Creek at Roberts Road (RM 4.10), **SR** = Sugar Run at Taylor Road (RM 7.00). Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level). Blank spaces indicate that the compound was not detected in the sample. Parameters noted in italics do not have data sufficient to produce an evaluation.

Big Darby Creek Tributaries Sediments											
Analyte	Units	**HR**	**BR**	**TC**	**PR**	**RR**	**LD1**	**LD2**	**LD3**	**LD4**	**SR**
Solids	%	48.6	57.2	46.0	47.5	41.2	42.8	41.4	38.0	33.6	61.6
TOC ◙	%	3.4 LEL	3.0 LEL	3.9 LEL	3.4 LEL	4.4 LEL	3.5 LEL	3.8 LEL	5.0 LEL	2.2 LEL	5.1 LEL
Acetone	mg/kg					*0.137*					

Table B.5.3. Results of chemical/physical sediment quality sampling conducted in the Big Darby Creek study area during July-September, 2000. Parameters in *italic* have no established guideline for comparison. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level but less than the Severe Effect Level). Shaded boxes exceed the consensus-based threshold effect concentration (TEC) published in MacDonald, 2000. Shaded boxes with bold print exceed the consensus-based probable effect concentration (PEC) published in MacDonald, 2000. Shaded boxes with a subscript "p" have possible concentrations >TEC and/or >PEC (in bold), but were below that particular test method detection limit, so chronic effects are possible but not certain. All other parameters are compared with Ohio EPA sediment reference guidelines (Ohio EPA1996, 2003). Descriptive guidelines are as follows: Not elevated, elevated (✚).

Big Darby Creek Mainstem Sediments										
		River Mile								
Analyte	Units	**63.80**	**54.20**	**53.90**	**52.00**	**34.10**	**27.00**	**23.80**	**13.40**	**3.10**
Solids	*%*	*31.6*	*29.6*	*27.4*	*42.9*	*33.0*	*31.3*	*43.8*	*44.2*	*30.1*
NUTRIENTS										
TOC ◙	%	5.0_{LEL}	6.3_{LEL}	7.2_{LEL}	4.3_{LEL}	4.5_{LEL}	2.9_{LEL}	3.3_{LEL}	2.8_{LEL}	3.7_{LEL}
Ammonia	*mg/kg*	*68*	*NA*	*52*	*NA*	*32*	*NA*	*34*	*42*	*83*
Phosphorus ◙	mg/kg	1420_{LEL}	NA	1670_{LEL}	NA	1310_{LEL}	NA	971_{LEL}	1100_{LEL}	1700_{LEL}
METALS										
Aluminum	mg/kg	27700	28900	30800	25100	11800	17800	18500	25900	44000 ✚
Arsenic	mg/kg	11.6	11.1	9.47	12.0	7.44	11.0	7.21	10.2	14.0
Barium	mg/kg	203	188	231	175	125	189	139	135	264 ✚
Cadmium	mg/kg	0.507	0.540	0.706	0.634	0.339	0.396	0.263	0.315	0.425
Calcium	mg/kg	48900	50100	46400	26800	58800	72900	44300	45900	82000
Chromium ◙	mg/kg	36	37	41 ✚	30 LEL	31	32	25	25	36LEL
Copper	mg/kg	13.5	16.9	18.5	27.2	11.7	15.4	13.9	17.9	20.9

Continued

Big Darby Creek Mainstem Sediments										
		River Mile								
Analyte	Units	**63.80**	**54.20**	**53.90**	**52.00**	**34.10**	**27.00**	**23.80**	**13.40**	**3.10**
Iron	mg/kg	23900	23900	24400	27100	16000	22800	17100	19200	27800
Lead	mg/kg	48 ☆p	49 ☆p	55 ☆p	108	42p	43p	33	33	48 p
Magnesium	mg/kg	11400	15600	12900	10800	12700	16500	15300	18800	19400
Manganese	mg/kg	540	391	272	306	259	381	212	378	651
Nickel	mg/kg	48✚p	**49 ✚p**	**55 ✚p**	33p	42✚p	43 ✚p	33p	33p	48 ✚
Mercury	mg/kg	0.055	0.084	0.099	0.077	0.070	0.060	0.044	0.045	0.055
Potassium	mg/kg	7500	7210	9120	6520	3700	6000	6090	6050	10200
Selenium	mg/kg	2.39✚	2.46✚	2.75✚	1.58	2.09	2.13	1.66	1.64	2.37✚
Sodium	*mg/kg*	*5970*	*6140*	*6890*	*3950*	*5220*	*5320*	*4150*	*4110*	*5930*
Strontium	mg/kg	848✚	803✚	804✚	432✚	1940✚	1900✚	507✚	603✚	1640✚
Zinc	mg/kg	90.7	113	98.4	114	63.2	96.1	85.4	72.3	128

Table B.5.4. Results of chemical/physical sediment quality sampling conducted in the Big Darby Creek study area during July-September, 2000. Parameters in *italic* have no established guideline for comparison. Underlined values indicate concentrations below the method detection limit. Parameters noted with a ◙ are compared with the Ontario guidelines published by Persaud and Jaagumagi, 1993 (LEL = greater than the Lowest Effect Level). Most other parameters are compared with Ohio EPA ecoregional or statewide sediment reference guidelines (Ohio EPA 1996, 2003). Descriptive guidelines are as follows: Not elevated, elevated(✚). Shaded boxes exceed the consensus-based threshold effect concentration (TEC) published in MacDonald, 2000. Shaded boxes with bold print exceed the consensus-based probable effect concentration (PEC) published in MacDonald, 2000. Shaded boxes with a subscript "p" have a possible concentration > TEC but were below that particular method detection limit, so chronic effects are possible but not certain.

Big Darby Creek Tributaries Sediments											
Analyte	Units	**HR**	**BR**	**TC**	**PR**	**RR**	**LD1**	**LD2**	**LD3**	**LD4**	**SR**
Solids	%	*44.4*	*51.6*	*41.1*	*41.3*	*38.2*	*46.9*	*40.5*	*38.4*	*31.6*	*46.5*
NUTRIENTS											
TOC ◙	%	3.4 LEL	3.0 LEL	3.9 LEL	3.4 LEL	4.4 LEL	3.5 LEL	3.8 LEL	5.0 LEL	2.2 LEL	5.1 LEL
Ammonia	*mg/kg*	*140*	*42*	*27*	*53*	*94*	*31*	*NA*	*57*	*NA*	*24*
T. Phosphorus ◙	mg/kg	1340 LEL	834 LEL	1270 LEL	917 LEL	1250 LEL	853 LEL	NA	1520 LEL	NA	1050 LEL
METALS											
Aluminum	mg/kg	15700	16800	17200	13100	23200	15300	21800	27900	21600	27600
Arsenic	mg/kg	11.1	8.74	12.7	11.2	11.5	11.1	10.6	11.3	9.60	17.3✚
Barium	mg/kg	144	99.5	142	136	143	124	180	190	172	155
Cadmium	mg/kg	0.520	0.348	0.449	0.319	0.439	0.344	0.423	0.370	0.426	0.454
Calcium	mg/kg	43900	20100	54700	73000	46000	46800	52500	60400	70200	15300
Chromium ◙	mg/kg	24	21	25	27	27	23	25	30	36	31LEL
Copper	mg/kg	19.9	14.0	12.7	9.2	15.6	9.4	11.0	11.7	13.6	20.6
Iron	mg/kg	19500	18200	19600	15500	21600	16000	19400	19900	19400	30000 ✚
Lead	mg/kg	32	28	33	37p	36p	31	33	39p	48p	31
Magnesium	mg/kg	16200	10000	21700	19600	17600	20400	18600	18200	18500	8050
Manganese	mg/kg	329	254	452	393	213	228	412	498	412	365
Mercury	mg/kg	0.038	0.042	0.047	0.041	0.055	0.053	0.061	0.063	0.067	0.054
Nickel	mg/kg	32p	28p	33p	37p	36p	31p	33p	39p	48✚p	36
Potassium	mg/kg	5150	4510	4710	3710	6770	3970	5240	5440	5210	6560
Selenium	*mg/kg*	1.61	1.38	1.65	1.83	1.77	1.55	1.65	1.96	2.39 ✚	1.56
Sodium	*mg/kg*	*4020*	*3460*	*4120*	*4570*	*4440*	*3880*	*4120*	*4910*	*5970*	*3910*
Strontium	mg/kg	213	203	601 ✚	1840 ✚	512 ✚	204	590 ✚	703 ✚	828 ✚	121
Zinc	mg/kg	99.2	70.1	68.9	51.1	75.9	67.7	68.4	86.7	97.8	102

HR = Hellbranch Run at mouth (RM 0.50), **BR** = Buck Run at mouth (RM 0.10), **TC** = Treacle Creek at mouth (RM 0.80), **PR** = Proctor Run at McMahill Road (RM 1.60), **RR** = Robinson Run at U.S. 42 (RM 0.70), **LD1** = Little Darby Creek at Allison Road (RM 41.20), **LD2** = Little Darby Creek at Rosedale-Plain City Road (RM 24.50). **LD3** = Little Darby Creek at U.S. 42 (RM 15.30), **LD4** = Little Darby Creek at Roberts Road (RM 4.10), **SR** = Sugar Run at Taylor Road (RM 7.00)

Tributary stream sediments were also evaluated for heavy metals. The most impacted stream locale was Sugar Run at RM 7.00. Here, arsenic concentrations were elevated as were chromium and iron. Copper, nickel, and zinc concentrations were slightly elevated (Table B.5.4). This was the only tributary that exhibited detectable concentrations of chromium and nickel as well as the highest values for copper, iron, and zinc. The Hershberger Landfill may be the source of these metals.

Metals were found in sediments throughout the Big Darby Creek mainstem. There were two locations of particular concern: RM 52.00, downstream of the Plain City WWTP, and at RM 3.10 near the mouth. Sediment lead concentrations of 108 mg/kg greatly exceeded the TEC at RM 52.00 (Table B.5.3). The sediment chromium concentration exceeded the LEL. Other relatively higher concentrations of zinc (114mg/kg) and copper (27.2 mg/kg) indicated metals present in the sediments possibly from a defunct metal plating shop, the Plain City WWTP and Sweeney Run NPS inputs. Toxicity from these sediment metals could have contributed to the decrease in macroinvertebrate community ICI and diversity at this site compared to upstream.

At RM 3.1 on Big Darby Creek sediment aluminum and barium was elevated in comparison to the Ohio EPA sediment reference values. Nickel was elevated (48 mg/kg) and exceeded the TEC concentration. The zinc sediment concentration at RM 3.1 of 128 mg/kg also exceeded the TEC concentration. The sediment chromium exceeded the LEL (Table B.5.3). The elevated sediment metals and silt bedload with attached phosphorus and ammonia noted earlier likely contributed to decreased mussel diversity in this reach.

Sediment metals including nickel, lead, zinc and chromium at RM 54.2 and RM 53.9, which are in the vicinity of Ranco and US Rt. 42, may be causing toxicity. These sediment metal concentrations along with other factors (i.e., sediment total phosphorus and ammonia) could have contributed to the documented decline of mussel diversity in this reach. Although detection limits somewhat confound the lead and nickel analyses, the shaded areas in the tables document values that might exceed the TEC at sites not discussed.

B.6 Instream and Riparian Habitat in Support of Aquatic Life

The guidance document "Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams" (Ohio EPA, 1999), discusses the importance of habitat quality and the effect of habitat disruptions on aquatic life. Passages from that document pertinent to the Big Darby Creek watershed are provided below.

> Ohio EPA uses the Qualitative Habitat Evaluation Index (QHEI; Rankin, 1989, 1995) to assess the physical habitat quality of streams and rivers. This index measures the important components of lotic (i.e., riverine) macrohabitat (i.e., large scale habitat features) that are essential to sustaining high value aquatic communities. The major categories of macrohabitat include substrate quality, instream cover (physical structure), stream channel morphology and condition, riparian quality and bank erosion, pool and run-riffle quality, and gradient. Comparisons between the QHEI and IBI has resulted in a list of critical habitat components associated with the occurrence of IBI scores corresponding with the Warmwater Habitat (WWH) or Exceptional Warmwater Habitat (EWH) biocriteria ("warmwater attributes") and a list of components that are associated with degraded communities (high and moderate influence "modified attributes"; Rankin, 1989, 1995). These modified attributes were further divided into " high" influence or "moderate" influence attributes based on the statistical strength of the relationships. By examining a combined database of least impacted reference sites and physically modified reference sites essentially free from point source associated chemical impacts, a relationship was developed between the IBI and the accrual of modified habitat attributes.

The "associations report" goes on to discuss how the accumulation of attributes representative of a modified condition decreases the likelihood that a stream will meet the criteria for the WWH aquatic life use designation. This relationship is presented in Table B.6.1.

Table B.6.1. Modified habitat attributes and predicted percent attainment.

Number of Modified Habitat Attributes	Percent of Streams That May Attain a Warmwater Habitat Aquatic Life Use
4	<50%
6	<25%
7	rare occurrence

The associations report gives the following as guidance for assessing future implementation of Best Management Practices (BMPs):

> As a "rule of thumb", goals for BMPs and habitat restoration should strive to reduce the number of modified attributes (moderate influence) to four or fewer, reduce the number of modified to warmwater attributes to less than 6, and to eliminate all high influence modified attributes. These measures are needed to have a reasonable probability of attaining the WWH biocriteria.

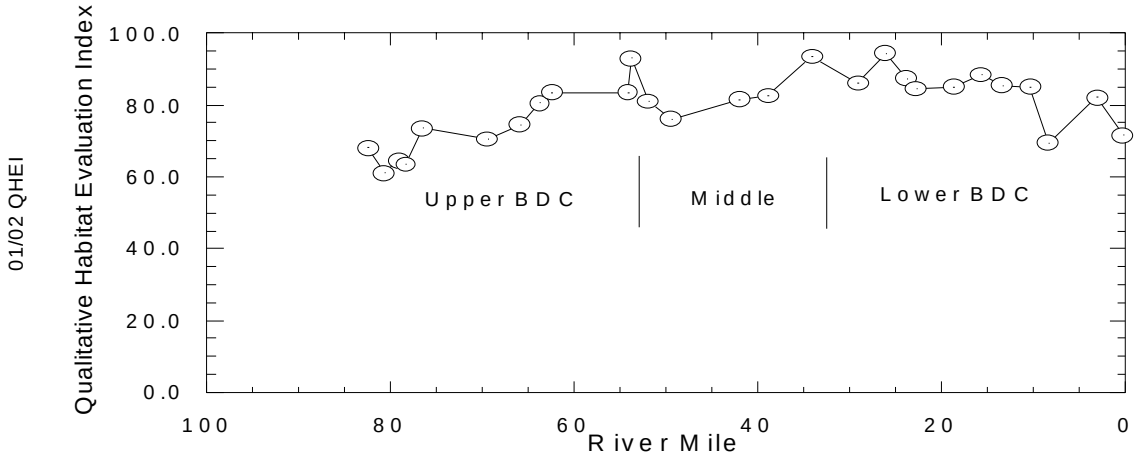
Table B.6.1 provides the breakdown of the QHEI positive and modified habitat attributes from the 2001/2002 and historical Big Darby Creek watershed survey. The results depicted here can be used to determine which BMPs should be implemented and to evaluate the likelihood of meeting the WWH use designation.

Big Darby Creek (02-200)

Determination of the aquatic biological potential and beneficial use attainability of a given stream segment requires the analysis of riparian and instream habitat characteristics, disturbance type, potential rate of recovery, and plans for maintenance of modifications (Rankin 1989). Table B.6.1 presents a matrix of Warmwater Habitat characteristics, Modified Warmwater Habitat characteristics (further broken down to characteristics that have high influence or moderate influence on altering aquatic community performance) and individual site habitat characteristics for use in helping to determine the appropriate designated aquatic life use of a stream segment.

The Qualitative Habitat Evaluation Index (QHEI) in the Big Darby Creek mainstem in 2001/2002 ranged from good (i.e., 61.0) at RM 80.8 to extraordinary (i.e., 94.5) at RM 26.1 (Table A.15 and Figure B.6.1) with a mean QHEI of 79.7 for the 27 locations evaluated, well

Figure B.6.1. Longitudinal trends in the Qualitative Habitat Evaluation Index in Big Darby Creek based on evaluations conducted in 2001/2002.



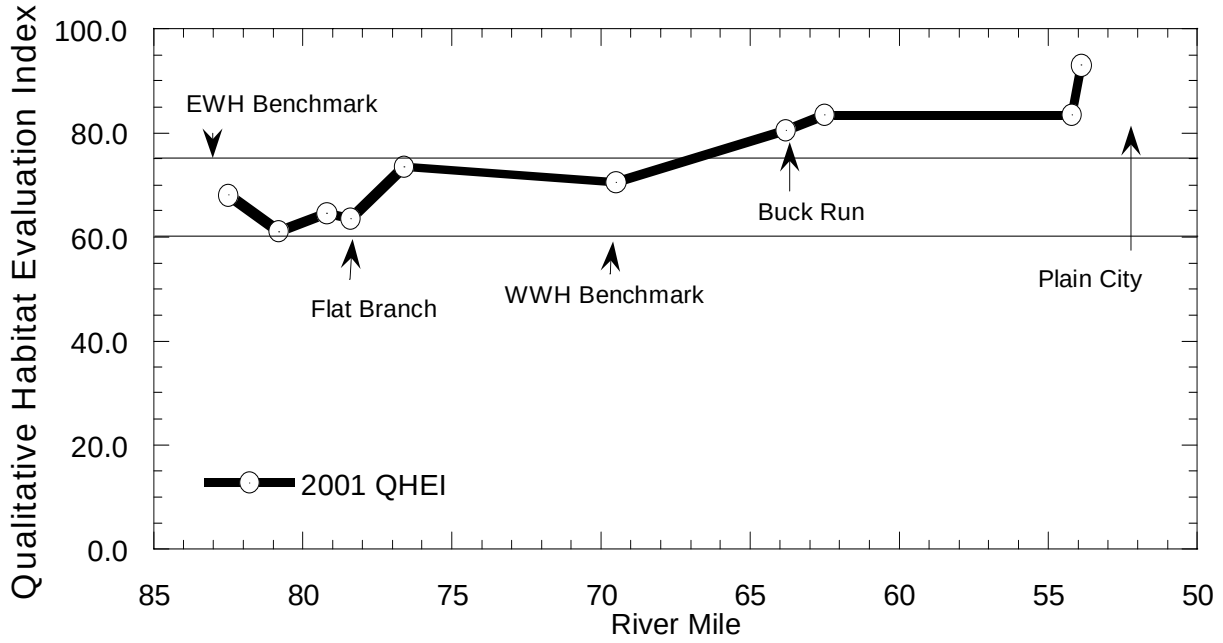
into the excellent range. Comparison of QHEI scores with the biological performance of sites in the Ohio EPA database has shown that segments with average scores higher than 60 are easily capable of achieving the Warmwater Habitat (WWH) aquatic life use designation criteria based on habitat alone (Rankin 1989). Segments equaling or exceeding a mean QHEI of 75 - 80 have been shown to be capable of achieving the Exceptional Warmwater Habitat (WWH) aquatic life use designation criteria based on habitat alone. It is important to note that this evaluation stresses the analysis of habitat characteristics of a segment and not of individual sites. Individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at higher quality adjacent sites if other water resource parameters are adequate. The converse rarely occurs. Sites with good quality habitat located in the midst of a low quality stream segment will generally not support a community equivalent to that found in a high quality segment.

Upper Big Darby Creek (Headwaters to Plain City)

Within this segment Big Darby Creek is currently designated as WWH from its headwaters to its confluence with Flat Branch (RM 83.5 - RM 78.48). However, this segment has been recommended to be re-designated as EWH based on its improved instream biological community performance. Downstream from Flat Branch, Big Darby Creek is designated EWH to its confluence with the Scioto River (RM 78.48 - 0.0).

Evaluation of riparian and instream habitat quality at the twelve (12) sites located within this segment in 2001/2002 yielded an average QHEI of 74.95. A QHEI average value in this range demonstrates that this segment possesses the physical characteristics and thus the potential to support EWH aquatic communities. Figure B.6.2 presents the longitudinal pattern in habitat quality for this segment in 2001/2002. This plot demonstrates that habitat quality improves from its headwaters gradually with downstream position. The major re-location started in the late1980s of US Rt. 33 has exposed this segment to repeated insults to habitat quality at several locations for nearly 20 years. Construction of the new alignment within the Big Darby Creek watershed has proceeded from its eastern bounds westward. This staging of construction resulted in sediment loads and changes in hydrology first impacting Buck Run and then Flat Branch and then areas downstream from their respective confluences. More recently the relocation of the County Rd. 152 intersection and the re-alignment of the roadway in the very headwaters of Big Darby Creek resulted in several hundred feet of the stream channel being relocated and channelized. This relocation, as well as inadequate implementation of the specified erosion control BMPs resulted in high sediment loadings to the stream during and immediately after construction. Numerous citizen complaints resulted in eventual implementation of the specified BMPs and an eventual re-design and reconstruction of the stream channel following Natural Stream Design Principles orchestrated by experts from ODNR Division of Soil and Water Conservation (DSWC). Habitat quality in the headwaters has been improving as the bed load of fines has moved downstream or been side cast into the flood plain (where it hasn't been diked off from the stream). Expectations are that habitat quality will continue to improve as the sediments are flushed out or stabilized and planned restoration and protection measures enacted and thus the segment average should further increase. This segment will be closely monitored in the future. Additionally a preliminary investigation has been

Figure B.6.2. Longitudinal Trends in the Qualitative Habitat Evaluation Index in the Upper Big Darby Creek Mainstem, 2001-2002.



conducted by scientists from the Ohio State University (OSU) and funded by the U.S. Army Corps of Engineers on the suitability of the creation/restoration of riparian ecosystems at the confluence with Flat Branch and Big Darby Creek to deal with water quality problems, potentially improve biotic integrity of downstream Big Darby Creek and increase the amount of wetland habitat in this portion of the watershed (Mitsch et al., 2002).

Middle Big Darby Creek - (Plain City to the confluence with Little Darby Creek: RM 52.1 - 34.1)

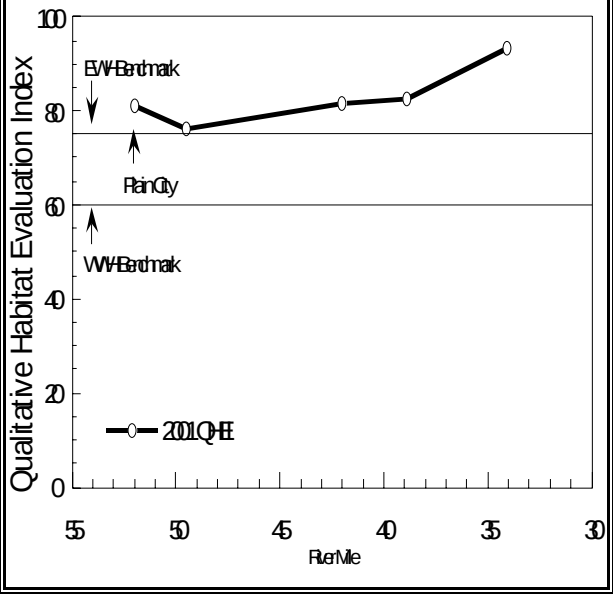
Five sites were located within this approximately 17.9 mile segment in 2001/2002. The average QHEI for the segment of 82.9 again well exceeded the values judged suitable for supporting EWH aquatic communities (Figure B.6.4). The existing aquatic life use EWH has, therefore, been judged appropriate and should be retained. Although major strides have been made towards protecting or maintaining existing habitat quality within this segment impacts have taken place in the upper reaches. Just upstream from Plain City filling of the floodway flushed considerable amounts of sediment into the stream prior to the implementation of erosion control BMPs (Figure B.6.3). Downstream from SR 161 along the east shore of Big Darby Creek paralleling Plain City Tuffco Sand and Gravel has constructed a dike close to the stream channel. This dike has cut Big Darby Creek off from its floodplain affecting the hydrology in the immediate vicinity. In contrast, further downstream, numerous efforts have protected the riparian buffer and floodplain which should go a long way towards ensuring the maintenance of existing habitat quality and perhaps results in some improvement. The Franklin County Metropark system has purchased a considerable amount of land north of I-70 to establish the

Prairie Oaks Metropark. Big Darby Creek flows through the middle of the park. The land purchased was previously used primarily for rowcrop agriculture. Additionally, a large parcel of land was used as a quarry. When the quarry eventually ceases operation a potential source of stress to this segment of Big Darby Creek will be eliminated. The quarry started out as a gravel operation which had gravel washing and its attendant problems. As gravel deposits were depleted the quarry switched to the mining of the limestone substrata. Eventually pumping of the mine pit was required as the mining proceeded below the water table. Pumping of ground water from mine pits can cause several problems, cooler waters can shift several biological processes particularly spawning, unoxygenated waters are obviously stressful, ground waters can contain high levels of a variety of dissolved minerals, increased flow can affect local hydrology, etc. Most of these stressors will be eliminated when the mining ceases operation.

The segment of Big Darby Creek between the I-70 Interstate Highway and the confluence with Little Darby Creek is a largely continuous patchwork of conservation easements, parklands and protected land with a relatively intact wooded riparian buffer. This land is currently owned, held or managed by ODNR - Scenic River Program, The Nature Conservancy, Camp Ken-Jockety Girl Scout Camp, Battelle Institute, Franklin County Metropark and others. If maintained in its current state habitat quality will remain adequate to support the exceptional community that has been documented there. Conditions may actually improve if best management practices for nonpoint sources are implemented in the watershed upstream.

Figure B.6.3. Sediment from a construction site delivered to the floodplain and subsequently to Big Darby Creek just north of Plain City, 1999.

Figure B.6.4. Longitudinal Trends in the Qualitative Habitat Evaluation Index in Middle Big Darby Creek Mainstem, 2001-2002.



Lower Big Darby Creek (confluence of Little Darby Creek to its confluence with the Scioto River RM 34.1 - 0.0)

A total of eleven locations were evaluated for riparian and instream habitat quality downstream from the confluence with Little Darby Creek in 2001 and 2002. The segment average QHEI was 83.6. Similar to the upstream segments evaluated this stretch possesses an abundance of positive habitat features more than capable of supporting EWH aquatic biological communities. It is currently designated EWH, which is appropriate and should be retained.

Significant changes in riparian and instream habitat in the lower reaches of Big Darby Creek since the last major significant sampling in the early 1990s were associated with the June 1997 flood. This major flood caused significant damage to some of the dikes in this lower reach that had separated the stream from its floodplain. Unfortunately, some of the dikes were "repaired" by dredging and bulldozing streambed sediments to re-establish the berm causing impact to local aquatic communities. Further downstream at the mouth, a better, more lasting solution was implemented. A collaborative project between the local landowner, ODNR Division of Wildlife (DOW) and DSWC, Pickaway SWCD and U.S. FWS resulted in moving the dike away from the stream channel which permitted the re-establishment of a floodway and a wooded riparian buffer. Discussions are ongoing to further extend this project upstream. As a result of this project natural stream recovery processes should result in improved habitat scores in this very lower reach. Another project that will likely go forward is the re-opening of the original eastern channel around Snake Island planned by ODNR - DOW and Ohio Department of Rehabilitation and Corrections (DRC) which will increase channel length by approximately one mile. This will effectively reduce local gradient and should reduce some of the erosion problems currently being experienced in the vicinity.

Big Darby Creek Upper Tributaries - Flat Branch to Robinson Run

Flat Branch (02-223) (RM 78.48)

Flat Branch is a small tributary located in the very headwaters of the Big Darby Creek watershed. Stream length is 4.7 miles with a watershed area of 14.46 sq. mi. Its streambed gradient is 4.5 ft/mi which falls in the low-moderate category for a stream of this size. The majority of the watershed lies in Union County. It flows roughly from the northeast to the southwest where it confluences with the Big Darby Creek mainstem at RM 78.48 just west of the Logan-Union County Line. A significant portion of the watershed lies within the Honda of America property. Flat Branch's headwaters originate just north of the Honda of America property, passes through the middle of the property and confluences with upper Big Darby Creek approximately one mile south of the Honda of America property and 300 feet upstream from County Rd 153 bridge (B&N, 2002). Contributing runoff to the 13.5 mi^2 (8,608 acres) upstream from the US Rt 33 bridge are about 3,500 acres of agricultural land (mostly rowcrop), 1,600 acres of woodlot and runoff and/or discharges from the East Liberty Automobile Plant (ELP), ELP water treatment plant, Honda R&D Americas, Inc., the Transportation Research Center (TRC), Marysville Automobile Plant (MAP), the Benton Road Water Treatment Plant

(BRWTP), the Honda Support Office (HSO) and the Credit Union. There are also a couple of ponds and wetlands adjacent to the streams.

The stream channel of Flat Branch has been extensively modified in the past yielding poor to very poor instream and riparian habitat quality (Figures B.6.5 to B.6.8). The preponderance of

Figure B.6.5. Flat Branch downstream of O'Dell Road, 2001. Note turbid condition of water.

Figure B.6.6. Flat Branch downstream from O'Dell Road, 2001, looking upstream towards the riffle. Again, note the turbidity.

Figure B.6.7. Flat Branch downstream of the upstream tributaries, looking upstream, 2001.

Figure B.6.8. Flat Branch adjacent to SR 739 downstream of tributaries, downstream view in channel.

high and moderate influence negative habitat attributes currently limit the potential for this tributary to support aquatic communities. These attributes include little to no recovery from channelization, high percentage of silt and muck substrates, no sinuosity, sparse to no cover, reduced residual pool volumes, fair to poor development, low current velocities, extensive embeddedness and the absence of defined riffles. In recognition of the impact of the reduced habitat quality of Flat Branch on resident aquatic communities and the changes in

hydrology on the Big Darby Creek mainstem a variety of activities are being studied or implemented to improve or restore stream habitat. The Ohio Chapter of The Nature Conservancy (TNC), in collaboration with the U.S. Army Corps of Engineers (USACOE) and The Ohio State University have initiated a study to determine the restoration potential of the upper headwaters of the Big Darby Creek watershed (Mitsch et al., 2002). Restoration projects discussed have included a wetland or series of wetlands created or restored in the upper watershed to improve water quality, ameliorate flood peaks, and provide habitat. Efforts have also been made on the part of Honda of America to widen the vegetated buffer and put in storm water retention ponds.

Little Darby Creek (Logan County) (02-251) (RM 78.34)

This Little Darby Creek is also located in the very headwaters of the Big Darby Creek watershed. Its confluence is just over one tenth of a mile downstream from that of Flat Branch at RM 78.34. Comparable in stream length to Flat Branch at 4.5 miles physically it differs in almost every other respect. It flows from the northwest to the southeast in Logan County and originates in the much hillier Cable moraine. This portion of the Cable moraine coincides with an area of glaciated Ohio called the boulder belt where glacial erratics from Canada are found at a concentration of 1 - 100/acre. Its streambed gradient of 26 - 32 ft/mi is in the high to very high range. The kinetic energy associated with these steep gradients typically results in scouring flows that sweep finer sediments downstream resulting in coarser streambed sediments and higher quality habitats.

Habitat evaluations conducted in 1988 and 2001 yielded QHEIs that demonstrated the potential for the headwaters to support good to very good communities (i.e. WWH to marginal EWH communities) (Figures B.6.9 and B.6.10). In 1988 a site just upstream from the mouth was judged to be excellent and received a score of 88 placing it as one of the highest scoring sites in

Figure B.6.9. Little Darby Creek (Logan Co.) at CR 277 looking upstream, 2001. Note wooded buffer and coarse stream substrates.

Figure B.6.10. Little Darby Creek (Logan Co.) downstream CR 277, 2001. Again note coarse stream bed materials being filled with fines.

the state. However, prior to the 2001 evaluation, one of the adjacent landowners had recently removed the riparian vegetation and had pushed the gravel downstream and armored the now eroding bank to "stabilize" it. This had reduced the QHEI score to 68, which is still well within the range demonstrated capable of supporting WWH biological communities. A similar activity in the upper reaches was investigated by Ohio EPA staff in late 2002. A landowner in the vicinity of SR 287 had dredged the stream channel and stockpiled the spoil upland, effectively creating dikes along both sides of the stream and adversely impacting instream habitat. As these pictures (Figures B.6.11 to B.6.15) show, the stream bed materials have shifted from coarse gravel cobble sized material found upstream from the project segment to sand and other fines within the channelized segment. The confinement of the floodwaters within the diked channel has prevented the expulsion of the fines into the floodplain and retained them within the channel. This is being conveyed downstream to the next landowner as evidenced in Figure B.6.15. The extensiveness of this project has concerned the downstream landowners to the point that there is concern about property being flooded and needing to extend the dredging. This is illustrative of the problems associated with channelization. Rather than dealing with the core cause of the problem it deals with the symptom(s) and passes the problem along to the next group downstream forcing them to then deal with their unwanted problem.

Figure B.6.11. Coarse substrates and clear water typical of segment upstream from project area in Little Darby Creek (Logan Co.).

Figure B.6.12. Little Darby Creek (Logan Co.) view of unauthorized channelization in the headwaters.

Figure B.6.13. Little Darby Creek (Logan Co.) view of previous unauthorized channelization in headwaters. Note diking and entrenchment.

Figure B.6.14. Sand and fine substrates predominate in freshly channelized segment, Little Darby Creek (Logan Co.), 2001.

Figure B.6.15. Sand substrates in Little Darby Creek (Logan Co.) upstream of SR 287 bridge, 2001 as a result of unauthorized channelization.

Unnamed Tributary to Big Darby Creek

(02-361) (RM 74.91)

Similar to Little Darby Creek this small, unnamed tributary originates in the boulder belt of the Cable end moraine in Logan County. It flows in a general easterly direction into Union County where it confluences with Big Darby Creek at RM 74.91 just upstream from the mouth of Spain Creek. Biological sampling and the instream and riparian habitat evaluation were conducted towards the mouth where the stream flowed across ground moraine. The QHEI of 62.5 and the habitat features present demonstrate the potential for this stream to support WWH aquatic communities (Table A.15 and Figure B.6.16).

Figure B.6.16. Unnamed tributary to Big Darby Creek (RM 74.91) at Innsburg-Cratty Rd.

Spain Creek (02-222) (RM 74.3)

Spain Creek flows in an easterly direction just south of the Logan - Champaign County line and then the Union - Champaign County line. It confluences with Big Darby Creek at RM 74.3. Stream length is 7.3 miles with a drainage area of 9.1 sq. mi.(Table A.15). North Lewisburg, one of the few small municipalities in the Big Darby Creek watershed, is located approximately 1.5 miles upstream from its mouth. North Lewisburg is a bedroom community for Marysville, the Honda complex and its attendant satellite support infrastructure and is experiencing relatively rapid population growth. Gradient in most of the subwatershed is 21-22 ft/mi. (relatively high). Instream and riparian habitat over the years (1981-2001) has been fairly consistently judged as very good to excellent with QHEIs averaging 76. Extensive sampling across the state has revealed that stream segments with QHEIs that average greater than 75 and possessing no interfering water chemistry problems hold the potential to yield EWH aquatic communities. The upstream portions of Spain Creek although still of very good quality appear capable of supporting WWH aquatic communities. Additionally, significant declines have been experienced in habitat quality upstream from North Lewisburg with the QHEI dropping from 82.5 to 72.0 at Gilbert Rd.- RM 3.7. The main difference between the years was the increase in the embeddedness and the absence of silt free substrates. This can be attributed to a shift in landuse from old field with very low density rural residential to a mix of residential and oldfield. Habitat quality in the lower reaches of Spain Creek downstream from North Lewisburg have been evaluated on several occasions since 1981 and have always yielded QHEI scores in the mid to high 70s clearly capable of supporting EWH biological communities (Table B.6.1 and Figure B.6.17).

Pleasant Run (02-221) (RM 72.01)

Pleasant Run also originates in the boulder belt of the Cable end moraine and flows in a general easterly direction to meet Big Darby Creek at RM 72.01. Its drainage lies completely within Champaign County with its main channel possessing a gradient ranging from 22 ft/mi. in the Cable moraine to 14 ft./mi. where crosses the end moraine and meets Big Darby Creek. Similar to the majority of the tributaries originating from the Cable moraine upstream this tributary has instream and riparian habitat with the potential to support very good WWH to EWH communities. This stream appears to be a "gaining" stream with good ground water contribution. It was sampled during the drought of 1988 and while many other streams in the vicinity dried up completely this stream still had good flow and was distinctly cool despite the high atmospheric temperatures. Based on the more recent results, habitat quality in 1988 was probably judged downward as a result of the severe low water conditions experienced during 1988. The more recent declines documented in 2001, however, were the result of the relatively recent channel work in the downstream reaches of this stream (Figures B.6.18 and B.6.19).

Figure B.6.17. Spain Creek upstream from the Cratty Rd. Bridge, 2001.

Figure B.6.18. Pleasant Run downstream of Middleburg Rd., 2001.

Figure B.6.19. Pleasant Run upstream from Middleburg Rd. with a view of substrate composition, 2001.

Tributary to Big Darby Creek (RM 69.40)

This unnamed tributary originates on the west side of Big Darby Creek and confluences with the mainstem just upstream from the Collins Rd. bridge. This small stream possesses a preponderance of positive habitat attributes. Modified habitat attributes included fair

development, heavy silt cover and extensive embeddedness. On balance it yielded a QHEI of 62.5 and was judged suitable for supporting WWH aquatic communities. Since the first evaluation of riparian and instream habitat quality of this small stream were conducted in 2001 it was not possible to document long term trends in habitat quality.

Hay Run (02-220) (RM67.6)

Hay Run is a very small stream with a stream length of 3.6 miles and drainage area of 5.82 square miles. It confluences with Big Darby Creek just upstream from Milford Center on the west shore. Unlike many of the streams originating from the west side of the upper watershed Hay Run does not drain the Cable moraine. It drains the ground moraine along the Big Darby Creek mainstem which yields a shallower gradient of 7.35 ft/mi which would place it in the low-moderate range. Hay Run was sampled at Middleburg Road and it has been modified in the past and is in a state of recovery (Figures B.6.20 and B.6.21). Substrate quality is mixed with larger cobble and gravel moderately embedded with silt and sand. Many other habitat attributes are in the low moderate range suggesting a marginal ability to support WWH aquatic communities. Ground water influenced Hay Run yielded mean temperatures during the 2001 field season about 3.5 degrees cooler than many other streams in the vicinity. Despite the less than optimum habitat the ameliorating effect of the ground water appeared to hold adequate sway to support EWH biological communities. Since the first evaluation of riparian and instream habitat quality of this small stream were conducted in 2001 it was not possible to document long term trends in habitat quality.

Figure B.6.20. Hay Run upstream from Middleburg Rd. Note coarse substrates, clear water, and attached filamentous algae.

Figure B.6.21. Hay Run downstream from Middleburg Rd. Note algal mats - evidence of nutrient enrichment.

Prairie Run (02-359) (RM 63.84)

Prairie Run was first evaluated in 2002. Prairie Run is a very small stream that originates from the west of Big Darby Creek in ground moraine. Gradient at the one site sampled towards its mouth was 13.7 ft/mi. placing it in the moderate range. Evaluation of the instream and riparian

habitat yielded a QHEI of 23, in the very poor range. No positive WWH attributes were noted at the site. A preponderance of high influence modified habitat attributes, however, was documented. They included lack of recovery from channelization, silt/muck substrates, the absence of sinuosity, the almost total lack of cover, and little residual pool volume. Moderate influence modified habitat attributes also depressed habitat quality. The absence of riffles and extensive embeddedness were noteworthy. Some of the impact appeared to be relatively recent. Coarse substrates were discernable underneath the unconsolidated 6-8 inch thick layer of silt coating the majority of the sampling zone. The source of this silt, upstream from the zone, should be found and stabilized to reduce its contribution to Big Darby Creek.

Since the first evaluations of riparian and instream habitat quality of this small stream were conducted in 2001, it was not possible to document long term trends in habitat quality.

Buck Run (02-209) (RM 63.74)

The Buck Run subwatershed lies on the east side of the Big Darby Creek mainstem. Its channel closely parallels Big Darby Creek for most of its 6.8 mile length flowing from northeast to southwest until it merges with Big Darby Creek in the vicinity of Bridgeport. The majority of its watershed lies within the Powell end moraine. There is less geographical relief to the land surface east of Big Darby Creek and the majority of sites sampled in Buck Run over the years have local gradients of 5-7 ft/mi which places them in the range of low - moderate to moderate range for most sites. Land use in the subwatershed is a mixture of rowcrop agriculture, livestock and pasturage. Local habitat in 2001 varied widely in quality from very good to excellent at the site at the mouth to poor at several sites scattered throughout this small stream. Inspection of the site description sheets reveal that in almost every situation the lowered habitat quality has been associated with pasturage with open access to the stream. This results in trampled, false banks, increased siltation and embeddedness, reduced instream cover amounts and diversity.

Instream and riparian habitat in Buck Run has been evaluated several times since 1988 at varying locations in the watershed making it possible to tracks trends in habitat quality over time (Figures B.6.22 to B.6.26).

In 1988, as a part of a screening survey for a Non-Point Source Pollution Research Project, site description sheets were completed for eight sites from RM 12.9, downstream from Holy Cross Epps Rd. to the mouth at RM 0.1. The mean QHEI for this segment was 50.5. This mean score falls in the range of scores requiring a closer evaluation to determine the appropriateness of the existing WWH aquatic life use designation. It was noted in this survey that the relocation of US Rt. 33 had deposited considerable amounts of silt into the headwaters of this stream. The silt layer was estimated to be 18 inches thick in spots lowering the QHEI in the upper reaches of this stream. This silt probably has been and will be flushed downstream with elevated flows, temporarily impacting downstream reaches. Localized impacts from free access of livestock to the stream, channelization, removal of the riparian buffer, etc. were also noted at the sites evaluated in 1988.

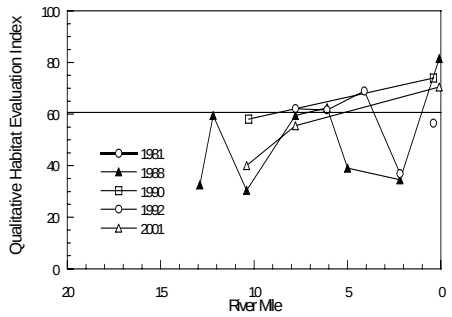
Figure B.6.22. Buck Run upstream from the Sam Reed Rd. Bridge. Note turbid waters.

Figure B.6.23. Buck Run downstream from the Sam Reed Rd. Bridge.

Figure B.6.24. Buck Run upstream from Orchard Rd., 2001.

Figure B.6.25. Confluence of Buck Run with Big Darby Creek from the Streng Rd/ bridge, 2001.

Figure B.6.26. Longitudinal and temporal patterns in the Qualitative Habitat Evaluation Index in Buck Run between 1981 and 2001.



Sampling in 1990 at two sites, RM 10.3 - Allen Center Rd. and 0.4 - the mouth, yielded a mean QHEI of 66.0. Significant improvement was noted at the upstream site. This site, when evaluated in 1988, had been recently channelized for a short distance, in conjunction with the construction of a bridge, yielding a QHEI of 30.5. Natural recovery processes resulted in an increase to 58.0 in 1990 demonstrating the rate and potential for recovery in this basin.

In 1992, biologists from ODNR Division of Natural Areas and Preserves (DNAP) sampled four sites in Buck Run as a part of a Section 319 urban storm water grant. Qualitative habitat evaluation index scores in 1992 ranged from 69.0 at RM 4.1, upstream from the US 36 bridge, to 37.0 measured at RM 2.2, upstream from Sam Reed Rd. Mean QHEI for the four sites was 57.4, comparable to the mean value measured in 1988. Three of the four sites sampled were noted to have sparse to no cover, the only high influence modified habitat attribute observed within the subbasin in 1992. In addition to the three moderate influence modified habitat attributes found at upstream sites, the downstream site also had moderate silt cover, no instream cover and moderate embeddedness. Riffle, pool, run development declined from good at the upstream sites to fair in the mid reaches and poor at the downstream site. It is apparent that this stream is subject to a variety of habitat disruptions along its length and that some of the impacts are cumulative. However, as mentioned previously, prevailing instream gradient and natural recovery processes have demonstrated the potential for recovery from habitat disruptions.

In 2001 three sites were sampled from Allen Center Rd - RM 10.4 to the mouth site - RM 0.1 with a reach mean QHEI of 55.3. The site at Allen Rd. appears to be subject to periodic disruptions in habitat quality. In 1988 a QHEI of 32.5 was recorded which is almost in the very poor range and obviously a channel modified condition. This site had by 1990 recovered to a QHEI of 58 - almost in the good range. By 2001 the QHEI had slipped to 40.0 in the middle of the poor range. A reworking of the stream channel had obviously occurred since it was last sampled. The site at SR 245 although remaining fairly stable in habitat quality is starting to show signs of declining quality with increases in the amounts of embeddedness. Similarly the site at the mouth although measured at the high end of the good range in the most recent sampling represents a significant decline from the excellent habitat found in 1988. Differences noted between the years include a shift in streambed substrate composition, moderate siltation, fair development, slower current velocities, and moderate overall embeddedness.

Although the ability of habitat quality to improve over time has been documented in Buck Run periodic disruptions are slowly lowering overall habitat quality in Buck Run. Channelization and free access of livestock to the stream appear to be sources most significantly contributing to the

accumulation of high and moderate influence modified habitat attributes in the Buck Run watershed.

Robinson Run (02-207) (RM 53.69)

Robinson Run is small, previously modified stream not under maintenance 3.2 miles in length with a drainage area of 10.9 square miles and a moderate stream bed gradient of 11.84 feet mile. The channel of Robinson Run parallels closely the southern terminus of the Powell end moraine flowing southeasterly through the relatively flatter ground moraine of Union County. It confluences with Big Darby Creek just upstream from Plain City. Stream bed substrates were predominately cobble and gravel with lesser amounts of boulder, hardpan, sand and silt at the upstream site RM 2.1 Hickory Ridge Rd and SR 736. Gravel was the predominant substrate at the downstream site RM 0.1 (Figures B.6.27 and B.6.28). The mean QHEI for the two sites evaluated was 67.0. Values in this range generally have been found suitable to support WWH communities. Habitat improved slightly towards the mouth associated with an increase in local streambed gradient. A comparison with previously sampling conducted in 1992 revealed almost identical scores to the 2001 results. Robinson Run appears to be maintaining its good habitat quality in the reach evaluated.

Figure B.6.27. Robinson Run upstream from flow site, 2001.

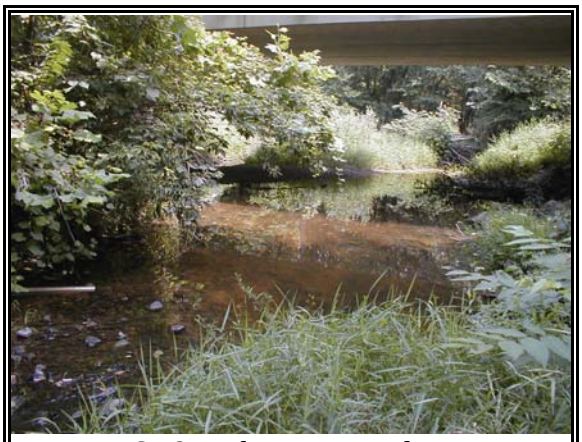


Figure B.6.28. Robinson Run downstream from the flow site, 2001.

Big Darby Creek Middle Tributaries

Sweeney Run (02-357) (RM 52.11)

Sweeney Run has the unique distinction of not being listed in the Gazetteer of Ohio Streams. Much of its length has been channelized in the past. In its upper reaches the channel work has been done in conjunction with agricultural drainage and in the lower reaches in association with the development of Plain City. Numerous storm water drains and debris are present in the channel within Plain City. Additionally, portions of the lower reach have had the trees removed and banks shaped within the last five years. Despite these habitat disruptions the segment at the

mouth of Sweeney Run had fair-good habitat. A QHEI of 58 was recorded at RM 0.2. Positive WWH features included coarse substrates (i.e., cobble, gravel, and gravel) moderate sinuosity and cover amounts, fast currents, and relatively deep pools (Figures B.6.29 and B.6.30). Habitat attributes that detract from the streams suitability to support aquatic communities included the channel recovering from channelization, moderate silt cover, fair development and moderate riffle and overall embeddedness. Many of the later negative attributes were probably due to the erosion resulting from the recent bank work and the residential development taking place along the stream channel on the southwest borders of Plain City. The stream possesses adequate gradient (> 31ft/mi) and enough positive attributes to recover well into the WWH range if adequate storm water and erosion control BMPs are implemented.

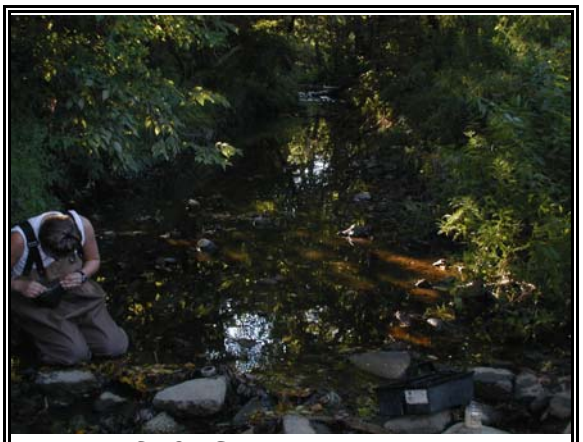


Figure B.6.29. Sweeney Run near its mouth in Plain City, Ohio, 2001

Figure B.6.30. Sweeney Run downstream view near mouth, 2001.

Sugar Run (02-206) (RM 50.62)

Sugar Run originates in Union County. It flows across the Powell end moraine in the southern portion of the county and then into ground moraine. It confluences with Big Darby Creek five miles from its origin just downstream from Plain City in Madison County. It has a drainage area of 19.5 square miles and an average streambed gradient of 7.8 ft/mi - in the moderate range. Sites evaluated for habitat quality at the mouth have consistently scored in the range judged suitable for supporting WWH aquatic communities (Figure B.6.36). The headwaters of this stream, however, have consistently been judged poorer and unfortunately the trend in habitat quality has been downward (Figures B.6.31 to B.6.35). Channelization and habitat destruction associated with free access livestock pasturing were the problems documented in previous sampling. The construction of the Rolling Meadows Golf Course has furthered this decline. The site located at RM 5.4, downstream from US Rt 42 has declined significantly in quality over time (Figure B.6.35). When first evaluated in1990 this segment possessed habitat suitable for support of a marginal EWH aquatic community (i.e., QHEI = 72). Steady declines in the intervening years has yielded ever worsening habitat with the most recent sampling yielding a QHEI of 38.5. Based on historical sampling and the most recent effort Modified Warmwater Habitat would be the appropriate use designation upstream from US Rt. 42 upstream and Warmwater Habitat downstream from US Rt. 42.

Figure B.6.31. Sugar Run upstream Industrial Parkway, 2001. Note golf course backing grassed banks.

Figure B.6.32. Sugar Run downstream Industrial Parkway, 2001.

Figure B.6.33. Sugar Run upstream from Taylor Rd. Note row cropping beyond grassed banks.

Figure B.6.34. Sugar Run downstream from Taylor Rd, 2001. Note residential land use.

Figure B.6.35. Sugar Run downstream US Rt. 42 bridge, 2001.

Figure B.6.36. Sugar Run upstream Cemetery Pike, 2001.

Unnamed Tributary to Sugar Run (02-358) (RM 7.39)

This very small tributary to Sugar Run originates from the east side of Sugar Run almost at its headwaters. It is totally contained within the Powell end moraine with its attendant geological characteristics. At the site where the stream was evaluated, Industrial Parkway - RM 0.1, it had been extensively modified (Figures B.6.37 and B.6.38). It possessed all of the high influence negative attributes including recent or no recovery from channelization, silt substrates, the absence of sinuosity, sparse instream cover, and shallow pool depths. Numerous moderate influence negative habitat attributes were also present including moderate silt cover, poor development, low sinuosity, high to moderate riffle and overall embeddedness and a lack of riffles. Based on the cumulative effect of these attributes and the low QHEI score of 27.0 this stream segment is judged incapable of supporting Warmwater Habitat aquatic communities. This ditch has been petitioned under the Ohio County Ditch Law and is routinely maintained by

Figure B.6.37. Unnamed tributary to Sugar Run RM 7.39 upstream Industrial Parkway, 2001.

Figure B.6.38. Unnamed tributary to Sugar Run RM 7.39 at Industrial Parkway, 2001.

the Union County Soil and Water Conservation to keep it in its current state. Based on the documented reduced instream habitat quality and that it will be legally maintained in its current state this stream was recommended to be designated Modified Warmwater Habitat.

Worthington Ditch (02-356) (RM 50.62)

This approximately six mile long stream confluences with Big Darby Creek approximately 1.1 miles downstream from Plain City, from the west. It flows almost directly due east just south of Converse - Huff Rd. Although the predominant landuse in the watershed has been agriculture, large lot residential development has taken place along Converse-Huff Rd. in the last 5-10 years. The south side of Plain City is also spreading southward towards this catchment.

Although the stream channel possesses adequate gradient (i.e., > 20 ft/mi) and, therefore, the potential energy to regrade its stream channel the current evaluation of habitat quality revealed that it had not significantly recovered from past channel work. Coarse substrates and relatively deep pools were the main positive habitat features present. Attributes detracting from habitat quality include a channel that has shown little recovery from channelization, no sinuosity and sparse cover. Moderate influence modified habitat attributes included increased silt cover, inadequate development, low number of cover types, lack of fast current, and elevated overall and riffle embeddedness. These attributes yielded a QHEI of 46.5 (Figure B.6.40). Immediately downstream from this segment (Figure B.6.39) where some woody vegetation was permitted to remain along the stream banks yielded WWH macroinvetebrate communities and an evaluation that the stream in its current form in this segment is capable of supporting WWH aquatic biological communities and should be designated WWH. Worthington Ditch would benefit by the addition of a vegetated riparian buffer to filter runoff and provide shading to

Figure B.6.39. Worthington Ditch downstream from Plain City-Georgesville Rd.

Figure B.6.40. Worthington Ditch upstream from Plain City-Georgesville Rd.

the stream channel. This evaluation is the first time that Worthington Ditch has been monitored and, therefore, a trends assessment cannot be conducted.

Ballenger-Jones Ditch (02-355) (RM 49.68)

This approximately six mile long tributary originates on the west side of Big Darby Creek about two miles south of Plain City. It flows almost directly east and confluences with Big Darby Creek at the intersection of Amity Pike Rd and Plain City - Georgesville Rd. and just upstream from Amity. The streams flows through ground moraine its entire length. Land use although primarily row crop agriculture has significant number of large lot residences as well as horse stables. The Jonathan Alder High School campus is also situated in this small subwatershed. The qualitative habitat evaluation was conducted just upstream from Plain City - Georgesville Rd. Adjacent landuse was large lot residential with mowed banks and little in the way of riparian vegetation (Figure B.6.41). However, there was a predominance of positive warmwater habitat attributes present including little evidence of channelization, coarser streambed substrates, a good variety of substrates, high sinuosity, moderate amounts of instream cover, a variety of current types and deep pools. A few negative attributes were also present including heavy to moderate silt cover, and moderate embeddedness in the riffles and the zone overall. Nonpoint sources of pollution are the likely contributors to these negative attributes and if controlled would likely yield higher quality instream habitat. Overall the QHEI score of 69 strongly suggests that this stream should be capable of supporting Warmwater Habitat Aquatic communities particularly in its lower reaches (Figure B.6.42). This evaluation is the first time that Ballenger-Jones Ditch has been monitored and, therefore, a trends assessment cannot be conducted.

Figure B.6.41. Ballenger-Jones Ditch upstream from SR 142, 2001.

Figure B.6.42. Ballenger-Jones Ditch downstream from SR 142, 2001.

Yutzy Ditch (02-364) (RM 47.1)
This small tributary which originates on the west side of Big Darby Creek and confluences just upstream from the Scioto - Darby Rd. in Franklin County (Figure B.6.43). A considerable portion of this stream has been channel modified particularly in the upstream reaches. A large portion of the stream has estate and large lot residential landuse along its length. This is backed by rowcrop agriculture. The Canaan Middle School is located in the middle reaches of the watershed. Although Yutzy Ditch has been observed flowing throughout the year over the course of several years it had become desiccated at the selected site towards the end of the 2001 field sampling season when it was planned to be sampled.

Figure B.6.43. Yutzy Ditch at Plain City-Georgesville Rd. looking upstream.

Fitzgerald Ditch (02-272) (RM 44.96)
Another tributary originating from the western side of Big Darby Creek confluences with Big Darby Creek 0.5 mile upstream from the Lucas Rd/Beach Rd. Suspension Bridge. Much of the upper reaches of Fitzgerald Ditch have been channel modified. Lower reaches (~RM 1.5 downstream) have been modified to a much lesser degree. The instream habitat evaluation conducted downstream from St Rt 142 yielded a QHEI of 56.4 (Figures B.6.44 and B.6.45). Moderate influence negative habitat attributes were the main factors resulting in the slightly less than optimal habitat. These attributes were: recovering from channel modification, moderate silt cover, fair development, lowered sinuosity, no fast current, and moderate riffle and overall embeddedness.

An evaluation of habitat quality had been conducted further up in the watershed in response to a fish kill in 1994. A custom applicator of farm chemicals had released a large volume of ammonia into Fitzgerald Ditch upstream from US Rt. 42. The stream segment evaluated just downstream from US Rt. 42 had been channelized with a straight, trapezoidal channel and only grass as vegetation along the stream bank. The only positive habitat feature were the coarse streambed constituents (i.e., boulder, cobble and gravel substrates).

Negative habitat features included no recovery from channelization, sparse cover, shallow depths, moderate silt cover and embeddedness, and moderate to extensive run embeddedness and the lack of functional riffles. Some of these attributes may have been exacerbated by the small dams that were being used to temporarily hold back the ammonia laden water from upstream. This segment has been documented to be in the area under county ditch maintenance by the Madison County Engineer's Office. This portion of the stream has been judged not suitable for supporting WWH aquatic communities and has been recommended to be designated as MWH.

Figure B.6.44. Fitzgerald Ditch upstream from Plain City - Georgesville Rd.

Figure B.6.45. Fitzgerald Ditch downstream from Plain City - Georgesville Road.

Little Darby Creek and Tributaries

Little Darby Creek is the largest tributary to Big Darby Creek with a drainage area of about 176 square miles and a stream channel length of 38 miles. The average stream bed gradient over its course is 5.9 ft/mi. However, along its length Little Darby Creek flows through a variety of different landscape features that yield a wide range of stream bed gradients and consequent instream habitat characteristics (Figure B.6.60). Habitat quality varies from amongst the best in the state (e.g., QHEI = 99 at RM 4.1) to good (e.g., QHEI = 63.5 at RM 0.7) towards the mouth and within the area that is still recovering from the removal of a run-of-the-river dam (Figure B.6.58). The average QHEI for the eleven sites evaluated in 2001 was 80.5. This demonstrates that habitat quality overall is suitable for sustaining EWH biological communities and that the existing EWH is appropriate and should be retained (Figures B.6.46 to B.6.59 and Figure B.6.1). Despite the overall high quality, documented problems have also been noted. As many of the photos that follow show, high quality habitat is

Figure B.6.46. Little Darby Creek RM 41.2 downstream from Allison Rd. Note wooded riparian buffer and good stream development.

Figure B.6.47. Little Darby Creek RM 39.6 downstream of SR 29.

Figure B.6.48. Little Darby Creek RM 39.6 downstream SR 29.

Figure B.6.49. Little Darby Creek RM 34.7 downstream Irwin Rd.

Figure B.6.50. Little Darby Creek RM 34.7 downstream Irwin Rd. Note condition of stream banks.

Figure B.6.51. Little Darby Creek RM 34.7 downstream from Irwin Rd.

Figure B.6.52. Little Darby Creek RM 33.0 upstream from Bates Rd. Note wooded riparian buffer.

Figure B.6.53. Little Darby Creek RM 33.0 downstream from Bates Rd. Note false banks and absence of any bank vegetation.

Figure B.6.54. Little Darby Creek RM 29.5 at Axe Handle Rd.

Figure B.6.55. Little Darby Creek RM 29.5 at Axe Handle Rd.

Figure B.6.56. Little Darby Creek RM 15.3 upstream US 42.

Figure B.6.57. Little Darby Creek RM 15.3 upstream US 42. Note fast riffle.

Figure B.6.58. Little Darby Creek near mouth, just upstream Alkire Rd.

Figure B.6.59. Longitudinal trends in the Qualitative Habitat Evaluation Index in Little Darby Creek, 2001.

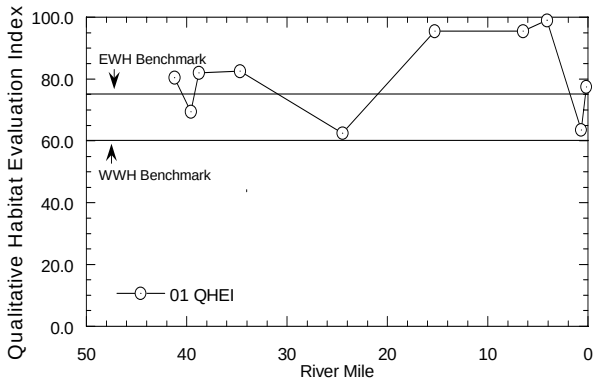
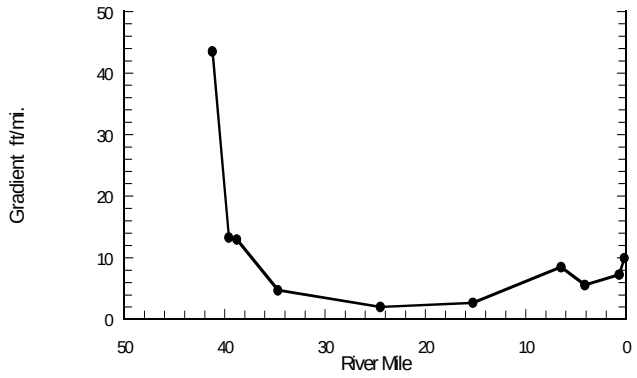


Figure B.6.60. Gradient (ft/mi)of sites sampled in the Little Darby Creek mainstem during 2001.



frequently interspersed with areas where most if not all of the riparian vegetation has been stripped off and bank erosion is contributing fines to the stream channel (e.g., Figure B.6.53). The Little Darby Creek mainstem originates in the boulder belt of the Cable moraine in Champaign County, then flows through the southwestern corner of Union County into Madison County which contains the majority of the watershed. The Champaign County portion of the watershed is characterized by its steep gradient, coarse substrates, good to excellent development, fast currents, and low embeddedness. Upon leaving the Cable moraine Little Darby Creek flows through ground moraine for the majority of its length. Gradient there drops from >43 ft/mi to about 13ft/mi in the vicinity of Mechanicsburg, which is a gradient range with sufficient potential energy to transport sediment and rework the stream channel after modification to re-establish normal stream development (i.e., riffle, pool, run complexes). Glacial maps of Ohio reveal that the stream course of Little Darby Creek with the ground moraine portion of its course is lined with significant deposits of alluvium and glacial outwash (Figure A.2). These deposits are responsible for the relatively coarse substrates and the ground water input to the stream. Mid reaches of the stream (from about RM 30 to RM 15) possess fairly low gradients on the order of 2-3 ft/mi. Gradients in this range have classified as low (Ohio EPA, 1989) and possess less potential energy and thus have less ability to expel and transport sediments and re-establish natural channel features after disruption. These are the areas that need more help if disrupted and more protection if currently undisturbed.

Clover Run (02-218) (RM 39.8) (EWH)

This small tributary originates in the very headwaters of Little Darby Creek and confluences with it immediately south of Mechanicsburg. It comes off of the boulder belt of the Cable Moraine and drains some of the hilliest portions of the entire Big Darby Creek watershed. The local gradient of 47.62 places it in the very high category. Overall riparian and instream habitat was good and judged suitable for supporting WWH aquatic biological communities (Figure B.6.61). Moderate siltation and embeddedness and little to moderate erosion were the main negative habitat influences noted. The first evaluation of instream and riparian habitat took place in 2001 so an analysis of trends in Clover Run was not possible.

Figure B.6.61. Clover Run at Maplegrove Cemetery.

Lake Run (02-216) (RM 36.9) (EWH/EWH Deferred)

This small tributary originates just north of Mechanicsburg. It flows through the Cable end moraine and has a couple of glacial kettle lakes situated on it or draining to it. Local gradient of 16.39 ft/mi is in the moderately high range. Very few negative habitat attributes were present at the site evaluated and resulted from historical channelization and recent construction activities which had delivered sediment to the stream channel. These negative attributes include moderate overall embeddedness and low-moderate riffle embeddedness (Table B.6.1). The stream is close to being recovered from channelization. It currently yielded a QHEI of 71 in the very good range (Figure B.6.62). That coupled with the moderately high gradient should swiftly flush out the contributed sediments if adequate erosion control practices are in place. This stream should quickly recover from this temporal impact and, therefore, the existing EWH use is being retained pending future monitoring.

Figure B.6.62. Lake Run upstream from State Route 4.

Jumping Run (02-217) (RM 3.9)

Jumping Run is a 2.8 square mile tributary to Lake Run. Although silt and muck substrates contributed to the moderate embeddedness detected this stream it was still judged to be suitable for the WWH aquatic life use (Table A.15 and Figure B.6.63). The first evaluation of instream and riparian habitat took place in 2001 so an analysis of trends in Jumping Run was not possible.

Figure B.6.63. Jumping Run at SR 559.

Treacle Creek (02-213) (RM 31.3)

Treacle Creek is 14.2 miles long with a drainage area of 37.1 sq/mi and a local gradient in the moderate- high ranges in its headwaters and mid reaches and drops into the low-moderate range towards the mouth where it transitions from ground moraine to end moraine. Several sites have been evaluated since 1992. With the exception of the site at Winget Rd. all segments evaluated have received QHEI scores in the sixties yielding a segment average of 65.3 (Figure B.6.65). The site at Winget Rd. has been channelized historically and maintained more recently. In all

years evaluated an extensive pasture lined both sides of the stream (Figure B.6.64). Livestock were given free access to the stream and had severely trampled both banks yielding thick deposits of silt which blanketed essentially the whole site and in some places resulted in unconsolidated layers as thick as 24 inches.

Figure B.6.64. Treacle Creek upstream from the covered bridge.

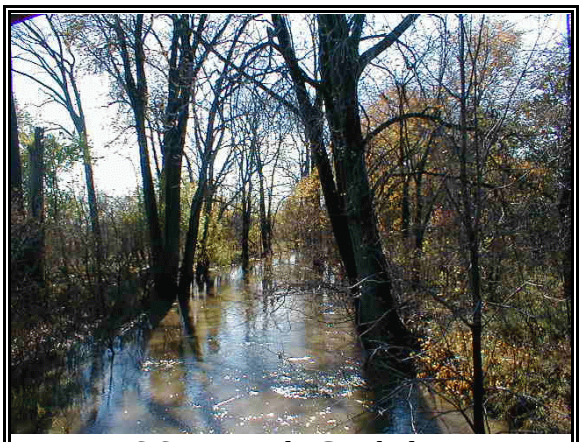


Figure B.6.65. Treacle Creek downstream from the covered bridge.

Sampling conducted in 1992, 1993 and 2001 has yielded fairly consistent results at the sites evaluated with QHEI values averaging greater than 60 upstream from RM 5.0 (Figure B.6.66). The site upstream from Eagle Rd. which has yielded QHEIs averaging around 30 would benefit by fencing the cattle from the stream and providing a single point of access for watering. Allowing re-vegetation would stabilize the stream bank and filter sediments coming off the pastured land which would also benefit Little Darby Creek downstream from the confluence with Treacle Creek. Ground water contribution to the stream channel and proximity to higher quality stream segments has ameliorated the impact of the negative attributes in Treacle Creek and permitted either full or partially support of EWH communities at all sites except the most downstream site.

Howard Run (02-215) (RM 5.4) (EWH)

Howard Run is 3.2 miles long with a drainage area of 2.72 sq. mi. and a overall gradient of 23.1 ft/mi placing it in the high range. Locally the gradient at the site sampled was considerably less at 13.27 ft/mi. falling in the moderate range. The site had a mix of positive and negative habitat attributes yielding a QHEI of 55.5 (Figure B.6.67). Only one high influence, modified habitat attribute was noted - low sinuosity. However, the site was recovering from historical channelization and given the steep overall gradient of the stream there is sufficient energy for this site to revert to the high quality present in the rest of the stream.

Figure B.6.66. Longitudinal and temporal patterns in the Qualitative Habitat Evaluation Index for sites sampled in Treacle Creek during 1992, 1993 and 2001.

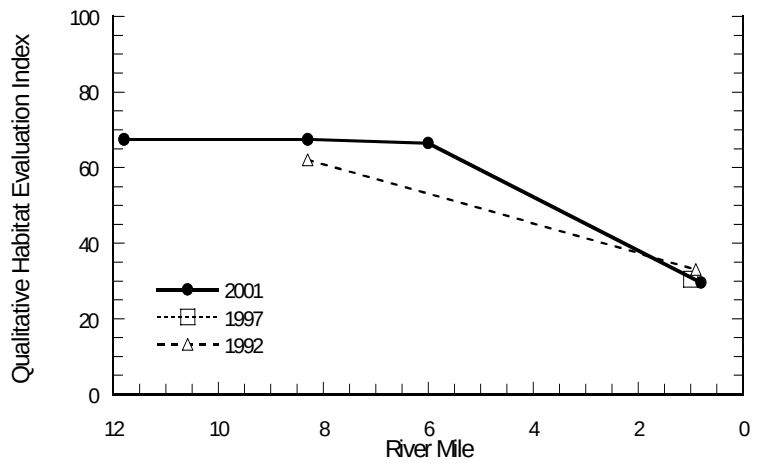


Figure B.6.67. Howard Run at McMahill Rd.

Proctor Run (02-214) (RM 3.69) (EWH)
Proctor Run is six miles long with a local gradient of 21.4 ft/mi and drains a watershed of 10.4 sq/mi. Proctor Run originates in Champaign County in the boulder belt of the Cable Moraine. It then flows almost directly east downslope through the rest of the Cable moraine and into ground moraine and Union County. Three sites were evaluated in Proctor Run yielding QHEI scores ranging from 65 to 73. Positive warmwater habitat attributes predominated at all three sites (Figure B.6.68). No high influence modified habitat attributes were found although moderate amounts of silt and embeddedness somewhat lowered habitat quality.

A single site, RM 1.7 - upstream from Mc Mahill Rd., had been evaluated previously in 1992 as well as in 2001. Although slight differences were noted between the years overall habitat quality was judged very similar and of very good quality.

Barron Creek (02-212) (RM 24.4) (EWH)
Barron Creek is 4.8 miles long, has a gradient of 8.3 ft/mi. and drains a watershed of 6.3 sq/mi. It is listed in the Gazetteer of Ohio Streams as intermittent. Despite this notation discernable flow was present during the summer of 2001, one of the driest periods on record in central Ohio. Habitat at the site sampled has been impacted by channelization yielding low to no sinuosity, fair to poor development, silt substrates in spots, slower currents and moderate overall and riffle embeddedness (Figures B.6.69 and B.6.70). The QHEI was 44.5, in the poor range. The presence of a spring in the sampling zone prevented worse instream biological performance.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Barron Creek so an analysis of longterm trends in Barron Creek was not possible.

Wamp Ditch (02-363) (RM 23.0) (Undesignated/WWH Recommended)
Wamp Ditch originates on the east side of Little Darby Creek entering about one mile upstream from the Morris Rd. bridge. Local gradient is 12.5 ft/mi, in the moderate range. Habitat quality is poor (QHEI = 44.5) with four high influence modified habitat attributes including recent or no recovery from channelization, no sinuosity, sparse cover and little residual pool volume. A number of moderate influence modified habitat attributes drive habitat quality further down including fair to poor development and moderate overall embeddedness (Figure B.6.71).

Figure B.6.68. Proctor Run RM 3.69 upstream of bridge.

Figure B.6.69. Barron Creek RM 24.4 south of Rosedale-Plain City Rd.

Figure B.6.70. Barron Creek RM 24.4 south of Rosedale-Plain City Rd.

Figure B.6.71. Wamp Ditch upstream from Vogelburg Road.

Spring Fork (02-211) (RM 17.46) (EWH)

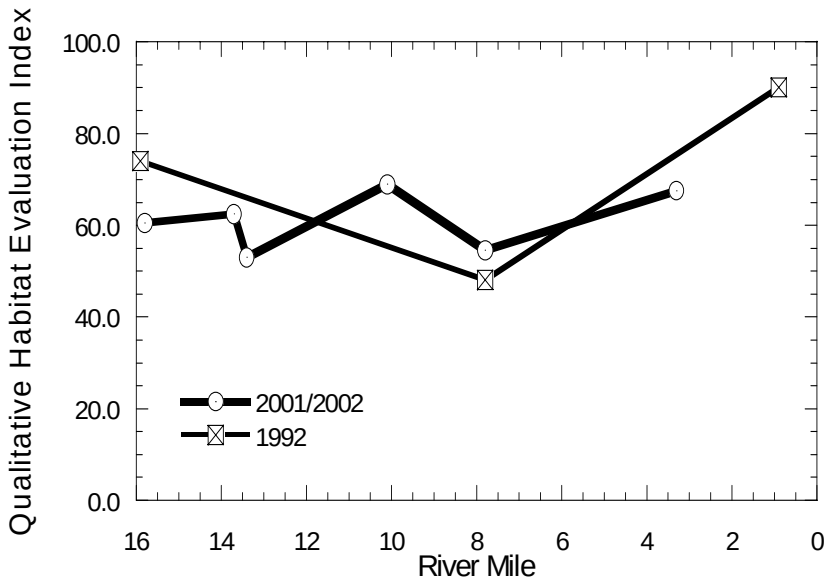
Spring Fork is one of the larger Little Darby Creek tributaries at 12 miles long and a drainage area of 37.9 sq/mi. Local gradient averages out at 7.2 ft/mi. Although the majority of the stream flows through ground moraine the headwaters originate in the boulder belt of the Cable Moraine with its attendant habitat features. Habitat quality in Spring Fork has been evaluated at several locations between 1992 and 2002 (Figures B.6.72 and B.6.73). In 1992 habitat quality in the headwaters and at the mouth were very high in quality particularly the mouth site which scored amongst the top tier of sites in the entire state. The mid reaches represented by the site at RM 7.8 , upstream Rosedale - Milford Center Rd. had impacted habitat quality. Historically channelized with strong evidence of use in the near past as pasturage (e.g., well trodden paths, false bank formation, elimination of understory) yielded habitat in the fair range. This same site a decade later has shown modest improvement into the upper end of the fair range. This appears to have been accomplished largely by the flushing of fine sediments from the system over the intervening years. Embeddedness has declined, coarser substrates have been exposed, pools deepened, etc. In contrast the site at RM 15.8, upstream from Wren Rd. has shown significant declines due a shift in landuse practice which has resulted in smothering of the coarser substrates, reduced sinuosity, reduced current velocity and increased embeddedness.

The mean QHEI for all of the locations evaluated in 2001 and 2002 was 61.6, solidly in the good range. Many of the sites were in the process of recovering from the effects of channelization which had resulted in fair stream development, moderate silt cover and moderate amounts of overall and riffle embeddedness.

Bales Ditch (02-362) (RM 3.64) (Undesignated/WWH Recommended)

Bales Ditch, a small tributary to Spring Fork, originates in ground moraine and flows in a general easterly direction confluencing with Spring Fork close to Plumwood, Ohio. The local gradient at the site sampled was 17.86 ft/mi placing it in the moderate high range. Habitat quality was judged very good (QHEI = 70). A moderately wide to wide riparian buffer coupled with an undisturbed stream channel, moderately high gradient and glacial till yielded a diverse and moderately stable stream channel. The habitat was judged to be easily capable of supporting a WWH aquatic biological community.

Figure B.6.72. Longitudinal trends in the Qualitative Habitat Evaluation Index in Spring Fork, 1992 and 2001/2002.



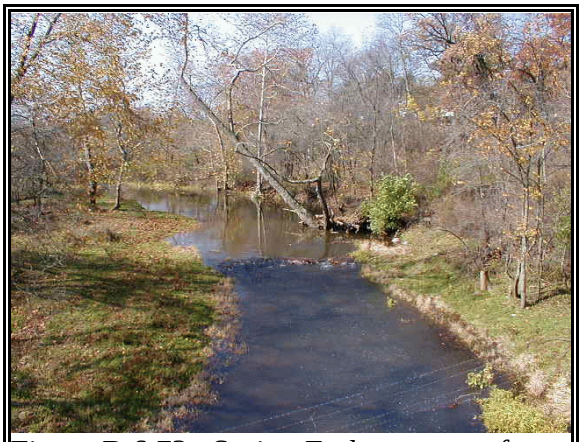


Figure B.6.73. Spring Fork upstream from Lafayette-Plain City Road, 2001.

Hellbranch Run and Tributaries

Hellbranch Run (02-204) (RM 26.1) (WWH)

Hellbranch Run is one of the few significant tributaries to Big Darby Creek east of the mainstem. It originates in and is solely contained within Franklin County. The eastern half of the watershed is rapidly being encroached upon by growth in Hilliard. The course that the stream channel follows is almost directly south and it enters Big Darby Creek a few miles south of Darbydale. Watershed length is 12.8 miles, watershed area is 37.7 square miles with an average gradient of 11.2 ft/mi. The mean QHEI recorded for the six sites sampled in the mainstem of Hellbranch Run in 2001 was 67.92. As mentioned previously, comparison of QHEI scores with biological performance of sites in the Ohio EPA database has shown that segments with average scores higher than 60 are capable of achieving the Warmwater Habitat (WWH) aquatic life use designation criteria based on habitat alone. Obviously, the mainstem of Hellbranch Run is capable of physically supporting the existing warmwater habitat aquatic life use designation. Localized habitat disruptions, however, considerably lower the mean score. These include: the segment at Alton Rd which has been dredged, deepened and straightened historically and which has declined in quality since last evaluated in 1992. Similarly, Kunz Rd. which possessed very good habitat in 1992 (QHEI = 74.5) has declined significantly in habitat quality in the intervening years with a QHEI of 51.0 recorded in 2002. Aggregating the sites in the lower four miles yields a considerably higher average QHEI of 83.8 demonstrating the potential of lower Hellbranch Run to support a very high quality aquatic community given adequate water and sediment quality. Evidence of this potential was demonstrated in the 2001 results. Two of the three sites in this segment would marginally meet the EWH criteria. Only the site downstream from the Timberlake WWTP partially met EWH criteria (Figure B.6.74). Initiatives to address habitat problems in the two source water tributaries to Hellbranch Run and at their confluences, as well as efforts to improve wastewater treatment at the existing small WWTPs to Hellbranch Run, should address further habitat and water quality shortfalls and should permit improvements in instream biological performance.

Figure B.6.74. Hellbranch Run downstream from the Timberlake (Cordell Regional) WWTP, 2001.

Hamilton Ditch (02-259) (RM 11.9) (MWH to Feder Rd., WWH Feder Rd. (RM 2.1) to mouth)

Hamilton Ditch, the western headwater source tributary for Hellbranch Run, was first evaluated for habitat and water resource quality in 1992. Landuse in this small subwatershed was predominately agricultural at that time. However, it was noted that large portions of the stream

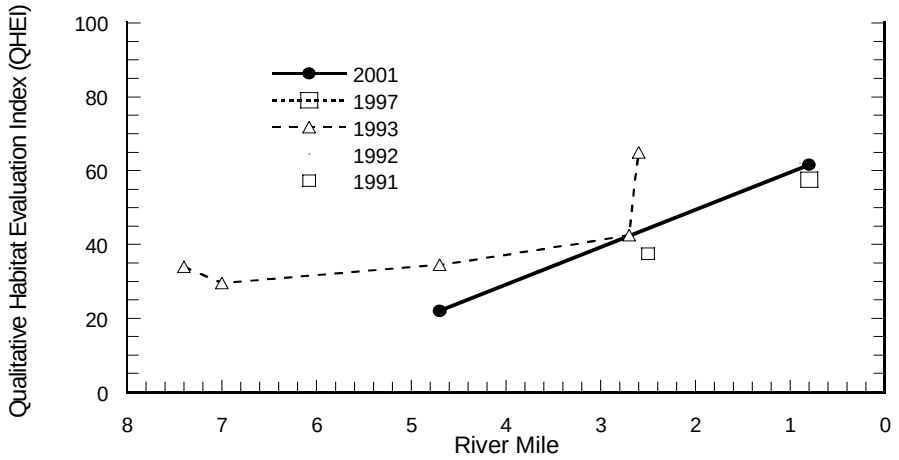
course had been channelized and when coupled with upstream and adjacent land uses yielded a preponderance of high and moderate influence modified habitat attributes at the one site evaluated, RM 1.3 upstream from the Conrail Railroad tracks adjacent to Cole Rd. These negative attributes included channelization with no recovery, low sinuosity, sparse to no cover, heavy to moderate silt cover, fair to poor development, low to no sinuosity, high to moderate stream embeddedness and extensive to moderate riffle embeddedness. Thick and unconsolidated layers of sand in backwater areas revealed a recent and ongoing problem with erosion contributing significant amounts of sediment to the stream. These instream habitat problems yielded a QHEI of 40.0. However, since Hamilton Ditch was an undesignated stream at the time and under pressure from suburban development, the quality of instream and riparian habitat was assessed at four additional locations in 1993 to determine the appropriate aquatic life use designation. Habitat quality was poorer further upstream at RM 3.4, upstream from Walker Rd., scoring only 34.0. This was in direct response to the modified nature of the stream. In contrast, the site upstream from Feder Rd. (RM 2.1) with a significant increase in local gradient yielded a QHEI of 74.5. The local gradient appeared to be capable of flushing contributed fine sediments at rates of delivery at that time. Some sand was noted being deposited in backwaters of pools and silt behind the small dam present in the zone. It was felt that any significant increase over those rates of delivery would result in smothering of habitat features and lessened biological potential. Scores at the mouth of Hamilton Ditch although slightly less than 60 had an equivalent number of WWH and modified habitat attributes. In the aggregate the segment from Feder Rd. downstream had more positive habitat features than modified habitat features largely as a result of the increased gradient. As a result this portion of the stream was recommended to be designated as Warmwater Habitat. Upstream from Feder Rd. due to the pervasive and negative nature of the prevailing instream conditions was recommended to be designated Modified Warmwater Habitat.

Two sites sampled in 2004, RM 3.4, Walker Rd. and RM 0.5, US Rt. 40, replicated sites evaluated during 1993 (Figures B.6.75 and B.6.76). Significant declines were recorded at both sites in 2001 from this previous sampling (Figure B.6.77). The upstream site already judged poor (i.e., QHEI = 34.0) in 1993 declined into the very poor range (i.e., QHEI = 21.0).

Figure B.6.75. Hamilton Ditch at Walker Rd. RM 3.4 upstream view.

Figure B.6.76. Hamilton Ditch upstream from US Rt. 40, 2001.

Figure B.6.77. Longitudinal and temporal trends in the Qualitative Habitat Evaluation Index in Clover Groff Ditch, 1991, 1992, 1993, 1997, and 2001.



Clover Groff Ditch (02-245) (RM 11.19)

Clover Groff Ditch, the other and eastern headwater source tributary for Hellbranch Run was also sampled at one location in 1992, RM 0.9, upstream from Broad St. In contrast to Hamilton Ditch, a preponderance of warmwater habitat attributes at this site yielded a QHEI of 62.5. Additional sampling was conducted in 1993 to assist in assigning an aquatic life use designation and to get a better handle on the effects associated with the residential construction taking place within this small subwatershed. Similar to Hamilton Ditch the upper portion of the watershed has been significantly modified with the three sites upstream from Feder Rd. yielding an average QHEI of only 32.7.

Low gradient coupled with extensive channelization and the recent contribution of agricultural and construction derived sediment have resulted in the poor conditions measured there. The stream is somewhat different in character from Feder Rd. downstream. Gradient increases, especially at the mouth where the stream channel has not been modified, the stream switches from a predominance of high and moderate influence modified habitat attributes to a preponderance of positive WWH attributes. However, observations made during sampling suggest that habitat quality in this tributary is declining. Although the extensiveness of siltation was estimated to be less than in Hamilton Ditch sand entering the stream from upstream and adjacent land uses were starting to cause embeddedness and loss of channel volume. Additionally, in new residential areas of the watershed the riparian buffer is being removed, which is resulting in increased stream bank erosion. Clover Groff Ditch was designated as Modified Warm Water Habitat from its headwaters to upstream from Feder Rd. and Warmwater Habitat from this point downstream to its mouth based on the evaluations conducted in 1992 and 1993.

Sampling in 2001was conducted at RM 4.7 - upstream from Roberts Rd. and upstream from US Rt. 40 - RM 0.5. Habitat quality at RM 4.7, upstream from Roberts Rd. while judged as having poor habitat quality in 1997 had significantly worsened in 2001 yielding very poor quality habitat (i.e., from a QHEI of 34.5 to a QHEI of 22). Differences between the years include the loss of pool depth, the shift in assessment that the channel was recovering from channelization to no recovery, maximum depth less than 40 cm., no fast currents and extensive embeddedness. Inadequate erosion control and storm water BMPs in the upper reaches of Clover Groff Ditch have deposited large amounts of silts in the stream channel filling in the pools and smothering the coarse streambed materials (Figure B.6.78).

Figure B.6.78. Clover Groff Ditch RM 4.7 upstream from Roberts Rd. Large storm sewer from residential subdevelopment.

Lower Big Darby Creek Tributaries

Smith Ditch (02-353) (RM 31.69) (Undesignated/EWH Recommended)

Smith Ditch, originates in Madison County just north of the village of Lily Chapel. It flows in a southeasterly direction to the Madison - Franklin County line near Wrightsville where is takes on a more direct easterly course flowing through the Battelle- Darby Metropark before joining with Big Darby Creek less than 2.5 miles downstream from the confluence with Little Darby Creek.

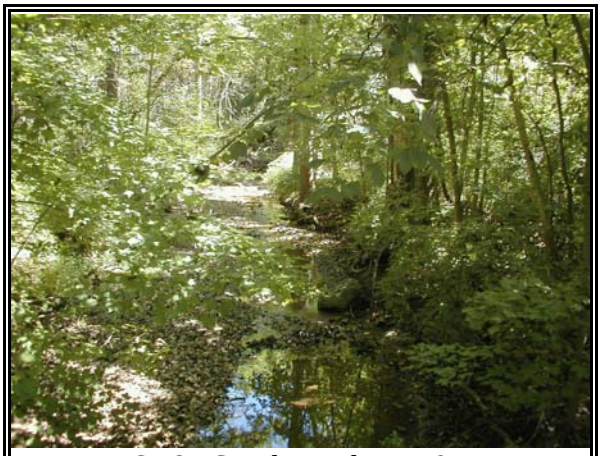


Figure B.6.79. Smith Ditch RM 0.2 at Biggert Rd. looking downstream.

Gradient in this small direct tributary is very steep ranging between 35-40 ft/mi, in the very high range. Habitat quality was judged to be very good to excellent as a result of its coarse substrates, highly sinuous course, wooded canopy and well developed channel features (Figure B.6.79). Confirmation of its ability to support an EWH aquatic biological community was secured during sampling in 2001. EWH criteria were fully met at the upstream site and partially met at the downstream site where fish did not perform to expectations.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Smith Ditch so an analysis of longterm trends in habitat quality was not possible.

Unnamed tributary to Smith Ditch (02-354) (RM0.06) (Undesignated/WWH Recommended)

This very small tributary enters Smith Ditch almost at its mouth. Gradient is even steeper than found in sites sampled in Smith Ditch (76.92 ft/mi). Gradients this steep are not optimum for supporting normal aquatic life. Other habitat attributes, however, were very good with coarse substrates and a good representation of cover types with deep pools and aquatic macrophytes the only missing elements. The stream channel was moderately to highly sinuous and possessed a wide forested buffer for a good percentage of the sampling zone. In all the stream was judged capable of supporting very good aquatic biological communities.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat in the Unnamed Tributary to Smith Ditch so an analysis of long term trends in habitat quality was not possible.

Gay Run (02-298) (RM 26.48) (Undesignated/WWH Recommended)
Gay Run enters Big Darby Creek from the west approximately halfway in between Darbydale and Harrisburg. Gay Run at its mouth is a losing stream, losing surface water flow to the thick layer of glacial till found along the lower valley of Big Darby Creek. As a consequence, the lower site was found to be dry when sampling was attempted in 2001. In contrast, the upstream site had perennial flow with springs observed within the sampling zone (Figure B.6.80). It was evaluated and sampled in 1997 and 2001 and yielded QHEIs in the mid sixties on both occasions. Gay Run clearly has habitat adequate to support WWH biological communities. The presence of perennial pools, ground water flow contribution in its upper reaches and the proximity to the high quality repopulation resource of the mainstem of Big Darby Creek are more than adequate to supersede the occasional intermittency found at the mouth and support the assignment of the WWH designation.

Figure B.6.80. Gay Run at Boyd Rd. looking downstream.

Springwater Run (02-203) (RM 24.0) (WWH)
This small tributary happens to drain a very narrow end moraine from the late Wisconsinan glaciation which occurs as hummocky ridges that are higher than the adjacent terrain. Local gradient was 50 ft/mi which exceeds the very high range and although capable of flushing fines downstream would not be optimal for supporting aquatic life. This small tributary flows through the center of Harrisburg and was obviously channelized in the past and was observed to be recovering from that impact. The QHEI for the stream segment downstream from Main St. was 50, in the fair range. Although coarse substrates in the form of boulders, cobble and gravel were present the moderate amount of sand also present contributed to the moderate overall and riffle embeddedness noted for this site. While not possessing optimum habitat for supporting aquatic life this site did possess an adequate number of WWH attributes which when associated with the ameliorative effects of the ground water augmenting the stream base flow permitted the maintenance of a WWH aquatic community in this stream.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Springwater Run so an analysis of longterm trends in habitat quality was not possible.

Unnamed Tributary to Big Darby Creek (02-352) (RM23.57) (Undesignated/WWH Recommended)
This small tributary flows from the west and confluences with Big Darby Creek just south of the SR 762 bridge opposite of the small village of Orient. Stream gradient of this very small stream was the highest in the study area at 111.1 ft/mi. Streams with this high of gradient

characteristically have a flashy hydrograph. Although water fills the stream channel after rainfall or snowmelt in many cases during normal to low flow conditions the channel will dry up to isolated pools or if receiving groundwater to interstitial flow. This was indeed the case during the sampling accomplished in 2001. The stream had interstitial flow. Despite the very low flow there were preponderance of WWH attributes that would have been greater under higher perennial flow. This site received a QHEI of 61.5.

Unnamed tributary to Big Darby Creek (02-270) (RM 20.2) (Undesignated/WWH Recommended)

This small tributary enters Big Darby Creek from the west at RM 20.2 and to a segment that supports some of the rarest species encountered in the Big Darby mainstem. Habitat at RM 0.8 upstream from Harrisburg - Darbyville Rd. has been evaluated in 1994 and during the 2001 survey (Figure B.6.81). Though largely similar between the years and yielding an evaluation of excellent a slight decline was noted in 2001 (i.e., from a QHEI 0f 80.5 to 77.5). This was mainly due to an increase in the amount of embeddedness noted. There has been an increase in large lot residential development in the subwatershed that is probably responsible for this shift. Although this small stream is being recommended to be designated WWH based on the current instream biological performance this stream has the potential to support an EWH community when water quality conditions at the Clark's Lake Subdivision are rectified. The only WWH attribute missing from this stream was silt free substrates, which also contributed to some of the negative attributes noted. Ground water was also a strong influence on the biological composition of this stream. One fish species, the central mottled sculpin, an obligate coolwater species, comprised a large percentage of the resident fauna.

Figure B.6.81. Unnamed tributary to Big Darby Creek at RM 20.2 upstream Harrisburg-Darbyville Rd.

Unnamed tributary to Big Darby Creek (02-366) (RM 18.41) (Undesignated/WWH Recommended)

Unlike many of the streams discussed just upstream, this creek empties into Big Darby Creek from the east, downstream from the Scioto-Darby Creek Rd. bridge. A small reservoir is situated at its headwaters with the balance of the watershed agriculture. Local gradient was greater than 27 ft/mi, which places it in the high range. Positive WWH attributes included normal overall and riffle embeddedness. High influence modified habitat attributes included no sinuosity, sparse cover and shallow maximum depths. The QHEI score for this site was 52.5.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on this stream so an analysis of long term trends in habitat quality was not possible.

Greenbrier Creek (02-2020) (RM 16.75) (WWH)

Greenbrier Creek's headwaters originate in the ground moraine of Pickaway County near the small unsewered village of Derby. It flows in a general southeasterly direction towards the Big Darby Creek mainstem. In its lower reaches within the Big Darby Creek beltway it encounters alluvium and alluvium terraces deposited in present and former floodplains and low-level outwash terraces which are composed of sand and gravel. Gradient in the ground moraine area was very high at approximately 35 ft/mi and flattened out to about 18 ft/mi in the alluvium/outwash areas. QHEI scores ranged from 57.0 at Scioto-Darby Rd. to 74.5 at Harrisburg - Darbyville Rd. The segment average QHEI was 65.75 well within the range judged suitable for supporting WWH communities.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Greenbrier Creek so an analysis of longterm trends in habitat quality was not possible.

Georges Creek (02-201) (RM 14.4) (WWH)

Georges Creek enters Big Darby Creek from the west about 1.4 miles upstream from the small village of Darbyville. The stream channel for most of its course flows through a steep valley coming off the edge of Late Wisconsinan ground moraine. Local stream gradient was >58 ft/mi. which is steeper than the very high range. Due to the velocity of flows encountered at this steepness of gradient particularly at flood stage it is felt to be more than is optimal for the support of aquatic life. Other habitat attributes, however, were positive. These included: no channelization, coarse substrates including boulder, cobble and gravel, moderate sinuosity, moderate cover amounts, slightly greater than normal embeddedness, and deep pools. This yielded a QHEI of 61.0 with the stream judged capable of supporting WWH aquatic communities which was verified by the concurrent biological sampling conducted.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Georges Creek so an analysis of longterm trends in habitat quality was not possible.

Lizard Run (02-273) (RM 12.93) (Undesignated/LRW Recommended)

This small tributary which also flows from the west and discharges to Big Darby Creek at the village of Darbyville was found to be dry when attempted to be sampled mid-field season 2001. Subsequent trips to sample or evaluate Lizard Run have yielded similar results Lizard Run is a true ephemeral stream. This is largely a function of the glacial geology that underlies the stream channel and results in Lizard Run becoming a losing stream with little or no flow except after rain events or snow melt periods. As a consequence of the natural ephemeral nature of this stream and the limitations imposed by this stressor this stream is recommended to be designated as a Limited Resource Water.

The sampling conducted in 2001 was the first evaluation of instream and riparian habitat on Lizard Run so an analysis of longterm trends in habitat quality was not possible.

B.7 Macroinvertebrate Community

B.7.1 Watershed Assessment

Big Darby Creek Mainstem

Upper Big Darby Creek - Headwaters to Plain City

The aquatic macroinvertebrate community was of very good to exceptional quality in the extreme headwater segment (from RM 83.2 downstream to the confluence of Flat Branch with Big Darby Creek at RM 78.48). All ICI scores in this reach, which ranged from 42 to 56 longitudinally, met the WWH biocriterion, the current designated aquatic life use for this reach, and also met or exceeded the EWH minimum score (i.e., ICI = 42) (Tables B.7.1 and B.7.2). Community quality improved and seemed to be recovering well from the previous ODOT stream work upstream from CR 152 in 1997 at approximately RM 82.6. Total **EPT** [**E**phemeroptera (mayfly), **P**lecoptera (stonefly), **T**richoptera (caddisfly)] taxa, number of sensitive taxa, and total taxa increased and indicated improvements in community quality in the upper Big Darby Creek headwaters downstream to the Flat Branch confluence - RM 78.48 (Figures B.7.1 to B.7.5). In fact, the entire mainstem of Big Darby Creek has demonstrated the ability to support EWH macroinvertebrate communities based on the 2001/2002 sampling results.

The upper Big Darby Creek site, RM 83.2, could also be classified as Coldwater Habitat (CWH). Seven coldwater species out of 26 different species, including the coldwater caddisfly *Diplectrona modesta*, comprised 9.1 percent of the total different species collected. The coldwater community totaled > 11 percent of the macroinvertebrate population collected during the sampling period on the colonizers. The well established riparian buffer consisted of 100 feet of large, mature trees lining both banks ranging from 25% open to a closed canopy undoubtedly contributing to support this fauna.

The CWH component of the macroinvertebrate population at RM 82.5, the next site downstream, had decreased to two taxa. This site was downstream from the ODOT project where stream was relocated and still possessed only limited canopy. The coldwater macroinvertebrates were affected by the lack of a thick mature riparian corridor in this area. Only a 30-40' width of short shrubs and grass lined the streambanks providing very limited shading with 50% to 25% open canopy. Eventually the riparian canopy will expand and vertical shading will increase.

The next downstream site at RM 79.3, with 40 to 100 feet of large trees and increased shading adjacent Big Darby Creek ranging from 50% open to a closed canopy, had three CWH taxa present including the caddisfly *Ceratopsyche slossonae*, but they comprised < 2 percent of the macroinvertebrate community population. With the CW macroinvertebrate taxa showing increased representation further downstream from the ODOT stream segment it is recommended to also designate Big Darby Creek as CWH from the headwaters to RM 78.5 just upstream from the confluence with Flat Branch (RM 78.48) particularly when coupled with the fish community sampling results.

Relative numerical abundance (or density) in Big Darby Creek downstream from the confluences with Flat Branch and Little Darby Creek (Logan Co) at RM 78.3 doubled to >1000 organisms/ft^2 on the artificial substrate samplers. Elevated total suspended solids (TSS), nitrite, TKN, and total phosphorus (TP) concentrations input from Flat Branch which equaled the 75th - 90th percentile of ECBP ecoregion background values and the Flat Branch WWTP which discharged TSS at >95th percentile and nitrites and TP at 90th percentile vs. ECBP background (Table B.3.2) were suspected contributors to the increase in numerical abundance. Low mean diel D.O.s which ranged from 4.29 mg/l to 4.62 mg/l with lows of 3.5 -3.87 mg/) and large nutrients and TSS loads were recorded in Flat Branch in 2001. These Flat Branch inputs and similarly elevated TSS and nutrient loads from Flat Branch WWTP have caused instream D.O. violations of the EWH minimum (i.e., < 5 mg/l) and mean D.O. concentration (i.e., < 6 mg/l) downstream from the confluence at RM 78.4. Elevated concentrations of some metals were also found downstream from the Flat Branch WWTP. Correspondingly, the ICI decreased from 56 upstream to 50 downstream from Flat Branch. Sensitive taxa, total EPT taxa, and total number of taxa declined or remained static at RM 78.3 (Figures B.7.1 to B.7.9). The copper exceedence from Flat Branch and metals inputs from Flat Branch WWTP may have adversely affected community composition. The abnormally large *Hydra* population documented (wtd. ICI= 31.8) was indicative of large amounts of available nutrients /organic matter in the water column (suspended solids with attached algae and/or free suspended algae) downstream from Flat Branch. The moderately intolerant, filter feeding, tanytarsini midge population (*Rheotanytarsus sp.*) (wtd. ICI= 44.0) also doubled and ameliorated somewhat the negative influence of the skewed community composition. High quality water from Little Darby Creek (Logan Co.) (RM 78.34) diluted some the adverse effects to the macroinvertebrate community from the Flat Branch and Flat Branch WWTP inputs.

Big Darby Creek had recovered by North Lewisburg Rd. (RM 76.6) with an ICI of 56. This site yielded normal community abundance (shaded canopy at the site) and the highest number of sensitive taxa collected in the upper watershed including freshwater mussels (Figure B.7.8). Exceptional conditions were documented here with an ICI of 56. Relative density decreased as a result of the shaded canopy at the sampling site. This occurred despite non-point source (NPS) inputs that included extremely high TSS, nitrites, TKN, and TP with values at the 95th and 90th percentile vs. ecoregion background concentrations (Table B.3.2). Decreasing nutrient inputs and sedimentation through widened riparian areas upstream from North Lewisburg Rd. will result in even higher stream quality.

Exceptional community quality persisted, but declined slightly downstream to Milford Center, RM 67.2, as overall the number of sensitive taxa, total EPT, and total taxa decreased. But at RM 67.2, upstream from Milford Center, due to stable and favorable habitat six mussel taxa were collected. This was the highest number of mussel taxa collected in the upper BDC watershed from its headwaters to just upstream from Plain City. Habitat included vegetated side channels and pools with stable gravel bars. The substrates were loose, though in the rocky upstream pools some silt had accumulated and covered over the top surfaces of the rubble and boulders present. Stable banks anchored by trees that limited erosion and improved stream sinuosity had created favorable side pool habitat.

Table B.7.1. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) from Big Darby Creek and tributaries sampled in the Big Darby Creek watershed, June - October, 2001. (Aquatic life uses listed are those currently designated in the Ohio Water Quality Standards or the recommended use changes).

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI[c]	Narrative Evaluation[c]
Big Darby Creek Eastern Corn Belt Plains (ECBP) - (WWH/EWH + CWH Recommended)											
83.2	1.3	385	43	54	77	16	18	6,5	40.7	42[ns]	Very Good
82.5	1.5	298	37	55	69	16	18	6,3,18,5	39.7	46	Exceptional
79.3[R]	5.6	544	49	63	86	17	21	3,38,44,42,43,2,10	39.7	56	Exceptional
Big Darby Creek (ECBP) - (EWH)											
78.3	25.1	1024	48	64	87	19	23	8,3,9,44,43,20	40.9	50	Exceptional
76.5[R]	32.0	415	51	55	82	19	23	2,9,44,6,20,21	39.7	56	Exceptional
69.4	74.0	144	47	52	82	17	22	9,8,43,6,45,1,3	41.8	52	Exceptional
64.4[R]	88.0	285	50	58	80	22	26	9,6,20,28,34	41.0	50	Exceptional
62.9[R]	120	147	35	50	70	13	18	3,42,43,21,26	39.3	42[ns]	Very Good
54.1[R]	136	118	36	61	81	23	25	45,3,9,12,14,10	41.9	42[ns]	Very Good
53.9	136	Mod.-Low	--	75	75	20	20	3,45,9,10,12,14,6,	39.7	E[d]	Exceptional
52.1	150	176	46	58	80	19	24	3,2,45,9,10,11,12	39.7	52	Exceptional
52.0	150	239	34	40	58	13	16	3,45,10,12,9,18	39.1	44[ns]	Very Good
49.7	177	550	40	69	89	18	23	3,45,9,10,21	40.7	56	Exceptional
42.1[R]	240	430	40	58	83	19	25	3,45,2,9,12,8,46,4,	42.3	50	Exceptional
34.2	253	305	47	65	86	26	29	3,2,11,8,14,47,41,	41.2	52	Exceptional
26.9[R]	453	981	45	63	85	20	29	2,40,9,3,10,22,6,1	41.6	54	Exceptional
23.8	498	849	67	72	103	23	29	3,10,14,9,11,6,22,	41.6	46	Exceptional
22.5	505	1571	48	64	86	22	33	5,27,9,3,41,8,6	40.4	56	Exceptional
19.1	512	274	56	77	113	19	27	12,2,3,14,9,10,8,4	42.3	E	Exceptional
13.5[R]	534	1222	52	67	87	17	25	41,3,45,5,27,10	40.4	56	Exceptional
3.2[R]	552	1375	55	73	94	26	33	1,2,8,3,10,47,48,2	42.3	56	Exceptional
Flat Branch (ECBP) - Modified Warmwater Habitat (MWH)											
3.2	3.3	Moderate	--	35	35	8	8	8,3,23,21,34,22	33.8	G	Good
2.2	9.3	Moderate	--	31	31	6	6	3,23,21	33.3	MG	Marg. Good
1.0[RM]	13.8	440	46	36	62	9	16	6,20,21,52,49,42	35.1	50	Exceptional

Continued.

Table B.7.1. Continued.

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI	Narrative Evaluation[c]
Unnamed Trib. to Flat Branch (RM 1.50) (ECBP) - (Undesignated/MWH Recommended)											
0.1	3.5	Low	--	24	24	4	4	27,21,50	33.2	F	Fair
Little Darby Creek (Logan Co.) (RM 78.34) (ECBP) - (EWH/EWH + CWH Recommended)											
3.5[R]	2.4	345	49	54	72	16	18	2,6,43,5,27,42,44,9	40.8	54	Exceptional
0.4	5.4	873	52	52	83	12	15	2,3,6,20,38,49,42,43,44,9	40.6	50	Exceptional
Unnamed Trib. to Big Darby Creek (RM 74.91) (ECBP) - (Undesig./ EWH Recommended.)											
0.3	3.9	Mod.-Low	--	44	44	14	14	3,45,10,44,9,18,21	41.0	VG	Very Good
Spain Creek (ECBP) - (WWH/WWH + CWH Recommended)											
5.7	3.5	Mod.-Low	--	54	54	11	11	3,45,10,44,9,18,21	35.0	MG[ns]	Marg. Good
Spain Creek (ECBP) - (WWH/EWH +CWH Recommended)											
3.4[R]	6.0	331	40	52	72	15	18	3,6,10,2	40.6	44	Very Good
0.1[R]	9.1	254	46	47	66	12	19	2,3,12,42,43,44	39.3	56	Exceptional
Pleasant Run (ECBP) - (EWH)											
4.1	4.9	Mod.-Low	--	46	46	15	15	9,44,13,4,11	39.1	VG[ns]	Very Good
0.5[R]	9.4	468	59	52	86	19	27	3,2,6,34	37.8	56	Exceptional
U. T. to Big Darby Creek (RM 69.41) (ECBP) - (Undesignated/WWH Recommended)											
0.3	4.6	Moderate	--	40	40	10	10	45,10	37.8	G	Good
Hay Run (ECBP) - (WWH/EWH Recommended)											
0.2	5.8	Mod.-High	--	42	42	11	11	45,11,4	39.3	VG	Very Good
Buck Run (ECBP) - (WWH)											
10.4	5.1	Mod.-Low	--	32	32	6	6	23,26	30.4	MG[ns]	Marg. Good
7.8	9.2	Mod.-Low	--	46	46	9	9	20,27,31	35.1	G	Good
5.0	18.1	High-Mod.	--	48	48	10	10	20,27,26	32.6	MG[ns]	Marg. Good
0.6	29.7	Mod.-Low	--	46	46	7	7	9,29,10,53,26,21,24,22,4	33.3	MG[ns]	Marg. Good

Continued.

Table B.7.1. Continued.

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI	Narrative Evaluation[c]
Robinson Run (ECBP) - WWH											
5.5A	4.6	Low	--	14	14	2	2	9,29,13,26,51	29.8	VP*	Very Poor
2.1	8.4	High-Mod.	--	30	30	2	2	53,21,34	29.8	F*	Fair
0.8	11.5	High-Mod.	--	51	51	8	8	10,11,22	39.0	MG[ns]	Marg. Good
Sweeney Run (ECBP) - (Undesignated/WWH Recommended)											
0.2	4.0	Mod.-Low	--	28	28	4	4	8,13,54,4,25	26.4	F*	Fair
Sugar Run (ECBP) -(WWH/MWH Recommended)											
7.7	4.3	Mod.-Low	–	21	21	4	4	3,22,26,21,24	32.0	F	Fair
(ECBP) (WWH)											
6.9	9.5	Mod.-Low	–	46	46	10	10	3,8,6,31,24,21	33.2	MG	Marg. Good
5.5	11.0	Mod.-Low	–	46	46	7	7	3,31,24,8,42	35.0	G	Good
0.5	19.4	Moderate	–	52	52	16	16	3,25,6,31	38.7	VG	Very Good
U. T. to Sugar Run (RM 7.39) (ECBP) - (Undesignated/MWH Recommended)											
0.1	5.0	Mod.-Low	--	35	35	9	9	3,13,26,31	34.4	MG	Marg. Good
Worthington Ditch (ECBP) - (Undesignated/ WWH Recommended)											
0.2	4.4	High-Mod.	--	40	40	9	9	5,55,12,11,26,18,54,4	37.5	MG[ns]	Marg. Good
Ballenger-Jones Ditch (ECBP) - (Undesignated/WWH Recommended)											
0.2	6.0	High-Mod.	--	48	48	19	19	8,11,3,6,26	39.7	E	Exceptional
Yutzy Ditch (ECBP) - (Undesignated/ WWH Recommended)											
0.4	4.3	Mod.-Low	--	34	34	8	8	11,4,6,13	35.9	MG[ns]	Marg. Good
Fitzgerald Ditch (ECBP) - (Undesignated/WWH Recommended)											
0.5	5.1	High-Mod.	--	32	32	7	7	5,3,9,11,21	35.1	MG[ns]	Marg.Good

Continued.

Table B.7.1. Continued.

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI	Narrative Evaluation[c]
Little Darby Creek (ECBP) - (EWH/EWH+CWH)											
41.2	3.3	Moderate	--	56	56	15	15	3,11,27,13	40.4	VG	Very Good
39.3	12.5	3914	48	66	81	13	15	5,27,3,13	36.8	48	Exceptional
38.8	13.2	1305	56	66	89	16	17	3,5,27,18,21,13	38.1	48	Exceptional
34.6	25.9	516	52	64	90	13	18	3,45,4,22,9,10,26,21	33.9	56	Exceptional
Little Darby Creek (ECBP) - (EWH)											
29.4	70.0	1400	55	54	78	17	24	3,45,11,6,22,9,4,26	39.4	50	Exceptional
24.5	83.0	504	46	85	95	22	25	45,6,22,5,27,9,3,43,42,34	40.4	58	Exceptional
17.0	142	318	36	68	81	17	21	3,45,10,6,28,9	39.3	48	Exceptional
15.4	151	325	48	63	86	21	23	3,5,27,2,45,10,22,4,28	40.9	50	Exceptional
6.4	163	510	43	68	88	16	20	5,2,3,45,10,1	39.7	54	Exceptional
3.8	170	1366	38	68	78	20	21	5,3,2,6,45,27	40.9	52	Exceptional
0.5	176	842	50	60	79	20	27	45,3,8,2,6,10,5,2	41.9	56	Exceptional
Clover Run (ECBP) - (EWH/WWH Recommended)											
0.6	2.0	Mod.-Low	--	47	47	14	14	3,2,5,6,4,38,42	39.7	VG	Very Good
0.2	2.4	Mod.-Low	--	37	37	8	8	3,6,18,13,22	38.3	G	Good
Lake Run (ECBP) (EWH/EWH Deferred)											
0.9	6.0	Mod.-Low	–	38	38	12	12	10,41	38.3	VG	Very Good
Jumping Run (ECBP) (Undesignated/WWH Recommended)											
0.2	2.4	Mod.-Low	–	37	37	8	8	3,6,18,13,22	38.3	G	Good
Treacle Creek (ECBP) - (EWH)											
11.7	5.7	Moderate	--	52	52	11	11	5,27,22,30,6,4,10,13,37	38.1	VG[ns]	Very Good
8.3	10.3	Moderate	--	63	63	17	17	2,5,45,6,10,21,13	41.0	E	Exceptional
6.0	17.0	Mod.-Low	--	59	59	13	13	3,5,27,6,21	38.3	VG[ns]	Very Good
0.7	37.3	Mod.-Low	--	44	44	5	5	27,3,37,22,18,34,21	36.8	MG*	Marg. Good
Howard Run (ECBP) - (EWH)											
0.6	2.6	Mod.-Low	--	46	46	10	10	2,3,45,10	38.1	VG[ns]	Very Good

Continued.

Table B.7.1. Continued

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI	Narrative Evaluation[c]
Proctor Run (ECBP) - (EWH)											
4.9	3.9	Mod.-Low	--	54	54	13	13	3,44,45,12,9,6,18	40.0	VG^{ns}	Very Good
3.2	9.1	High-Low	--	55	55	15	15	4,6,12,9,3,20,45,27,21	39.3	VG^{ns}	Very Good
1.7	10.0	Mod.-Low	--	67	67	22	22	2,3,45,6,9	39.7	E	Exceptional
Barron Creek (ECBP) - (EWH/WWH Recommended)											
2.1	4.9	Mod.-Low	--	44	44	8	8	10,53,6,51	32.7	MG^{ns}	Marg. Good
0.1	6.3	Mod.-Low	--	39	39	6	6	22,45,34,21	33.3	MG^{ns}	Marg. Good
Wamp Ditch (ECBP) - (Undesignated/WWH Recommended)											
0.1	4.8	High-Mod.	--	48	48	9	9	4,26,22,31,10	31.0	MG^{ns}	Marg. Good
Spring Fork (ECBP) - (EWH)											
15.8	4.3	Mod.-Low	--	36	36	8	8	5,44,18,24,13	36.2	G*	Good
13.3	8.3	Mod.-Low	--	58	58	13	13	5,3,19,22,18,9	39.3	VG^{ns}	Very Good
7.7	19.3	Moderate	--	38	38	11	11	9,6,18,22,31	39.1	G*	Good
Bales Ditch (ECBP) - (WWH Recommended)											
0.4	5.2	Mod.-Low	--	53	53	10	10	4,9,10,12,21,26,13	36.2	G	Good
2.2	1.2	Mod.-Low	--	42	42	7	7	3,18,21	35.9	G	Good
Smith Ditch (Trib. to BDC @ RM 31.69) (ECBP) - EWH (recommended)											
2.1	5.9	Moderate	--	58	58	15	15	5,12,2,10,45,6,18	38.7	E	Exceptional
0.2	6.7	Moderate	--	45	45	11	11	3,5,12,4,6	39.7	E	Exceptional
Hellbranch Run (ECBP) - (WWH)											
9.4	24.8	740	40	36	55	6	9	5,27	33.2	46	Exceptional
7.4	27.9	656	44	39	60	11	17	5,27,8,3	39.4	48	Exceptional
5.7	30.5	Mod.-Low	--	47	47	10	10	5,27	39.0	G	Good
Hellbranch Run (ECBP) - (WWH/EWH Recommended)											
3.7	32.6	349	41	45	69	10	13	3,2,8,5,27,10,9,11	39.2	50	Exceptional
0.9	35.3	270	45	55	80	16	19	3,2,8,9,10	38.3	VG	Very Good
0.5	35.4	Mod.-Low	--	57	57	10	10	3,2,9,8,5,27,10,21,42	38.9	VG	Very Good

Continued.

Table B.7.1. Continued

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI	Narrative Evaluation[c]
Hamilton Ditch (ECBP) - (MWH)											
3.4	3.4	Mod.-Low	--	42	42	2	2	31,5,11,32	33.9	F	Fair
(ECBP) - (WWH)											
0.5	9.4	707	42	41	61	4	8	5,27,11,13,31,24	32.0	40	Good
Clover Groff Ditch (ECBP) - (MWH)											
4.7	3.8	Mod.-Low	--	19	19	0	0	27,22,33	33.2	VP*	Very Poor
(ECBP) - (WWH)											
0.8	6.7	167	27	30	43	5	6	10,21	39.0	20*	Fair
Springwater Run (ECBP) - WWH											
0.8	1.8	Mod.-Low	--	28	28	3	3	13,3,18	33.2	F*	Fair
U.T. Big Darby Creek (RM 20.20) (ECBP) - (Undesignated/WWH Recommended)											
0.8	4.3	High-Low	--	42	42	9	9	5,45,4,18,10	39.5	G	Good
Greenbrier Creek (ECBP) - WWH											
2.7	4.4	Low	--	32	32	7	7	7,5,12,18,10	39.3	MG[ns]	Marg. Good
Georges Creek (ECBP) - WWH											
0.5	1.2	Low	--	32	32	6	6	9,5,38,43	39.3	MG[ns]	Marg. Good
Lizard Run (ECBP) - (Undesignated/LRW Recommended)											
0.2	1.2	Very Low	--	3	3	0	0	30,13	0.0	VP*	Very Poor

Ecoregion Biocriteria: Eastern Corn Belt Plains	INDEX	WWH	EWH	MWH[e]	LRW
	ICI	**36**	**46**	**22**	**8**

[a] EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), & Trichoptera (caddisflies) taxa richness.

[b] Qualitative Community Tolerance Value (QCTV) is derived as the median of the tolerance values calculated for each qualitative taxon present (see discussion in Methods Section).

[c] Qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate an Invertebrate Community Index (ICI) score.

[d] Qualitative narrative assessment used in lieu of quantitative score due to lack of requisite current velocity, loss and/or vandalism of artificial substrates.

[e] Modified Warmwater Habitat for channel modified areas.

R Regional reference site
RM Regional modified reference site
* Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.
ns Nonsignificant departure from ecoregion biocriterion (≤4 ICI units).

Predominant organism code list

1 *Isonychia* mayflies	12 water pennies	23 burrowing mayflies	34 *Argia* damselflies	45 *Neophylax* caddisflies	56 tipulids/cranefly
2 *Chimarra* caddisflies	13 pond (LH) snails	24 various beetles	35 limpet snails	46 *Protoptila* caddisflies	
3 hydropsychid caddisflies	14 moth larvae	25 isopods	36 helgrammites	47 *Ceraclea* caddisflies	
4 snail-cased caddisfly	15 blackflies	26 scuds / shrimp	37 *Sialis* sp	48 *Oecetis* caddisflies	
5 tanytarsini midges	16 aquatic worms	27 midges	38 *Helichus* beetles	49 *Ancyronyx* beetles	
6 flathead mayflies	17 *Tricorythodes*	28 crayfish	39 tabanids	50 freshwater mussels	
7 nonred midges	18 red midges	29 flatworms	40 stoneflies	51*Peltodytes* beetles	
8 baetid mayflies	19 Bryozoa	30 tipulids	41 polycentropids	52 *Berosus* beetles	
9 riffle beetles	20 *Caenis* mayflies	31 corixids	42 *Dubiraphia* beetles	53 hydrobiid snails	
10 river (RH) snails	21 damselflies	32 dragonflies	43 *Macronychus* beetles	54 *Fossaria* snails	
11 cased caddisflies	22 fingernail clams	33 leeches	44 *Optioservus* beetles	55 ephemerellid mayflies	

Table B.7.2. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) from Big Darby Creek and tributaries sampled in the Big Darby Creek watershed, June - October, 2002. (Aquatic life uses listed are those currently designated in the Ohio Water Quality Standards or proposed use changes).

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI[c]	Narrative Evaluation[c]
Big Darby Creek (ECBP) - (EWH)											
67.2	81.0	73 /(Mod.-	31	51	66	18	20	2,1,3,28,10,34,12,9,38,37	41.9	E[d]	Exceptional
66.0	83.0	1104	40	59	73	14	15	5,10,3,45,19,34,21	39.7	40*	Good
38.9	247	297	46	61	83	23	30	3,45,10,8,9	42.3	52	Exceptional
28.6	450	Mod.-High	--	78	78	26	26	10,45,48,17,1	41.9	E	Exceptional
26.1	496	Moderate	--	61	61	21	21	10,3,9,1,23,6,40,28	43.3	E	Exceptional
15.8	529	2032	44	59	68	30	32	3,1,48,8,6,11,10,9,24	43.7	52	Exceptional
15.1	532	1994	46	58	73	22	27	3,11,5,48,8,9,27,17	43.6	54	Exceptional
11.2	537	1740	42	77	88	26	33	3,2,45,4,48,9,1,10,8,50,43,42	42.0	52	Exceptional
8.4	544	1714	50	65	73	26	30	3,1,2,10,8,11,48,5,27,17,55	42.1	52	Exceptional
5.3	550	981	51	52	75	24	29	3,9,2,27,48,17,6,52	42.7	52	Exceptional
Little Darby Creek (ECBP) - (EWH)											
33.2	28.0	219	39	54	67	15	18	9,43,3,22,42,8,5	40.7	54	Exceptional
26.5	72	577	41	68	85	21	25	5,3,8,11,20,31,43,6,42	39.7	52	Exceptional
23.2	89	Moderate	--	75	75	24	24	3,8,9,43,17,20,23,45,4	41.9	E	Exceptional
20.5	98	473	30	58	72	16	21	1,10,45,6,42,3	39.3	48	Exceptional
15.3[R]	151	332	27	56	66	19	21	45,46,6,10,1,5,28	40.7	46	Exceptional
Spring Fork (ECBP) - (EWH)											
10.1	14.6	327	40	41	62	13	20	5,9,44,3,12	41.9	56	Exceptional
3.4	32	754	66	51	85	13	16	5,27,3,8,6,9,43,42,32	39.3	E	Exceptional
3.3	32	65 / Mod.	46	44	66	13	17	3,12,4,6,34,21,9	40.4	56	Exceptional
Hellbranch Run (ECBP) - (WWH)											
0.5	35.4	182/(Mod.-	53	63	78	14	16	56,3,5,48,10,1,49	39.7	VG	Very Good
U. T. to Big Darby Creek (RM 18.41) (ECBP) - (Undesignated/WWH Recommended)											
0.1	3.5	Mod.-	--	43	43	8	8	11,48,6,28,52,31	35.7	G	Good

Continued.

Table B.7.2. Continued.

Stream River Mile	Drainage Area (mi.^{2})	Rel. Density (#/ft.^{2})	No. Quant. Taxa	No. Qual. Taxa	Total No. Taxa	Qual. EPT[a]	Total EPT	Predominant Organisms	QCTV[b]	ICI[c]	Narrative Evaluation[c]
Greenbrier Creek (ECBP) - (WWH)											
1.3	7.0	Moderate	--	40	40	10	10	3,4,6,18,22	39.3	VG	Very Good

Ecoregion Biocriteria: Eastern Corn Belt Plains

INDEX	WWH	EWH	MWH	LRW
ICI	**36**	**46**	**22**	**8**

[a] EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), & Trichoptera (caddisflies) taxa richness.

[b] Qualitative Community Tolerance Value (QCTV) is derived as the median of the tolerance values calculated for each qualitative taxon present (see discussion in Methods Section).

[c] Qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data are not available to calculate an Invertebrate Community Index (ICI) score.

[d] Qualitative narrative assessment used in lieu of quantitative score due to lack of requisite current velocity, loss and/or vandalism of artificial substrates.

[R] Regional reference site

* Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.

[ns] Nonsignificant departure from ecoregion biocriterion (≤4 ICI units).

Predominant organism code list

1 *Isonychia* mayflies	12 water pennies	23 burrowing mayflies	34 Argia damselflies	45 *Neophylax* caddisflies	56 tipulids/cranefly
2 *Chimarra* caddisflies	13 pond (LH) snails	24 various beetles	35 limpet snails	46 *Protoptila* caddisflies	
3 hydropsychid caddisflies	14 moth larvae	25 isopods	36 helgrammites	47 *Ceraclea* caddisflies	
4 snail-cased caddisfly	15 blackflies	26 scuds / shrimp	37 *Sialis* sp	48 *Oecetis* caddisflies	
5 tanytarsini midges	16 aquatic worms	27 midges	38 *Helichus* beetles	49 *Ancyronyx* beetles	
6 flathead mayflies	17 *Tricorythodes*	28 crayfish	39 tabanids	50 freshwater mussels	
7 nonred midges	18 red midges	29 flatworms	40 stoneflies	51*Peltodytes* beetles	
8 baetid mayflies	19 Bryozoa	30 tipulids	41 polycentropids	52 *Berosus* beetles	
9 riffle beetles	20 *Caenis* mayflies	31 corixids	42 *Dubiraphia* beetles	53 hydrobiid snails	
10 river (RH) snails	21 damselflies	32 dragonflies	43 *Macronychus* beetles	54 *Fossaria* snails	
11 cased caddisflies	22 fingernail clams	33 leeches	44 *Optioservus* beetles	55 ephemerellid mayflies	

Figure B.7.1. Longitudinal trends in the ICI and the estimates ICI score based on the Qualitative Narrative on the mainstem of Big Darby Creek based on sampling conducted in 2001 and 2002.

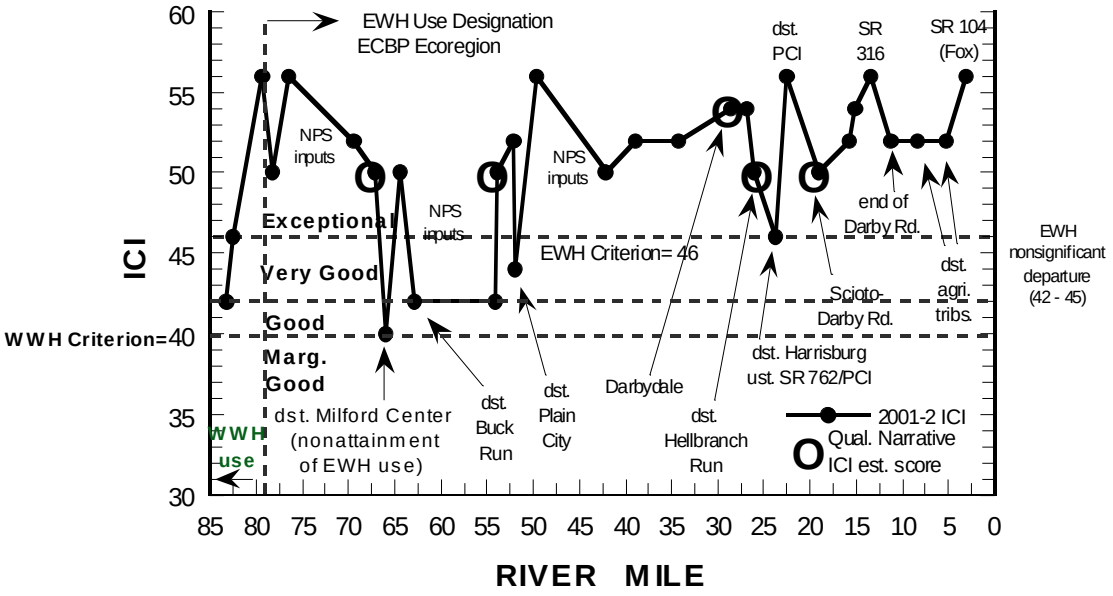


Figure B.7.2. Longitudinal trends in the Total EPT taxa collected from sites on the mainstem of Big Darby Creek in 2001-2002.

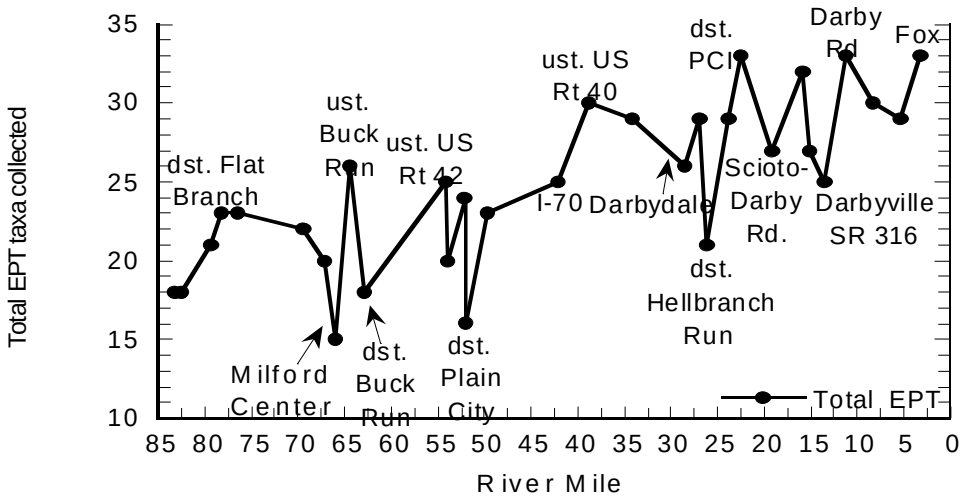


Figure B.7.3. Longitudinal trends in the number of sensitive macroinvertebrate taxa collected from sites on the mainstem of Big Darby Creek in 2001-2002.

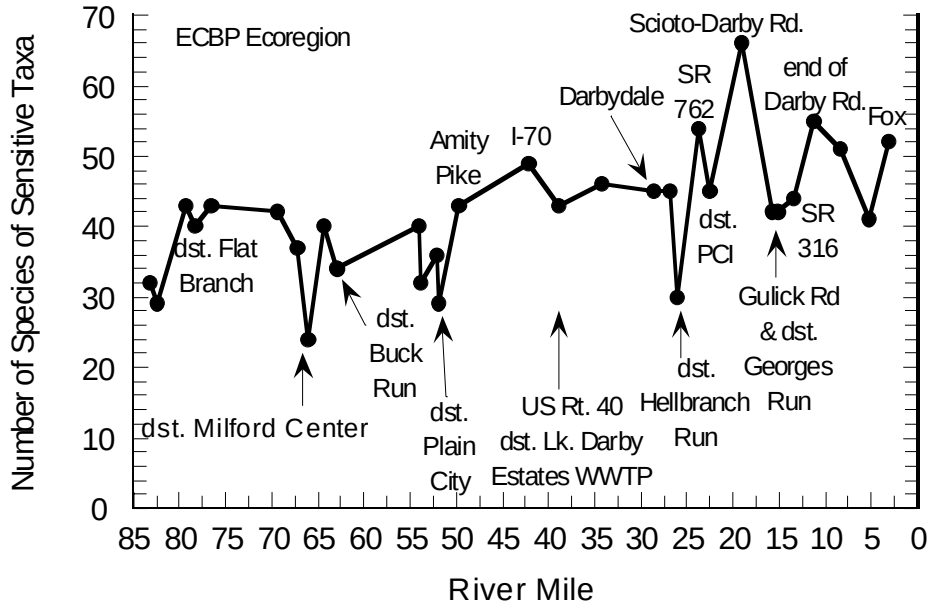


Figure B.7.4. Longitudinal trends in the Invertebrate Community Index and the number of sensitive taxa collected from sites on the mainstem of Big Darby Creek in 2001-2002.

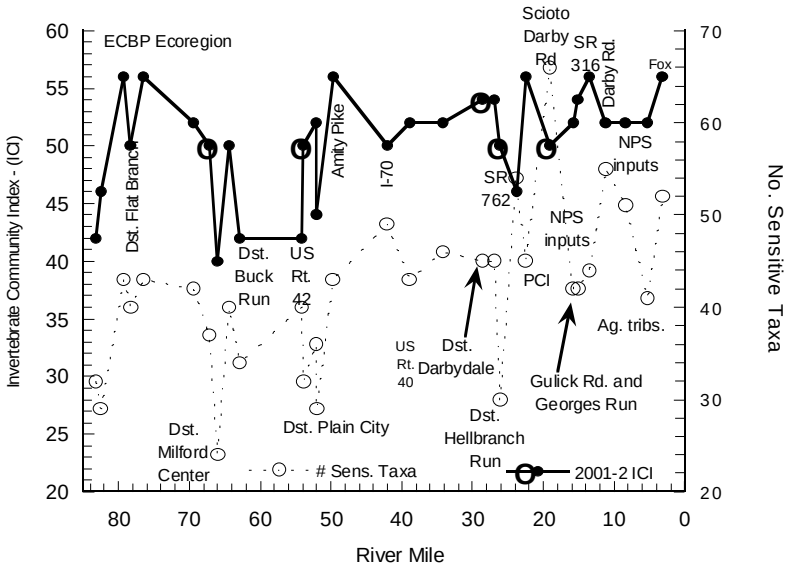


Figure B.7.5. Longitudinal trends in the Invertebrate Community Index and the total number of macroinvertebrate taxa collected from sites on the mainstem of Big Darby Creek in 2001-2002.

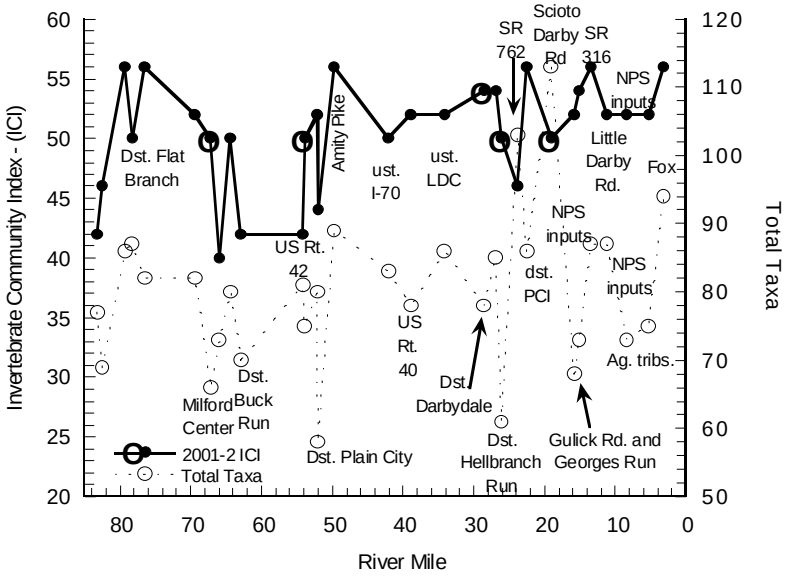


Figure B.7.6. Longitudinal trends in the relative density of macroinvertebrate taxa per sq. ft. in the Big Darby Creek mainstem based on sampling in 2001 and 2002.

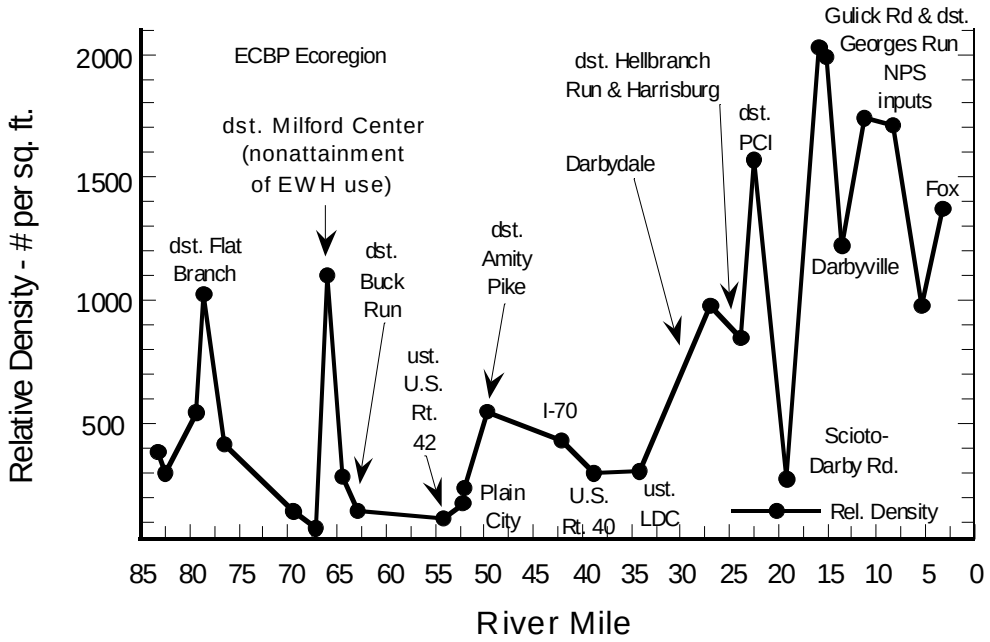


Figure B.7.7. Longitudinal trends in the Invertebrate Community Index and the Relative Abundance (no./sq.ft.) of Macroinvertebrates on the Big Darby Creek mainstem based on sampling conducted in 2001 and 2002.

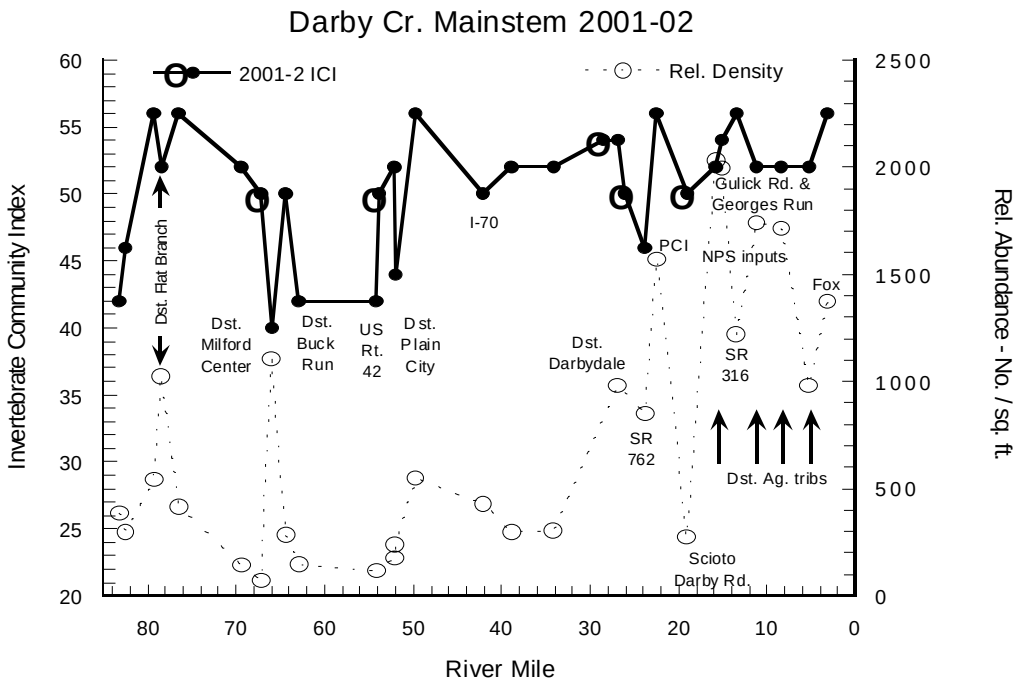


Figure B.7.8. Longitudinal trends in the Invertebrate Community Index and the number of bivalve mussels observed from sites on the mainstem of Big Darby Creek in 2001-2002.

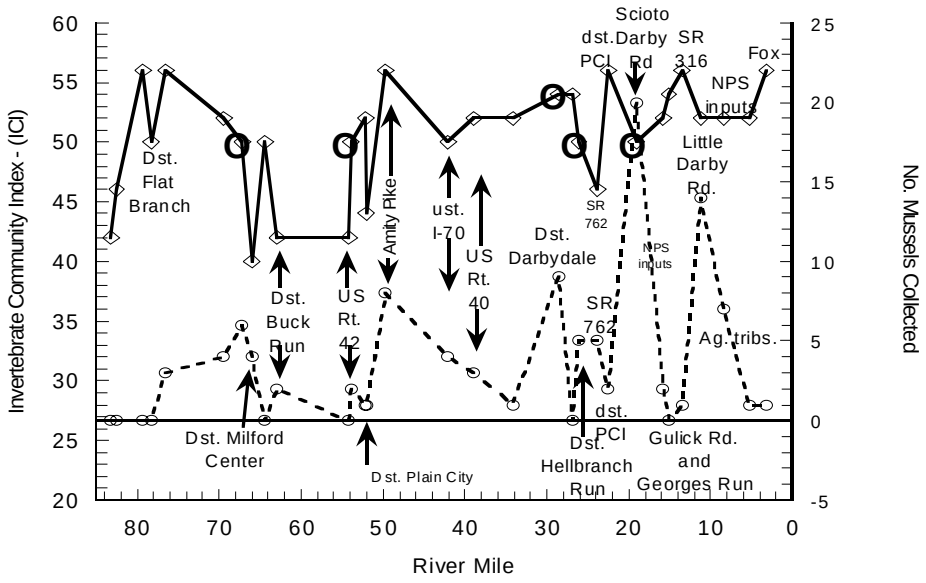
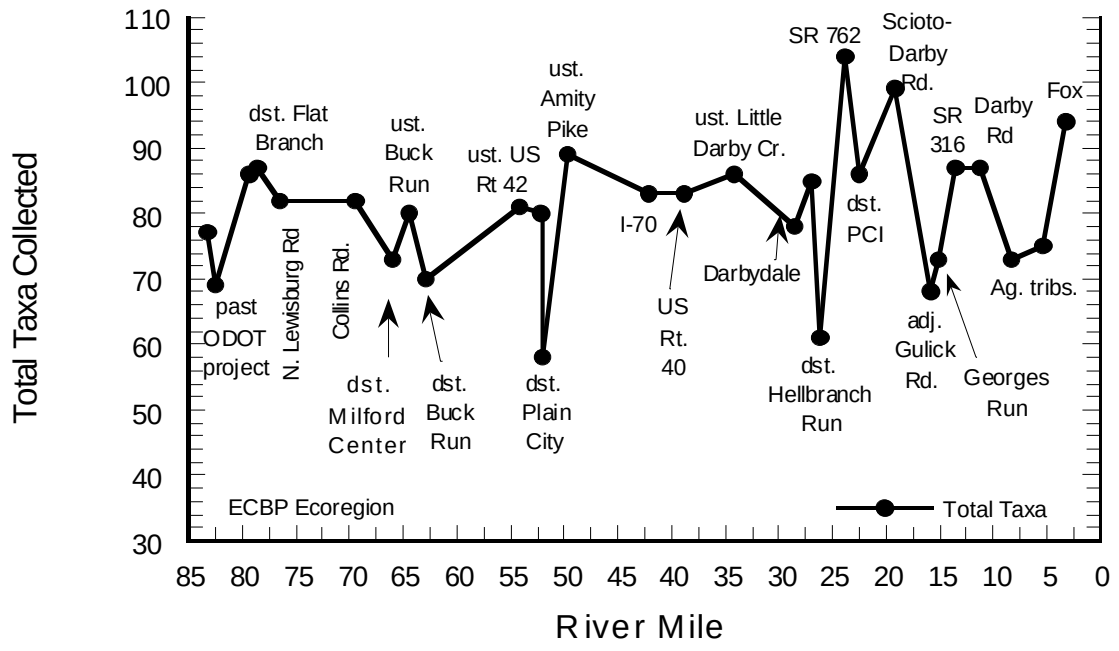


Figure B.7.9. Longitudinal trends in the Total macroinvertebrate taxa collected from sites on the mainstem of Big Darby Creek in 2001-2002.



This site yielded normal community abundance (shaded canopy at the site) and the highest number of sensitive taxa collected in the upper watershed including freshwater mussels (Figure B.7.8). Exceptional conditions were documented at the reference site at North Lewisburg Rd. (RM 76.6) with an ICI of 56. Relative density decreased as a result of the shaded canopy at the sampling site. This occurred despite NPS inputs that included extremely high TSS, nitrites, TKN, and TP with values at the 95th and 90th percentile vs. ecoregion background concentrations (Table B.3.2). Decreasing nutrient inputs and sedimentation through widened riparian areas upstream from North Lewisburg Rd. will result in even higher stream quality.

Exceptional community quality persisted, but declined slightly downstream to Milford Center, RM 67.2, as overall the number of sensitive taxa, total EPT, and total taxa decreased. But at RM 67.2, upstream from Milford Center, due to stable and favorable habitat six mussel taxa were collected. This was the highest number of mussel taxa collected in the upper BDC watershed from its headwaters to just upstream from Plain City. Habitat included vegetated side channels and pools with stable gravel bars. The substrates were loose, though in the rocky upstream pools some silt had accumulated and covered over the top surfaces of the rubble and boulders present. Stable banks anchored by trees that limited erosion and improved stream sinuosity had created favorable side pool habitat.

Recent agricultural and fertilizer spills and kills, and past sewage and storm water inputs from Milford Center impaired the macroinvertebrate community downstream from Milford Center, RM 66.0. The ICI dropped to 40 which did not meet the EWH criterion from an exceptional evaluation upstream from Milford Center at RM 67.2 and an ICI of 52 at RM 69.4. Silted and embedded substrates limited colonization. Only 15 total EPT taxa and 24 sensitive taxa were collected which was the lowest total collected on BDC mainstem. No baetid mayflies were collected. This could suggest short, sporadically toxic conditions emanating from inputs upstream, since flow was adequate. Macroinvertebrate community abundance increased 4- or 5-fold more than the upstream Milford Center site (i.e., to about 1100 organisms/ft^2) in response to increased NPS nutrient inputs. More tolerant filtering or scavenging organisms, like *Hydra* sp., *Physella* sp. and other tolerant snails, and flatworms (wtd. ICI = 26.8), increased to approx. one-fifth of the sampled population in response to these nutrient increases. The spike (*Elliptio dilatata*), plain pocketbook *(Lampsilis cardium*), and the cylindrical papershell (*Anodontoides ferassacianus*) mussels were collected upstream (RM 67.2), but not close downstream to Milford Center (RM 66.1). Mussel diversity decreased some downstream from Milford Center and stayed depressed until U.S. State Route 42 as a result of past spills and kills, silty conditions present and other NPS effects through much of the segment (i.e., nutrient enrichment and lower dissolved oxygen concentrations).

The community recovered to exceptional levels (i.e., ICI = 50) upstream from Streng Rd. and the confluence with Buck Run, RM 64.4. Though still silty in places, habitat quality improved with nice riffle / run / pool complexes with rubble substrates. The total EPT taxa increased from 15 downstream from Milford Center, RM 66.1, to 26 at RM 64.4 which was the highest total in the upper watershed.

Downstream from Buck Run and upstream from St. Rt. 38 at RM 62.9 the silt and nutrient load significantly decreased macroinvertebrate quality. The ICI score declined to 42 at the low end of the EWH range. Aquatic macrophytes, mainly water willow, predominated in areas adjacent to portions of the slow runs and wide pools in this reach of Big Darby Creek. This macrophyte production was partially in response to nutrient inputs from Buck Run [e.g., TKN (1.17 mg/l) and ammonia (0.107 mg/l) at the 95th and 90th percentiles, respectively vs. ECBP background concentrations] and other NPS inputs further upstream (nitrates concentration of 6.30 mg/l at RM 63.8). The riparian corridor was narrower, allowing more sunlight penetration which permitted increased instream production. Diel D.O. readings were below 6 mg/l (~ 5.7 - 5.9 mg/l) during continuous monitoring on 7/04/01 slightly downstream in this reach and at the mouth of Buck Run indicating the potential for D.O. to limit the Big Darby Creek macroinvertebrate community downstream from Buck Run. Substrates and surfaces were quite silty, and all of the factors listed above contributed to significant reductions of total EPT taxa, sensitive taxa, total taxa, and total abundance (Fig. 2-5). Because of silted conditions in the pools and slow runs, only the more silt-tolerant giant floater (*Pyganodon grandis*) and fatmucket (*Lampsilis radiata luteola*) mussels were collected in this reach downstream from Buck Run.

Downstream to U.S. Rt. 42 (RM 54.1) the ICI also scored 42 (very good), though the diversity in the macroinvertebrate community increased (sensitive taxa and total EPT taxa) (Fig. 2-5). Many mayflies and caddisflies were collected only during qualitative sampling because of the low numbers present. The QCTV value of 41.9 was one of the higher values on the BDC mainstem. There was some silt present and more embedded substrates due to accumulated sediment/silt load from upstream, but the riparian area adjacent Big Darby Creek through this reach was much wider allowing for good, stable stream development providing a variety of habitat.

Full recovery to exceptional macroinvertebrate quality was verified from downstream U.S. Rt. 42 (RM 53.9) to upstream from the Plain City WWTP (ICI = 52) and downstream Sweeney Run which drains municipal Plain City (RM 52.1).

The ICI downstream from the Plain City WWTP decreased to 44 which marginally met the EWH biocriterion, but community quality declined significantly (~ 30 percent) amid effluent inputs of excess organic solids, high fecal coliform bacteria exceedences, excessive nutrients (ambient NH_3, nitrates, nitrites, TKN, and TP concentrations > 95th percentile of ECBP background) and low diel D.O. concentrations. Violations of the EWH minimum and mean D.O. criterion (< 5.0 mg/l and 6.0 mg/l, respectively) were recorded downstream from Plain City WWTP. The lowest recorded D.O. readings for 20-22 August 2002 were 4.98, 4.12 and 3.81 mg/l, respectively. The mean D.O. concentrations that were EWH criterion violations were 5.85 mg/l on 8/21 (data range of 4.12-9.09 mg/l) and 4.36 mg/l on 8/22 (data range of 3.81-6.15 mg/l). As a consequence of these stressors, twenty-two fewer macroinvertebrate taxa were collected at RM 52.0 than at the upstream site, and only thirteen qualitative EPT taxa were collected. This was the lowest number of qualitative EPT taxa collected at any of the Big Darby Creek mainstem sample sites.

<u>Middle Big Darby Creek</u> - from Sugar Run to upstream from Little Darby Creek
Recovery to exceptional conditions occurred upstream of Amity Rd. (RM 49.7) with an ICI of 56. Total taxa collected almost doubled with 23 EPT taxa and eight mussel species present including the intolerant fluted shell (*Lasmigona costata*) and plain pocketbook *(Lampsilis cardium*). Qualitative macroinvertebrate sampling occurred on 9/14/01. A fair number of dead mussels were observed on 9/25/01 when electrofishing the same sampling location. A kill may have occurred in the interim or the empty shells may represent downstream movement of dead from a previous upstream kill (e.g., Milford Center). OEPA was notified by Franklin County Metroparks personnel describing a possible kill in this reach. Spills and occasional episodes of low dissolved oxygen have been documented from Plain City and the lower reaches of Sugar Run that would impact Big Darby Creek (i.e., RM 52 -49).

Exceptional Warmwater Habitat performance continued downstream from I-70 to upstream U.S. Rt. 40 at RM 38.9. Abundance decreased, as total load inputs were less through this reach. ICI scores dropped slightly from 56 at Amity Rd. (RM 49.7) to 52 downstream at RM 38.9. Total taxa and sensitive taxa decreased from the I-70 site (RM 42.1) to downstream from the Lake Darby Estates WWTP at U.S. Rt. 40 (RM 38.9), though 30 total EPT taxa were collected.

Mussel diversity decreased from eight near Amity Rd. (RM 49.7) to three at U.S. Rt. 40 (RM 38.9). Previous raw sewage inputs (i.e. from a former campground), poor WWTP performance, and other possible inputs (e.g., quarry discharges, spills and kills, hypolimnetic waters from impoundment, and sedimentation) have kept diversity lower than previously recorded.(Watters and Flaute Myers, 2003). Near U.S. Route 40 the mussel diversity is showing some recent improvements. Upstream from Little Darby Creek in the Franklin county Metropark Exceptional Warmwater Habitat performance was documented with increases in total EPT taxa (RM 34.2)

Big Darby Creek Lower Mainstem - downstream from Little Darby Creek to its mouth Exceptional habitat quality within the Franklin County Metropark property (mean QHEI = 93.5) supported Exceptional Warmwater Habitat biological performance (ICI = 52) from the upstream site (above the confluence) to downstream from the Little Darby Creek confluence and on to Darbydale. Macroinvertebrate sampling immediately downstream from Darbydale (RM 28.6) indicated exceptional conditions despite storm water, wastewater or nutrient-linked inputs with high fecal coliform bacteria concentrations. Nine mussel species, including six observed live species, were collected close to Darbydale (RM 28.6). Nutrient enrichment was evident downstream 1-2 miles from Darbydale and adjacent to Georgesville-Harrisburg Rd. (RM 26.9), as relative abundance increased threefold to about 1000/ft^2. The total EPT taxa collected downstream from Darbydale decreased over twenty percent. No live or fresh-dead mussels were collected/observed downstream in this nutrient-enriched sample site (only old shells) compared to the nine species found at the downstream edge of Darbydale (RM 28.6). A dissolved oxygen sag documented in this enriched segment was a major factor contributing to the decreased macroinvertebrate diversity. At RM 27.7, the mean diel D.O. concentration for August 1, 2001 was measured at 5.77 mg/l - a water quality violation of the EWH mean D.O. criterion of 6.0 mg/liter.

Exceptional habitat (QHEI = 94.5) downstream from Hellbranch Run (RM 26.1) ameliorated much of the effects of Hellbranch Run inputs. Stable habitat supported five mussel species in this reach, including the intolerant plain pocketbook (*Lampsilis cardium*) and wavy-rayed lampmussel (*Lampsilis fasciola*) - an Ohio Species of Concern (ODNR, 2002). Macroinvertebrate community performance did decrease slightly but was still evaluated as exceptional. These were areas of sediment accumulation.

Upstream from St. Rt. 762 and the PCI WWTP the macroinvertebrate community marginally met the EWH criterion with an ICI of 46 at RM 23.8. The exceptional macroinvertebrate community assemblage was quite diverse with a total of 103 taxa collected (2nd highest total in the survey). The lower exceptional score resulted from the relatively high percentage of the moderately intolerant *Elimia* river snails which comprised about 25 percent of the collected sample (i.e., over 1400 individuals) and unbalanced the community percentage metrics. Relative density was similar to the upstream sites at about 850 organisms/ft^2. There was more sediment, silt and sand present here than upstream from agricultural NPS inputs, but the broken bedrock slabs and scattered boulders mixed with smaller substrates and good flow created a variety of available macrohabitats. The undersides of slab bedrock pieces were protected from

some silt and sand accumulation. A very similar mussel community to upstream utilized these habitats, upstream from St. Rt. 762 at RM 23.8.

Downstream from the PCI WWTP at RM 22.5 the ICI increased to 56. The macroinvertebrate community was dominated by mayflies (*Isonychia*, baetids, *Stenonema pulchellum*, and *Tricorythodes sp*.), caddisflies (*Cheumatopsyche* and *Polycentropus sp*.), and Tanytarsini midges. Total EPT taxa increased to 33. Nutrient inputs from the PCI WWTP which were at median ECBP background concentrations increased macroinvertebrate density to about 1600/ft.^{2}, but it seemed to be good quality effluent based on the biology. Several unsewered areas and small package WWTPs are scheduled to tie into the PCI WWTP by 2005. These will include the Derby area, the Clark's Lake WWTP, and several local Mobile Home Parks. These actions will eliminate many localized problem areas in the lower watershed. This will, however, increase the importance of continuously operating the PCI WWTP to yield high quality effluent to protect endangered and sensitive biological communities downstream.

Continuous D.O. monitors downstream from the PCI WWTP indicated relatively small D.O. swings. Night D.O. concentrations stayed above 6.0 mg/l downstream to Scioto Darby Rd. (RM 18.9). There were, however, very low D.O. concentrations (i.e., < 1.0 mg/l) on 20-22 Aug. 2002 in the Clark's Lake Tributary (RM 20.2) with some higher concentration of nutrients (NH3 and nitrite at the 95th percentile and TKN and TP at the 90th percentile of ECBP background) and additional inputs from Foxlair MHP WWTP. Drought conditions in 2002 lead to interstitial flow in the Clark's Lake Tributary. This stream appears to be normally a losing stream with deep perennial pools found in its lower reach. Although stream flow is probably reaching Big Darby Creek through interstitial or ground water flow, high water events would probably flush inputs into Big Darby Creek and affect instream biota in Big Darby Creek downstream from its confluence at RM 20.2. Both the Clark's Lake WWTP and the Foxlair MHP WWTP will be diverted to PCI for wastewater treatment in 2003, eliminating these wastewater source inputs through this reach. This will definitely benefit the biological communities downstream in Big Darby Creek, possibly allowing for recovery of some sensitive or endangered organisms downstream from these tributaries.

Big Darby Creek fully lived up to its reputation for biodiversity at Scioto Darby Rd (RM 19.1). The 113 taxa collected was the highest total of any site in the 2001 survey area. Instream habitat at this location included an extensive island/bar complex with multiple side channels. Twenty mussel taxa were collected (including many intolerant species and one Ohio Species of Concern - the wavy-rayed lampmussel (*Lampsilis fasciola*). The federally endangered species once found infrequently in this reach, the northern riffleshell mussel *(Epioblasma torolusa rangiana*) was not collected here during this survey. Downstream from the Scioto Darby bridge at RMs 18.45 and 18.1 the night time D.O. concentrations dropped to about 5.5 to 5.6 mg/l for extended periods on 10-11 July 2002. The mean daily D.O. concentrations stayed just above the required minimum (of 6.0 mg/l) at 6.03 and 6.01 mg/l during this continuous monitoring in July 2002. Decreased inputs of nutrients from eliminated unsewered inputs, reduced agricultural NPS inputs and reduced organic enrichment from WWTPs diverted to the PCI

WWTP should result in improved instream conditions in this reach upstream and downstream from Scioto Darby Rd.

Potential sources of nutrient inputs to Big Darby Creek near Gulick Rd. (RM 15.8) include: agricultural NPS inputs; Greenbrier Creek at RM 16.75 (TSS, nitrates and TP at 75th percentile vs. ECBP ecoregion), and from small tributaries to Big Darby Creek (RM 18.41, RM 18.18, & RM 15.85). Relative abundance increased 600 percent to 2000 organisms/ft.^{2} from the upstream site at Scioto Darby Road. Filter feeding macroinvertebrates were the predominant taxa (i.e., hydropsychid caddisflies and *Rheotanytarsus* and *Polypedilum* midges) and nutrient enriched conditions were evident. Algal strands and dense plant/algal mats covered the rocky substrates. Dissolved oxygen ranging from <6 mg/l. at night to 12 mg/l in the afternoon was recorded with continuous D.O. monitors on 10-12 September 2002 at RM 15.7.

Through these lower reaches the riparian width varied with property owner. Nutrient inputs occurred directly from agricultural fields or through delivery via small tributaries to Big Darby Creek. A levee impinged on river right at RM 15.8, Gulick Rd.. There was no canopy cover and a large gravel bar and side channel. There was no surface flow, just interstitial flow in the side pool during the summer of 2002. Erosion was evident against the levee on the right and the opposite bank behind the bar at high flows. Embedded conditions were present. All of these factors decreased diversity substantially from 113 total taxa upstream to 68 total taxa in the reach at RM 15.8. Mussel taxa counts decreased to two observed taxa, although a lot of old shells were present. Changes in stable mussel habitat areas (flow increases and erosion of unstable banks) and low dissolved oxygen from excess plant respiration/decay have contributed to this decline. Low exceptional scores still met the criterion (ICI = 52).

Similar conditions were present downstream from Georges Run at RM 15.1. Another unnamed tributary to Big Darby Creek discharged at RM 15.50. Much of this reach was leveed with riprap placed along the denuded shaped banks. Other areas had narrowed riparian widths with more open canopy adjacent to the Big Darby Creek mainstem. More silt was present in the slow runs and pools and had accumulated on the substrates. Macroinvertebrate community abundance was still high (~ 2000 organisms/ ft.^{2}), though there were less caddisflies and more Tanytarsini midges. Large amounts of fixed and suspended algae carpeted the margins and portions of the runs. Dissolved oxygen had even larger swings from 12.5 mg/l in the afternoon to 5.5 mg/l at night. Eroding leveed areas with little stream margin habitat and embedded conditions continued to limit the mussel population through these reaches.

The reach downstream to St. Rt. 316, Darbyville, generally had more slow run / pool habitat where larger substrates were covered with unstable spongy gravel/sand deposits and also covered with silt and muck in pools and some margins. Where there was stronger flow a more diverse community was present. The range in diel D.O. concentrations was still wide, though slightly less, varying from about 11 mg/l to 5.3 mg/l dissolved oxygen. Relative community abundance decreased to about 1200 organisms/ft.^{2} with most areas generally having a little more intact riparian corridor (and likely less NPS nutrient inputs). The percentage of mayflies in the community and the total taxa increased, and subsequently the ICI increased to 56.

At RM 11.2 (lane off Darby Rd.), stable habitat adjacent to portions of the stream with areas of wider riparian corridors offset any nutrient enriching inputs from upstream (Darbyville and downstream, including Lizard Run during high flow events). Riffle and run substrates were a little spongy in this segment as some silt and sand was mixed within the gravel/small cobble substrates. Side gravel bars with water willow and side channels and other side pools protected by downed trees or protruding banks (with trees holding the banks) were present yielding more diverse instream habitat. The macroinvertebrate community was predominated by filtering hydropsychid caddisflies, baetid and *Isonychia* mayflies. The 33 total EPT taxa collected here tied for the highest number of EPT taxa collected in the Big Darby Creek mainstem survey. This also was the location of largest live population of mussels observed largely due to more optimum mussel habitat here. Species observed included the intolerant Fluted shell (*Lasmigona costata*), buckhorn (*Tritogonia verrucosa*), deertoe (*Truncilla truncata*), plain pocketbook (*Lampsilis cardium*), and an Ohio species of concern, the wavy-rayed lampmussel (*Lampsilis fasciola*). There was also a live washboard mussel (*Megalonais nervosa*), an Ohio endangered species, observed and tentatively identified. Dissolved oxygen fluctuations were less variable ranging between < 10 mg/l and about 5.7 mg/l. Diversity did not appear to have been negatively impacted by this dissolved oxygen regime. Steps need to be taken to ensure that the dissolved oxygen minimums do not decline any further. One strategy to protect the diversity of this reach of Big Darby Creek is to protect or enhance the riparian buffer upstream which would tend to limit sediment loss from farm fields, reduce nutrient inputs and minimize the loss of habitat from bank erosion.

At RM 8.4 just downstream from a small agricultural tributary (RM 8.5) a similar macroinvertebrate community (i.e., ~ 1700 organisms/ft.^{2} and ICI = 52) was present with similar nutrient enrichment. Total taxa declined modestly. Seven bivalve taxa were observed here. However, most were found near the opposite bank out of the area of influence of the tributary inputs. Tributary nutrient inputs could be decreased to further improve community quality and decrease nutrient enrichment and low nighttime dissolved oxygen concentrations.

Further downstream narrow or nonexistent riparian corridors combined with high flows result in erosion to unstable banks and/or bedload movement which destabilizes habitat and substrates. These unstable conditions decreased mussel habitat further. Diel dissolved oxygen swings increased modestly downstream from RM 8.5 and RM 5.4 with the minimum D.O.s slightly lower (i.e., ~ 5.5 mg/l). Dissolved oxygen in deeper pools may be at risk through these lower reaches of Big Darby Creek (RMS ~ 8.5 to 5). The ICI score at RM 5.4 downstream from the agricultural tributary at RM 5.86 was also a 52. The decline in macroinvertebrate density (i.e., to about 1000 organisms/ft.^{2}) suggests some decline in nutrient enrichment.

Diversity increased to 33 total EPT taxa and 94 total taxa at St. Rt. 104 (RM 3.2). The ICI also increased to 56 as a result of the exceptional riffle habitat (i.e., boulder/cobble with smaller sand substrates and fast flow). Some erosion of the banks were evident particularly at outside bends. Riparian density and width needs to be increased to protect against bank erosion and decrease diel D.O. swings (> 17 mg/l to 7 mg/l recorded 20-22 Aug. 2002) during summer conditions. Side pools or glides contained more silt and sediment than in past with some areas being quite

soft and unconsolidated. Sedimentation and/or erosion during high flows is a concern in the lower reaches of Big Darby Creek where riparian areas were too narrow or of inadequate density. Unstable habitat will continue to limit mussel populations in the lower portion of Big Darby Creek mainstem until storm water flows are controlled.

Big Darby Creek Upper Tributaries - Flat Branch to Sweeney Run

Flat Branch (02-223) (RM 78.48) (MWH)

Flat Branch was a channelized stream with excess nutrients (i.e., TP, TKN, nitrite and NH_3) and sediment / suspended solids (TSS) present. Upstream (RM 3.2 - good quality) there was some recovery of instream development with some small, rocky riffles present resulting from slumpage. However, agricultural fields along river left allowed sedimentation, nutrient runoff and excess algal production as a result of the open canopy. This was confirmed by high instream temp. (28.1^{o} C), highly elevated E. coli (42,000 colonies/100 ml.) and fecal coliform (22,000 colonies/100 ml.) counts found. Lots of baetid mayflies and hydropsychid caddisflies were present in the small refuge riffles (including the intolerant *Acerpenna pygmaeus* mayfly) and good numbers of burrowing mayflies in the clay bottom which predominated the shallow pools or glides.

The water in Flat Branch at RM 2.2 was a whitish-green color. This site was downstream from an unnamed tributary draining large portions of Honda. The channel was still deeply incised, but some small willows and other small trees were growing along the banks. However, the stream margin was primarily vegetated with grass. The stream channel has some root mats, and limited hard substrates on the stream bottom. Small rocky substrates were embedded in the top of the clay bottom substrates. Some banks had slumped which increased the erosional bed load. The EPT taxa total and the tanytarsini midge population decreased at this site to a marginally good condition, but which still met the MWH biocriterion. An acutely toxic concentration of copper (81 ug/l) was documented here, and instream bacterial counts were elevated.

Habitat in Flat Branch upstream from the old SR 33 bridge possessed similar riparian habitat to other upstream portions of the subwatershed with an open canopy and a largely brushy/weed riparian corridor. The upland habitat quality adjacent to Flat Branch at the downstream site (RM 1.0) improved with the riparian corridor widening to 40-50 feet of mature trees. The instream habitat features still reflected modified conditions and less than optimal substrates (i.e., gravels and fine silt/clays with scattered embedded rubble with some woody debris present). The ICI at RM 1.0 scored a 50 and indicated exceptional quality based on the organisms collected from the artificial substrate colonizer sample. EPT taxa richness increased significantly from the six collected upstream to the sixteen recorded at this site. Nutrient concentrations and bacteria counts were still elevated at the mouth of Flat Branch and consequently increased loadings to Big Darby Creek. However, contributions could have been higher. Diel dissolved oxygen measured in 2002 and macroinvertebrate density (440/ $ft.^2$) measured at RM 1.0 were more moderate due to shading and other factors resulting from the wooded corridor. Low dissolved oxygen measurements in Big Darby Creek downstream from

the confluence with Flat Branch were partially the result of Flat Branch nutrients, algae and TSS inputs.

Unnamed Tributary to Flat Branch (02-365) (RM 1.50) (Undesignated/MWH)
This unnamed tributary to Flat Branch consisted of a short channelized watercourse that drained the reservoir adjacent to the TRE automotive testing facility. Slow flow coupled with substrates of fine clays, silt and rotted detritus yielded very turbid conditions. The shoreline was largely unprotected except for weeds and grass with some slumped or cracked falling banks. Elevated nutrients (i.e., TSS, nitrite, TKN, and TP at 75th - 90th percentile vs. ECBP background) and an open canopy resulted in excess primary production. Numerous waterfowl, particularly Canada geese, inhabited the channel and shore line of this tributary and the reservoir upstream contributing to the nutrient enrichment problem. Algal mats, aquatic vegetation, and suspended algae were very common. Small runs, riffles and some rocky substrates were found towards the mouth of this tributary, though there was a large accumulation of silt and clays on the rocky substrates limiting colonization and being delivered to Flat Branch. The giant floater (*Pyganodon grandis*), a bivalve compatible with silty and slow pooled conditions, was present in large numbers. The macroinvertebrate community here, with few EPT taxa collected and generally a tolerant community, was fair quality but still attained the MWH biocriterion ($\geq$22).

Little Darby Creek (02-251) (RM 78.34) (Logan Co.) (Undesignated/EWH Recommended)
Little Darby Creek in it's headwaters was a high quality stream (ICI = 54 and 50). Both sites have been used as ecoregional reference sites as a result of their relatively undisturbed condition and high water resource quality. Total taxa collected at the RM 3.5 and 0.4 sites was 72 and 83, respectively, which included several intolerant mayflies and caddisflies. Little Darby Creek could be characterized as having clear water with good riffle/run/pool development and predominantly rubble substrates with smaller substrates in its pools. Some woody debris was present in the stream channel with fairly good habitat along it's margins including undercut banks. Even in this small subbasin, some NPS nutrients and *E. coli* were elevated (i.e., TSS, nitrite, TKN, and TP sometimes were at > 90th percentile). Additionally one grab water sample had a toxic copper concentration of 46 ug/l. While these elevated nutrient concentrations may have increased loadings to the mainstem of Big Darby Creek the relatively higher instream dissolved oxygen concentrations and lower water temperatures in Little Darby Creek probably improved water quality in Big Darby Creek when compared to inputs from Flat Branch. Some channelization occurred after sampling in 2002 which will adversely impact water resource quality in the future.

Unnamed Tributary to Big Darby Creek (02-361) (RM 74.91) (Undesignated/EWH Recommended)
There was a very good macroinvertebrate community present in this unnamed tributary to Big Darby Creek though there was evidence of some unstable habitat. Along one side the banks were eroding and collapsing where the riparian corridor was too narrow and destabilized during high flow. Siltation was a problem. The stream was observed to run dark brown after a morning

rainfall. Instream evidence of this problem included partial embeddedness in the riffles and runs with silt deposition in pools. Nutrient, bacteria, and silt inputs (nitrates and TP at >90th percentile and TSS at >75th percentile vs. ECBP background) could be reduced to this tributary and to Big Darby Creek if the riparian corridor was widened and the tile delivery slowed or decreased. One possibility would be to change the delivery to the riparian corridor instead of direct delivery to the stream channel.

Spain Creek (02-222) (RM 72.01) (WWH/WWH+CWH Recommended Hdwtrs to RM 5.0) (WWH/EWH+CWH Recommended RM 5.0 to mouth)
Spain Creek marginally met the WWH biocriterion downstream from Mingo - North Lewisburg Rd. (RM 5.7) with a marginally good quality community. Unrestricted cattle access upstream and past channelization allowed increased nutrient, waste, bacteria, sand, and silt inputs to upper Spain Creek (i.e., nitrite at 90th percentile and TSS at **205 mg/l** was at >95th percentile vs. ECBP background). These sources adversely affected the macroinvertebrate community as evidenced by the predominance of tolerant limpet snails, planorbid and *Physella* snails, besides common Hydropsychid caddisflies. There were also four different leech species collected. The stream channel was characterized as a "U-shaped" channel with sandy riffles from slumped banks with some rubble perched on top which was very unstable and of variable quality.

Downstream near Gilbert Rd. (RM 3.4) the habitat stabilized with solid, small rubble and coarse gravel riffles present. Eighteen total EPT and 72 total taxa were collected with a large increase of sensitive or cool water taxa (38 here compared to eleven upstream, including the mayfly *Diphetor hageni* (I) , the stonefly *Stenonema vicarium* (MI), caddisflies *Chimarra aterrima* (MI) and *Ceratopsyche slossonae* (CW/MI), and the cool water midge Polypedilum aviceps (MI)). The EWH biocriterion proposed for the remainder of Spain Creek was marginally met with an ICI of 44 (nonsignificant departure from the criterion of 46). Hydropsychid caddisflies were not on the colonizers due to slow current velocity at the end of the colonization period, even though they were one of the predominant organisms on the natural stream substrates. Several hydropsychid metrics should, in normal flow, have scored higher and indicated the potential for an even higher ICI score. High TSS from non-point sources upstream and local construction inputs, elevated *E. coli* counts, and an elevated ammonia concentration (0.208 mg/l at >95th percentile vs. ECBP background) indicated sporadic stress to the macroinvertebrate community.

Macroinvertebrate quality near the mouth of Spain Creek, downstream from the North Lewisburg WWTP, was still exceptional (i.e., ICI = 56) and greatly exceeded the EWH biocriterion. There was a more balanced macroinvertebrate community with many sensitive organisms present (including the intolerant mayflies *Acerpenna pygmaeus* and *Diphetor hageni*, the sensitive midges *Tvetenia bavarica gr.*, *Corynoneura spp*. and *Thienemanniella lobapodema*, and the fatmucket (*Lampsilis radiata luteola*) and the squawfoot (now named the creeper - Strophitus undulatus undulatus) mussels (MI). Some nutrient inputs increased downstream from the effluent, as TP, nitrite, and NH_3 concentrations sometimes exceeded the 90th -95th percentile of ECBP background concentration. Bacterial concentrations were still elevated. Shading from the tree canopy prevented negative effects from excess nutrient

enrichment. The overall water quality inputs from Spain Creek positively influenced Big Darby Creek water quality, as full attainment in Big Darby Creek occurred downstream from the Spain Creek confluence near Collins Road (RM 69.4).

Pleasant Run (02-221) (RM 72.01) (EWH)

Pleasant Run at Dunn Rd. (RM 4.1) was a previously channelized stream with wide, shallow, slow runs connected by gravel/sand riffles. It was obviously ground water influenced with cool water temperatures. Some marl encrustations had covered the larger substrates present. Water quality appeared very good with fifteen EPT taxa present, though there seemed to have been some algal die off based on the predominance of the tolerant *Physella* snails along with sensitive, cased caddisflies *Helicopsyche borealis* and *Neophylax sp.*. The riparian corridor was narrow, but intact amidst agricultural fields. Elevated bacterial concentrations were evident here. One live unionid mussel was observed but not identified.

Near the mouth and upstream from Middleburg-Plain City Rd. (RM 0.5), the macroinvertebrate sample at this ecoregion reference site indicated exceptional water quality with an ICI of 56. The total EPT taxa almost doubled to 27 and a very diverse community (86 total taxa) was present including midges which were under-represented upstream. Fresh shells of the sensitive Wabash pigtoe (*Fusconaia flava*), fatmucket (*Lampsilis radiata luteola*), and slippershell mussel (*Alasmidonta viridis* whose hosts include sculpins and johnny darters) were collected. There were rubble substrates consistently in lotic areas and lots of woody debris instream with wide riparian areas (30' to > 100') of larger trees shading most of the stream channel. Consequently most nutrient concentrations were below the median ECBP background concentrations, and bacteria counts had decreased slightly from upstream values. Pleasant Run was judged to significantly contribute to the exceptional conditions found downstream from its confluence (RM 72.01) in Big Darby Creek.

Unnamed Tributary to Big Darby Creek (02-360) (RM 69.4) (Undesignated/WWH Recommended)

This unnamed tributary to Big Darby Creek met the recommended WWH biocriterion. A good macroinvertebrate community was present in this stream. The sensitive, cased caddisfly Neophylax sp. and the river snail, Elimia sp., predominated, but this community lacked diversity and had a much higher percentage of tolerant organisms such as planorbid snails, leeches, and flatworms. A few elevated bacterial counts were also recorded. This groundwater-fed stream (temp. = 62° F) has been channelized and, therefore, has more silt in the streambed. The wooded riparian corridor was patchy in distribution with the balance a grass filter strip. The narrow woods remaining, though incomplete, did help shade, keep water temperatures lower and limited excess algal productivity to the small open canopy areas. Nutrient inputs (nitrate, nitrite, TKN, and TP at >75th to >95th percentile vs. ECBP background conditions) from adjacent agricultural areas were elevated, including TSS (lesser degree), and contributed to algal production and some silt accumulation in Big Darby Creek downstream from its confluence.

Hay Run (02-220) (RM 67.6) (WWH/EWH Recommended)
Hay Run was a small, unshaded, modified stream in its upper reaches, but the sample site near the mouth (RM 0.2) exhibited a very good macroinvertebrate community and marginally met the EWH biocriterion. This groundwater-fed stream (temp. = 13.1° C or 56° F at the time of sampling) contained rocky substrates with decent base flows. All of the predominant and common organisms in the riffle and pool habitats were sensitive taxa (including the cased caddisflies *Neophylax sp.* (I) and *Helicopsyche borealis* (MI) and the moderately intolerant mayfly *Isonychia sp.*). Where there was some unshaded stream channel (usually closed canopy) a significant amount of algal and periphyton growth was present. Macroinvertebrate densities were moderate to high and also indicated nutrient enrichment (nitrate and nitrite concentrations ranged from > 75th percentile to > 95th percentile vs. ECBP background). *E. coli* concentrations were similarly elevated. Hay Run inputs into Big Darby Creek contributed to the enrichment found upstream from Milford Center. Decreased NPS nutrient inputs into Hay Run via wider riparian corridor (and hopefully more filtered runoff) would improve community quality here and downstream in Big Darby Creek below Hay Run.

Buck Run (02-209) (RM 63.74) (WWH)
The Buck Run headwaters (5 mi.^{2}) sampled at Allen Center-Pottersburg Rd. (RM 10.4) was mostly a pooled reach with soft clay bottoms that was turbid brown (high TSS at 75th to >95th percentile vs. ECBP background). There were also short reaches of constricted slow runs with woody debris and small sand/rubble riffles. The canopy was mostly open (75 percent) with one bank short grass and the other bank small trees. The moderately intolerant burrowing mayfly, *Hexagenia limbata*, was predominant in the macroinvertebrate community in the pools. Six EPT taxa were collected and this upper reach was evaluated as marginally good meeting the WWH biocriterion.

Lotic habitat improved near St. Rt. 245 (RM 7.8) with increased rocky substrates and a stable riffle present. Some substrates were embedded with silt deposition noticed in the pools and on rocks along the stream margin. Caenis mayflies were predominant in the run, and hydropsychid caddisflies, isopods, riffle beetles, and baetid mayflies were the common organisms collected in the riffle. The midges collected in the pools were mainly the tolerant midges *Chironomus decorus* and *Dicrotendipes simpsoni*, but sensitive midges were present in the run and riffle (the moderately intolerant *Corynoneura n. sp. 1*, *Microtendipes pedellus gr.*, and *Tanytarsus sp.*). This segment with improved habitat yielded a marginally good macroinvertebrate community (nine EPT taxa), but there were some indications of stress. A violation of the WWH Dissolved Oxygen minimum WQS (3.69 mg/l) was recorded here. Ammonia and nitrite (>95th percentile vs. ECBP background) were at potentially chronically toxic concentrations, and TSS and other nutrient parameters were also very elevated at times (> 90th percentile vs. ECBP background).

Near Milford - Amrine Rd. (RM 5.0) Buck Run was a wide, modified slow run/pool with unstable, steep, incised, collapsing banks (of grass/weeds) where slumpage had created a slow run. Rocky cobble and rubble were common stream substrates with adjacent pockets of silt, sand, and/or detritus. This reach was a sediment sink. Heavy silt and silty algae had accumulated $\geq$ 1 inch deep on the parent substrates. A dissolved oxygen concentration of 3.52

mg/l was documented here. EPT taxa collected at RM 5.0 were comparable those collected at RM 7.8 with increased populations of Tanytarsini midges and the rare midge *Paratendipes sp. 1*. However, the lower quality habitat limited the community quality (only 9 of the 48 taxa were sensitive organisms). The community sampled at this site was characterized as marginally good. Riparian restoration and bank stabilization would greatly increase habitat quality by reducing erosion, siltation, algal production, and allowing for improved stream riffle/run/pool development.

Near its mouth Buck Run (RM 0.6) was still a fairly sluggish stream with extensive and fairly deep pools. The giant floater mussel, *Pyganodon grandis*, which favors this type of habitat was collected here. Despite good habitat there were not many mayflies, and the total EPT taxa decreased from upstream. Riffle beetles, flatworms, and fingernail clams were predominant in the various habitats. The macroinvertebrate community was evaluated as marginally good. Excess nutrients, *E. coli* (still elevated but not to the levels of upstream sites) and TSS were still present, despite uptake and filtering by the extensive beds of aquatic macrophytes. and contributed to increased loadings in Big Darby Creek. The ICI in Big Darby Creek decreased significantly from the 50 found upstream to 42^{ns} at RM 62.9 which only marginally met the EWH biocriterion. Overall, riparian habitat improvements, livestock setbacks and exclusion, and widening of the greenbelt corridor surrounding Buck Run would improve the biological community and decrease silt, nutrient, and TSS inputs downstream into Big Darby Creek.

Robinson Run (02-207) (RM 53.69) (WWH)

Robinson Run near Hawn Rd. at RM 5.5 (4.6 $mi.^2$ drainage) was of very poor quality with low EPT totals and low total taxa. This channelized, open canopy, ditched stream was enriched with lots of algae and periphyton on rocks along the margin and near the surface. Substrate size ranged from boulders in the runs and pools to silt from slumped banks that accumulated in depositional areas with rubble and coarse gravel predominant overall. No midges were collected and the only mayfly taxa collected was the moderately tolerant (MT) *Callibaetis sp.*. Almost all of the cranefly pupae and all of the hydroptilid caddisfly cases collected in the riffle had hatched and were empty. Decayed, blackish anaerobic scum on the rock surfaces indicated low dissolved oxygen conditions had undoubtedly limited the macroinvertebrate community quality. Pools were almost devoid of life except for tolerant lunged pond snails *Physella sp.* and scuds at low densities. Low dissolved oxygen was the likely culprit for this community suppression. Riparian growth would be a good first step to help the stream water quality of Robinson Run in this upper reach.

Fair water quality conditions existed near St. Rt. 736 (RM 2.1). There were high numbers of moderately intolerant hydrobiid snails present probably from nutrient enrichment and variable dissolved oxygen concentration with other organisms limited (only two EPT taxa collected and at least one-third of the community tolerant organisms). Pooled areas had substrates that revealed anaerobic black stains on their sides and bottoms. These substrates yielded very few organisms. Low diel dissolved oxygen concentrations were likely based on the lack of common community organisms in expected habitats. No mayflies nor pupated or larval hydropsychid caddisflies were collected on rocks in the narrow shallow runs which had had more flow earlier.

Agricultural NPS run-off was still a significant stressor, as well as the discharge from the small WWTP upstream (i.e., Darby Meadows WWTP at RM 5.23). Ammonia, nitrate, nitrite, and TKN were elevated with some concentrations exceeding the > 90th and/or > 95th percentile versus ECBP background conditions. Despite the point source and NPS inputs better riparian conditions with increased shading and slightly lower temperatures allowed the macroinvertebrate community quality to improve slightly to fair conditions compared to very poor upstream.

The downstream site on Robinson Run at U.S. Rt. 42 (RM 0.8) was still nutrient enriched. Macroinvertebrate community composition had improved with moderate to high community density. Habitat quality had also improved with good development within a largely intact wooded riparian corridor. There were > 70 cm. deep pools with undercut banks held by trees with submerged roots. Rocky substrates were common with some silt deposition also. Some embeddedness with silt and/or sand in riffles and runs were a symptom of TSS bedload (> 90percentile vs. ECBP background) and storm water flashiness primarily from upstream agricultural areas and possibly some urban storm runoff. Bacterial concentrations were elevated here and upstream. High densities of *Elimia* snails (MI) were noted here and predominated in all habitats. Fingernail clams and hydroptilid (pursed) caddisflies were also prominent in the riffle and run, respectively. Eight EPT taxa were collected, including the moderately intolerant *Chimarra obscura* and *Pycnopsyche* caddisflies and indicated better conditions. However, facultative flatworms, craneflies, scuds, and alderflies were common in the riffle and run habitats indicating variable conditions. This site was marginally good meeting minimum WWH expectations. Decreasing the NPS inputs would stabilize and improve macroinvertebrate community quality, decrease nutrient enrichment, and decrease nutrient and sediment loadings into the pooled reach of Big Darby Creek upstream from Plain City where biological scores had decreased slightly. The TSS (partially from siltation), total phosphorus, and nitrogenous compounds currently were mostly >75th percentile to >90th percentile vs. ECBP background range.

<u>Sweeney Run</u> (02-357) (RM 52.11) (Undesignated/WWH Recommended)
Sweeney Run was affected by agricultural runoff, storm water runoff and other inputs from Plain City (i.e., nitrates, nitrites and TSS were very elevated as well as fecal coliform counts > 12,500 counts/100 ml. and E. coli at 7,000 counts/100 ml). Both tolerant and sensitive organisms (*Neophylax* sp. (I) and (MI) *Helicopsyche borealis*) were collected at RM 0.2. The macroinvertebrate community was judged to be fair based on the low number of EPT taxa collected (4) and that the majority of the prominent organisms were tolerant. Sanitary sewer work in 1998 to decrease leakage to storm sewers decreased some sewage inputs to Sweeney Run. Work on the storm sewers in 1997 in a portion of Plain City, which now discharges to Big Darby Creek in Mc Kitrick Park, also decreased some NPS inputs to Sweeny Run. Additional samples in Sweeney Run (chemical and biological) are warranted to determine water quality upstream from Plain City and help locate elevated fecal coliform and/or *E. coli* sources to determine whether agricultural NPS inputs from upstream of Plain City or municipal/county related (e.g., sewage from on-lot septic systems with storm water connections), storm water runoff (i.e., possibly runoff from manure at fair), spills, and/or other sources were the cause of

the problem). An additional source of stress to Sweeney Run is the mosquito fogging program which occurs annually in Plain City and which could periodically be affecting the macroinvertebrate communities.

Big Darby Creek Middle Tributaries - Sugar Run to upstream from Little Darby Creek

Sugar Run (02-206) (RM 50.92) (WWH/MWH Recommended)

The channelized upper reaches of Sugar Run, are currently designated WWH. Local habitat quality and biological sampling results resulted in a recommendation for this segment to be re-designated as MWH. The fair macroinvertebrate community documented at RM 7.7 met the MWH biocriterion (i.e., $\geq$ 22). Very slow current flow contained within grass-covered and slumping banks characterized this stream reach. Murky green water with lots of algae were evidence of the nutrient enriched condition of the waters. High TSS, TKN, nitrates, and TP were measured at $\geq 90^{th}$ percentile and/or $\geq 95^{th}$ percentile of ECBP ecoregion background concentrations. Depressed nighttime dissolved oxygen concentrations resulting from algal respiration from agricultural NPS runoff, and golf course runoff likely has also hindered community quality.

Somewhat improved water quality conditions were found downstream at Taylor Rd. (RM 6.9) with ten qualitative EPT taxa collected (including the intolerant mayfly *Leucrocuta sp.* and the moderately intolerant mayflies of the genera *Centroptilum* and *Procloeon*). In contrast only four EPT taxa were found upstream. Also, the number of taxa collected at RM 6.9 more than doubled to 46 despite it being only a marginally good quality community. The canopy was open with the riparian zone consisting of a 50 ft wide strip of grass and weeds along both banks. The primary land use in the area was row crop agriculture. Siltation and runoff from adjacent land has colored the water column brown and turbid. Low dissolved oxygen concentrations were documented periodically with lows reaching 2.88 mg/l at RM 7.0. A violation of minimum the MWH D.O. criterion occurs when concentrations are $\leq$ 3.0 mg/l. Nutrient NPS inputs were similar or higher compared to upstream with increased NH_3 and nitrate concentrations. Despite these adverse factors, live paper pondshell mussels (*Utterbackia embecillus*) were observed within this reach. Increased woody riparian growth would improve quality by shading the stream thus decreasing stream temperatures, decreasing algal production, increasing water and nutrient absorption, decreasing silt delivery, and stabilize the stream banks.

Better habitat was found at RM 5.5. This sampling site was in the WWH designated reach. The 60 ft. wide woody riparian buffer upstream from U.S. Rt. 42 fostered more natural conditions and yielded good community quality. Hydropsychid caddisflies in the riffle and baetid mayflies in the slow run were predominant due to better habitat along with corixids and beetles. Overall community quality increased slightly. However, low flows, elevated nutrients, bacterial inputs, and embedded substrate conditions were likely the limiting factors to even greater community quality improvements.

Near the mouth of Sugar Run habitat quality improved. Many more sensitive mayflies, caddisflies, and midges were collected (like the mayfly *Nixe sp.* with weighted ICI = 47.2 and

the midge *Rheotanytarsus pellucidus* with a weighted ICI of 46.3) near Cemetery Pike at RM 0.5. Sixteen total EPT taxa, including an intolerant stonefly from the *Neoperla clymene complex*, resulted in an aggregate of 52 total taxa. The very good community present here was directly related to increased habitat quality, reduced silt, lowered nutrients concentrations, and more consistent dissolved oxygen concentrations. Sugar Run water quality inputs into Big Darby Creek do add some NPS loadings in the form of excess nutrients and sediment to the BDC mainstem. Sugar Run nutrient inputs (TSS, nitrates, nitrites, TKN and TP) measured from the 75th to the 95th percentile compared to ECBP background concentrations and were higher than upstream inputs from Robinson Run into Big Darby Creek upstream from Plain City. A measured total phosphorus concentration of 0.58 mg/l at RM 0.5 represented an especially high NPS concentration. However, nutrient concentrations discharged from Sugar Run into Big Darby Creek were much lower than nutrient concentrations measured downstream from the Plain City WWTP discharge. Big Darby Creek ICI scores did show recovery downstream from the confluence with Sugar Run at Amity Pike in comparison to ICI scores closer to the Plain City WWTP. Any decrease in nutrients and sediment discharged from Sugar Run associated with habitat improvements in the upper watershed would greatly improve Big Darby Creek water quality and protect vital biological communities downstream from Plain City.

Unnamed Tributary to Sugar Run (02-358) (RM 7.39) (Undesignated/MWH Recommended)

This tributary was a channelized, shallow and mostly pooled stream with very low flow and slow current due to its gradient and modified channel. The banks were mostly grass or lined with rip rap. Some areas had slumped banks. Modified Warmwater Habitat is the recommended aquatic life use for this currently undesignated stream. The macroinvertebrate community was of marginally good quality with nine EPT taxa collected. Three sensitive mayfly taxa and one midge taxa were collected. Despite poor riffle quality, hydropsychid caddisflies along with freshwater shrimp and also intolerant *Physella* snails were predominant in the riffle/run area. Delivery of excess nutrients to this tributary as a result of the limited riparian corridor and adjacent agricultural fields has led to excess nutrients and mats of algae being exported to Sugar Run.

Worthington Ditch (02-356) (RM 50.62) (Undesignated/WWH Recommended)

Worthington Ditch was sampled at RM 0.2, downstream from Plain City - Georgesville Rd./ St. Rt. 142 contained a marginally good community in its lower reaches. Large concentrations of algae in the pools and high populations of Tanytarsini midges and blackflies in the riffles indicated nutrient enriched conditions instream. Nutrient concentrations mostly exceeded the > 75th percentile but nitrate concentrations also exceeded the 95th percentile ECBP background concentrations. Nine EPT taxa were collected, including some sensitive organisms. Moderately intolerant (MI) caddisflies (e.g., *Chimarra aterrima*), the intolerant stonefly *Agnetina capitata complex*, and MI midges *Paratrichocladius sp.* and *Paratanytarsus n. sp. 1*, which are also cold water taxa, were some of the sensitive taxa collected in the macroinvertebrate community in lower Worthington Ditch. Groundwater influx and shading from a modest amount of wooded riparian vegetation in the lower reach downstream from St. Rt. 142 has yielded cooler instream water temperatures and ameliorated some of the effects

from nutrient enrichment introduced to the channelized open stream segment further upstream. Increasing the grass and/or wooded riparian buffer upstream from St. Rt. 142 would improve water quality of Worthington Ditch and the water quality being delivered to Big Darby Creek at RM 50.62.

Ballenger-Jones Ditch (02-355) (RM 49.68) (Undesignated/WWH Recommended)
Ballenger-Jones Ditch water quality was higher than that found in Worthington Ditch despite having similar nutrient concentrations to Worthington Ditch. The agricultural land use upstream gave way to a 300 to 400 yard long grassy, slightly treed and partly shaded, meandering reach that allowed for natural processing of nutrients and WWTP wastewater and permitted lower water temperatures than found in the open canopy conditions further upstream. Downstream from St. Rt. 142 there was a fairly stable natural bed through the woods leading to Big Darby Creek (RM 49.68). An exceptional macroinvertebrate community was evident with 19 EPT taxa collected. Many sensitive taxa including baetid mayflies, hydropsychid and cased caddisflies, stenonemid mayflies, and freshwater shrimp were predominant in the riffles, pools, or runs. Allowing more trees upstream in the grassy area and increasing the extent of the stream canopy would further benefit Ballenger-Jones Ditch stream quality. This would also benefit the critical receiving reach of the Big Darby Creek mainstem. After sampling in 2001 the channel was modified in the lower wooded section of this stream.

Yutzy Ditch (02-364) (RM 47.1) (Undesignated/WWH Recommended)
Yutzy Ditch was of marginally good quality at the site near St. Rt. 142 , RM 0.4, and met the recommended WWH aquatic life use biocriterion. There was still some slight flow and groundwater recharge or supplemental interstitial flow and modest canopy in the lower reach that moderated water temperatures (~ 70° F). A more natural stream channel was present approximately 400-500 yards upstream from St. Rt. 142 with riffles and functional pools comprised of predominately rocky substrates. This pattern continued downstream to the mouth (confluence with BDC @ RM 47.1). Further upstream the stream was conventionally channelized and quite deeply entrenched. A short segment upstream from the sampled reach was petitioned and maintained by the Madison County Engineer's Office. Nitrate, TKN, and TP concentrations were very elevated from upstream inputs ($\geq$ 75th percentile to $\geq$ 95th percentile vs. ECBP background). At the sample site near St. Rt. 142 there were eight EPT taxa collected including sensitive mayflies and caddisflies. Moderately intolerant water pennies (beetle larvae), *Helichus sp.* beetles, and tanytarsini midges *Rheotanytarsus sp.* and *Rheotanytarsus n. sp. 1* (also a coolwater taxa) were present. Various sensitive or more adaptive cased caddisflies and stenonemid mayflies were predominant in the riffles and pools, and tolerant *Physella* snails in the more variable margin habitat. Additional sampling should be conducted further upstream prior to recommending an aquatic life use for the upper portions of Yutzy Ditch.

Fitzgerald Ditch (02-272) (RM 44.96) (Undesignated/WWH Recommended)
Fitzgerald Ditch, a direct tributary to BDC at RM 44.96, receives effluent from the Canaan Community MHP WWTP upstream from the sampling site near St. Rt. 142. Nutrient

enrichment was evident at RM 0.5 with algal mats present on the mostly rubble and coarse gravel substrates. There were high to moderate densities of filtering hydropsychid caddisflies, larval and adult riffle beetles, and *Rheotanytarsus sp.* midges with *Polypedilum* midges very common in the riffles or runs. Ammonia (0.215 mg/l), nitrate (11.4 mg/l), TKN, and TP (1.48 mg/l) were > 90th percentile to > 95th percentile versus ECBP background. *E. coli* and fecal coliform bacteria concentrations were very elevated in at least one sampling in 2001 (4400 and 6000/100 ml., respectively), and a slight antiseptic odor (possibly chlorine) was present. These chemical inputs, particularly NH_3 and possibly chlorine, could be related to the lack of mayflies collected at RM 0.5 (only one baetid mayfly and no stenonemid mayflies). The community overall was determined to be marginally good and attained the recommended WWH aquatic life use (nonsignificant departure).

Little Darby Creek - Mainstem

Sixteen sites were sampled in the Little Darby Creek mainstem and all but two colonizers were recovered. All sites met the established and recommended EWH biocriterion scores at each site (Table B.7.1). There were differences in exceptional quality through different reaches of Little Darby Creek. There was a range of fifteen to 27 EPT taxa, 28 to 46 sensitive taxa, and zero to twelve mussels collected per sampled site. Different highlights, variables, and challenges to stream community quality will be discussed in the following narratives.

At its headwaters Little Darby Creek was a very good to exceptional quality coolwater stream (temperature ~ 56° F) with the coolwater hydropsychid caddisfly *Ceratopsyche slossonae* and coldwater cased caddisfly *Glossosoma sp.* predominant in the riffle with the coldwater mayfly *Baetis tricaudatus* the most common mayfly collected. The very good community marginally met the recommended EWH biocriterion (nonsignificant departure). There were fifteen EPT taxa, six to seven coldwater taxa, and a total of 28 sensitive taxa collected downstream from Allison Rd. (RM 41.2). Adjacent and connected to the creek was a wetland / seep complex with noticeable cool, groundwater recharge. There were some negatives as a fair number of blackflies and *Physella* snails were present. Upstream was an open pasture area that could be a source of past NPS inputs. Past NPS sedimentation had caused some riffle embeddedness and it appeared that recreational vehicles were exacerbating the problem at the time of collection.

The next sample site was downstream of St. Rt. 29 where Little Darby Creek winds southeast and east through the south edge of Mechanicsburg. The site was downstream from the Clover Run confluence and just downstream from a fertilizer / feed distributor storage facility and an open pasture with cows in the stream. The macroinvertebrate community population indicated excess nutrient enrichment with high to moderate population densities of filtering midges and hydropsychid caddisflies in the riffles and runs. Relative density increased approximately 800 percent to approximately 4000/ft.^{2}. The nutrient loading to this area needs to be reduced

(Figure B.7.10). The qual. EPT taxa collected decreased, and the QCTV dropped significantly from 40.4 upstream to 36.8 at RM 39.3 (Figures B.7.11 and B.7.12). This resulted from a shift to more tolerant midges (like *Cricotopus C. bicinctus*) and larger populations of aquatic worms and *Physella* snails. There were some slumped and caved-in banks in the open pasture area. The stream bed was spongy where banks were destabilized by cattle. There were consistently elevated *E. coli* counts. Cattle were not fenced out of Little Darby Creek upstream from the sample site at RM 39.3. Sedimentation from destabilized banks rendered some rocky bottom substrates unusable for colonization. Coarse substrates in depositional and margin areas were covered with silt. The cooler water temperatures instream (~ 52° F) ameliorated some of these problems with this site yielding an ICI of 48, which met the EWH biocriterion. Increased bank stabilization, cattle exclusion and more dense streambank canopy cover upstream on Little Darby Creek mainstem and on Clover Run would decrease the NPS erosional sedimentation/siltation and nutrient inputs from various sources.

Figure B.7.10. Longitudinal trend in the Relative Density of Macroinvertebrates in Little Darby Creek based on samples collected in 2001 and 2002.

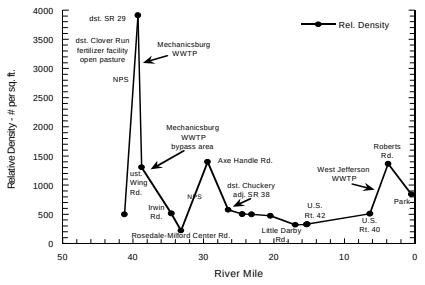


Figure B.7.11. Longitudinal trend in the QCTV in Little Darby Creek based on samples collected in 2001 and 2002.

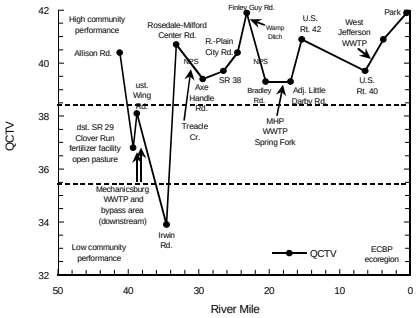
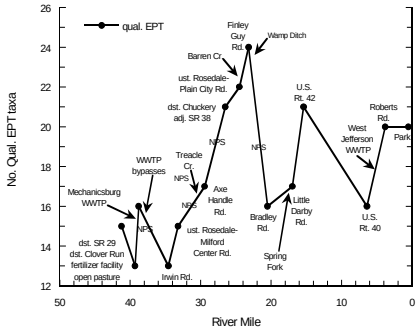


Figure B.7.12. Longitudinal trend in the number of Qual EPT taxa in Little Darby Creek based on samples collected in 2001 and 2002.



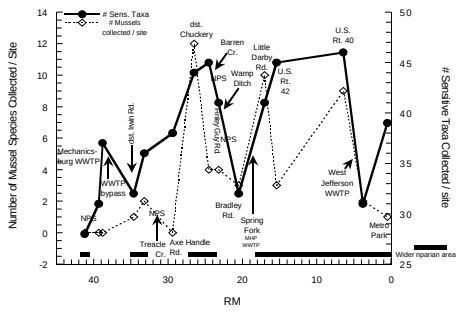
The next sampled reach was upstream from Wing Road (RM 38.8). The sampled location, where the colonizer was placed, was downstream from the Mechanicsburg WWTP, but upstream from the WWTP bypass which was closer to Wing Rd. The stream here was more defined with a narrower channel and good riffle/run complexes. Good riparian cover existed on

the north bank, but Little Darby Creek flowed through the edge of an open pasture where *E. coli* concentrations were equal to or greater than upstream NPS sources. The south banks were trampled and destabilized from cattle. This resulted in silt and sediment mixed in with the bottom rocky substrates. The macroinvertebrate community collected was still of very good to exceptional quality, with the number of sensitive taxa increased compared to upstream (Figure B.7.14). Intolerant taxa collected included the mayflies *Pseudocloeon frondale*, *Diphetor hageni*, and the midge *Tvetenia discoloripes group*. However, some of the pool and margin community was predominated by the tolerant *Physella* snails, *Chironomus decorus gr.* midges, and silt-resistant limpet snails due to the wastewater and NPS inputs. A couple of the pools sampled were adjacent to or downstream from the WWTP bypass outfall. Nutrient enriched conditions continued with nutrients $\geq 75^{th}$ percentile vs. ECBP background, but the relative abundance decreased to approximately 1300/ft.^{2} (Figure B.7.10). Four coolwater taxa, including caddisflies *Glossosoma sp.* and *Ceratopsyche slossonae*, were still present, and the cooler water temperature assisted in ameliorating water quality impacts from wastewater and NPS inputs. Based on the coldwater taxa collected here and further upstream the CWH aquatic life use designation was recommended from the headwaters to upstream from Lake Run (RM 37.0). Based on the pool sampling downstream where the Mechanicsburg WWTP bypass was located, there was the likelihood that the macroinvertebrate community downstream from Wing Rd. might have been more impacted than upstream above the WWTP bypass. The fish results downstream from Wing Rd. indicated further impact.

The macroinvertebrate community quality downstream from Irwin Rd. (RM 34.6) was improved with an ICI of 56 (Figure B.7.14). This was attributed to the distance of the site from the Mechanicsburg WWTP and periodic WWTP bypass discharges and natural stream assimilative processes. The relative density has decreased toward baseline conditions (Figure B.7.10). Large increases in the proportion of baetid mayflies and decreases in the total numbers of tolerant (T) midges and aquatic oligochaete worms fueled the increases in the ICI score. There was still room for improvement in community quality, as the ratio of very tolerant and tolerant organisms present (i.e., organic tolerant midges, leeches, worms, and snails) outnumbered the intolerant (I) taxa present by a seven-to-three margin, though their numbers were much lower than upstream. The number of sensitive and qualitative EPT taxa collected was slightly lower, and the total EPT taxa was still less than twenty (Figures B.7.12 and B.7.14). The QCTV was correspondingly lower (Figure B.7.11). Possible reason(s) could have been: 1) habitat restrictions with less riffle habitat in the recovering channelized reach; or 2) periodic short-term minor impacts from the Mechanicsburg WWTP bypasses; or 3) chronic dairy waste spills near the county line and/or from other residual periodic NPS inputs (i.e., upstream sedimentation from erosion in open pastures). Improved quality was such that moderately intolerant giant floater mussels, *Pyganodon grandis*, were present at this location. Improvement to Mechanicsburg WWTP and the elimination of raw wastewater bypasses and other NPS inputs with increased riparian corridor width and density will definitely further improve water quality conditions downstream from Mechanicsburg.

The reach of Little Darby Creek upstream from Rosedale - Milford Center Rd. (RM 33.2) possessed a more continuous, mature woody riparian corridor that began downstream from a

Figure B.7.13. Longitudinal trends in the number of mussel species collected per site and the number of sensitive taxa collected in Little Darby Creek in 2001 and 2002.



tree farm at Irwin Rd. The south bank was virtually continuous with trees with riparian widths greater than 50 feet. The north bank had at least one very thin section where the eroding outside bank abutted against the agricultural crop field with maybe one foot of weeds, but most of the north bank riparian corridor was approximately 35 to 50 feet wide. Little Darby Creek in this reach had not recovered from past channelization. There were small sand and gravel riffles or riffles composed largely of sticks and woody debris. Moderately deep, short runs converged into mostly deep pools that had accumulated some sand and silt. Within this reach of more stable habitat and lessened NPS inputs, a density of about 220 organisms/ ft.^{2} was collected (Figure B.7.10). An ICI of 54 was scored here similar to the upstream value meeting the EWH biocriterion. The QCTV value improved dramatically (i.e., to 40.7).

There were more sensitive organisms collected with less tolerant taxa observed (Figures B.7.14 and B.7.15). Unique sensitive organisms collected included the mayflies *Diphetor hageni*, *Stenonema vicarium* and *S. terminatum*, and the cased caddisflies *Oecetis persimilis* and *Triaenodes ignitus*. Two mussel taxa, the Threeridge (*Amblema plicata plicata*) and the Wabash pigtoe (*Fusconaia flava*), were observed in this reach and were present where more stable and wider riparian habitat was found (Tables B.7.1 and B.7.2). Mussels, and sensitive

Figure B.7.14. Longitudinal trends in the number of sensitive species collected in Little Darby Creek in 2001 and 2002.

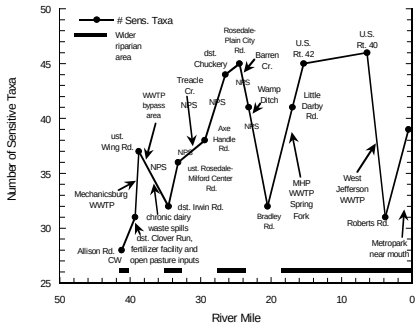
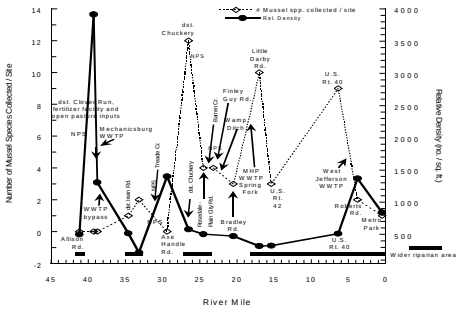


Figure B.7.15. Longitudinal trends in the number of mussel species collected per site and the relative density of macroinvertebrates collected in Little Darby Creek in 2001 and 2002.



taxa in general, also seem to have higher diversity where wider, mature, and more stable riparian areas were adjacent to Little Darby Creek and where there were no point source inputs or tributary NPS inputs that elevated silt and nutrient concentrations (Figures B.7.14 and B.7.15). Conversely, communities in good riparian areas usually have low baseline or decreasing relative community abundance correlated to limited inputs, shaded conditions, and lower temperatures. Wider riparian corridors adjacent to Little Darby Creek and its tributaries would limit sediment and nutrient inputs into the system and be more protective of sensitive organisms.

Downstream from Rosedale - Milford Center Rd.(aka Bates Rd. in Union County), no riparian buffer was present adjacent to Little Darby Creek as a result of an open pasture. Banks were broken down and devoid of vegetation. Sedimentation resulting from the free access of livestock to the stream channel had degraded instream quality (Figure B.7.16). Similar livestock agricultural practices were observed adjacent to Treacle Creek near Irwin and upstream from Winget Rd. (covered bridge) that yielded denuded, slumped, or false banks and excess silt or sediment inputs. Violations of the minimum EWH D.O. concentration (i.e., < 5 mg/l) in Treacle Creek were recorded at Winget Rd. during continuous monitoring on 9/13/01. Related NPS nutrient inputs from livestock and rowcrop cultivation were evident downstream in Little Darby Creek, as TSS, ammonia, nitrate, and nitrite concentrations instream at the Axe Handle Rd. site (at RM 29.5) were elevated to $\geq$ 75th percentile or $\geq$ 90th percentile compared to ECBP background conditions. Patterns in the macroinvertebrate community confirmed nutrient enriched conditions with 1400 organisms/ft.^{2} (Figure B.7.10). Filtering organisms (i.e., caddisflies and *Corbicula* clams) and scrapers or grazers (i.e., riffle beetles and *Stenacron sp.* mayflies) predominated in the riffles and runs. The shallower, more aerated pool downstream from the fast, oxygenated riffle reach had good diversity but low density. In this short aerated reach the ICI scored a 50 and met the EWH biocriterion. The pool upstream from the riffle at the bridge, a long pooled reach, was much siltier with more depositional sediments and contained fewer organisms with more limited diversity. No unionid mussels were collected here (Figure B.7.15). During sampling, black-green solids, perhaps rotting fresh hay or grass, were suspended in the water and floated downstream. These solids contributed to the oxygen demand further lowering instream dissolved oxygen concentrations.

Figure B.7.16. Landuse downstream from Bates Rd., RM 33.2, in Little Darby Creek, 2001.

Continuous monitoring just upstream from the riffle in the flowing water at Axe Handle Rd. revealed critically low D.O. concentrations. On 13 September 2001, the dissolved oxygen concentration dropped to $\leq$ 6.00 mg/l from 3:00-10:00 AM with a mean concentration during

that time of 5.66 mg/l. With D.O. concentrations in the pool depths undoubtedly being even lower, these night time D.O. values contributed to chronically impact the macroinvertebrate community in this vicinity. However, large reaches of Little Darby Creek in this portion of the watershed possessed similar physical characteristics and would be expected to react similarly. Reducing sedimentation, TSS, fecal bacteria, and nutrient inputs in the mainstem upstream and in Treacle Creek will improve water quality in Little Darby Creek through this reach and protect downstream resources.

Downstream to Chuckery the riparian corridor was of mixed quality. This segment possessed some largely open canopy as well as partial canopy with some unprotected banks. Excess sedimentation, nutrient enrichment and associated fluctuating or periodic low D.O. concentrations are a distinct possibility unless upstream and adjacent sedimentation and nutrient inputs are reduced coupled with an expanded shaded stream canopy which would reduce excessive algal productivity.

It is critical that the sediment/silt load contributed to this reach (i.e., from downstream from Rosedale - Milford Center Rd.[AKA Bates Rd. in Union County] to downstream Chuckery - which includes Treacle Creek and its tributaries) be reduced significantly in order to protect one of the last strongholds in the Darby watershed of the federally endangered clubshell mussel, *Pleurobema clava*, which occurs downstream from Chuckery.

Downstream from Chuckery and adjacent to St. Rt. 38 the Little Darby Creek mainstem was sampled at RM 26.5. One of the more stable, wider riparian corridors that exists in the upper mainstem continues downstream to Rosedale - Plain City Road. A very diverse community was found which utilized all of the available stable substrates. Slow, sandy run habitat was a prominent habitat with scattered shallow rocky and stick riffles in shallower areas. Permanent sand/gravel bars, formed behind or adjacent to sunken logs, yielded live mussel colonies. Scattered silt deposition in pools limited the macroinvertebrate community in those habitats. Clay bottom substrates were exposed near some banks. The ICI of 52 which met the EWH biocriterion confirmed the assessment of this exceptional and diverse macroinvertebrate community. There were 25 total EPT taxa and 85 total taxa collected which represented a significant increase from upstream (Table B.7.1). The relative abundance decreased to a more normal amount of 577 organisms/ft.^{2} because of the decreased nutrient inputs resulting from filtering by the riparian corridor and shading by the canopy (Tables B.7.1 and B.7.2). The increase in sensitive organisms collected was strongly linked to the very diverse mussel community present (Figures B.7.13, B.7.14 and B.7.15). Twelve mussel species were recorded, including live kidneyshell (*Ptychobranchus fasciolaris*), spike (*Elliptio dilatata*), and Wabash pigtoe (*Fusconaia flava*). The most rare mussel collected here was a fresh dead specimen of the federally endangered clubshell mussel (*Pleurobema clava*). Its habitat requirement include loose well-aerated sand and gravel substrates in riffles and runs free from silt which allow interstitial flow and oxygen regeneration to deeper substrates, since it burrows well below the surface (Watters, 1993). Sandy substrates that predominate in this reach, the wider and mature riparian corridor and groundwater recharge to Little Darby Creek are significant factors in why the clubshell mussel has survived here (Figure A.2 glacial geology map). Limiting siltation and

sedimentation from erosion or runoff from upstream sources is vital to the protection of this unique mussel's habitat. Increasing canopy cover adjacent Little Darby Creek upstream would decrease instream temperatures and algal production and keep baseline D.O. concentrations higher to protect the more intolerant organisms in the macroinvertebrate community.

The macroinvertebrate community at Rosedale - Plain City Rd. was located at the downstream end of this fairly lengthy and mostly contiguous wooded riparian area. Two small tributaries from the west draining agricultural fields as well as the adjacent agricultural fields had added nutrients to the system. Elevated TSS and TP concentrations were collected at $\geq 75^{th}$ percentile level while ammonia (0.11 mg/l) and nitrate (6.04 mg/l) were found to be $\geq 90^{th}$ percentile to $\geq 95^{th}$ percentile, respectively, compared to the ECBP background levels. These nutrient concentrations and TSS were all higher than those recorded at Axe Handle Road. Algal growth inhibited by the shaded conditions permitted the relative community abundance to decrease to 577 organisms/ft.^{2}. The exceptional macroinvertebrate community present scored a 58 (out of a 60 maximum) was the highest recorded during the survey (Table B7.1 and Figure B.7.14). The highest number of qual. taxa (85) and total taxa (95) were recorded here at RM 24.5 (Table B.7.1). The 25 total EPT taxa and 45 sensitive organisms collected approached the highest totals collected in the Little Darby Creek basin. Furthermore, all sites with many sensitive taxa (i.e., 44 to 46) were linked to wide, contiguous woody riparian corridors. This condition promotes habitat stability, increased shading, reduced nutrient inputs and lower mean temperatures) (Figures B.7.14 and B.7.15). A good mussel community was present with many fresh dead Threeridge (*Amblema plicata plicata*), and a live Wabash pigtoe (*Fusconaia flava*) was identified which yielded a site total of 4 bivalve species. Mussel community diversity was probably under represented at this sampling site. Overcast conditions and the thick canopy limited visibility more than usual reducing sampling effectiveness. The habitat upstream consisted of aerated, loose sand predominant in the runs and riffles with coarser substrates also present. This reach, representative of prime clubshell mussel habitat, was similar to upstream at RM 26.5 but with more larger substrates available for colonization and greater diversity of other macroinvertebrates. The temperatures were cooler here at Rosedale - Plain City Rd. than upstream (i.e., 65° to 75° F) This was attributed the extensive riparian canopy which also resulted in a more stable dissolved oxygen regime. Solidifying the riparian corridor and limiting TSS, reducing silt present in some pools, and lowering nutrient inputs through improved riparian habitat in tributaries with adjacent agricultural fields will insure continued exceptional community quality and protect vital habitat throughout this reach.

Just downstream from the Rosedale - Plain City Rd. bridge adjacent to the mouth of Barron Creek previous open pasturing had permitted livestock to trample and break down the banks which eroded further during higher flows. They are now fenced out of the stream. It is recommended that the narrow and limited riparian corridor and areas of open canopy downstream be converted to a wider woody riparian buffer to protect and improve Little Darby Creek stream water quality through this reach and to reduce biological isolation by connecting areas of greater biological diversity.

Downstream from Barron Creek and upstream from Finley Guy Rd. the silt load was observed to be heavy in depositional areas and along the margins away from the current. Riffle embeddedness increased at the next sample site, RM 23.2. An unusual phenomena was observed at this site. Travertine had encrusted the rocky substrates. The macroinvertebrate community was exceptional with similar EPT and sensitive taxa including some new taxa (Figures B.7.12 and B.7.14). Despite some embeddedness and encrusting of the surface that had limited some bottom substrate colonization, an intolerant stonefly (*Agnetina capitata complex*), the cased caddisfly *Protoptila sp.* (I), and the moderately intolerant *Anthopotamus sp.* mayfly were new taxa collected. Similar mussel taxa to upstream (i.e., 4) were collected including three live species: threeridge *(Amblema plicata plicata*), spike (*Elliptio dilatata*), and the kidneyshell (*Ptychobranchus fasciolaris*). All mussel taxa collected were species that need well oxygenated, flowing current and resided in the riffle or run habitats. No pool species were collected where heavier silt deposition had occurred. Again, areas of narrow and limited riparian corridor habitat and open canopy are recommended to be shifted to wider wooded riparian buffers to protect and improve Little Darby Creek stream water quality through this reach and downstream.

A slightly less exceptional quality community was collected downstream at Bradley Rd. (RM 20.5). The ICI recorded here was 48 (Table B.7.1 and Figure B.7.14). Qual. EPT taxa and sensitive taxa declined from upstream (Tables B.7.1 and B.7.2). The mixed patchwork of unprotected banks, some thin and some wide riparian corridor reaches left the mainstem less stable and more vulnerable to increased erosion during higher wet weather flows. As a result, silt contributed to riffle embeddedness. Also, the calcification encrusting the rocky substrates had converted the streambed into a hardened concrete-like surface in the main riffle area. More colonization occurred in the slow run and shallow riffle areas winding through the water willow beds. Sediment was deposited on the top of substrates in pools, but areas with protected bottom surfaces were colonized with higher quality organisms like stenonemid mayflies and *Neophylax* caddisflies. Mussel taxa observed were similar but the diversity decreased compared to sites upstream (Figure B.7.15). Allowing woody vegetation to fill in riparian corridor gaps, increasing riparian width, and stabilizing unprotected banks will improve water quality through this reach. These remedial actions will decrease water temperatures, which was 78° F at sampling, by increased shading, will decrease sedimentation, and will diminish substrate smothering, hardening, or embeddedness which will increase bottom substrate microhabitats.

Spring Fork joined Little Darby Creek upstream from the Little Darby Rd. ford at RM 17.4. Elevated N and P concentrations (>75th and/or 90th percentile versus ECBP background) with algal production (in open canopy) and low night time D.O.s just barely above the EWH minimum 5 mg/l were recorded at Lafayette Plain City Road (8/02). Also elevated fecal coliform and *E. coli* bacteria were recorded there more numerously than upstream with possible NPS livestock input and human inputs (i.e., Greentree MHP WWTP). Numerous continuing water quality violations for TSS, fecal coliform, CBOD and dissolved oxygen have been documented by Ohio EPA.

The macroinvertebrate community in Little Darby Creek scored an ICI of 48 downstream from Spring Fork at Little Darby Rd. at RM 17.0 (Figure B.7.14 and Table B.7.1). Upstream toward the ford the bottom substrates were less hardened consisting mostly of rubble and some coarse gravel interspersed with sand. Downstream of the ford some of the rubble was covered with concretions with interspersed sand, and some hardening or embeddedness in the bottom substrates had occurred. The riparian corridor upstream on the Little Darby Creek mainstem was more intact through this reach than further upstream (i.e., above the last site upstream from Bradley Rd.). As a result of the extended distance from the nearest point source (i.e., the Green Meadows MHP) and the amount of the riparian cover along the Little Darby Creek mainstem, the relative abundance at this site was the lowest at 318 organisms/ft.^{2} (Tables B.7.1 and B.7.2). With the more intact vegetated corridor, increases in quality or diversity were expected. Mussel diversity and the number of sensitive taxa collected in this reach increased significantly as well as the total number of taxa collected (Figures B.7.13, B.7.14 and B.7.15). A higher quality community was present. Ten live mussel taxa were collected in Little Darby Creek in this stream reach (Figure B.7.13). The federally endangered Clubshell mussel (*Pleurobema clava*) was observed in low numbers. Also the wavy-rayed lampmussel, *Lampsilis fasciola*, an Ohio Species of Concern, was collected in this reach. The lack of cooperation from local landowners in providing access to lower Spring Fork hobbled efforts to fully assess environmental conditions there and immediately downstream from the confluence in Little Darby Creek. The ability to sample and monitor lower Spring Fork is necessary to accurately assess the impact of the Green Meadows MHP WWTP to biological communities in Spring Fork and Little Darby Creek. Better knowledge of water resource quality will better protect endangered or very sensitive organisms that have low populations in Little Darby Creek. Conditions that would favor protection of these organisms include a good riparian stream corridor with high quality water and aerated, non-silty, unembedded sandy substrates. Therefore, point source and NPS inputs upstream in Spring Fork need to be minimized.

The reference site near U.S. Rt. 42 (RM 15.4) had increases in EPT and total taxa and, therefore, in the quality in the macroinvertebrate community (Figures B.7.12 and B.7.14). The ICI scored a 50 despite less than adequate flow velocities when retrieved in 2001. The main current had moved to the edge of colonizer. The QCTV value had also increased significantly (Figure B.7.12 and Table B.7.1). A similar ICI score was recorded just downstream in 2002 at RM 15.3. The riparian corridor was uniformly wide, and additional NPS inputs were minimal through this reach to U. S. Rt. 42. Ambient chemical concentrations were similar or less than upstream. Ammonia was not detected and TSS values were reduced.

Downstream from U.S. Rt. 40 and several small WWTPs and Fisher Cast Steel and upstream from the West Jefferson WWTP, the macroinvertebrate community was exceptional with an ICI of 54 at RM 6.4 (Table B.7.1). Excellent habitat development was evident in this stream reach with islands, gravel bars, side channels, water willow in margins and run edges, and big pools. The 46 sensitive taxa collected here was the highest total at any site and reflective of the excellent habitat. Predominant sensitive taxa included *Rheotanytarsus* midges (MI), *Isonychia* (MI), *Stenonema pulchellum* (MI) and *S. mediopunctatum* (I) mayflies, and *Chimarra obscura* (MI) and *Neophylax* (I) caddisflies. Some sensitive mussels observed were the intolerant wavy-

rayed lampmussel (*Lampsilis fasciola*) and plain pocketbook (*L. cardium*) and the moderately intolerant rainbow (*Villosa iris*) and spike mussels (*Elliptio dilatata*). Habitat protection, a limit to municipal inputs and storm water controls upstream and adjacent to West Jefferson are needed to protect this reach of Little Darby Creek upstream from the West Jefferson WWTP.

Downstream from the West Jefferson WWTP near Roberts Rd. (RM 3.8) an exceptional macroinvertebrate community was still present with an ICI of 52, but the community was nutrient enriched (~ 1400 organisms/ft.^{2}) at almost three times the relative density found upstream. Filtering *Rheotanytarsus* midges accounted for over 45% of the community with greater than 3000 organisms collected (Tables B.7.1 and B.7.2 and Figure B.7.10). There was some foam on the water surface downstream from the riffle. An antiseptic odor from the treated wastewater effluent was also observed. The community quality had decreased significantly from upstream due to periodic solids and overflow problems from the wastewater treatment plant. The number of qualitative and sensitive organisms downstream from West Jefferson WWTP decreased significantly (from 23 to 33 %, respectively). Furthermore, only two mussel taxa were collected downstream from West Jefferson WWTP - a 78 percent reduction in mussel diversity which indicated some water quality instability and episodic impacts (Figures B.7.13 and B.7.15). Plant and infrastructure improvements are needed to improve WWTP quality, decrease nutrient inputs, and protect downstream biological integrity and diversity below West Jefferson WWTP and further downstream into the park property and Big Darby Creek.

Downstream in the Battelle-Darby Metropark near the mouth at RM 0.5 an ICI of 56 and a decrease in relative density (i.e., to 842 organisms/ft.^{2}) indicated recovery from most West Jefferson municipal inputs (Table B.7.1 and Figure B.7.10). The QCTV value of 41.9 and the significant increase in sensitive taxa further confirmed the higher quality exceptional community present (Tables B.7.1 and B.7.2 and Figure B.7.14). The lower number of mussels in this reach could be due to the relative short time since dam removal and/or substrate movements, stability or quality. Mussel colonization in this lower reach also might be a slower process due to possible contamination from long-term deposition within the previous dam pool that has not yet been flushed downstream (Figure B.7.15).

Little Darby Creek Tributaries

Clover Run (02-218) (RM 39.8) (EWH/WWH Recommended)

Clover Run water quality was very good at the Maple Grove Cemetery (RM 0.6). Some intact wooded riparian areas on nearby hills and surrounding the cemetery positively influenced water quality. High quality sensitive organisms predominated in the riffle, run and margin habitats. The EPT taxa total collected here was similar to the most upstream Little Darby Creek site which had a similar drainage area. A couple of coolwater taxa were still present despite some open canopy areas adjacent to row crop agriculture further upstream. Elevated fecal coliform and E. coli bacteria counts were detected, but nutrient inputs were mostly at median background levels. Small amounts of sediment had accumulated at this site. The flashy nature of the stream had resulted in some bank erosion. Some of the sediment may also have come from upstream.

If a wider riparian buffer was allowed to become established which would decrease TP and silt Clover Run would improve to even higher quality.

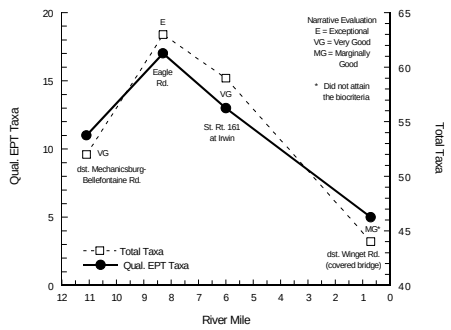
Lake Run (02-216) (RM 36.9) (EWH/EWH Deferred)
Lake Run was a small, rocky, cooler (~ 60º F) stream that drained into Little Darby Creek at RM 36.9 (6 mi.^{2} drainage). A nice riparian corridor was present downstream from St. Rt. 4 (RM 0.9) and a short distance upstream. Above that short upstream reach a golf course was built adjacent to both sides of the stream. Some clayey sediment had accumulated in the pools and on rocky substrates in other areas from post-construction NPS sedimentation. Attached benthic growth was present on the rocks, but the density of the macroinvertebrate community did not indicate enriched conditions. All nutrient inputs were at median levels except for elevated bacteria concentrations and ammonia, which was >75th percentile to >90 percentile concentration vs. ECBP background. The highest number of *Pycnopsyche* caddisfly cases were observed. However, all were empty, and all of the *Neophylax sp.* cases observed or collected had already hatched and were empty also. Twelve EPT taxa were collected in this EWH deferred stream which was determined to still be of very good quality despite the excess sediment present. Further improvements in community quality should occur as the sediments contributed by the construction activities are flushed or stabilized.

Jumping Run (02-217) ((RM 3.9) (EWH/WWH Recommended)
Jumping Run was a small headwater stream (i.e., 2.4 mi.^{2} drainage) that emptied into Lake Run at RM 3.00 north of Mechanicsburg. The sample site downstream from St. Rt. 559 (RM 0.2), mainly consisted of pools with bottoms of unconsolidated sediments and some detritus from agricultural sources. Included in this segment was a rocky riffle comprised of cobble, smaller substrates along with some woody debris. A decent forest corridor downstream ameliorated some upstream NPS inputs (i.e., sediment or some nutrients). Cooler temperatures (66º F) probably helped to maintain instream D.O. based on the macroinvertebrate community present. Eight EPT taxa and 37 total taxa were collected. Jumping Run met the biocriterion for its recommended WWH aquatic life use.

Treacle Creek (02-213) (RM31.3) (EWH)
Treacle Creek downstream from Mechanicsburg-Bellefontaine Rd. at RM 11.7 was still in very good quality condition despite siltation from open pasturage upstream and streamside row crop agriculture that encroached on the riparian buffer along one shoreline. Several spots on the bank were filled with riprap where the bank had become destabilized and erosion had occurred. Due to these factors a layer of silt 1/4 to 1/3 inch thick covered rock surfaces in the pools and slow runs. Cooler instream water temperatures (i.e., 53º F), a mostly covered canopy, and a variety of substrate and margin habitat types somewhat counterbalanced the impact of silt. At least one-third of the 52 taxa observed were sensitive, but the diversity of baetid mayflies and stoneflies were limited or not collected. When some action is taken to decrease or eliminate sediment inputs, this stream reach that marginally met the EWH biocriterion should improve greatly.

Community quality improved at Eagle Road (RM 8.3) to exceptional despite some embeddedness in the riffles and runs upstream from the bridge. The source of the sedimentation was from further upstream. Siltation in the downstream pools was from recently completed bridge work. There was a wider riparian corridor at this site with nice development upstream. Downstream portions of this site was recovering from historical channelization. This site was more diverse with sensitive *Chimarra aterrima* caddisflies, *Rheotanytarsus sp.* midges, *Neophylax sp.* caddisflies, *Elimia sp.* snails, and facultative stenonemid mayflies predominant in the riffle/run/pool complexes. The highest total taxa and EPT taxa in Treacle Creek were collected in this reach (Figure B.7.17). Control of sediment was still an important issue.

Figure B.7.17. Longitudinal trends in Qual EPT taxa and total macroinvertebrate taxa found in Treacle Creek in 2001.



Near Irwin Rd. (RM 6.0) the macroinvertebrate community decreased to very good which still marginally met the EWH biocriterion. However, open pastures upstream had caused bank instability from riparian corridor loss or elimination, erosion, and siltation and deposition in pools and runs. Therefore, there were primarily smaller substrates present. Downstream there was a reach with deep channelized pools where agricultural crop land was directly adjacent to the right bank. However, the narrow riparian corridor that formerly stabilized the right bank had recently been removed as evidenced by slash and trees lying in the channelized pool. There were elevated *E. coli* counts as high as 2300 colonies /100 ml. The highest TSS concentration collected (134 mg/l) was a full order of magnitude higher than upstream and greater than the 95th percentile versus ECBP background conditions. Nitrates and TKN concentrations were also very elevated (>75th percentile compare to ECBP background). As a consequence the number of EPT taxa decreased by about 25 percent and the QCTV decreased significantly to a similar value as the RM 11.7 site which was also narratively scored as very good (Table B.7.2). Leaving a decent riparian buffer and fencing out livestock will decrease significantly the nutrient and sediment inputs and improve water and community quality.

The biological performance downstream from Winget Rd. and the covered bridge (RM 0.8) did meet the biological criterion. Treacle Creek upstream was inhabited by cattle in open pastures with no buffers and slumped and eroding banks. The channel downstream was flanked by 20 to 35 feet of more mature wooded riparian buffer with row crop agriculture beyond. Instream there was still some entrenchment in the previously widened channel. The solid substrates have a thick layer of silt and solids with embeddedness common. Woody debris was the primary hard substrate still available, as the bottom substrates were of medium to soft consistency (i.e., clay to silts). A less sensitive macroinvertebrate assemblage persisted in this reach which was affected by NPS inputs of sedimentation, excess nutrients, and low minimum diel D.O.

violations. Fecal coliform and E. coli counts >10400 colonies/100 ml., and ammonia, nitrate, TSS, nitrite, and TKN were above the 75th or 90th percentile compared to ECBP background values. Only five EPT taxa were collected here with 30 percent fewer taxa overall than the highest quality sampled site. The midge community was predominated by more facultative species like *Polypedilum flavum* and *Tribelos* spp. and also more tolerant taxa like *P. (P.) illinoense*. Increased NH_3 and other nitrogenous compounds were documented at this site. Some high quality coolwater midges (*Paratanytarsus n. sp. 1*, *Micropsectra sp.*, and *Parametriocnemus sp.*) were still present in the 54º F water. Other sensitive organisms, like moderately intolerant *Chimarra* and *Ceratopsyche* caddisflies and giant floater mussels (*Pyganodon grandis*), were still present because of the available canopy shaded a good portion of Treacle Creek and the cooler water temperatures in concert ameliorated some of the NPS impacts. The marginally good macroinvertebrate community present needed decreases in sedimentation and the other NPS-related nutrient inputs mentioned above to allow an improved community to flourish and meet the EWH biocriterion.

Howard Run (02-215) (RM 5.4) (EWH)

Howard Run at McMahill Rd. (RM 0.6) was a small stream partially recovered from past channelization. It has developed fairly good meanders upstream as a consequence of the good gradient present. A fair amount of peat and filamentous algae was present on the coarse substrates with some dark silt covering the bottom. Shrubs (10 ft.) and grass (25 ft. wide) comprised the thin riparian corridor. Siltation lowered quality modestly, but sensitive organisms were still predominant in the riffle, run and pool habitats (i.e., *Chimarra obscura* (MI) and *Neophylax sp.* caddisflies and the river snail *Elimia sp.*). Cooler water and largely closed canopy helped to lessen the impacts from NPS inputs. The macroinvertebrate community very marginally met the EWH biocriterion. Reducing siltation, widening the woody riparian corridor and permitting natural recovery from past channelization would improve the benthic community quality of Howard Run. These steps in turn would also reduce sedimentation and nutrient inputs to Treacle Creek (present sampled concentrations for nitrate were >90th percentile and TKN at >75th percentile versus ECBP background conditions).

Proctor Run (02-214) (RM 3.69) (EWH)

Proctor Run was sampled at three locations. Upstream at Park Rd. (RM 4.9) coarse substrates in riffles and runs were covered with a fairly uniform layer of fine dark brown silt. The short segment between the bridges may have been modified in the past. The water quality was still very good despite some issues with the resident macroinvertebrate community marginally meeting the EWH biological criterion. High quality sensitive organisms, like *Neophylax* and *Chimarra aterrima* caddisflies and *Stenonema vicarium* and *Diphetor hageni* mayflies, were among the predominant or common taxa in the sampled habitats. Raw sewage from septic tanks just upstream of the riffle lowered the macroinvertebrate community performance. Elevated TSS, ammonia, and TP concentrations were observed here exceeding the 75th and 90th percentile vs. ECBP background. Flatworms and blackflies were present in the riffles and runs with a low density of tolerant *Chironomus (C.) decorus* in the downstream pool. Tolerant *Physella* and *Helisoma* snails were the organisms predominant in the margins.

Near St. Rt. 559 (RM 3.2) Proctor Run was primarily a channelized grass-lined stream with mostly pea gravel and sandy substrates. The water was clear with a fairly good gradient forming occasional riffles. The upstream riffle had large amounts of rubble and consequently many more organisms. In fact, the high riffle density of macroinvertebrates and the greatly increased filamentous algal growth present indicated slight nutrient enrichment with many nutrient parameters at median to >75th percentile vs. ECBP background. The riparian width was still at least 25 feet or greater, but the sand and sediment bedload had increased. The source of the very high fecal coliform bacteria counts (i.e., >40,000/100 ml.) measured here could have been agricultural runoff and/or from failing septic systems. The macroinvertebrate community was very similar in quality to upstream despite the open canopy. The very good community marginally met the EWH biocriterion.

At McMahill Rd. (RM 1.7) this wooded stream reach was in exceptional condition. Due to closed canopy and a 40 - 150 ft. riparian corridor NPS nutrient inputs were minimized and ambient nutrient concentrations were at the median background concentrations. Proctor Run at this location was a picturesque, small to medium sized stream with coarse substrates. There were 22 mayfly and caddisfly taxa collected. Primarily sensitive benthic organisms were predominant or common in most habitats. Sensitive predominant organisms included *Chimarra aterrima* and *Neophylax sp.* (I) caddisflies and *Stenonema vicarium* and *S. mediopunctatum* (I) mayflies. A rare midge, *Eukiefferiella brehmi gr.*, was also collected among the high quality midge community present. Upstream community quality in Proctor Run could improve to exceptional quality if buffer protections and failing septic systems were improved.

Barron Creek (02-212) (RM 24.4) (EWH/WWH Recommended)

Barron Creek at RM 2.1 was a cool groundwater recharged stream (~ 60° F) that flows through an area of intensive row crop agricultural land use. Past channelization in the upper reach had occurred. The canopy was open with groomed grass buffer strips. Excess NPS nutrient inputs caused enrichment with gross algal production and a large biomass of aquatic macrophytes present. Substrates in the bottom of shallow pools were black and with little oxygen content from accumulated decayed detritus. In portions of the stream with open canopy all organisms were observed in areas with flow primarily on top of rocky substrates in the upper pools and upper margin edges (grasses). Other areas were not inhabited. Tolerant hydrobiid and planorbid snails and leeches were common at low densities in the open canopy pools. In contrast, under the bridge there was a better quality community in the shaded canopy, as the flow and cooler water temperatures provided a more amenable environment. Eight EPT taxa were collected in this soft shaded reach, including Pycnopsyche sp. and an intolerant stonefly, *Agnetina capitata complex*. The river snail, *Elimia sp.*, was the predominant macroinvertebrate in the riffle and rocky pools of this small refuge area. The cool groundwater recharge to Barron Creek ameliorated more severe impacts to the open canopy area of the stream which comprised most of the stream near Rosedale - Plain City Road. Barron Creek could harbor a higher quality macroinvertebrate community with a wooded riparian buffer. This canopy would provide essential shading and absorb some NPS runoff nutrients to reduce primary production which would significantly reduce the decaying algal/aquatic decaying biomass. This would have the

consequence of raising D.O. concentrations and protecting the resident macroinvertebrate communities.

Barron Creek near the mouth (RM 0.1) was impacted by livestock in an open pasture. Unvegetated banks had collapsed and a large amount of silt covered the rocky substrates and lowered water quality conditions at the stream bottom. TSS was recorded here as high as 48 mg/l (>90th percentile compared to ECBP background), and other NPS nutrient inputs, including nitrites, NH3, TKN, P, from upstream row crop agriculture and/or livestock inputs were >75th percentile to >90th percentile compared to ECBP background conditions. Cattle waste was present instream, as the fecal bacteria concentrations had counts as high as 60,000 and 80,000 / 100 mls.. Despite the turbid and silty conditions enough quality benthic organisms were still present and predominant in the slow run/pool sampled, that the narrative evaluation was marginally good. Fencing out livestock and stabilizing banks with a widened woody riparian corridor would improve water quality and biological diversity in lower Barron Creek and downstream below the confluence at RM 24.4 in a pivotal and environmentally sensitive reach of Little Darby Creek.

Wamp Ditch (02-363) (RM23.0) (Undesignated./MWH Recommended)

Wamp Ditch was sampled near the mouth downstream from Vogelsburg Rd. (RM 0.1) Upper Wamp Ditch drains primarily agricultural land and flowed through a 1/4 - mile long partially groomed, grass buffer (30-50 yards wide) into and through a small open pasture into Little Darby Creek at RM 23.0. There was evidence of nutrient enrichment. Pool bottoms were blackish with rotting algal detritus which precluded the use of the bottom substrates by the macroinvertebrate community. However, decent macroinvertebrate community diversity was still present on the available rocky substrates. Several higher quality cased caddisflies were collected yielding a total of nine EPT taxa. The snail-cased caddisfly *Helicopsyche borealis*, the river snail *Elimia sp.*, water pennies, and fingernail clams were either predominant or common in the riffle and runs. Scuds and corixids were also predominant, and the high densities of all of these organisms collected at all sampled habitats indicated nutrient enriched conditions. Despite the agricultural NPS influences the stream still yielded a marginally good community. Cooler water temperatures (61° F) from groundwater recharge lessened some enrichment effects. Decreasing NPS nutrient inputs and increasing shading adjacent to the stream would reduce algal production and would stabilize diel D.O. concentrations in the pool bottoms. This would allow for higher water quality instream and increased biological diversity. Higher quality water with lower nutrients and algal inputs and more stable dissolved oxygen concentrations would then flow into this sensitive area of Little Darby Creek.

Spring Fork (02-211) (RM 17.46) (EWH)

Spring Fork was sampled at five locations to more fully assess this confirmed EWH tributary of Little Darby Creek. Access at a historically sampled site at Lafayette - Plain City Rd. was denied, so the lower two miles were not re-assessed based on recent data.

Spring Fork upstream from Wren Rd. (RM 15.8) was of good quality but did not meet the EWH biocriterion. The lack of more caddisfly and dipteran diversity (low taxa totals) and a less

sensitive community present pointed toward lowered quality (Figures B.7.18 and B.7.19). Only eight EPT taxa were collected. NPS nutrient inputs had occurred as the parameters, from TSS (21 mg/l) to TKN (1.06 mg/l) and TP (0.15 mg/l) ranged from >75th percentile to >90th percentile compared to ECBP background conditions. Other evidence also indicated NPS nutrient inputs. Fecal coliform and E. coli counts were elevated. Tolerant *Physella* snails or facultative taxa, like *Stictochironomus sp.* midges, were predominant or common in the runs, pools and margin and also indicated a community of warmwater quality. Other tolerant taxa collected included leeches and more tolerant dragonflies. The QCTV (36.2) was lower than the value typically associated with an exceptional macroinvertebrate community.

Spring Fork community quality improved downstream near State Route 29 (RM 13.3). Increased community diversity and quality (13 EPT taxa and 58 total taxa) was present, as the number of sensitive taxa collected doubled (Figures B.7.18 and B.7.19). A few sensitive taxa collected included the intolerant mayfly *Pseudocloeon frondale*, the Cylindrical Papershell mussel (*Anodontoides ferussacianus*), *Ceratopsyche C. morosa gr.* caddisflies, and several moderately intolerant midges (e.g., *Tvetenia bavarica*, *Nilotanypus fimbriatus*, and the cool water *Parametriocnemus sp.*). There were increased densities of filterers with facultative taxa predominant and increased periphyton, present in response to similar continued NPS inputs upstream. A more consistent and wider woody riparian buffer upstream would help limit nutrient inputs, lower instream water temperatures, and better protect water quality.

Figure B.7.18. Longitudinal trends in the Invertebrate Community Index and the number of Sensitive Taxa collected in Spring Fork in 2001.

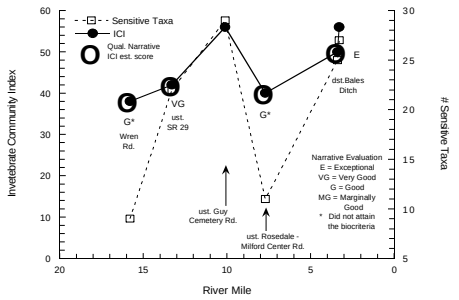
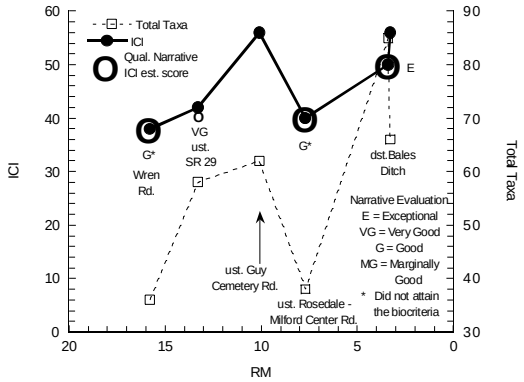


Figure B.7.19. Longitudinal trends in the Invertebrate Community Index and the total number of taxa collected in Spring Fork in 2001.



Good but intermittent riparian corridor present along Spring Fork upstream from Guy Cemetery Rd. was sufficient quality to still support an exceptional warmwater macroinvertebrate community. The ICI at RM 10.1 was 56 with a high quality community present. Where the stream buffer was limited, increased high flow storm water inputs had caused erosion through destabilized banks and increased the sediment/sand bedload. The accumulation sand and silt in the margin, runs, and pools had covered some of the rocky substrates and decreased habitat

quality. Where the permanent, stable rocky substrates were present and not covered or embedded by silt or sand, there was a diverse sensitive community present. Failing to connect woody riparian buffers will continue to allow erosion, sedimentation, and nutrient inputs to destabilize Spring Fork habitat.

A decrease in total taxa and the number of sensitive organisms present occurred downstream in Spring Fork near Rosedale - Milford Center Rd. (RM 7.7) (Figures B.7.18 and B.7.19). The baetid mayfly population decreased from upstream. There was some decent riparian area on the left bank for a short distance upstream from the sampled area, but the channel was choked with sediment. Upstream right was a hay field and/or an open pasture. Row crop agriculture was adjacent to the left bank upstream. NPS nutrient and sediment inputs were increased in this reach, as nitrate (5.06 mg/l) and other parameter concentrations were greater than the 75th percentile to >90th percentile compared to background. TSS was at the highest measured concentration (32 mg/l) in Spring Fork at this site. Also an *E. coli* concentration of 58,000/100ml. was measured and indicated manure inputs. Only eleven EPT taxa were collected compared to 20 total EPT taxa upstream. The number of sensitive and total taxa collected decreased, as the inhabitable areas on wood and rock substrates that were not embedded by sediment was very limited. Also all of the caddisfly cases were empty. Quality conditions apparently worsened in late summer and triggered a complete hatch. Facultative organisms, such as riffle beetles, the red midge *Stictochironomus sp.*, fingernail clams, corixids and *Stenacron* or *Stenonema femoratum* mayflies were predominant in all sampled habitats. This community structure indicated good, but not exceptional community quality. Decreased sedimentation and increased bank stabilization via exclusion of livestock with riparian corridor widening would be recommended actions for improving Spring Fork water quality and to attain the EWH biocriterion in this reach.

Downstream from Bales Ditch there was an exceptional community present at RM 3.4 and RM 3.3. The previous year to sampling (2001) a beaver pond had still impounded Spring Fork here and was breeched by high flows the next year. The treed riparian corridor on the east bank was removed to prevent the reestablishment of the impoundment. So the stream channel was not quite as defined at RM 3.4, and a second set of colonizers were set downstream in the more defined channel. Similar results were observed, as the macroinvertebrate community at RM 3.4 was narratively assessed as exceptional, and the sample at RM 3.3 scored an exceptional ICI of 56. There was some increase in density (754 organisms/ft.^{2}). Also aquatic macrophytes covered most margins and filled the slow run channel. Sediment from upstream NPS inputs (i.e., erosion and runoff from agriculture fields) had accumulated in the impoundment area and had caused some embeddedness. Silt deposition had also covered the tops of most rock substrates and most of the aquatic macrophytes present. Some high flow scouring and erosion had already occurred where the adjacent woody riparian corridor had been removed. The reestablishment of a consistent wooded riparian corridor in this lower section of Spring Fork would protect against erosion, shade the stream, and absorb and limit the impacts of nutrient inputs and siltation which, if unchecked, could destabilize the exceptional Spring Fork water quality.

Downstream from Green Meadows MHP WWTP there was a violation or near violation of the mean instream D.O. concentration on 22 August 2002 at Lafayette - Plain City Rd. (RM 0.75). Numerous elevated fecal bacteria concentrations were recorded, and all nutrient parameters, especially ammonia (not recorded elsewhere in Spring Fork) were elevated overall to the highest collective concentrations observed in Spring Fork (>75th or >90th percentile compared to ECBP background conditions). This indicated nutrient enrichment and associated low diel D.O. concentrations, as the accumulated algal biomass decayed. Numerous violations of dissolved oxygen, TSS, cBOD, and fecal coliform bacteria have continued to be documented (M. Gallaway, personal communication - 11/21/2003). The biological conditions were not assessed in this reach as planned, because access was denied. Due to the sensitivity of lower Spring Fork and the vitally important habitat in Little Darby Creek immediately below the confluence at RM 17.4, it is imperative to adequately sample downstream from Green Meadows MHP to assess its potential impact to Spring Fork and Little Darby Creek and protect downstream habitat and water quality.

Bales Ditch (02-362) (RM3.64) (Undesignated/ WWH Recommended)

Bales Ditch at Rosedale - Milford Center Rd. (RM 0.4) was a small cooler (62° F) tributary to Spring Fork that drained an area west of Plumwood and emptied into Spring Fork at RM 3.64. Despite some past channelization, the good macroinvertebrate community present in this partially recovered stream met the WWH biocriterion. There was a decent riparian corridor of grass - lined banks for 20-30 feet with some small trees and bushes for greater than 30 yards on both banks. Algal accumulation on the rocky substrates with some black organic detritus present in some pools confirmed NPS nutrient inputs upstream (i.e., nitrate at 8.28 mg/l which was >95th percentile with other nitrogenous parameters at >75th percentile compared to ECBP background conditions). Ten EPT taxa and 53 total taxa were collected with mostly sensitive organisms predominant in the riffles and pools (*Helicopsyche borealis* caddisflies, *Elimia* snails, water pennies, and riffle beetles including *Optioservus fastiditus*). Other high quality taxa collected included a small *Leptophlebia* / *Paraleptophlebia* mayfly, the caddisfly *Chimarra obscura*, and several moderately intolerant midges. Preserving and strengthening the riparian corridor upstream will keep and improve the macroinvertebrate community quality in Bales Ditch and improve the water quality input into Spring Fork.

Hellbranch Run and Tributaries

Hellbranch Run (02-204) (RM 26.1) (WWH)

Hellbranch Run, formed at the confluence of Hamilton Ditch and Clover Groff Ditch, was sampled at six sites, and the scores ranged from good to an exceptional score of 50. The upstream sample site was two miles below the confluence and well downstream from Alton Rd. at RM 9.4. There was a fairly good woody riparian corridor adjacent to both banks, but siltation from upstream sources still was affecting substrates. There was some algal production and slight enrichment from elevated nutrients (i.e., TKN and TP at >90th percentile and all other nutrient parameters were >75th percentile vs. ECBP background). The moderately intolerant tanytarsini midges were predominant *(Rheotanytarsus sp., R. pellucidus*, and *Tanytarsus*

glabrescens group Type 7 midges) in the riffle, run and pool habitats. The tanytarsini midges together comprised over 50 percent of the total benthic organisms collected with a combined weighted average ICI of about 44. Besides the predominant *Rheotanytarsus* and *Tanytarsus* midges, there was also good mayfly and caddisfly colonization, and the actual ICI scored at this site was a 46 (exceptional). This score occurred despite an increased *Hydra* and flatworm population (artifact of the more open, pooled conditions upstream, excess nutrients and the subsequent presence of suspended and settled solids of algae and some other organic solids). Decreased upstream NPS siltation inputs and more riparian shading further upstream would further benefit stream quality and allow diversity to increase.

The Hellbranch Run macroinvertebrate community improved near Kunz Rd. at RM 7.4. Silt embeddedness was still an issue, but the habitat overall had improved. The nutrient inputs were decreased from upstream concentrations to median levels (compared to ECBP background conditions). Seventeen EPT taxa were collected, and nearly 42 percent of all taxa found were categorized as sensitive (i.e., moderately intolerant or intolerant). Tanytarsini midges, *Baetis* mayflies, and *Cheumatopsyche sp.* caddisflies were predominant with good density and diversity of other mayflies present (the common *Stenacron sp.* and the intolerant baetid mayfly *Acerpenna pygmaea* to the less represented *Stenonema pulchellum* (MI) and intolerant *S. exiguum*). A decrease in NPS silt inputs via storm water and/or unprotected banks eroding and wider riparian corridors would allow even greater diversity and quality in this reach of Hellbranch Run.

Hellbranch Run macroinvertebrate community quality decreased to good downstream from Oakhurst Knolls WWTP (RM 5.7) and adjacent to the golf course. Only TKN and TP concentrations were consistently >75th percentile with one TP spike of 0.307 mg/l, which was likely linked to post-storm water runoff, that was >95th percentile compared to ECBP background conditions. The *E. coli* bacteria counts were elevated and at higher values than other Hellbranch Run sample sites. The number of sensitive organisms significantly decreased compared to the previous upstream sample site. This was the only benthic invertebrate site that did not at least marginally attain the Exceptional Warmwater Habitat criterion. Periodic inflow and infiltration issues need addressed and resolved at the Oakhurst WWTP to prevent possible bypasses/spills of partially treated or untreated waste. Nutrient runoff from the golf facility could also be affecting the macroinvertebrate community downstream, and care needs to be taken when applications of nutrients or herbicides/pesticides might occur (e.g., upcoming weather conditions) to prevent runoff into Hellbranch Run.

Better developed riffles with large rubble and boulder substrates were present downstream from Beatty Rd. (RM 3.7) with *Chimarra* and Hydropsychid caddisflies, Baetid mayflies, *Caenis* mayflies and Tanytarsini midges predominant. *Elimia* snails, riffle beetles, and hydroptilid caddisflies were also predominant in the run or other habitats. The highest ICI score of 50 was recorded here. Sixty-two percent of the collected taxa were sensitive organisms. The density in this reach was less due to decreased nutrient inputs with most parameters at median levels compared to ECBP background conditions and decreased algal production from the more mature, treed, riparian corridor that shaded Hellbranch Run from an almost complete stream

canopy. Algal production had occurred where direct sunlight was still prevalent coloring the water greenish-brown. Some siltation was still evident and the observed embedded substrate conditions reduced the abundance of stenonemid mayflies with very few collected. Continued efforts to decrease NPS sediment and nutrient inputs should permit even greater water quality and biological diversification.

Downstream from Lambert Rd. (RM 0.9) a diverse macroinvertebrate community was collected with 16 qual. EPT taxa and 80 total taxa collected. *Chimarra* and hydropsychid caddisflies, baetid mayflies, riffle beetles and *Elimia* river snails were the predominant organisms in this very good or *marginally exceptional* community. Unfortunately additional siltation had caused more embeddedness and some soft depositional substrates in pool bottoms and along some margins. Chemical inputs had caused more suspended algae and attached algal matter in the runs. Possible sources include a small school WWTP upstream and/or adjacent agricultural fields. The excessive number of snails yielded an imbalanced or skewed community. With reductions in sediment inputs and wider riparian partitions to capture runoff constituents, the less abundant, sensitive, benthic organisms present will become more populous with reduced chronic stressors. More intolerant stenonemid mayflies should appear with less siltation and embeddedness.

Hellbranch Run downstream from the Timberlake Subdivision WWTP toward the mouth (RM 0.5) was sampled in 2001. This WWTP has a history of poor plant management and no plant maintenance. Highly elevated NH_3 , TP, and TKN concentrations were recorded downstream along with minimum low D.O. violations. A very good macroinvertebrate community was observed that was lower in EPT taxa and overall diversity. Stenonemid mayflies were not found, and leptocerid caddisflies were less abundant. Algal production had decreased some but the substrates were highly embedded from accumulated silt.

Another colonizer was set at RM 0.5 in 2002 because it was lost in 2001. Due possibly to increased scrutiny on the WWTP operations, the macroinvertebrate community quality appeared slightly better but was still categorized as Very Good. The number of EPT taxa and sensitive taxa had increased, including *Stenonema exiguum* (I) and (MI) *S. pulchellum* and several sensitive midges. Also, three mussel taxa were noted in this lower reach: the Wabash Pigtoe (*Fusconaia flava*), the creeper (*Strophitus undulatus*), and the rainbow mussel (*Villosa iris iris*). With the Timberlake Subdivision WWTP tying into a regional WWTP by 2005, improvement to a solidly exceptional macroinvertebrate community downstream would likely occur soon after tie-in had occurred. Sediment accumulation along with nutrient inputs would still be the biggest detriment to deal with in the lower Hellbranch Run.

Clover Groff Ditch (02-245) (RM 11.19) (WWH)

Clover Groff Ditch, the eastern tributary contiguous with Hilliard and metropolitan Columbus, was sampled at Roberts Rd. (RM 4.7). Accumulated sediment trapped in the modified, entrenched channel covered most rocky substrates and neutralized most of the habitat, and gray septic storm water inputs from the adjacent suburban area collectively caused enriched conditions that were likely periodically toxic. The Modified Warmwater Habitat biocriterion

was not met, as poor macroinvertebrate community performance was documented. The poor quality community present had no mayflies or caddisflies, and approximately 37 percent of the taxa collected were tolerant to various negative effects. Numerous elevated fecal bacterial counts were measured, and NPS parameters like ammonia (**0.278** mg/l), nitrite (0.05 mg/l) and TP (**0.912** mg/l) were greater than the 90th or the 95th percentile compared to ECBP background conditions. These same parameters and also TKN had consistently exceeded the 75th percentile of ECBP background conditions. Predominant organisms were increased numbers of filtering midges *Polypedilum flavum* and *Glyptotendipes (G.) sp.* and fingernail clams which inferred enriched conditions. Leeches, tolerant of periodic low dissolved oxygen, were common in all habitats and was one of the predominant pool organisms. Steps to hold, slow down and/or treat NPS municipal storm water runoff should be considered to improve the quality of Clover Groff Ditch. Decreased upstream sedimentation would allow flushing and utilization by the macroinvertebrate community of some of the rocky or firm substrates present in the bottom substrates but currently buried or covered.

Clover Groff Ditch sampled downstream near U.S. Rt. 40 at RM 0.8 scored an ICI of 20. This biological score did not attain the WWH biocriterion, though the macroinvertebrate community quality was much improved with six EPT taxa and more sensitive taxa present. Embedded natural substrates was one factor that limited the population diversity and size. The lower population density collected (167/ft.^{2}) was expected given the more closed riparian corridor and canopy upstream from the sample site. Other possible adverse inputs affecting this downstream macroinvertebrate community were: upstream inputs from discharges (i.e., Cypress Wesleyan School WWTP at RM 1.30 which had poor plant maintenance and discharge flows double of plant capacity, failing on-site septic systems discharges, and NPS nutrient inputs. Some elevated *E. coli* concentrations indicated the presence of some form of organic waste inputs. The highest recorded NH_3 and TP concentrations were still >90th percentile vs. ECBP background, and all nutrient parameters including ammonia, nitrite, TKN, and TP were commonly >75th percentile compared to ECBP background conditions. With orders for the Cypress School discharge to be connected to the city of Columbus sanitary sewer and upstream construction slowing, any riparian corridor widening and reductions in sedimentation would allow improvements in water quality and in the macroinvertebrate community.

Hamilton Ditch (02-259) (RM 11.19)

Hamilton Ditch, the more rural western tributary forming Hellbranch Run, was sampled upstream from Walker Rd., at RM 3.4. Upstream influences were agriculture with a portion of the stream adjacent to some single lot homes. More building of subdivisions is ongoing a couple of miles upstream from Walker Rd. The stream segment sampled was channelized in the past and was still mostly straight and entrenched typical of a Modified Warmwater Habitat Stream segment. The slow current combined with the physical limitations of entrenched channels resulted in trapped sediment. So the channel substrates were partially embedded with silt/sediment decreasing the available rocky or hard substrates. There still was some cobble, a little rubble, and some wood with some smaller gravel usually covered in silt. Values of **140** mg/l and **96** mg/l **TSS** were among the highest, if not the highest concentrations collected during the survey (>95th percentile or higher compared to ECBP background conditions). A

small area with collapsed banks formed a faster riffle area, and *Rheotanytarsus sp.* midges and hydropsychid caddisflies were resident there. This indicated some potential if natural stream development could occur. Some *Oecetis* pupae were attached to larger cobble or rubble in the run where larger rocky substrates were not affected by accumulated sediment. These were the only two EPT taxa collected, and only four organisms present were categorized as moderately intolerant. Predominant organisms were water boatmen, *Rheotanytarsus sp.* midges, *Oecetis* caddisflies, and dragonflies. Tolerant organisms, though, comprised 33 percent of the taxa collected in response to the extremely elevated agricultural and municipal NPS chemical inputs. Ammonia (**0.40** mg/l), TKN (**1.61** mg/l), and TP (**0.443** mg/l) had concentrations that exceeded the 95th percentile, and all of the other common nutrient parameter measurements except nitrate exceeded the 90th or the 75th percentile compared to ECBP background conditions. The fair macroinvertebrate performance met the MWH biocriterion, but by decreasing the NPS sediment, organic, and chemical inputs and allowing some natural stream development Hamilton Ditch water quality could greatly improve.

At RM 0.5 Hamilton Ditch upstream from U.S. Rt. 40 attained the WWH biocriterion with an ICI score of 40. There was eight EPT taxa collected including a stonefly, and the midge community had fairly good diversity. Attainment occurred despite a low gradient, pool and slow run habitat (lack of riffles) with silt and clay substrates that was prevalent in that reach. Slow current had likely reduced mayfly and caddisfly colonization. Predominant organisms in the "riffles" and runs from qualitative sampling were tanytarsini midges and other midges, and the stick-cased Leptocerid caddisfly *Mystacides sepulchralis*. The number of tolerant and facultative organisms like oligochaete worms, isopods, and *Physella* snails will decrease with decreased NPS inputs upstream. The nutrient parameters were lower than upstream but still very elevated (NH_3, TKN, and TP) to the 90th percentile vs. ECBP background conditions in some nutrient parameters.

Lower Big Darby Creek Tributaries (downstream from Little Darby Creek to the mouth)

Smith Ditch (02-353) (RM 31.69) (Undesignated/WWH Recommended)

Smith Ditch, a tributary to Big Darby Creek that enters downstream from the Little Darby Creek confluence, was sampled near Georgesville-Wrightsville Rd. at **RM 2.1**. There was an exceptional macroinvertebrate community present with the high quality habitat supporting a diverse, sensitive community. Cobble and boulders were present with deep pools ($\geq$ 80 cm) along with smaller substrates. All habitats were predominated by sensitive organisms which included *Chimarra* and *Neophylax* caddisflies, water pennies, Tanytarsini midges, and *Elimia* river snails. Almost forty percent of the macroinvertebrate taxa collected were species classified as sensitive organisms. Minimizing NPS inputs (elevated TP, fecal bacteria counts) will keep Smith Ditch a high quality, exceptional stream.

Smith Ditch near the mouth and downstream from Biggert Rd. (**RM 0.2**) was not quite as diverse due to some embeddedness from NPS sedimentation, but an exceptional community was still present. Moderate to high diversity was observed in the riffle and run habitats. The QCTV of 39.7 was improved compared to upstream and appropriate for an exceptional

community. *Chimarra aterrima* and *Helicopsyche borealis* caddisflies and *Rheotanytarsus pellucidus* midges were among the predominant organisms with good numbers of mayflies present. The intolerant baetid mayfly *Diphetor hageni* and moderately intolerant *Stenonema vicarium* mayfly were also collected, as well as a high quality midge community. Notable midge taxa included the intolerant *Stempellinella n. sp. nr. flavidula*, the cold water midge *Paratanytarsus n. sp. 1*, and the MI midge of the *Tvetenia bavarica group*. A decrease in upstream NPS sedimentation and flashy storm water inputs will keep Smith Ditch at a very high quality and continue to contribute high quality water to Big Darby Creek.

Gay Run (02-298) (RM 26.48) (Undesignated/WWH Recommended)
Gay Run was sampled downstream from Boyd Rd. (RM 0.2) near the mouth. A fairly nice riparian corridor was present which served to protect the varied instream habitats. There was a good quality macroinvertebrate community present, and the WWH biocriterion was met. The common *Cheumatopsyche sp.* caddisflies were predominant in the riffles and slow runs with *Chimarra aterrima* caddisflies and Stenonemid mayflies common. Facultative red midges *Stictochironomus sp.* were predominant in the pools. Eight total EPT taxa were collected, and several of those caddisflies (hydroptilid and leptocerid cased caddisflies) and *Stenonema femoratum* mayflies were commonly found in some or all sampled habitats.

Springwater Run (02-203) (RM 24.0) (WWH)
Springwater Run was sampled near U. S. Rt. 62 (RM 0.8) to assess the biological community and any impacts from the small town of Harrisburg. Elevated fecal bacteria counts and nutrient runoff {i.e., nitrate, TKN, and TP ranging from >75th to >90th percentile (TP = 0.22 mg/l)} yielded nutrient enriched conditions with mats of algae coating the stream bed. Only three to four caddisfly and mayfly taxa were collected. The 28 total taxa found was relatively low. Tolerant Physella snails were among the predominant organisms in all habitats present. The abundance of tolerant snails and low diversity yielded a fair macroinvertebrate community which did not meet the recommended WWH biological criterion. Harrisburg is currently unsewered with septic tank leachate reaching the stream. Ways to sewer this community and tie it into the PCI WWTP are currently being investigated. This should greatly reduce nutrient and waste inputs to Springwater Run. Increasing shading along Springwater Run by allowing growth of trees would also reduce instream water temperatures at least 4 to 5° C, limit algal production, and stabilize dissolved oxygen concentrations.

Unnamed Tributary to Big Darby Creek (aka Clarks Lake Outlet) (02-270) (RM 20.2) (Undesignated/WWH Recommended)
The tributary to Big Darby Creek at RM 20.20, also known as the Clarks Lake Outlet, was sampled at Harrisburg - Darbyville Rd. (RM 0.8) to assess the impact of the Clark Lake subdivision WWTP on stream resource quality and to determine the appropriate aquatic life use designation. There were definitely fecal bacteria inputs. Nutrient inputs were also highly elevated. Some ammonia (0.529 mg/l) and nitrite (0.228 mg/l) concentrations were >95th percentile, and TKN (1.16 mg/l) and TP (0.216 mg/l) concentrations were >90th percentile compared to ECBP background conditions. Other nitrite, TKN, and TP values were still

elevated above the 75th percentile versus ECBP background conditions. As a result of these nutrient inputs and suspended algal production, the filtering Tanytarsini midges were predominant in the riffles and runs. The high density of these organisms in the riffles indicated some nutrient enrichment. Other predominant organisms included *Helicopsyche borealis*, the facultative red midge *Stictochironomus sp.*, and *Elimia* river snails. (*Neophylax* caddisfly cases were abundant, but all were empty, possibly from some stressor.) Overall though, the nine EPT taxa documented, and the 42 total taxa collected indicated good community quality and diversity despite the nutrient inputs. Waste treatment systems at Clark's Lake will be tied into sewers delivering wastes to the PCI Regional WWTP. This decrease in nutrient and waste inputs will allow improvements in water quality in this tributary and in turn higher water quality into Big Darby Creek in a vitally important reach based on its biodiversity and number of rare species.

Unnamed Tributary to Big Darby Creek (02-366) (RM 18.41) (Undesignated/WWH Recommended)

The Unnamed tributary to Big Darby Creek was sampled near its mouth. The small, permanently-flowing stream with cool groundwater recharge (17.2° C) was recovering from past channelization near the mouth. Small trees had regrown and were present down in the entrenched channel and caused development with shallow pool formations with meanders in the bottom substrates in response to permanent structure. There were mostly sand and silt substrates, but where higher gradient occurred coarse gravel, cobble and wood were some of the larger riffle substrates present. Where stable substrates were present, good diversity was also present. Forty three total taxa including a fairly diverse midge community and 8 EPT taxa (including the intolerant *Neoperla clymene complex* stonefly) indicated the presence of a good quality macroinvertebrate community. The accumulated sediment in BDC at the tributary mouth was from NPS sedimentation into Big Darby Creek and the erosion of the exposed, unstable unprotected banks at the mouth. The banks of the lower tributary and at the mouth need more woody growth to stabilize them and stop further erosion.

Greenbrier Creek (02-202) (RM16.75) (WWH)

Greenbrier Creek at Mt. Sterling - Commercial Point Rd. (RM 2.7) marginally attained the WWH biocriterion. Potential sources of stress upstream included agriculture NPS run-off and the unsewered village of Derby. The mostly closed riparian corridor and the considerable distance from those inputs permitted instream recovery to take place and some sensitive benthic organisms to be collected. However, only seven EPT taxa were found with no baetid mayflies present. There was some embeddedness and elevated nutrient inputs from NPS sources upstream (e.g., storm water, sedimentation, septic, and agricultural inputs). Nitrate {(7.57 mg/l) and TP (0.216 mg/l) were highly elevated (>90th and >95th percentile with most other parameters >75th percentile compared to ECBP background conditions)}. The low D.O. violation (3.07 mg/l) could have been related to decaying grass dumped into the stream. The filtering midges, *Rheotanytarsus* sp. and *Polypedilum flavum* midges were predominant in the riffle in response to the nutrient inputs noted above and subsequent suspended algal particles. A mixture of sensitive and facultative organisms (i.e., water pennies, red midges, *Stenonemid* mayflies, and damselflies) were predominant in the other habitats and were indicative of a

marginally good quality community. The sewer project sending waste from unsewered Derby to the PCI Regional WWTP within the next two years will decrease nutrient inputs and should improve downstream biological performance in Greenbrier Creek.

Greenbrier Creek was also sampled upstream from Burro Lane (RM 1.3) and upstream from the unnamed headwater trib. (at RM 1.2) adjacent to Burro Lane in 2002. Good habitat quality upstream in the reach supported a very good macroinvertebrate community. Most NPS nutrient inputs were less than upstream but some (i.e., TSS, nitrate, and TP) were still greater than the 75th percentile versus ECBP background. The number of sensitive taxa, EPT taxa, and total taxa increased when compared to upstream. Some sensitive taxa collected included the mayfly *Stenonema vicarium*, the MI midge *Nilotanypus fimbriatus*, and *Chimarra obscura*, and *Helicopsyche borealis* caddisflies. Decreasing sedimentation and widening the riparian corridor would further protect Greenbrier Creek and further improve water quality. It should be noted that a good number of salamanders were present here in the edges of rocky margin habitats.

Greenbrier Creek was sampled at RM 1.1 in 2001 below the unnamed tributary and adjacent to Burro Lane. The macroinvertebrate community was poorer than the site sampled at RM 1.3 upstream. The stream bottom was hardened and looked scoured with a very limited macroinvertebrate community present. From here downstream the channel was dry (sampled in 2001, a drought year, and site was down in floodplain where infiltration/interstitial flow apparently began to occur - a "losing stream"). Upstream in the tributary some stream channelization had recently occurred with sediment runoff a consequence. Also there were open burro pastures with some bare slopes upstream that had likely contributed to bank instability, erosion and silt/sediment loads downstream which would cause hardened substrate conditions. These conditions were not present in 2002. The burros were gone which permitted the grass to re-establish on the slopes and no further stream manipulations had been conducted. Also with normal precipitation the lower portion of Greenbrier Creek was free flowing. The pool sampled in 2001 at this site had been dry prior to sampling due to drought and subsurface flow and had only refilled from a recent rain (it had rained heavily 1-2 days prior to sampling), permitting only a pioneering community to re-establish. Regardless, sampling in 2002 documented that any impacts from 2001 were temporary and the 2002 sampling at RM 1.3 indicated very good quality conditions.

Georges Creek (02-201) (RM 16.75) (WWH)

The sample site in Georges Creek at RM 0.5 was in a habitat-limited reach due to past channelization and diked conditions. There were small trees in the riparian area adjacent to the diked portion of Georges Creek. Six caddisfly taxa were collected, including the moderately intolerant *Chimarra aterrima* and the cold water caddisfly *Diplectrona modesta*. No mayflies were observed though. Other sensitive taxa present included water pennies, *Helichus*, and *Macronychus glabratus* beetles, *Helicopsyche borealis* caddisflies, and the predominant *Rheotanytarsus* sp. midges. The QCTV was 39.3 which is usually indicative of good biological performance. The marginally good macroinvertebrate community performance marginally met the WWH biocriterion. Upstream at London Rd. some stream "maintenance" had occurred with the substrates pushed around and out of the stream channel. This coincided with the fish

sampling location. The channel had been excavated and debris piled on the banks adjacent to London Rd.

Lizard Run (02-273) (RM 12.93) (Undesignated/LRW)

Lizard Run was sampled at Main St./London Northern Rd. (**RM 0.2**) in Darbyville. During sampling (2001 drought year) the stream was completely dry except for a small pool under the bridge. An extremely limited aquatic community was present (three taxa). Lizard Run seemed to be mostly a flashy storm water conveyance (hard-packed bottom) to Big Darby Creek (at RM 12.93). The site was likely also where the stream, when flowing, would sink into the floodplain and become a "losing stream". Until sampling further upstream to confirm an alternate use designation, a Limited Resource Water Use designation was recommended.

B.7.2 Changes in Biological Community Performance: Macroinvertebrate Communities

Big Darby Creek Mainstem: 1977 to 2001-02

Big Darby Creek has been surveyed numerous times since 1979 by the OEPA with one sample prior to that time, in 1977. Despite some taxonomic differences that would improve earlier scores marginally, the 1979 survey data revealed poorer instream biological community performance in some segments particularly in the upper portion which were associated with point sources or unsewered communities. There were consistently higher percentages of dipteran taxa and tolerant organisms which indicated greater contributions of wastewater. One segment with lowered community performance extended from downstream of the then unsewered Village of Milford Center (~ RM 66) to Ranco, Inc. near Plain City (~ RM 53). The other area of fair macroinvertebrate community performance was also associated with point source dischargers. This segment extended from approximately U.S. Rt. 40 (RM 40.6) downstream to RM 36. Point source dischargers immediately upstream from this impacted segment included Olen Corporation, Camp Wissalohican (an unsewered community at the time), Battelle Memorial Institute, Camp Ken-Jockety and immediately upstream Lake Darby Estates WWTP and the Greentree MHP. A small WWTP at Darby Dan Farms contributed directly to the segment. All sites downstream from the Little Darby Creek confluence to the lowest sampling site in the Big Darby Creek mainstem either met or marginally met the EWH biocriterion in 1979 (Figure B.7.2.1).

The 1986-1988 data indicated decreased community quality in response to pollutants associated with growth and development in the upper watershed particularly in the area affected by development associated with Honda, Flat Branch and North Lewisburg. Some issues that affected the macroinvertebrate community in the late 1980s were also evident downstream from Buck Run, near Ranco, U.S. Rt. 42, and Robinson Run (Figure B.7.2.1). The Plain City WWTP and nonpoint source issues from Buck Run still impacted macroinvertebrate community quality during the 2001/2 water quality survey.

Macroinvertebrate sampling results from 1990-1993 revealed that WWTP upgrades and subsequent improved wastewater treatment had facilitated improvements in macroinvertebrate community performance in the upper Big Darby Creek watershed. This included segments upstream from Plain City and from upstream from I-70 to downstream from U.S. Rt. 40. The upgraded Lake Darby Estates WWTP, which is situated just upstream from Rt. 40, has experienced improved effluent quality for the past ten years as a result of improved and relatively consistent plant operation. However, some larger rain events have hydraulically overloaded the WWTP resulting in episodes of poorer effluent quality. This has resulted in ICI scores from 1990-93 ranging from 50 to 34 in different sample years (Figure B.7.2.2). Samples near Harrisburg, Orient, and downstream from the PCI WWTP showed some improvements but also some inconsistencies (i.e., ICI range of 42 to 56) with storm water inputs and wastewater overflows after rain events that negatively affected the community quality.

The 1997 sampling recorded the effects of the ODOT project that relocated the upper Big Darby Creek mainstem, as scores at RM 82.5 and RM 81.5 were decreased. At RM 82.5 in 2002 the ICI of 46 indicated recovery to exceptional conditions, though the riparian tree canopy was still immature and more open conditions were still present (Figure B.7.2.3).

Figure B.7.2.1. Longitudinal and temporal trends in the Invertebrate Community Index based on sampling conducted in the Big Darby Creek mainstem in 1979 and 2001.

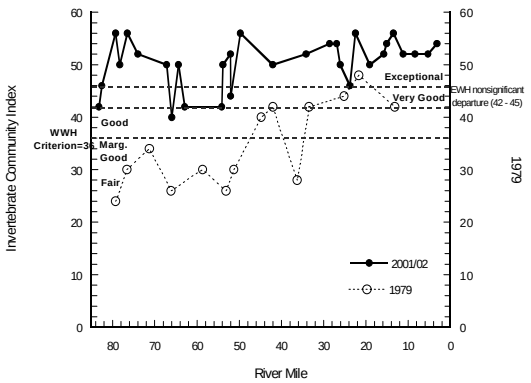


Figure B.7.2.2. Longitudinal and temporal trends in the Invertebrate Community Index based on sampling conducted in the Big Darby Creek mainstem in 1979, 1986/88, 1990-93 and 2001/02.

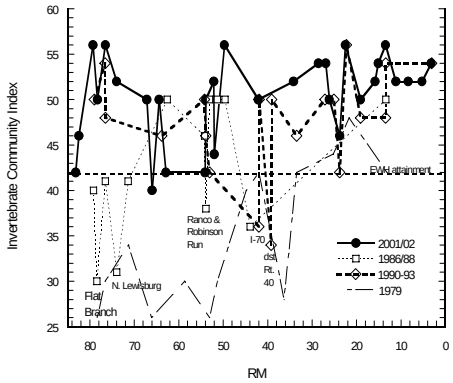
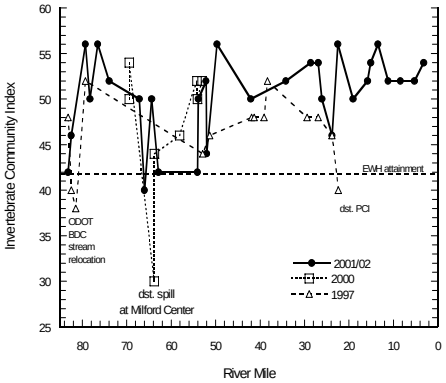


Figure B.7.2.3. Longitudinal and temporal trends in the Invertebrate Community Index based on sampling conducted in the Big Darby Creek mainstem in 1997, 2000, and 2001/02.



Downstream from the Pickaway Correctional Institute WWTP in 1997 the ICI was 40. Plant improvements were ordered by the Director of the Ohio EPA through Director's Final Findings and Orders (DFFOs) to ensure compliance with the Clean Water Act's general water quality criteria normally referred to as "Free Froms" (OAC 3745 -1 - 04) and total suspended solids (TSS) limits. Additionally the PCI WWTP will be expanded to accommodate the connection of package WWTPs with operational problems and unsewered areas. More consistent operation at the WWTP in recent years have resulted in improvements in stream quality downstream from the discharge with an ICI of 56 recorded in 2001 (Figure B.7.2.3).

The eliminations of these WWTPs and local unsewered areas should benefit stream quality downstream from Harrisburg to Scioto Darby Rd.

The 2000 samples were collected in response to a large release of organic material that was discharged from an agricultural supply company in Milford Center (~ RM 66) that killed a large percentage of fish, insects and mussels residing in a segment extending five miles downstream from the spill. Fair quality conditions were observed at RM 63.8 soon after the spill passed downstream. Other sites downstream were sampled prior to the plume of the spill reaching that location. Follow-up samples collected in late summer indicated significant recovery had occurred. However, the vast majority of the bivalve mussel community was killed. Some mussels did survive and were observed through the sampled reach in September 2000. Sensitive benthic organisms like burrowing mayflies, *Lype sp.* and polycentropid caddisflies were also severely degraded. This site still had not recovered by 2002 (i.e., ICI of 40 at RM 66.0) (Figure B.7.2.3).

Major upgrades and improvements have occurred, are ongoing, or planned for many WWTPs (e.g., PCI, Plain City, West Jefferson, Mechanicsburg- pending). Also new regional plants (Darbydale and PCI) will soon begin accepting wastewater from currently poorly functioning small WWTPs (e.g., Oak Hills MHP and Foxlair MHP) and provide service to the unsewered communities, like Darbydale, Derby, and Harrisburg. The elimination of inadequately treated or untreated domestic sewage, particularly between RM 34 and RM 19, should improve water quality significantly in a very sensitive reach of Big Darby Creek. Widely adopted storm water controls would assist in stabilizing downstream habitat which is strongly suspected as a contributing factor towards the decline of bivalve molluscs and other habitat sensitive species.

Flat Branch (02-223) (RM 78.48) (MWH): 1988 - 2001
The Flat Branch macroinvertebrate community showed improvement towards the mouth in 2001 compared to 1988 and 1997 surveys. More stabilization in the subwatershed (i.e., less construction and NPS inputs) allowed increased diversity in the macroinvertebrate community. There still were increased nutrients and TSS, though that affected Big Darby Creek water quality in 2001 downstream from the confluence (i.e., low dissolved oxygen concentrations).

Little Darby Creek (02-251) (RM 78.48) (Undesignated/ EWH Recommended):1988-2001
All of the samples over the years in Little Darby Creek (Logan County) met the EWH biocriterion except for the 1988 sample which was evaluated as good. The upper site in 2001 at RM 3.5 (ICI of 54) ranked higher than the 1997 upstream sample at RM 3.7 of 44 which was marginally exceptional. The riparian corridor in 2001 along a majority of the stream had been continuous and relatively wide and, therefore, supported greater diversity. However, a portion of the stream was channelized after the 2001 sample which likely affected community quality for some distance. High quality water from Little Darby Creek (Logan Co.) Probably helped ameliorate some of the water quality impacts from Flat Branch on Big Darby Creek.

Spain Creek (02-222) ((RM 74.3) (WWH): 1988 - 2001
The 1988 survey indicated good conditions at RMs 2.6 and 0.1 despite only primary treatment at the North Lewisburg WWTP at that time. Secondary treatment was installed at the North Lewisburg WWTP in the next few years. Although the WWTP still had problems, treatment did improve through the 1990s. In the upper subwatershed (i.e., RM 5.7) in 2001, near non point sources (i.e., historic channelization and cattle in open pastures), there were sludge and solids present in the stream bottom. Despite these stressors, community quality was marginally good, meeting the recommended WWH biocriterion. The sites at RMs 3.4 and 0.1 in 2001 reflected the improved conditions and supported the recommended EWH biocriterion for the middle and lower reaches. Full capacity of the approximately 0.2 MGD WWTP is projected to be reached by 2010, so care and attention is needed with plant operation, redesign and storm water controls to protect the exceptional biological community downstream in Spain Creek and in Big Darby Creek.

Pleasant Run (02-221) (RM 72.01) (EWH): 1998 - 2001
All sites met or marginally met the EWH biocriterion in 1988, 1997 and 2001. The ICI score in 2001 of 56 at RM 0.5 improved from the1988 survey and was similar to the 1997 survey.

Buck Run (02-209) (RM63.74) (WWH): 1990 and 2001
Buck Run samples near the mouth in 1990 indicated excess nutrient enrichment and sedimentation with large numbers of the moderately tolerant *Glyptotendipes sp.* and other filtering midges indicative of excess algal production. Buck Run samples in 2001 indicated marginal attainment of the WWH biological criterion despite the same issues including an absence of streamside habitat which caused erosion, nutrient runoff, TSS and sedimentation. Dealing with some of these habitat related issues would greatly improve the quality of Buck Run and decrease the negative inputs into Big Darby Creek.

Robinson Run (02-207) (RM53.69) (WWH): 1992 and 2001
Robinson Run near the mouth had similar diversity between the 1992 and the 2001 sample. A slight improvement at RM 0.8 could be related to sealing a landfill leak near Ranco, although some landfill issues are still present. Upstream agricultural non-point inputs and a small WWTP input still affected the upstream macroinvertebrate community.

Sugar Run (02-206) (RM50.92) (WWH): 1990 - 2001
Stream quality has improved, particularly between RM 8 and RM 3, since 1992 and 1995 (Figure B.7.2.4). Possible factors include the closing of the landfill upstream and the stabilization of the land surface in the upper watershed. Construction adjacent to Sugar Run and its tributaries and the channel manipulation/straightening through the industrial area has been completed or diminished. Some unsanctioned stream manipulation has continued to occur sporadically in the Sugar Run subbasin, hence similar quality (VG) macroinvertebrate communities were observed at the RM 0.5 site in 1995 and 2001. No improvement has occurred. Open pastures bracketing St. Rt. 161 and associated erosion and sedimentation from broken and destabilized stream banks were still affecting downstream quality. The exceptional score at RM 6.9 in 1990 indicated

higher water quality potential from RM 7.0 downstream if the streamside habitat is allowed to stabilize the banks and the channel is not manipulated. Spills have continued to occur in the subwatershed and have contributed to perturbations in water resource quality.

Little Darby Creek (02-210) (RM 34.1) (EWH): 1979 to 2001-02

There have been some improvements made at Mechanicsburg WWTP since the early 1990s. This was reflected in the significantly improved ICI scores at Irwin Rd in 1996 (Figure B.7.2.5). Also a long-term dairy spill area that had sporadically discharged into Little Darby Creek near the Champaign - Madison County line (~ RM 37) was stopped and resolved (~ 1998-9) which could also be related to the measured improvements. The Mechanicsburg WWTP bypasses or overflows, a longstanding problem, were still occurring as recently as 2000. The 2001 macroinvertebrate sample site was downstream from the WWTP discharge but was upstream from the bypass location which was sealed in December 2001, so only the fish site at Wing Rd. evaluated the effects of any possible bypasses. More improvements in the collection system and waste treatment in Mechanicsburg are mandated to occur in the near future, and with their completion and the elimination of bypasses stream quality should improve further in upper Little Darby Creek.

Figure B.7.2.4. Longitudinal and temporal trends in the Invertebrate Community Index in Sugar Run based on samples collected in 1990, 1992, 1995 and 2001.

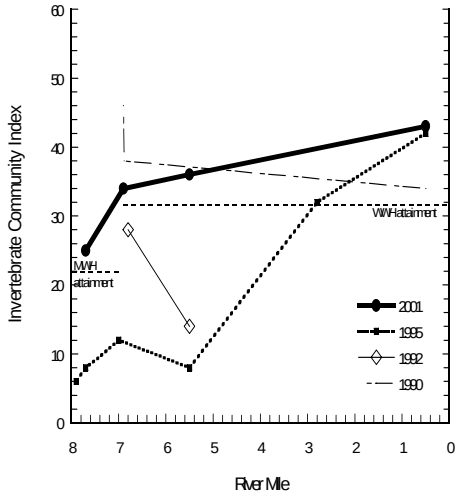
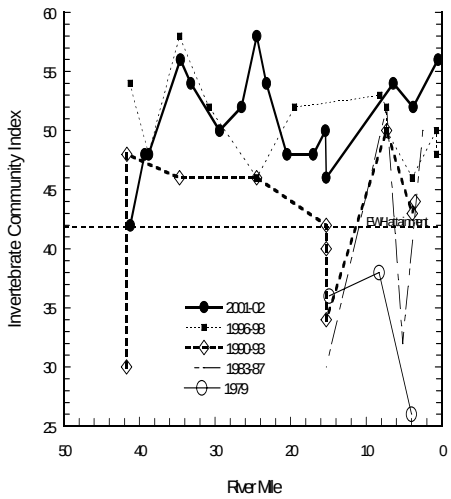


Figure B.7.2.5. Longitudinal and temporal trends in the Invertebrate Community Index in Little Darby Creek based on samples collected in 1979, 1983-87, 1990-93, 1996-98 and 2001-02.



Some improvements upstream from U.S. Rt. 42 (i.e., wide woody riparian area upstream) allowed scores to improve from those recorded in the early 1990s. The sag in community quality downstream from West Jefferson WWTP (~ RM 4) has decreased over time but has not been eliminated. Ongoing improvements at the West Jefferson WWTP and its municipal collection system, when finished, will improve final effluent quality and should eliminate losses of solids from the WWTP.

The two reaches that showed the largest relative declines in the current data were downstream from Rosedale-Milford Center Rd. to near Axe Handle Rd. and from downstream of Rosedale-Plain City Rd. to Bradley Rd. These declines were related to habitat and NPS inputs. Inadequate woody riparian width, excess nutrients, periodic lower diel D.O.s and sedimentation contributed to the declines observed. There was also a significant decrease in sensitive taxa (i.e., EPT taxa down 33 percent and mussel taxa decreased 78 percent) collected downstream from West Jefferson WWTP compared to the highly diverse macroinvertebrate community documented upstream. These decreases were due to excess nutrient enrichment, possible periodic decreases in diel D.O., and plant operation problems. The West Jefferson WWTP experiences periodic release of solids and overflows.

The collapse and removal of the dam near the mouth of Little Darby Creek has allowed the re-invasion of lower Little Darby Creek by many species long cutoff from that portion of the watershed. This has been reflected in the improvements in biological performance since 1996-98.

Treacle Creek (02-213) (RM 31.3) (EWH): 1992 - 2001
Treacle Creek was sampled in three different years at RM 0.7 and twice at RM 8.3. The upstream site evaluations both met the EWH biocriterion with similar ICIs - likely related to the lack of change in habitat and cool groundwater inputs present there. The downstream site at RM 0.7, where sedimentation and nutrients from open pastures upstream were still concerns, did not met the EWH biological standard in 1992 or in 2001. The 1997 ICI of 42 at RM 0.7 marginally met the EWH biocriterion which confirmed the potential and the appropriateness of the designated use.

Proctor Run (02-214) (RM 3.69) (EWH): 1992 - 2001
Proctor Run in 2001 at the downstream sampling site (RM 1.6/1.7) had improved slightly from 1992 with an increased exceptional score, number of EPT taxa, and greater diversity. The riparian corridor here in the lower reach was wider than previously which could account for the slight improvements.

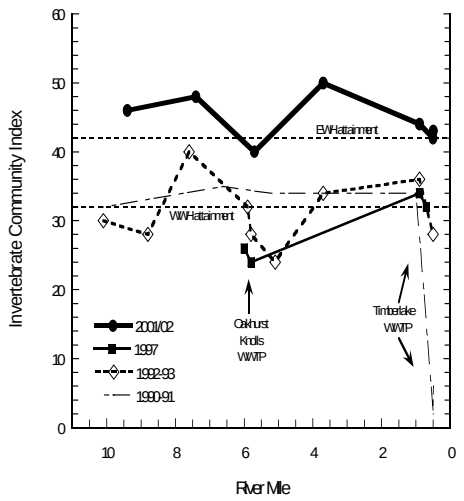
Spring Fork (02-211) (RM 17.46) (EWH): 1992 - 2002
Spring Fork sites were sampled in 1992 and 2001/02. Macroinvertebrate communities did not meet the EWH biocriterion upstream from Wren Rd. and near Rosedale - Milford Center Rd. (RM 7.7) in either 1992 and 2001. Both reaches were affected by nutrient runoff and sedimentation from row crop agriculture and/or open pastures. The lower portions of Spring

Fork met the EWH biocriterion, although the recent status of the lower mile of Spring Fork was not assessed. The reluctance of the resident landowner to grant permission to sample Spring Fork has resulted in the Green Meadows MHP WWTP not being adequately evaluated for its impact on resident aquatic communities in Spring Fork and its receiving stream, Little Darby Creek.

Hellbranch Run (02-204) (RM 26.1) (WWH): 1990 - 2001/02

Hellbranch Run has improved compared to earlier surveys and easily attained the WWH biocriterion throughout its length in the 2001-02 survey (Figure B.7.2.6). Downstream from the Oakhurst Knolls WWTP was the only site that did not at least marginally attain the EWH biocriterion in the latest survey.

Figure B.7.2.6. Longitudinal and temporal trends in the Invertebrate Community Index in Hellbranch Run based on samples collected in 1990-91, 1992-93, 1997, and 2001/02.



Downstream from the Timberlake WWTP and Oakhurst Knolls WWTP were the worst problem areas historically in Hellbranch Run based 1990-97 surveys. The upper portion near Alton Rd. was of fair quality during the 1992-93 sampling due to upstream influences, channelization and sedimentation. The Timberlake WWTP is under Director's Findings and Orders to close operations and connect to regional facility by 2005. Water quality in lower Hellbranch Run should significantly improve and benefit Big Darby Creek downstream of the confluence. Follow-up monitoring of Hellbranch Run should be conducted to determine the effectiveness of these environmental improvement efforts and to determine the appropriateness of the current designated aquatic life. The lower four miles of Hellbranch Run currently would be in partial attainment of the EWH aquatic life use due to fish community scores being less than EWH biocriteria at RM 0.5. It would take very little improvement in biological performance to push it into total compliance.

Hamilton Ditch (02-259) (RM 11.19) (MWH): 1991 - 2001

Hamilton Ditch upstream near Walker Rd (RM 3.4) has improved into the fair range and currently meets the Modified Warmwater Habitat biocriterion. The ICI of 40 upstream from U.S. Rt. 40 (Broad St.) also met the recommended WWH biocriterion for the lower reach of Hamilton Ditch. The historically deepened and straightened channel of Hamilton Ditch prevents the expulsion of sediment bedload into the floodplain or the development of normal riffle, pool and run complexes. Fair community performance, largely due to its sediment load, soft bottom

substrates, and a lack of natural stream development, persisted near the mouth (RM 0.3) from the 1992 through the 1997 survey years. The fair quality found at Feder Rd. in 1991 (RM 2.1) resulted from the siltation associated from construction of residential developments inputs adjacent and upstream. Deposits of grayish black solids from on-lot septic systems also contributed to the depressed macroinvertebrate community.

Habitat will continue to challenge the biological community quality until natural channel functioning is restored (i.e., varied depths, different habitats, and sediment-expelling capability). Future suburban development needs to incorporate adequate storm water BMPs in order for Hamilton Ditch water quality to improve. Stream development and sinuosity within a functioning floodplain with an intact riparian buffer are needed for a more natural Hamilton Ditch. Decreases in sediment and nutrient loads in Hamilton Ditch will allow for more community quality improvements downstream in Hellbranch Run.

Clover Groff Ditch (02-245) (RM 11.19): 1991 - 2001

The proximity of Clover Groff Ditch to the growing community of Hilliard results in poorer biological communities than documented in Hamilton Ditch. Residential development had already adversely affected stream quality in 1991. At RM 2.5 upstream from Feder Rd. extremely high numbers of oligochaetes (i.e., ~ 20,000 individuals), flatworms, leeches, and tolerant midges largely comprised the community present. The resultant ICI was a 10 (poor). In 2001 further upstream at Roberts Rd. (RM 4.7) storm water runoff and other residential inputs including septic tank leachate and unconsolidated sediment had caused very poor community quality to persist. Community quality downstream near U.S. Rt. 40 (Broad St.) was similar in 1992 and 2001 in the ICI range of 18 to 20. The Cypress School package WWTP is under Director's Findings and Orders to connect into Columbus sewers. Suburban storm water treatment, possibly through wetlands and better stream development (sinuosity) with a functioning floodplain to expel the excess sediment built up from construction runoff should help improve the quality of Clover Groff Ditch.

B.7.3 Drainage Area Comparisons: Macroinvertebrate Communities

Drainage Area Range: 1.2 - 2.6 mi^2

Four of the ten sites with drainage areas <2 mi.^{2} were currently designated or recommended to be designated Exceptional Warmwater Habitat (EWH). All met applicable criteria because cool groundwater from the bouldered and hummocky moraine fields into these headwater streams supported exceptional communities and ameliorated slight deficiencies in habitat quality. These sites had QHEIs ranging from 55 to 71.5 with some sites having thinner than desired riparian widths, sedimentation, and NPS agricultural inputs. These included Little Darby Creek (Logan County) at RM 78.34, Howard Run, and the two most upstream Big Darby Creek sites. Clover Run, whose source originates in the same geologic type area also marginally met the EWH biocriterion, despite some unstable banks, excess sedimentation, and nutrient inputs. Clover Run is currently designated WWH due to lower fish community performance (Figure B.7.3.1).

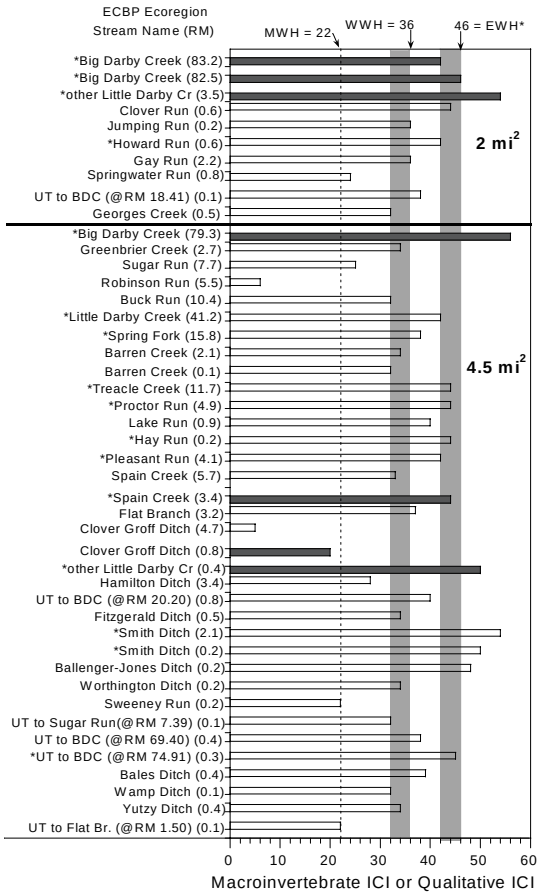


Figure B.7.3.1. Drainage area relationships (<2mi^2 and 4.5mi^2) in the Invertebrate Community Index at sites sampled in the Big Darby Creek watershed, 2001.

Of the six 2 mi.^{2} drainage area WWH sites, the one non-attaining site had problems with storm water inputs of nutrients and silt. Impacts from these stressors were exacerbated by the site's open canopy which caused excessive algal production. All six sites had increased sedimentation from reduced riparian widths which resulted in NPS runoff and eroding and unstable banks. Disturbed habitat in or around the streambed can naturally recover if left alone. Such was the case with Georges Creek and the unnamed tributary to Big Darby Creek (RM 18.41), as there had been some recovery from channelization. Georges Creek was altered after sampling.

Drainage Area Range: 3.3-6.7mi^2

Twelve of the thirty-five sites in this drainage area range were categorized as EWH streams. All twelve sites have their source in end moraines with hummocky till substrates (i.e., the western portion of the Big Darby Creek basin) that contribute cool groundwater which minimizes the effects of bacterial inputs, some sedimentation and NPS agricultural inputs. Habitat quality was

generally higher in these EWH streams with six of the twelve sites having QHEIs greater than 70. All sites meeting the criterion yielded at least eleven EPT taxa (i.e., 11-17 taxa). The one non-attaining macroinvertebrate site was at Spring Fork (i.e., RM 15.8) with eight EPT taxa, a greater predominance of tolerant taxa, and reduced diversity. Excess sedimentation, elevated TSS, and high nitrogen and phosphorus inputs were enough to reduce the community performance to the good range. An unnamed, small stream whose confluence to Big Darby Creek was at RM 69.40 scored only a good macroinvertebrate performance (recommended WWH) because of the cumulative negative effects of past channelization, sedimentation, and nutrients inputs. This was in contrast to a fairly similar unnamed tributary to Big Darby Creek (RM 74.91) which was designated EWH and met the criterion. A less complete woody riparian corridor protecting the stream at RM 69.40 compared to the unnamed tributary at RM 74.91 was likely the difference in the macroinvertebrate quality, as there were more effects from NPS storm water runoff. An interesting and important observation was that the four EWH streams that had lower nutrient inputs (i.e., near median ECBP concentrations or with a few samples greater) had more, wider, and/or intact contiguous woody riparian corridors (i.e., Big Darby Creek - RM 79.3, Little Darby Creek - RM 41.2, Pleasant Run - RM 4.1, and Smith Ditch - RMs 2.1 and 0.2) than the other sites.

Five sites in this drainage area range were Modified Warmwater Habitat stream locations. The non-attaining site (i.e., Clover Groff Ditch at RM 4.7) was affected by residential storm water runoff and excess siltation that contributed to the very poor community performance. The two sites with higher performance had at least some shading and, therefore, comparatively cooler stream temperatures (i.e., Hamilton Ditch - RM 3.4 and the unnamed tributary to Sugar Run - RM 0.1). Two sites that just met the MWH minimum, Sugar Run at RM 7.7 and the unnamed tributary to Flat Branch - RM 0.1, contended with excess silt and nutrient enriched conditions coupled with algal accumulation.

Eighteen of the thirty five 4.5 mi.^{2} sites were designated WWH with four (22%) not meeting the WWH biocriterion. Three of those four did not meet the biocriterion due to residential storm water runoff, spills, and/or accumulated wastewater inputs. Sweeney Run was influenced by inputs from Plain City, and Springwater Run was sampled adjacent to Harrisburg. Clover Groff Ditch (RM 0.8) had several dischargers upstream including a periodically overburdened school WWTP upstream. This WWTP is scheduled to be tied into municipal sewers and the discharge eliminated. The fourth site, Robinson Run (RM 5.5), was affected by excess agricultural inputs, high algal accumulation resulting from an open canopy and nutrients, and periodic low dissolved oxygen conditions. Fifty percent of the sampled WWH sites only marginally met the WWH biocriterion with ICIs ranging from 32-34. These sites generally were hampered by lack of riparian corridor upstream and excess sediment and nutrient accumulation from agricultural NPS inputs.

Drainage Area Range: 7.0 - 13.2mi^2

Sixteen sites were sampled with approximately a 9 mi.^{2} drainage area. There were eight EWH sites, six WWH sites, and two MWH sites within this drainage area range (Figure B.7.3.2). All eight EWH streams sampled have their source in end moraines with hummocky till substrates

(western portion of Big Darby Cr. basin) that contribute cool groundwater which minimized the effects of bacterial inputs, some sedimentation and NPS agricultural inputs. All eight EWH sites met or marginally met the EWH biocriterion. All four sites with higher community performance (i.e., in the range of ICIs = 54-56) had wider and more continuous riparian corridors ranging in width from 30 feet to greater than 150 feet at and upstream from the sample sites (i.e., Spain Creek at RM 0.1, Pleasant Run at RM 0.5, Treacle Cr. at Rm 8.3, and Proctor Run at RM 1.7). This factor kept NPS nutrient inputs to near the median ECBP concentrations or less. The shaded canopy also decreased algal production and allowed for more instream assimilation. Spain Creek, for example, did have higher nutrient concentrations at RM 0.1 due to upstream cattle and WWTP inputs, but the community density on the colonizer was still low at 254 organisms/ft.^{2} due to the shaded conditions. There was also the highest number of EPT taxa collected at these sites compared to others sampled in these respective streams. Mussels were observed at three of these four EWH sites, and the number of sensitive taxa observed was the highest or close to it compared to each respective streams. The two with slightly less total sensitive taxa were Spain Creek at RM 0.1 resulting from WWTP inputs and Treacle Creek at RM RM 8.3 which was impacted by bridge construction prior to sampling.

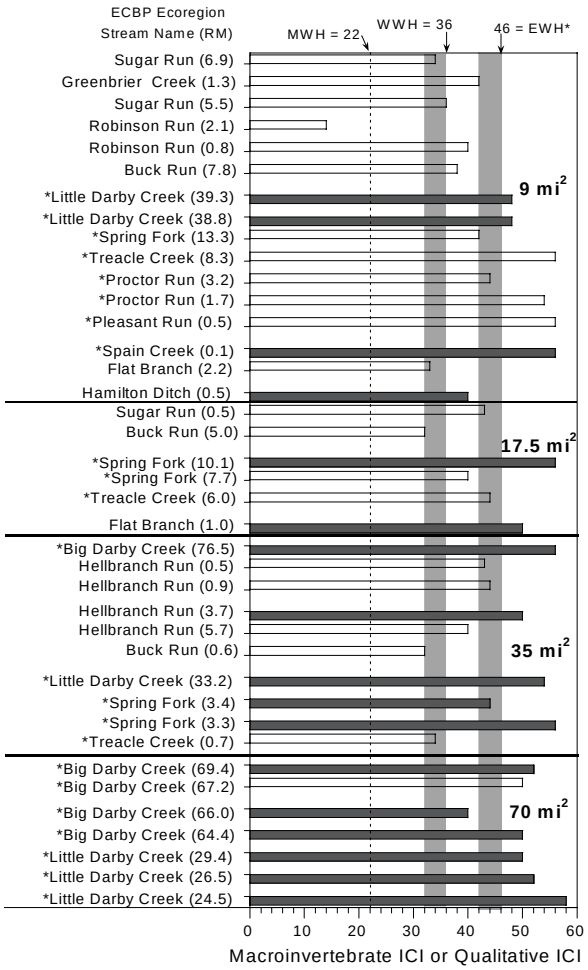


Figure B.7.3.2. Drainage area relationships (larger drainage areas) in the Invertebrate Community Index at sites sampled in the Big Darby Creek watershed, 2001.

Seven of the eight WWH or MWH sites met their respective biocriterion. The WWH site that did not meet was Robinson Run at RM 2.1. Elevated nutrient inputs from agricultural NPS inputs and a small WWTP discharge caused nutrient enriched conditions and periodic low dissolved oxygen concentrations. The impacts were lessened due to the riparian corridor (i.e., 5-7 feet of grass/weeds adjacent with 15-20 feet of small trees). The sites within this drainage area range tended to be more biologically stable and better able to withstand the occasional perturbation.

Drainage Area Range: 14.0 - 19.4mi^2

Only one of six sites in this drainage area range did not attain its designated use - the EWH-designated Spring Fork at RM 7.7. Community performance was only in the good range. This was due to a myriad of negative inputs that stemmed from having a one-sided riparian corridor with destabilized banks opposite from a hay field / open pasture. Stressors impacting instream biological community performance included buried natural substrates, excess sedimentation, manure, and excess nutrient inputs, and higher water temperatures (i.e., 76.5^o F) resulting from the open pasture and lack of canopy along one bank. These factors have led to lower D.O. concentrations and lowered overall instream water quality.

Buck Run at RM 5.0 marginally met the WWH biocriterion (MG) due to unstable banks and gross erosion and sedimentation resulting from a lack of a stabilizing woody riparian buffer adjacent to the stream in this former open pasture. Available large rocky substrates permitted some benthic colonization. At this drainage area range a reasonable wooded riparian corridor around a naturally meandering stream appears to limit nutrient inputs and siltation and permits aquatic communities to meet their potential.

Drainage Area Range: 28.0 - 37.3mi^2

Streams in this drainage area range are able accommodate some exposure to stressors and still maintain biological performance within the range of expectations. However, some of the more sensitive taxa including some of the intolerant mayflies, caddisflies, mussels and midges may be may be eliminated from the catch. WWH sites on Hellbranch Run and Buck Run, though attaining, had to contend with inadequate riparian corridors upstream that contributed to continued sediment bedload movement downstream. Buck Run at RM 0.6 only marginally met the WWH biocriterion with low numbers of sensitive taxa due to the sedimentation and nutrient inputs that pervaded most of the stream. A low number of eight to nine sensitive taxa were present in Buck Run from the RM 7.8 site downstream to RM 0.6. In contrast, the highest number of sensitive taxa were collected at 35 mi.^{2} sampling sites at Big Darby Creek (RM 76.5) and Little Darby Creek (RM 33.2) with 43 and 36 taxa, respectively.

Similarly the open pasture conditions upstream from the Treacle Creek sampled site (RM 0.7) and inadequate bank protection which yielded erosion, slumped banks, and sediment bedload downstream coupled with nutrient enrichment and periodic low dissolved oxygen concentrations resulted in the number of sensitive taxa declining from a high of 29 at Eagle Rd. (RM 8.3) to only thirteen at RM 0.7. Adverse effects noted upstream accumulated and were significant enough to result in not meeting the EWH biocriterion at RM 0.7.

In contrast to Buck Run, as habitat improved in Hellbranch Run and negative NPS inputs diminished, the number of sensitive taxa increased. Lower Hellbranch Run sites, with QHEIs of about 84, had 20 to 33 sensitive taxa present. All Hellbranch Run sites exhibited marginally exceptional performance except for the site at RM 5.7, which was affected by a nearby golf course and WWTP inputs, which yielded 14 sensitive taxa, the lowest total in the subbasin. Instream biological performance in Hellbranch Run will improve when consistent riparian and

storm water protections are in place and effluent inputs have been reduced through planned WWTP closures and tie-ins to regional WWTPs or sewer lines.

Drainage Area Range: 70.0 - 88.0mi^2

These larger wadable streams demonstrated exceptional biological performance barring any catastrophic impacts, such as the 2000 spill in Milford Center, or large constant inputs such as large dischargers which could acutely or chronically affect macroinvertebrate community performance. The site downstream from Milford Center at RM 66.0 one year after the large spill still did not meet the EWH biocriterion. There was only one-third the number of sensitive taxa and 25 to 40 percent lower EPT taxa totals when compared to the other six sites within this drainage area range. The two sites with the narrowest overall riparian widths (i.e., Big Darby Creek at RM 64.4 and Little Darby Creek at 26.5) yielded no mussels. Mussels were present at sites where at least one side of the riparian corridor equaled 50 feet. Also, two of the three sites with the narrower riparian widths (i.e., Big Darby Creek at RM 66.0 and Little Darby Creek at RM 29.4) had the highest community densities (i.e., 1100 to 1400/ft.^{2}) indicating nutrient enriched benthic communities. The two other sites on Little Darby Creek (i.e., RMs 26.4 and 24.5) in this drainage area range and which were also downstream from RM 29.4 had much wider riparian corridors (i.e., >50 ft. to 100 ft.). They also had community densities 50 percent less - a function of lower nutrient inputs and shaded canopy conditions. The wider riparian corridor along Big Darby Creek and Little Darby Creek at this drainage area range buffers the biological communities and helps protect against large or continuing impact events.

B.7.4 Trends in Unionid Mussel Communities

The Big Darby Creek watershed has been widely acclaimed for its diverse unionid mussel fauna (Watters, 1994). Surveys since 1986 have shown a general decline in species diversity throughout the watershed. Thirty percent of the species that have been observed in recent surveys are now found in very few locations and in low abundance (Watters 1998, Tetzloff 2000, Watters and Myers Flaute 2003). Aggregating the efforts of several groups and individuals that have surveyed the watershed between 2000 and 2002 yielded a cumulative total of 35 mussel species that are still present in the watershed (Table B.7.4.1). However, five previously collected mussel species were not found. Missing species included two special interest species, one Ohio threatened species, and one species considered endangered in Ohio (Table B.7.4.1).

Several interesting conclusions can be drawn from data presented in Watters and Myers Flaute (2003). Lower mussel diversity coincided with lowered Index of Biotic Integrity scores which is based on fish community attributes (Table B.7.4.2). Lower mussel diversity also was found in stream segments with low habitat quality as evaluated by the Qualitative Habitat Evaluation Index (Table B.7.4.2). Factors also contributing to these correlations, many of which are interrelated, included toxic impacts (which includes the impacts from spills), sedimentation/siltation, substrate embeddedness, lack of riparian corridor width, lack of stream shading from decreased canopy cover, bank destabilization, and nutrient inputs causing excess algal production and low nighttime dissolved oxygen concentrations.

Although the Invertebrate Community Index (ICI) measures the relative quality of the macroinvertebrate community, it did not correlate well with shifts in bivalve species richness (Figure B.7.8, Table B.7.1). This difference may be explained by the difference in response of aquatic insects (the main component of the ICI) versus bivalve molluscs to environmental perturbations. Unionid mussels, due to their filter feeding and sedentary life history, are frequently the most sensitive component of the aquatic environment and are the first to succumb to environmental perturbations. Due to their reliance on fish hosts to repopulate impacted areas and the long period of time that it takes for them to reach a size where they are large enough to be detected and identified by most current sampling procedures, it is also, therefore, generally a long time before live specimens are detected in previously impacted areas. Most other benthic macroinvertebrates, on the other hand, are quick to repopulate impacted areas due to their ability to re-invade through downstream drift and aerial routes.

The strongest spatial correlation in the historical mussel data was decreased mussel diversity in areas immediately downstream from dischargers (See Appendix C.3, Mussel Species Richness Maps). Evaluation of point source dischargers was the major focus of these earlier surveys in contrast to more recent surveys which had a broader focus. Areas showing lowered bivalve mussel diversity coincided with historical chemical sampling locations with elevated BOD5, ammonia, TKN, or nitrates present and the metals lead, zinc, copper and cadmium, parameters normally associated with point source dischargers (Appendix C.3, Mussel Species Richness Maps). Metals, such as copper and zinc, though previously bound can be released into solution through a combination of various chemical reactions (Burton et al., 1992). Besides contributing

to cumulative toxicity, these metals, which impact gills and decrease oxygen-carrying capacity in fish, could possibly be affecting mussels similarly (Sorenson, 1991). Additionally elevated chlorides, sulfates, higher conductivity, hardness and pH were also found downstream from point source dischargers in areas with decreased mussel diversity. Elevated pHs can be important since they can result in toxic microenvironments from increasing concentrations from un-ionized ammonia (USEPA, 1979, Thurston et al., 1974). Sulfates have been used in WWTP processes and chlorine stabilization (Merck Index, 1989) (See Appendix C.3, Mussel Species Richness Maps).

Bivalve distribution maps compared against maps detailing average chemical parameter concentration roughly by decade revealed impacts in the middle reaches in the 1980s (i.e., in the vicinity of Plain City and West Jefferson, and in the segment from upstream of I-70 to downstream from U.S. Rt. 40 downstream from package WWTPs and campgrounds) (Appendix C.3, Mussel Species Richness Maps). Impacts were also seen in the 1980s in the lower reaches of Big Darby Creek downstream from dischargers and associated with elevated BOD, low dissolved oxygen ammonia, and metals. These dischargers included the PCI WWTP and several small developments (mostly MHPs).

Table B.7.4.1. Unionid Mussel Distribution documented in surveys conducted in the Big Darby Creek Watershed during 1986, 1990, 1996, and 2000-2002[a].

Taxon	Common Name	Status	*1986*	*1990*	*1996*	*2000-2002*
Ligumia recta	**Black Sandshell**		X	X		X
Pleurobema clava	**Clubshell**	FE	X	X	X	X
Lasmigona compressa	**Creek Heelsplitter**	OSC	X	X	X	
Anodontoides ferussacianus	**Cylindrical Papershell**		X	X	X	X
Truncilla truncata	**Deertoe**	OSC	X			X
Elliptio crassidens	**Elephant Ear**	OE	X			X
Alasmidonta marginata	**Elktoe**	OSC	X	X	X	X
Lampsilis radiata luteola	**Fat Mucket**		X	X	X	X
Truncilla donaciformis	**Fawnsfoot**	OT	X	X	X	
Lasmigona costata	**Fluted-shell**		X	X	X	X
Leptodea fragilis	**Fragile Papershell**		X	X	X	X
Pyganodon grandis	**Giant Floater**		X	X	X	X
Ptychobranchus fasciolaris	**Kidneyshell**	OSC	X	X	X	X
Toxolasma parvus	**Lilliput**		X	X	X	X
Quadrula quadrula	**Mapleleaf**		X	X	X	X
Epioblasma rangiana	**Northern Riffleshell**	FE	X	X	X	X
Utterbackia imbecilis	**Paper Pondshell**		X	X	X	X
Quadrula pustulosa	**Pimpleback**		X	X	X	X
Potamilis alatus	**Pink Heelsplitter**		X	X		X
Potamilis ohiensis	**Pink Papershell**		X	X	X	X

Continued.

Table B.7.4.1. Continued

Taxon	Common Name	Status	*1986*	*1990*	*1996*	*2000-2002*
Tritogonia verrucosa	**Pistolgrip**		X	X	X	X
Lampsilis cardium	**Plain Pocketbook**		X	X	X	X
Uniomerus tetralasmus	**Pondhorn**	OT	X	X		
Cyclonaias tuberculata	**Purple Wartyback**	OSC	X	X	X	X
Quadrula cylindrica	**Rabbitsfoot**	OE	X	X	X	X
Villosa iris	**Rainbow**		X	X	X	X
Villosa fabalis	**Rayed Bean**	OE	X	X	X	
Obovaria subrotunda	**Round Hickorynut**		X	X	X	X
Pleurobema sintoxia	**Round Pigtoe**	OSC	X	X	X	X
Simpsonaias ambigua	**Salamander mussel**	OSC	X	X		
Alasmidonta viridis	**Slippershell**		X	X	X	X
Epioblasma triquetra	**Snuffbox**	OE	X	X	X	X
Elliptio dilatata	**Spike**		X	X	X	X
Strophitus undulatus	**Sqawfoot/Creeper**		X	X	X	X
Amblema plicata	**Threeridge**		X	X	X	X
Fusconaia flava	**Wabash Pigtoe**		X	X	X	X
Megalonaias nervosa	**Washboard**	OE	X	X		X
Lampsilis fasciola	**Wavy-rayed Lampmussel**	OSC	X	X	X	X
Lasmigona complanata	**White Heelsplitter**		X	X	X	X
Pleurobema cordatum	**Ohio Pigtoe**	OE				X
		Total	39	37	32	35

[a] - (adapted from Watters, 1998)

A similar comparison using data from the 1990s revealed losses in mussel diversity in upper Big Darby Creek around Flat Branch and in the middle reaches within and downstream from Plain City. Decreased mussel diversity in Little Darby Creek was found immediately downstream from the Mechanicsburg and West Jefferson WWTPs. Hellbranch Run had reduced mussel diversity which was associated with residential growth. Some of these same affected areas were also noted in Watters (1994).

Nutrient enrichment (i.e., high concentrations of N and P) and associated nighttime dissolved oxygen sags were documented in the 1990s (Appendix C.3, Mussel Species Richness Maps). High afternoon dissolved oxygen measurements confirmed nutrient enrichment. Lower dissolved oxygen readings may have been recorded during morning data collections or under clouded conditions. Dissolved oxygen sags with levels falling to very low concentrations can occur in pooled areas downstream from the supersaturated sites. In suspect stream reaches where low dissolved oxygen levels were recorded during previous surveys or observed during the present survey, additional continuous D.O. data monitoring was conducted.

Any relationships between low dissolved oxygen concentrations and decreased mussel diversity along with other supporting data is presented in Table B.7.4.2.

Table B.7.4.2. Stream segments with correlations between low dissolved oxygen concentrations and lowered fish community scores and bivalve mollusc diversity.

Stream reach	D.O. data	Other supporting data
BDC dst. Flat Br. WWTP & dst. Flat Br. confluence	6 hrs D.O. < EWH min with low of 4.4 mg/l 15 of 24 hours < min. ave. D.O. of 6.0 mg/l	Low fish IBI of 37.3 (2001)
BDC dst. Plain City & Sugar Run (RM 51.6 - 49.5)	D.O. < mean and min. D.O. (Low of 3.9 mg/l) D.O. < EWH min. (Low of 4.5 mg/l)	Low fish IBI / MIwb of 43 & 8.78-8.3, resp.(2001)
BDC dst. Darbydale (RM 27.7) dst. in pooled reach	12 hrs. D.O.< EWH min with low of 4.9 mg/l 17 of 24 hrs. < min. ave. D.O. of 6.0 mg/l	No fish sampled in this particular reach
BDC dst. Scioto Darby Rd pooled reach (RM 18.45)	13 hrs. < EWH mean of 6.0 mg/l with range of 5.4-5.9 mg/l	Total numbers of mussels noted decreased with time
Dst. U.T. to BDC dst. Scioto Darby Rd (@ RM 18.41) pooled reach (18.1)	12-13 hrs. < EWH mean of 6.0 mg/l with range of 5.4-5.9 mg/l	Sediment and some nutrients input
U.T. to BDC (@ RM 20.2)	D.O.< 1.0 mg/l D.O. (~ 36 hrs.) Directors Findings and Orders for Foxlair to tie into PCI WWTP has been filed	Foxlair MHP with poor effluent (high NH_3), periodic pulsed discharge via flushes of storm water in trib. (local toxicity at low flows); discharge trib. in area of Northern Riffleshell Mussel habitat reach (FE)
BDC adj. Gulick Rd. (RM 15-16) dst. U.T. to BDC (@ RM15.50)	~ 4 hrs. < EWH mean of 6 mg/l supersaturated conditions to high of ~ 12 mg/l down to ~ 5.7 mg/l - open canopy and nutrients	Only one species found (Tetzloff, 2000) two species (OEPA, 2002) 3 total specimens - only fresh dead
BDC dst. Georges Run (RM 14.8)	11 to 14 hrs < EWH mean of 6 mg/l with range of 5.4-5.9 mg/l & a daytime high of 12.5 mg/l nutrients input and limited canopy (mostly open) with higher stream temperatures / density >2000 org.(macroinvertebrates) / $ft.^2$	RM 15 - 14 no mussels collected (Tetzloff, 2000 or OEPA, 2002) - other factors were concrete rip rap on one eroded bank, little aquatic plants / shallows, more pooled
BDC near & dst. SR 316 (Darbyville) RM 13.5 / 12.9	RM 13.5 high >12mg/l D.O. (low of 5.2 mg/l) RM 12.9 9 hrs < EWH mean with low range of 5.4-5.9 mg/l) algae, enriched, ~ 1990 org. / $ft.^2$	RM 14-13 five total spp. found with only 7 total found (Tetzloff, 2000) unstable spongy substrates

Continued

Stream reach	D.O. data	Other supporting data
BDC dst. U.T. to BDC (@ RM 8.5) RM 7.9	9 hrs. < EWH mean of 6 mg/l D.O. (low of 5.7-5.9 mg/l) and high of ~ 10 mg/l 1714/ft.^{2} lots of algae in tributary - very enriched	RM 8-7 only one mussel species collected (one record) loss of riparian, eroded banks, unstable habitat or embedded substrates
BDC dst. SR 104 (RM	Supersaturated daytime D.O. > 17 mg/l, indicated nutrient enrichment so low nighttime D.O. threatens pooled reaches further downstream.	RM 3-2 only 3 species and five total individuals (all fresh dead not any live specimens) (Tetzloff, 2000) lots of silt below Fox riffle and soft substrates
Treacle Cr. RM 0.8	D.O. < EWH minimum of 5.0 mg/l (4.8 mg/l)	Didn't meet EWH in 1997- fish IBI and MIwb were 41 and 8.1, respectively (G to MG) and impacts from cattle of sediment/siltation and unstable banks and lack of canopy in open pasture area (only one sp. in wooded reach dst. that can handle some silt

Mussel species richness has generally declined in most reaches through time (Watters et al., 2003). Statistically significant decreases in mussel richness diversity occurred in 36% (i.e., 15 of 42) of the long-term sampled reaches and approximately 60% (i.e., 25 of 42) indicated non-statistically significant decreases or variable mussel species richness totals over time (minimum of four different samples through time and $R^2 > 0.50$). Less than five percent (i.e., 2 of 42) of the reaches showed statistically significant increases (Table B.7.4.3).

An effort was made to determine the causes and sources of statistically significant declines in unionid mussel diversity. All currently available data including historical data and that resulting from more recent surveys was evaluated and the causes of the impacts were catalogued for stream locations showing statistically significant decreases in mussel taxa richness (Table B.7.4.3).

Table B.7.4.3. Probable causes of declines in unionid mussel species richness.

Reaches with Statistically Significant Decreasing Mussel Taxa Richness (r^2>0.5)	Probable Causes of Declines
Big Darby Creek RM 66 - 63.8 (64.5-64.3) (dst. Milford Center)	A) Spills (grain storage(molasses)) / acutely low D.O. B) Embeddedness from NPS sedimentation (silt) C) Nutrient enrichment (6.30 mg/l nitrates > 95th %ile ECBP background) local potential effects from nitrite D) Sediment phosphorus (1420 mg/kg) >LEL and high sediment ammonia (68 mg/kg)
Big Darby Creek RM 54.1 (to RM 53.9) (pooled reach at and ust. and dst. SR 42	A) Significant drop due to historical metals (Ranco) (1960-1970s) sedimentation/ silt with elevated metals (Al,As,Ba,Cr,Mn,Hg,Zn) with Total Organic Carbon and Phosphorus (1670 mg/kg) > LEL (Persaud et al., 1993) and TSS > 75th %ile C) Embeddedness from the silt (NPS inputs - cattle & agri. upst.) D) Nutrient enrichment / low diel D.O. (N > 75th %ile, P > 95th %ile, P=1.75 mg/l) E) Spills in the area and upstream F) Sediment metals and sediment ammonia (52 mg/kg)
Big Darby Creek RM 51.5 - 51.3 (dst. Plain City upst. from Cemetary Pike (pooled / slow run reach)	A) BOD / suspended solids caused likely periodic chronic lower D.O. conc. B) Nutrient enrichment w' respiration and degradation added to low D.O. C) Some silt accumulation D) Spills in the Plain City area
Big Darby Creek RM 41.1 - 40.6 (dst. I-70 & dst. High Free Pike)	A) Raw effluent discharge / periodic toxic discharges 1970s camp ground converted to permanent homes with septic vaults and raw sewage. Legal proceedings & actions in 1996 led to WWTP installed & running in 2000 (Wissolohican Sanitary Sewer Dist.) B) Quarry discharges? C) Spills in the area
Big Darby Creek RM 39.5- 38.9 (dst. Darby Estates WWTP)	A) Historical impacts from NPDES discharge - lead, zinc, nitrites, and nitrates, BOD, solids, contributed to low D.O.s B) Sedimentation from NPS runoff C) Some historical spills
Big Darby Creek RM 3.2 (dst. SR 104)	A) Siltation B) Unstable substrates C) Substrate bedloads D) Sediment phosphorus (1700 mg/kg >LEL) and ammonia (83 mg/kg) and possibly metals

Continued

Reaches with Statistically Significant Decreasing Mussel Taxa Richness (r^2>0.5)	Probable Causes of Declines
Little Darby Creek RM 27.0 - 26.7 (dst. Chuckery)	A) Sedimentation from open pasture upstream, destabilized banks (erosion) B) Nutrient enrichment / low diel D.O. via agri. / livestock NPS inputs and large percentage of open canopy & woody riparian corridor immediately adjacent stream banks in the reach upst. NW of SR 161 (Union Co.) **OEPA sample at RM 26.5 was far enough downstream in the stable mature wooded canopy corridor that the habitat and nutrient impacts from upstream are buffered (12 mussel taxa collected).
Little Darby Creek RM 24.5 (dst. Rosedale-Plain City Rd.)	A) Sedimentation (NPS inputs - agri. and cattle inputs) B) Destabilized banks / lack stable wooded riparian corridor /canopy C) Hardened substrates or embeddedness
Little Darby Creek RM 17.9 -17.6	A) Lack of stable habitat upstream - partial riparian corridor with siltation and nutrients from upst. NPS inputs - cattle and crop agriculture with some embeddedness (some open pasture) B) Possible lower diel D.O. from NPS inputs
Little Darby Creek RM 17.6 -16.8	A) Inputs from Green Meadows MHP into Spring Fork and to LDC (@ RM 17.4) (past & present potentially toxic inputs with periodic low D.O.s (violations: TSS, fecal coliform bacteria, CBOD, & D.O. ($\leq$2.1-1.1 mg/l) very likely issues with ammonia B) Lack of stable habitat upstream - partial riparian corridor with siltation and nutrients from upst. NPS inputs - cattle and crop agriculture with some embeddedness (some open pasture) C) Localized cementing of the bottom substrates (consequence of nutrient enrichment/ high pH and calcium carbonate precipitation). D) Possible lower nighttime D.O. from NPS inputs
Treacle Creek RM 11.9 - 11.6 (near Mechanisburg - Bellefontaine Rd.)	A) Excess siltation from open pasture upstream and NPS agri. near with narrow, limited, inadequate riparian buffer width B) Ammonia (0.76mg/l) and nitrite > 95th %ile of ECBP background ** Mussel richness decreased from 2 (highest at first sample) to 0
Treacle Creek RM 8.3 (Eagle Rd.)	A) Sedimentation (silt) and embeddedness with black anaerobic conditions on bottom substrates in run B) Low D.O. conc. in bottom substrates (silt & nutrients from NPS runoff -nitrates >75th %ile & TP >95th %ile) - algae/low D.O. ** From one mussel to no live or fresh dead collected (older mussel specimens were observed, so more taxa also lost earlier)

Continued

Reaches with Statistically Significant Decreasing Mussel Taxa Richness (r^2>0.5)	Probable Causes of Declines
Hellbranch Run RM 10.4 - 9.9 (Alton Rd.)	A) Siltation and modified reach (sediment accumulation) ** Two species decreased to one species (both more common)
Sugar Run RM 0.7 - 0.4	A) Siltation/sedimentation and high TSS via erosion from unstable banks (open pasture upst.); sediment TOC and phosphorus >LEL (Persuad et al., 1993) B) High nutrients from upstream NPS inputs contributing to some enrichment, possible low D.O. or other effects (nitrite) here and dst. in BDC below confluence (N>90th %ile & P>95th %ile) C) Spills historically upstream

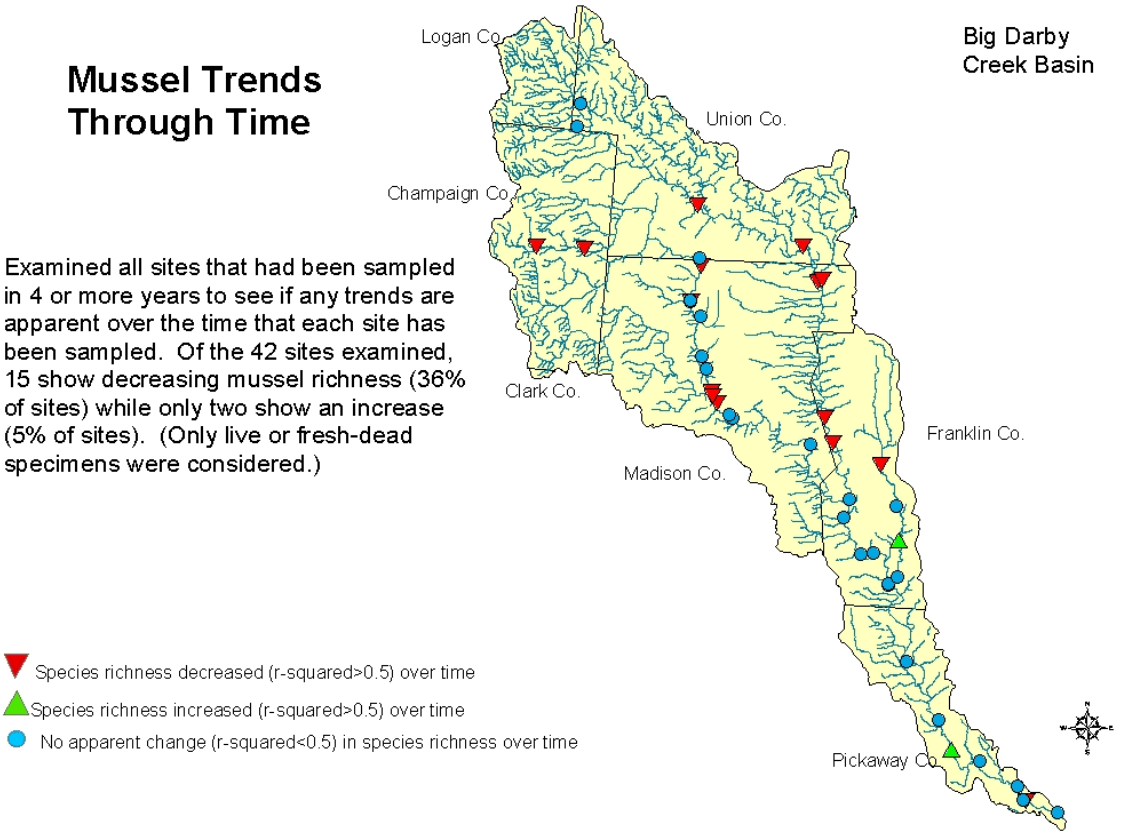
The two stream segments within the Big Darby Creek watershed that showed statistically significant increases in mussel diversity (though further examination indicated non-statistical significance (Watters and Flaute Myers, 2003) had an increasingly rare commodity - stable habitat. Hellbranch Run near Beatty Rd. (RM 3.8) had more stable and better defined riffle complexes with less silt than upstream reaches, which were choked with silt and buried riffles (Figure B.7.4.3). The stream begins to flow through a moraine boulder belt in this reach increasing substrate size and variety. Hellbranch Run in this vicinity to its mouth flows through a bouldered moraine geologic zone contributing many positive habitat attributes. The riparian corridor was also more prevalent, which contributed to the stability. The channel was also more defined with greater development compared to upstream were channelization had occurred. Another element to the higher diversity was improved wastewater treatment upstream with some distance for natural assimilation.

Big Darby Creek, RM 12.0 - 11.0, the other sampling reach with a positive and statistically significant trend in bivalve diversity, was modestly nutrient enriched from upstream NPS sources (Figure B.7.4.1). However, it did possess stable mussel habitats which included small side channels, bars with aquatic vegetation, side pools and areas behind woody debris. These habitat features protected the mussel beds from flooding which was common in the lower reach and which tended to displace and scour substrates (Figure B.7.4.2) (Tetzloff, 2000). The wooded riparian corridor directly adjacent to the stream protects the bank from erosion which in turn protected the mussel habitat.

Figure B.7.4.1. Big Darby Creek between RM 12 and 11 had 20 mussel species present (Tetzloff, 2000) due to stable treed banks and side habitat (side bars, channels and pools). Downed logs protected bank and mussel beds.

Figure B.7.4.2. Eroded banks with loss of riparian corridor on lower Big Darby Creek at RM 8.

Figure B.7.4.3. Trends in naiad mussels in the Big Darby Creek watershed over time.



Adapted from Watters and Flaute Myers, 2003.

Many of the rarer or more sensitive mussel taxa (i.e., the Clubshell, Northern Riffleshell, Rabbitsfoot, Snuffbox, and Wavy-rayed Lampmussel) are surviving in locations with stable and protective habitat features. These habitats, typically, are products of glacial remnants including end moraines, kames, and other geological features which yield steeper topography. These areas due to the pitch of the land are difficult to farm and, therefore, have led to a wider, more contiguous wooded riparian corridor. The abundant groundwater associated with these features is also felt to locally improve water quality (Figure A.2).

The groundwater in the western Darby Creek basin, particularly Little Darby Creek and its tributaries, possess relatively high concentrations of calcium bicarbonate ($Ca(HCO_3)_2$) in solution generally coupled with high hardness and alkalinity. In some locations where the water contained relatively large amounts of $Ca(HCO_3)_2$, with the equilibrium CO_2 that permits that solution, removal of the CO_2 through photosynthesis, resulted in the disruption of that equilibrium resulting in the precipitation of $CaCO_3$ (Wetzel, 1975; Curtis, 1979). This reaction, resulted in a rise of pH and calcareous incrustations on plants and other submerged objects (Cole 1983). This phenomenon has been observed in several locations in the aforementioned western portion of the Big Darby Creek watershed and Little Darby Creek. Lowered mussel diversity appeared to be associated with segments where the deposition of carbonates had resulted in cementing of the bottom substrates, which would have prevented or greatly reduced the ability of bivalves to move or re-establish within the stream bed. Locations where this phenomenon was observed included Little Darby Creek downstream from Barron Creek and Rosedale - Plain City Rd. toward Finley Guy Rd., in the reach upstream from Bradley Rd. ($\geq$ RM 20.5), and in a short reach off of Little Darby Rd. downstream from the confluence with Spring Fork (RM 17.0), and to a somewhat lesser extent (more in combination with sedimentation) near US Rt. 42.

In situations where a stable and wide riparian corridor was still present, for example downstream from Chuckery to near Rosedale - Plain City Rd, sensitive taxa like the endangered Clubshell mussel (*Pleuroblema clava*) survives in reaches where the ideal habitat of loose and well-aerated sand substrates allowed for mussel burrowing and regeneration of water quality in the lower substrates through interstitial flows. Shading provided by the intact forested canopy was felt to have reduced instream photosynthesis to a level that the bicarbonate - carbon dioxide equilibrium was not disrupted and, therefore, carbonate precipitation was not a problem. Restoring stable, contiguous wooded riparian corridors to the Little Darby Creek mainstem, and its tributaries is critical for protection of substrate quality which will protect the few sensitive mussels remaining in the scattered portions of the watershed still possessing stable habitats.

Besides increases in the riparian corridor width and subsequent streambank protection, decreases in storm water flows in the lower Darby basin would decrease erosion, slow down substrate bedload (and some entrenchment occurring (Tetzloff, 2000)) and would allow over time stable mussel habitat development (side channels, side bars, aquatic vegetation (like water willow) and side pools in conjunction with woody substrates).

Figures B.7.4.4 and B.7.4.5 present historical and more recent collection locations for bivalves in the Big Darby Creek watershed to provide a frame of reference that distribution maps of specific species can be compared against. Figures B.7.4.6 to B.7.4.11 present historical and current distribution data for selected rare and endangered mussels in the Big Darby Creek watershed. Discussions of their presence or absence from certain locales pertaining to habitat and land use will be discussed.

Figure B.7.4.4. Historical collection locations for bivalve mussels in the Big Darby Creek watershed (Watters and Myers Flaute, 2003).

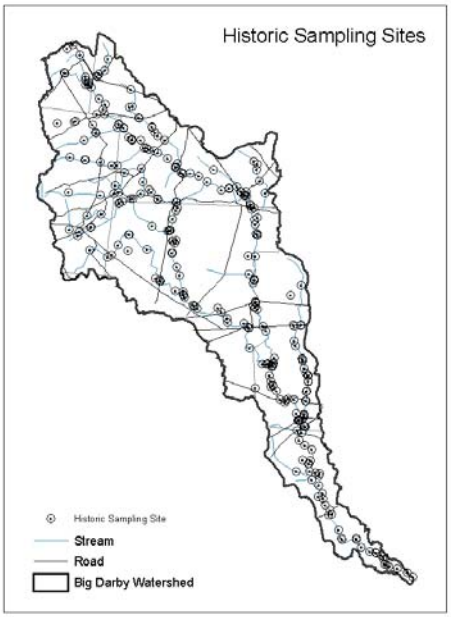
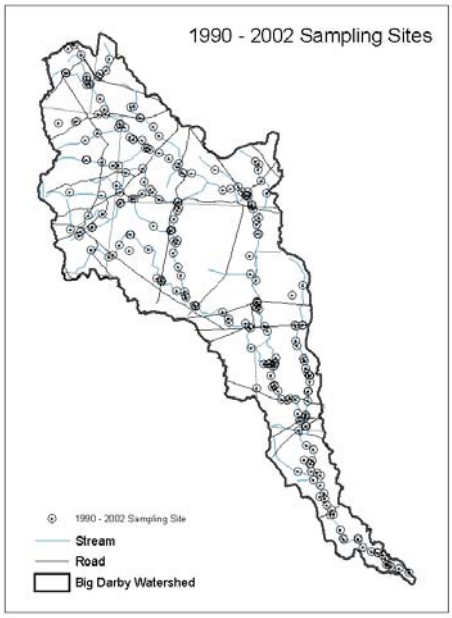


Figure B.7.4.5. Collection locations for bivalve mussels in the Big Darby Creek watershed (Watters and Myers Flaute, 2003).



The snuffbox mussel (*Epioblasma triquetra*)was found in ground moraine and till areas and/or adjacent to or in low or intermediate-level outwash terraces that are near low-level valley outwash (Figures B.7.4.6 and B.7.4.7). Ground moraine or end moraine features isolate some of these sites. With rolling or uneven terrain into the stream valley a more complete riparian corridor was still evident. Their habitat preference is clear, gravel riffles which would be present at sites dominated by alluvial and outwash terraces. Supplemental groundwater inputs would be likely as well as aerated gravel and sand riffle substrates. Their decreased presence in some historical areas was from poor WWTP operation (e.g., ammonia and metals) and NPS inputs like siltation, nutrient enrichment and low night D.O.s, and spills or kills.

Figure B.7.4.6. Historical distribution of the snuffbox in Big Darby Creek (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).

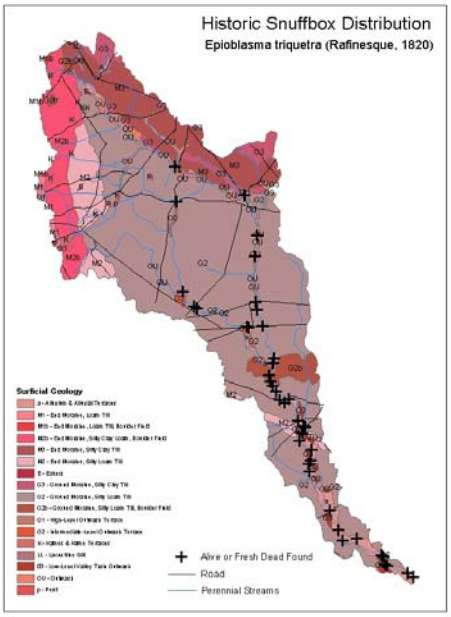
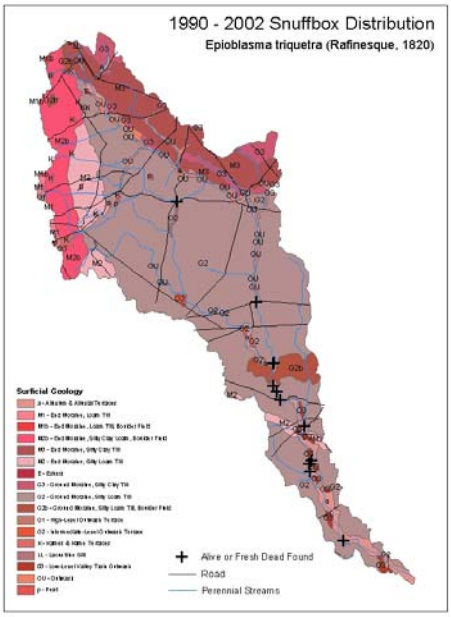


Figure B.7.4.7. Historical distribution of the snuffbox in Big Darby Creek, 1990 -2002 (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).



The washboard mussel (*Megalonaias nervosa*) was present in an area of ground moraine and till with boulders (Figures B.7.4.8 and B.7.4.9). There is a larger wide riparian area due to land use (parkland). The other site was in protected side pool in alluvium and alluvial terraces adjacent to low-level valley outwashes (somewhat narrow steep sided stream valley) with riparian corridor adjacent completely to the stream bank which stabilizes banks and allows for development of side pools or other habitat. The bottom was primarily loose sand and small gravel with a slight amount of silt settled on the pool surface.

Figure B.7.4.8. Historical distribution of the Washboard bivalve mussel in Big Darby Creek (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).

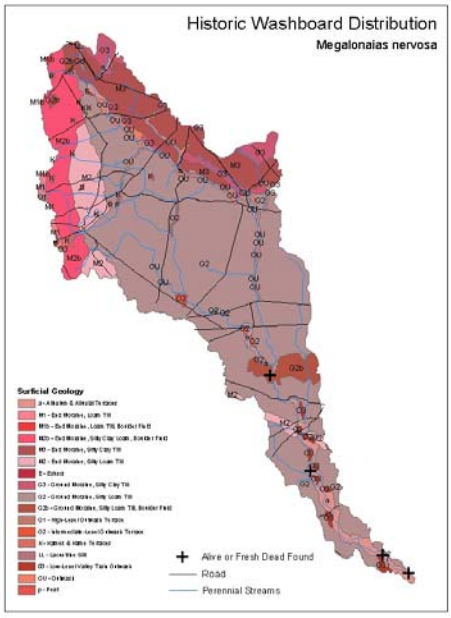
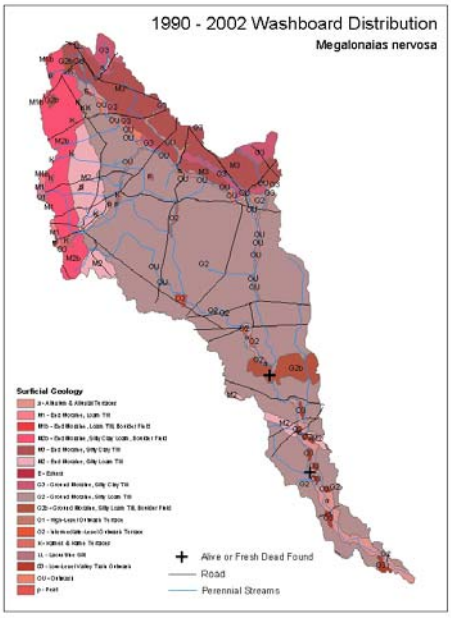


Figure B.7.4.9. Current distribution of the Washboard bivalve mussel in Big Darby Creek based on sampling from1990 - 2002 (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).



The federally endangered clubshell mussel (*Pleuroblema clava*) seems to be found near end moraine or in ground moraine (silty loam till) areas near alluvium terraces and/or outwash terraces (Figures B.7.4.10 and B.7.4.11). This matches their habitat preference for loose, coarse sand /gravel riffles (Watters, 1995). The clubshell mussel has a decreased presence downstream from West Jefferson and downstream from PCI discharges, but they are still present in more isolated reaches near alluvial and outwash terraces where wider riparian corridor is present, or where physical habitat (i.e., gradient adjacent stream) keeps land use activities and NPS inputs more distant from the river, whether from park activities, private lots, or agriculture. There is a probable threat in Spring Fork and downstream in Little Darby Creek from Green Meadows WWTP where there has continued to be water quality exceedences from their discharge. Siltation, embeddedness, and other NPS issues (nutrients, D.O.) are concerns and were reviewed earlier in this section.

Figure B.7.4.10. Historical distribution of the Clubshell bivalve mussel in Big Darby Creek (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).

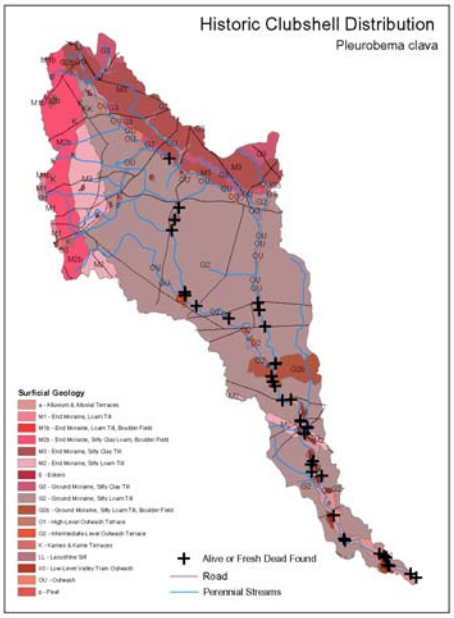
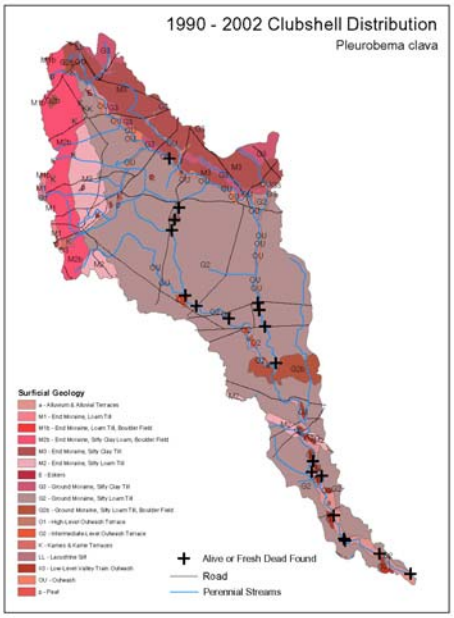


Figure B.7.4.11. Current distribution of the Clubshell bivalve mussel in Big Darby Creek based on sampling from1990 - 2002 (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).



The Ohio endangered rabbitsfoot mussel (*Quadrula cylindrica cylindrica*), since it rarely burrows buts lays on the surface substrates in slack water, has been susceptible to various impacts - sediment accumulation, low D.O.s from NPS nutrient effects, poor quality wastewater discharges, and spills (Watters,1995). It is still present in more stable isolated locations in Little Darby Creek in mixed sand and gravel (one site in lower BDC) where there is still cooler water temperatures and generally solid riparian buffers that allow for some shaded canopy (Cummings, 1992) (Figures B.7.4.12 and B.7.4.13).

Figure B.7.4.12. Historical distribution of the Rabbitsfoot bivalve mussel in Big Darby Creek (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).

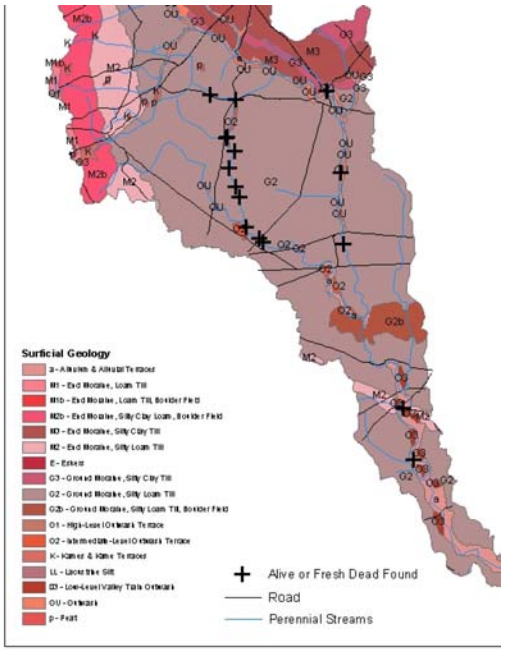
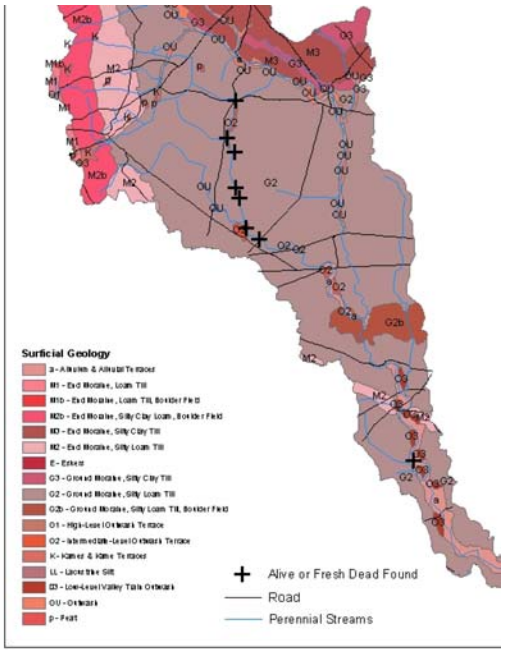


Figure B.7.4.13. Current distribution of the Rabbitsfoot bivalve mussel in Big Darby Creek based on sampling from1990 - 2002 (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).



Two of the hosts of the similar Cumberlandian subspecies of rabbitsfoot are the bigeye chub and spotfin shiner, which are resident in the Big Darby Creek basin (Watters,1995). The bigeye chub (*Notropus amblops*) prefers cool, clear water flowing through silt-free or silt-limited sand/ gravel riffles and pools (Trautman, 1981). It was last collected in 1930s in LDC, but recently with the removal of the dam at the mouth of Little Darby Creek bigeye chub populations were reestablished in Little Darby Creek. Ohio EPA fish collection data indicates bigeye chubs have been sampled and identified at RM 4.0 (1997) and at RMs 0.2, 4.1, 6.5, and 34.7 in 2001. It has not yet been collected in the reaches where current rabbitsfoot mussel populations reside. (It was

also collected in BDC at RM 10.4 downstream from rabbitsfoot mussel location in lower BDC.) The continued reestablishment and stability of bigeye chubs (a possible host of the rabbitsfoot mussel) in the middle reaches of Little Darby Creek depends on riparian buffer restoration in some areas of LDC (and BDC) to decrease NPS sedimentation. The spotfin shiner (*Cyprinella spiloptera*) is present throughout the watershed due to success of a better reproductive strategy against siltation (eggs attached under rocks). It is available as a possible host for the rabbitsfoot mussel to parasitize with glochidia and juveniles during the reproductive cycle. Practical habitat improvements in the LDC basin, in particular, could benefit this species and its potential host fish.

The federally endangered northern riffleshell mussel (*Epioblasma torulosa rangiana*) distribution was concentrated in Big Darby Creek from downstream the LDC confluence in park lands to the mouth (Figures B.7.4.14 and B.7.4.15). The moraine areas with alluvium or outwash sand and gravel seem to be the preferred glacial substrates which coincide with the preferred specific habitat of firm sand/gravel riffles in larger streams and medium to large rivers (Watters, 1995; Cummings et al., 1992). Current locations, if still there, are in park lands with

Figure B.7.4.14. Historical distribution of the Ohio Northern Riffleshell mussel in Big Darby Creek (Watters and Myers Flaute, 2003).GIS Surficial Geology Layer provided by ODNR (2000).

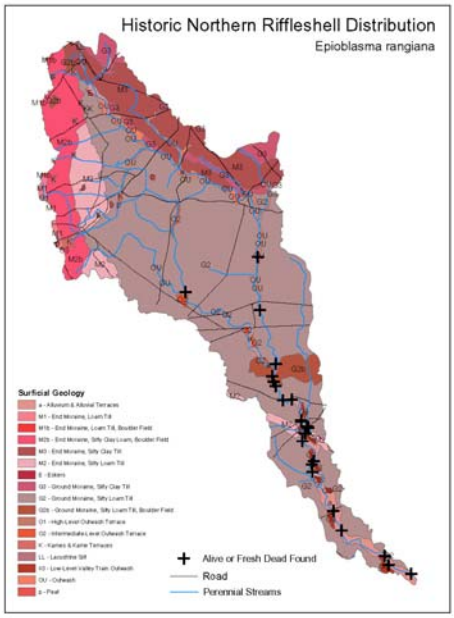
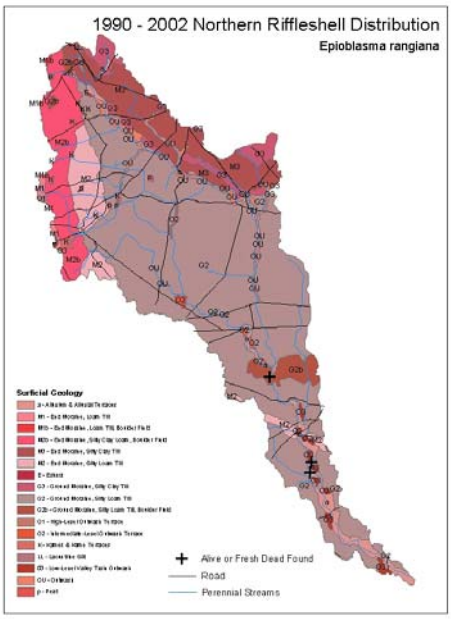


Figure B.7.4.15. Current distribution of the Northern Riffleshell mussel in Big Darby Creek based on sampling from1990 - 2002 (Watters and Myers Flaute 2003).GIS Surficial Geology Layer provided by ODNR (2000).



wide riparian buffer and in good habitat reach in lower Darby that had been relatively isolated. Losses due to poor wastewater quality and habitat instability seem to be major causes of the decreased distribution. Small malfunctioning waste treatment plants are being tied into a regional WWTP which also is functioning at a higher quality is addressing those water quality issues. Loss of stable mussel habitat (i.e., bars, side channels, water willow beds, unmoving unembedded riffles) due to increased storm water loads from upstream (particularly Hellbranch Run from increased metropolitan Columbus development pressures) inputs need to be slowed and controlled. Unembedded stable riffle/run habitat are essential to allow for the continued existence and possible reproduction of these and other sensitive mussel populations in the future. Also some mussel populations due to reduced numbers likely will have difficulty maintaining or increasing their numbers even after reducing or eliminating these stressors (Watters for USFWS, 1994).

The Ohio endangered rayed bean mussel (*Villosa fabalis*) seemed to have preferred locales with substrates from alluvium and glacial outwash with water willow habitat (Figures B.7.4.16 and B.7.4.17) (Watters,1995). However, it could be extirpated from the basin due to various factors; chemical impacts, sedimentation, loss of habitat, competition, habitat fragmentation which inhibit reproduction or recruitment (Butler et al. for USFWS, 2002). Its small size ($\leq$ 1 inch) does make it more difficult to locate.

In general, protection from destabilization of habitat due to loss of riparian width or increases in storm water inputs, NPS sedimentation, excess NPS nutrient inputs and poor quality wastewater inputs are essential to keep sensitive mussel distributions intact. Current ammonia and metal toxicity testing using mussels has indicated the possibility that lowered water quality criteria in specific locations might be needed to fully protect mussel species downstream from input sources (Ingersoll et al., 2003). These developments will continue to be monitored.

Figure B.7.4.16. Historical distribution of the Rayed Bean mussel in Big Darby Creek (Watters and Myers, 2002).GIS Surficial Geology Layer provided by ODNR (2000).

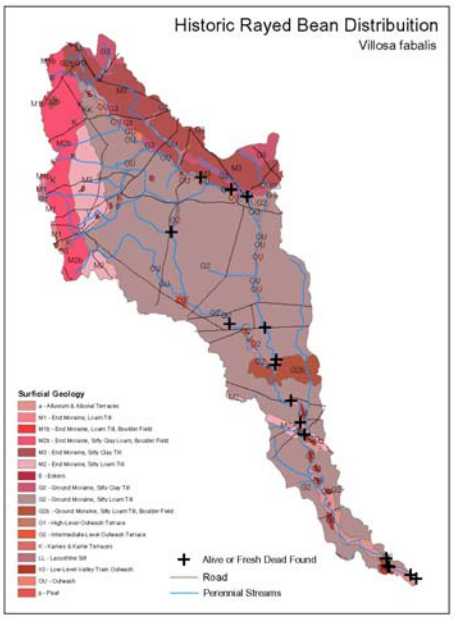
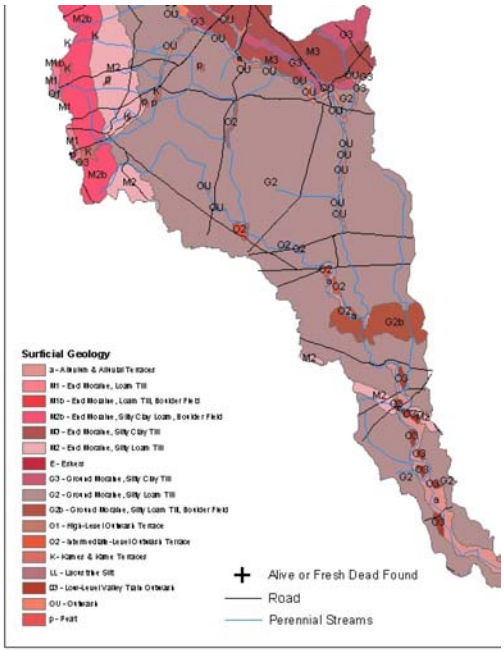


Figure B.7.4.17. Current distribution of the Rayed Bean mussel in Big Darby Creek based on sampling from1990 - 2002 (Watters and Myers, 2002).GIS Surficial Geology Layer provided by ODNR (2000).



B.8 Fish Community

B.8.1 Watershed Assessment

Fish communities were sampled 126 times in thirty-nine different streams within the Big Darby Creek watershed between July and October, 2001. A total of 61,882 individual fish representing 85 species and eight hybrids were collected during that sampling effort. This sampling follows large scale sampling efforts that occurred in the watershed during 1979 and 1992/1993 and has been designed to investigate impairments documented during those surveys and any trends or changes that have occurred in the watershed since that time. Additional samples were collected during the 2002 field season to fill gaps and further document identified impact areas from the 2001 survey.

Big Darby Creek Mainstem

Fish communities were sampled on the mainstem at 23 different locations extending from RM 82.5, at the very headwaters, downstream to RM 0.3, just upstream from its confluence with the Scioto River west of Circleville. A total of 23,406 fish representing 79 species of fish and six hybrids were collected between July and October, 2001. Evaluations of the integrity of the fish community based upon the Index of Biotic Integrity and the Modified Index of Well-Being ranged from marginally good (IBI - 37) downstream from the confluence with Flat Branch, RM 78.4, to excellent (i.e., IBI - 50, MIwb - 10.1) at all sites downstream from Alkire Rd., RM 34.1. Five additional sites were sampled on the mainstem during 2002, as mentioned above, to fill in gaps or to further document impairment.

In general, fish communities were judged to be very good or excellent and exceeded or marginally met their respective WWH or EWH criteria (Table B.8.1.1, Figures B.8.1.1 and B.8.1.2). There were a few noteworthy exceptions to this pattern, which was limited to the upstream portions of the watershed and which are described below.

Upper Big Darby Creek - (02-200) Headwaters to Plain City

The very headwaters of Big Darby Creek were relocated in 1997 as a consequence of the widening of U.S. Route 33 from a two lane road to a four lane limited access highway and the relocation and re-design of the intersection of U.S. 33 and Logan Co. Rd. 152, also known as the Honda interchange. Considerable concern raised by a variety of groups and individuals resulted in ODOT requesting technical assistance from Natural Stream Channel Design experts with the ODNR Division of Soil and Water Conservation. Reconstruction of the stream following the ODNR design and the natural flushing of sediments over time downstream has resulted in improved habitat at the very headwaters as of 2001 to the point where instream fish community performance met the EWH criterion. The next site downstream RM 80.8, SR 287, had a documented decline in habitat quality. The slug of sediment from upstream had increased embeddedness and siltation at this site. This led to a significant decline in IBI scores (i.e., from an IBI of 52 to 42) from EWH into the WWH range. Expectations are that this slug of sediment,

Figure B.8.1.1. Longitudinal trends in the Index of Biotic Integrity in the Big Darby Creek mainstem, 2001/2002.

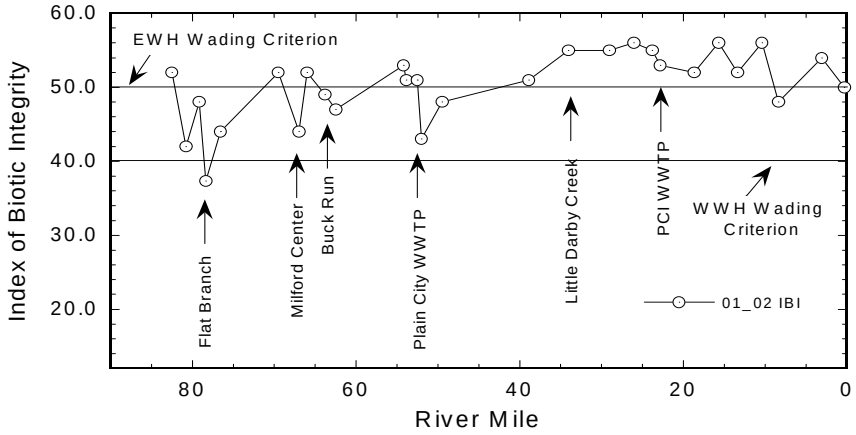
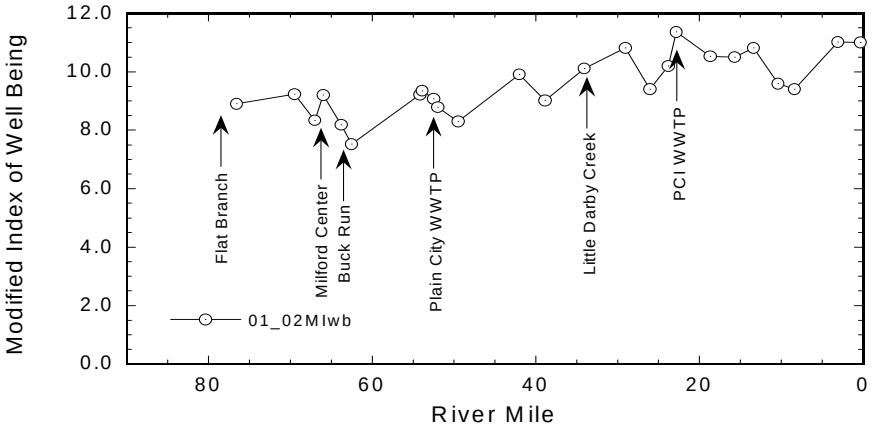


Figure B.8.1.2. Longitudinal trends in the Modified Index of Well Being in the Big Darby Creek mainstem, 2001/2002.



due to the relatively high local gradient, will move downstream resulting in gradual improvement of the QHEI and concomitant improvements in fish community performance. Unfortunately, this silt bedload will also result in declines further downstream as the sediment moves through the system. The impact of this stressor should attenuate with downstream distance as sediments are sidecast into the floodplain, where the stream channel has not been diked or the stream channel dredged, short circuiting this process. The site at RM 79.2 just upstream from the confluence with Flat Branch and the Flat Branch WWTP, which is situated on Big Darby Creek, is currently marginally meeting the EWH IBI criterion. Expectations are that this score will decline temporarily before eventually recovering back into the EWH range.

The poorest fish community performance recorded on the Big Darby Creek mainstem was found a short distance downstream from the confluence with Flat Branch (i.e., mean IBI = 37.3) at RM 78.4. Performance had improved marginally at RM 76.6; however, EWH criteria were still not being met. There are several causes associated with this significant decline. The Flat Branch WWTP is probably contributing to declines in water quality within this segment. Although exceedences of Ohio WQS downstream from the WWTP were limited to elevated bacterial counts there were other indications of water quality problems. The Flat Branch WWTP has had 264 NPDES permit violations reported to the Ohio EPA (January 2000 to December 2003) including (in order of decreasing frequency) total residual chorine, pH, fecal coliform bacteria, TSS, ammonia-N and dissolved oxygen and $cBOD_5$. These NPDES permit violations have been attributed to high inflows, operator error and improper chlorination settings. In addition to the water quality problems issuing from the Flat Branch WWTP the tributary, Flat Branch, has also been documented to be the source of water quantity and quality problems. Scouring flows disrupt habitat through stream channel destabilization and disrupt both benthic flora and macroinvertebrate fauna. Flat Branch has also been documented to be the source of water quantity and quality problems. Although Flat Branch accounts for less than 3% of the total watershed area of Big Darby Creek, it has been measured to contribute more than 11% percent of the total watershed flood flows (OSU, 2003). During normal flows, Flat Branch accounts for 88% of the flow at its confluence with Big Darby Creek even though it covers only 70% of the drainage area at that point.

Flat Branch was found to have elevated concentrations of several metals (i.e., Al, Fe, Zn) when compared to upstream Big Darby Creek sites (i.e., RMs 82.3 and 79.9). Measured high concentrations of aluminum persisted into Big Darby Creek downstream. A dissolved oxygen sag was documented downstream from the confluence (RM 75.2) with values dropping almost to 3.0 mg/l on several occasions at dawn during July and August, 2001 (OSU, 2003). These are concentrations which would be expected to prevent EWH biological performance. Further study should be conducted to apportion the relative contribution of the Flat Branch WWTP and Flat Branch to this problem.

Flat Branch was also discovered to be the source of a turbidity problem that extended as far downstream as the confluence with Buck Run in 2001. This problem likely originated on the Honda property, and Honda commissioned a study to determine the cause of the problem and to

derive a potential solution of the problem. Portions of the results of that study are presented in the water chemistry section.

Although judged in the good range, habitat may have modestly contributed to the depressed biological performance particularly at RM 78.4. Historical channelization had simplified the local habitat reducing diversity. Moderate to high embeddedness and unstable substrates in the riffles and runs were attributes which would have adversely affected darter and sculpin species, one of the declining metrics.

Almost complete improvement to EWH criteria was documented by the next site downstream, RM 69.2 - upstream from Collins Rd. In contrast the site at RM 68.1, adjacent to North Darby Coe Rd., fell to levels only slightly higher than those documented downstream from Flat Branch (i.e., IBI = 44 and MIwb = 8.34). Compared to the Collins Rd. sample only 1.1 miles further upstream there was a significant decline in the number of species from 27 to 18, a 66% reduction in intolerant species, a decline in sunfish and darter species and a noteworthy increase in percent DELT anomalies. Inspection of available water chemistry data did not immediately reveal the cause or source of the decline. Habitat probably also was not a major factor. Fish communities were performing very well in close proximity to this site and this factor would have buoyed up fish community performance in the face of modest habitat impacts, absent other stressors. Reductions in the relative number of individuals collected and in mean weight of many of the species suggest a community recovering from a previous adverse impact probably a water chemistry problem based on the increased percentage of anomalies. Macroinvertebrate community performance at RM 67.2, upstream from Milford Center, was at the Exceptional level supporting that the impact was either temporal in nature or not severe enough to extend 0.9 mile further downstream. This area is very rural in nature with agriculture and a sportsman club the only landuses adjacent or immediately upstream.

No sample was taken in Big Darby Creek downstream from Milford Center in 2001. To fill this gap in the longitudinal dataset a sample was taken at RM 66.0 in 2002. The IBI fully met and the MIwb marginally met their respective EWH criteria. This locality was immediately downstream from the upstream end of the Darby Creek Ag. Inc. spill/fish kill in July 2000. Although very significant recovery had taken place in the span of two years, the fish community still was not quite to levels measured in 1993 prior to the fish kill (i.e, IBI 52 vs. 54 and MIwb 9.2 vs. 9.7) (Figures B.8.1.3 and B.8.1.4). This segment should be resampled in the future to determine if full recovery to similar performance levels is ultimately accomplished.

The next few sites downstream, RMs 63.8 and 62.5, bracketing the confluence with Buck Run only partially met EWH criteria. These sites have historically supported EWH communities. Habitat evaluations done during this survey confirm that the habitat is still suitable and capable of supporting the EWH aquatic life use. Inspection of the biological index scores revealed that the IBI marginally met the EWH criteria. The MIwb, however, lagged behind. This is a fairly common response pattern to a fish kill, particularly when the impacted segment is closely bracketed by high quality segments. With cessation of the environmental stressors the impacted area is quickly re-colonized by pioneering representatives of most species, which typically are

Figure B.8.1.3. Longitudinal trends in Index of Biotic Integrity scores in the mainstem of Big Darby Creek during sampling conducted in 1992/1993 and 2001/2002.

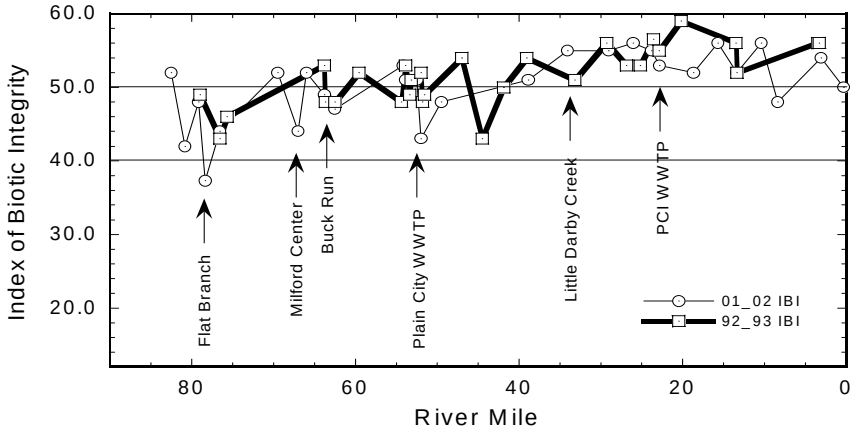
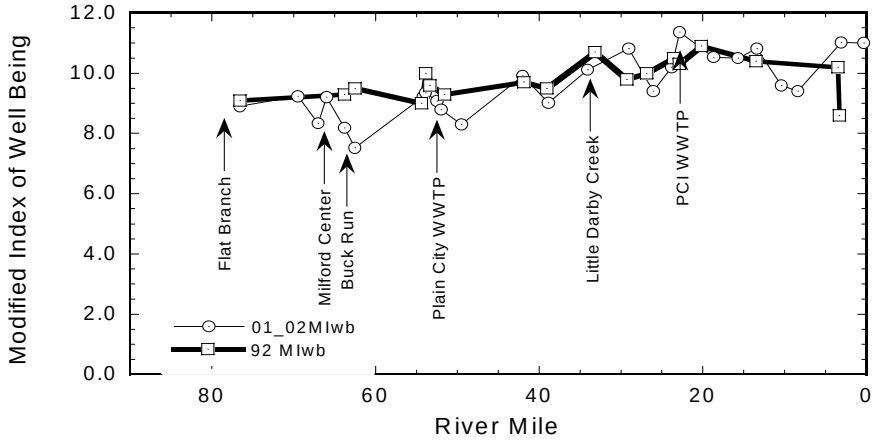


Figure B.8.1.4. Longitudinal trends in Modified Index of Well Being scores in the mainstem of Big Darby Creek during sampling conducted in 1992 and 2001/2002.



juveniles or sub-adults. This was reflected in the low average weight of many of the species in this segment. Growth of the pioneering individuals and recruitment into the area should result in gradually increasing average weight over time, absent any additional environmental stressors. However, spills have been recorded to Big Darby Creek at SR 38. A potential source is a custom applicator of farm chemicals whose property drains to a small ditch paralleling US 38 which drains to Big Darby Creek a short distance to the west.

Collection of fish tissue samples at RM 63.8 during 2002 revealed that large individuals were still lacking in this vicinity. The sampling crew had to sample several hundred yards upstream and still was not able to secure all of the desired samples. This further supports the need to conduct follow-up sampling in the segment to document the rate of recovery from this spill/kill.

Fish communities fully met EWH criteria downstream to Plain City and the confluence with Sweeney Run.

Middle Big Darby Creek - Plain City to Little Darby Creek

Significant impairment was detected downstream from the Plain City WWTP with both fish indices declining into the WWH range. QHEI scores in this segment ranged from 93.0 at the site just upstream from Plain City to 76.0 at RM 49.5, which was the next site downstream from the WWTP. Clearly a decline in habitat quality was not responsible for the decline in fish community scores. The habitat has historically supported EWH biological communities and is still fully capable of supporting that use.

Shifts in metric composition included slight increases in some of the negative metrics including the percentage of tolerant species and percent of omnivores, coupled with modest declines in the total number of species, relative abundance of individuals and a decline in the number of intolerant species. These shifts are characteristic of modest nutrient enrichment from a WWTP. The Plain City WWTP, discharging within the lax limits of its NPDES permit, yielded only one violation of the permitted fecal coliform limit. Additional indications of water quality problems from the WWTP included biosolids deposited on the streambed in sufficient quantities to violate one of the WQS "free froms" (i.e., Criteria that are applicable to all waters "To every extent practical and possible as determined by the director, these waters shall be: (A) Free from suspended solids or other substances that enter the waters as a result of human activity and that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life") and extremely high water column concentrations of ammonia, nitrate, nitrite and total phosphorus (i.e., > 95th percentile of background concentrations) immediately downstream. Furthermore a dissolved oxygen sag that dropped below the EWH minimum concentration was also found at RM 49.5 a short distance downstream from the WWTP.

Fish community performance had marginally improved by RM 49.5, upstream from Amity Pike, but the MIwb lagged behind staying in the WWH range primarily due to the unevenness and lower average weights of the largely intact EWH fish community.

Sites in the lower reaches of this segment improved and either fully or marginally meet EWH criteria. Substantial improvements in wastewater treatment have either already taken place or are planned for the immediate future to assist in the protection of this high resource.

Lower Big Darby Creek - Little Darby Creek to the mouth

Exceptionally high quality fish communities were found from US Rt. 70 to the mouth of Big Darby Creek, a distance of at least 42 miles. The most significant indication of stress in this segment was found at RM 8.4 where the IBI dropped to levels approaching WWH (Table B.8.1.1, Figure B.8.1.1). Nutrient enrichment appears to be a problem associated with the tributary discharging at RM 8.4 (Figure B.8.1.5). This segment warrants watching in the future.

Figure B.8.1.5. Build-up of algae on Big Darby Creek downstream from U.T. to mainstem at RM 8.4, 2001.

Table B.8.1.1. Fish community indices based on electrofishing samples at locations sampled by the Ohio EPA in the Big Darby Creek study area during July - October, 2001. Additional samples were collected in 2002 to fill in gaps and further delineate impact areas those samples are in bold.

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (Iwb)	Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
Big Darby Creek (02-200) (WWH/EWH + CWH Recommended)							
82.5	14	1798.59	NA	NA	52	68.0	Excellent
80.8	14	521.29	NA	NA	42*	61.0	Good
79.2	24	1298.00	NA	NA	48[NS]	64.5	Very Good
Big Darby Creek (02-200) (EWH)							
78.4	29	367.5	NA	NA	37*	63.5	Marg. Good
76.6	34	1473.75	11.11	8.9[NS]	43*	73.5	V.Good-Good
69.5	27	670.5	18.95	9.2[NS]	52	70.5	V.Good-Excel.
68.1	18	409.5	7.07	8.3*	44*	-	Good
66.0	**29**	**1273.5**	**8.41**	**9.2[NS]**	**52**	**74.5**	**V.Good-Excel.**
63.8	26	1002.75	7.20	8.2*	49[NS]	80.5	Good-V.Good
62.5	27	607.5	29.27	7.5*	47[NS]	83.5	Fair-V.Good
54.2	34	773.8	19.21	9.2[NS]	53	83.5	V.Good-Excell.
53.9	28	979.5	19.36	9.4	52	93.0	Excellent
52.5	30	952.5	12.20	9.1[NS]	51	-	V.Good-Excell.
52.0	25	890.25	13.10	8.8*	43*	81.0	Good
49.5	28	552.75	40.94	8.3*	48[NS]	76.0	M.Gd-V.Good
42.0	31	1454.25	35.71	9.9	55	81.5	Excellent
38.9	29	738.70	24.20	9.0*	51	82.5	V.Gd.-Excell.
34.1	41	1281.0	22.30	10.1	55	93.5	Excellent
29.1	45	602.67	136.97	10.8	55	86.0	Excellent
26.1	**28**	**424.5**	**14.02**	**9.4**	**56**	**94.5**	**Excellent**
23.8	36	707.00	181.34	10.2	55	87.5	Excellent
22.8	41	826.56	254.87	11.4	53	84.5	Excellent
18.7	36	516.00	170.58	10.5	52	85.0	Excellent
15.7	**35**	**14.82.0**	**55.70**	**10.5**	**56**	**88.5**	**Excellent**
13.4	42	991.00	141.10	10.8	52	85.5	Excellent
10.4	**32**	**609.69**	**25.92**	**9.6**	**56**	**85.0**	**Excellent**
8.4	**27**	**1009.5**	**61.27**	**9.4**	**48**	**69.5**	**Excell-V.Good**
03.1	41	694.00	206.04	11.0	54	82.0	Excellent
00.3	33	1229.14	195.55	11.0	50	71.5	Excellent
Flat Branch (02-223) (RM 78.48)[c](MWH)							
3.2	5	245.46	NA	NA	26	25.5	Poor
0.8	18	389.00	NA	NA	28	36.5	Fair
Little Darby Creek (02-251) (RM 78.34) (Logan Co.) (Undesignated/EWH Recommended)							
3.5	18	1417.00	NA	NA	55	71.5	Excellent
0.4	19	1926.00	NA	NA	50	68.0	Excellent

Continued

Table B.8.1.1. Continued

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (Iwb)	Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
U.T. to Big Darby Creek (RM 74.91) (Undesignated/EWH Recommended)							
0.2	14	1281.00	NA	NA	50	64.5	Excellent
Spain Creek (02-222) (RM 74.3) (WWH/WWH + CWH Recommended)							
5.7	10	832.00	NA	NA	44	66.0	Good
Spain Creek (02-222) (RM 74.3) (WWH/EWH + CWH Recommended)							
3.7	17	1360.71	NA	NA	56	72.0	Excellent
0.1	26	1499.50	NA	NA	53	76.0	Excellent
Pleasant Run (02-221) (RM 72.01) (EWH)							
4.6	16	1586.47	NA	NA	54	72.0	Excellent
0.5	20	958.00	NA	NA	58	59.5	Excellent
U.T. to Big Darby Creek (02-360) (RM 69.40) (Undesignated/WWH Recommended)							
0.3	14	400	NA	NA	44	64.5	Good
Hay Run (02-220) (RM 67.6) (WWH/EWH Recommended)							
0.3	17	494.12	NA	NA	54	52.5	Excellent
Prairie Run (02-219) (RM 63.84) (Undesignated/LRW Recommended)							
0.3	**10**	**145.5**	**NA**	**NA**	**28**	**23.0**	**Fair**
Buck Run (02-209) (RM 63.74) (WWH)							
10.4	8	300.00	NA	NA	26*	40.0	Poor
7.8	17	296.00	NA	NA	28*	55.5	Fair
0.1	20	255.00	8.92	7.1*	44	70.5	Fair- Good
Robinson Run (02-207) (RM 53.69) (WWH)							
2.1	10	116.00	NA	NA	30*	64.0	Fair
0.7	12	92.00	NA	NA	30*	70.0	Fair
Sweeny Run (02-357) (RM 52.11) (Undesignated/WWH Recommended)							
0.1	10	244.00	NA	NA	46	58.0	Very Good
Sugar Run (02-206) (RM 50.92) (MWH/WWH Recommended)							
7.5	6	153.00	NA	NA	26*	31.0	Poor
7.0	14	453.00	NA	NA	26*	29.5	Poor

Continued

Table B.8.1.1. Continued

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (Iwb)	Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
Sugar Run (02-358) (RM 50.92) (WWH)							
5.4	13	132.00	NA	NA	34*	38.5	Fair
0.5	15	204.00	NA	NA	40	65.5	Good
U.T. to Sugar Run (02-358) (RM 7.39) (Undesignated/MWH Recommended)							
0.1	9	549.00	NA	NA	30	27.0	Fair
Worthington Ditch (02-356) (RM50.62) (Undesignated/WWH Recommended)							
02	10	442.0	NA	NA	24*	--	Poor
Ballenger- Jones Ditch (02-355) (RM 49.68) (Undesignated/WWH Recommended)							
0.4	16	794.00	NA	NA	40	69.0	Good
Fitzgerald Ditch (02-272) (RM 44.96) (Undesignated/WWH Recommended)							
0.5	9	1398.00	NA	NA	32*	56.5	Fair
Little Darby Creek (02-210) (RM 34.1) (EWH)							
41.2	**9**	**870.17**	**NA**	**NA**	**48[NS]**	**70.5**	**Very Good**
39.6	12	880.00	NA	NA	42*	69.5	Very Good
38.8	13	1106.00	NA	NA	35*	82.0	Marg. Good
34.7	23	813.53	NA	NA	49[NS]	82.5	V. Good
29.5	19	172.5	20.89	8.8*	45*	--	Good
26.6	**29.0**	**883.5**	**22.48**	**10**	**54**	**58.0**	**Excellent**
24.5	24	439.50	68.20	9.3[NS]	52	62.5	V.Good-Excell.
23.1	**28**	**681.0**	**42.39**	**9.5**	**48[NS]**	**55.5**	**Excell -V.Good**
20.5	**26**	**718.5**	**10.66**	**9.3[NS]**	**56**	**64.5**	**V.Good-Excell.**
15.3	27	858.0	20.43	9.6	57	95.5	Excellent
6.5	29	847.50	17.30	9.3[NS]	58	95.5	V.Good-Excell.
4.1	31	1057.50	46.7	9.7	55	99	Excellent
0.2	26	1296.0	10.04	9.0[NS]	49[NS]	77.5	Very Good
Clover Run (02-218) (RM 34.1) (EWH/WWH Recommended)							
0.6	8	930.00	NA	NA	36*	60.0	Marg. Good
Lake Run (02-216) (RM 36.9) (EWH/EWH Deferred)							
0.9	19	618.0	NA	NA	42	71.0	Good

Continued.

Table B.8.1.1. Continued

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (Iwb)		Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
Jumping Run (02-217) (RM 3.9) (EWH/WWH Recommended)								
0.3		10	370.00	NA	NA	30*	63.0	Fair
Treacle Creek (02-213) (RM 31.3) (EWH)								
11.8		12	1216.00	NA	NA	40*	67.5	Marg. Good
8.3		21	1748.00	NA	NA	52	67.5	Excellent
6.00		20	940.59	NA	NA	48[NS]	66.5	Very Good
Howard Run (02-215) (RM 5.4) (EWH)								
0.5	13	1038.00	NA	NA		52	55.5	Excellent
Proctor Run (02-214) (RM 3.69) (EWH)								
4.9	18	844.00	NA	NA		42*	71.5	Good
3.1	21	2070.00	NA	NA		48[NS]	65.0	Very Good
1.6	19	1118.00	NA	NA		52	73.0	Excellent
Barron Creek (02-212) (RM 24.4) (EWH/WWH Recommended)								
2.1	18	1104.00	NA	NA		48	44.5	Very Good
Wamp Ditch (02-363) (RM 23.0) (Undesignated/MWH)								
0.1	4	92.50	NA	NA		30	45.5	Fair
Spring Fork (02-211) (RM 17.46) (EWH)								
15.8	13	1372.0	NA	NA		48[NS]	60.5	Very Good
13.7	21	2656.0	NA	NA		54	62.5	Excellent
10.1	**20**	**855.0**	**NA**	**NA**		**40***	**69.0**	**Good**
7.8	16	708.0	NA	NA		48[NS]	54.5	Very Good
3.3	**29**	**1986.0**	**27.95**	**9.8**		**52**	**67.5**	**Excellent**
Bales Ditch (02-362) (RM 3.64) (Undesignated/WWH Recommended)								
0.4	21	602.00	NA	NA		50	70.0	Excellent
Smith Ditch (02-353) (RM 31.69) (Undesignated/EWH Recommended)								
2.1	18	2802.00	NA	NA		52	77.5	Excellent
0.3	13	245.29	NA	NA		28*	73.0	Fair

Continued

Table B.8.1.1. Continued

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (Iwb)	Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
U.T. to Smith Ditch (02-354) (RM 0.06) (Undesignated/EWH Recommended)							
0.2	12	770.00	NA	NA	50	67.0	Excellent
Gay Run (02-298) (RM 26.48) (Undesignated/WWH Recommended)							
2.2	11	1212.00	NA	NA	46	66.5	Very good
Hellbranch Run (02-204) (RM 26.1) (WWH)							
10.3	17	254.00	9.50	6.80*	36[NS]	39.5	Marg. Good
7.4	21	739.00	6.82	8.20[NS]	32*	51.0	Fair
5.8	22	924.00	15.48	8.20[NS]	35*	65.5	Fair
Hellbranch Run (02-204) (RM 26.1) (WWH/EWH Recommended)							
3.7	26	1333.00	13.42	9.0[NS]	47[NS]	83.5	V. Good
1.00	27	823.00	13.94	9.2[NS]	49[NS]	84.5	Very Good
0.50	24	1243.00	10.80	9.1[NS]	41*	83.5	V.Good - Good
Hamilton Ditch (02-259) (RM 11.19) (MWH)							
3.4	5	180.00	NA	NA	16*	21.0	Very Poor
Hamilton Ditch (02-259) (RM 11.19) (WWH)							
0.5	8	198.00	NA	NA	24*	36.5	Poor
Clover Groff Ditch (02-245) (RM 11.19) (MWH)							
4.7	7	196.00	NA	NA	18*	22.0	Poor
Clover Groff Ditch (02-245) (RM 11.19) (WWH)							
0.8	13	358.00	NA	NA	28*	61.5	Fair
Springwater Run (02-203) (RM 24.0) (WWH)							
0.80	11	2172.00	NA	NA	50	48.5	Excellent
U.T. to Big Darby Creek (02-352) (RM 23.7) (Undesignated/WWH Recommended)							
0.2	3	74.00	NA	NA	30*	61.5	Fair
U.T. to Big Darby Creek (02-270) (RM 20.2) (Undesignated/WWH Recommended)							
0.8	13	712.00	NA	NA	44	77.5	Very Good
U.T. to Big Darby Creek (02-366) (RM 18.41) (Undesignated/WWH Recommended)							
0.3			**NA**	**NA**	**42**	**52.5**	**Good**

Continued

Table B.8.1.1. Continued

Stream/ River Mile	Cum. Species	Mean Rel. #	Mean Rel. Wt.	Modified Index of Well Being (MIwb)	Index of Biotic Integrity	QHEI[a]	Narrative Evaluation[b]
Greenbriar Creek (02-202) (RM 16.75) (WWH)							
2.70	13	1222.00	NA	NA	44	57.0	Good
1.30	13	3726.00	NA	NA	46	74.5	Very Good
Georges Creek (02-201) (RM 14.4) (WWH)							
0.90	6	3722.00	NA	NA	46	61.5	Very Good

	Wading	Headwaters	Boat
Eastern Corn Belt Plains WWH Criteria			
Modified Index of Well Being	8.3	NA	8.5
Index of Biotic Integrity	40	40	42
Eastern Corn Belt Plains EWH Criteria			
Modified Index of Well Being	9.4	NA	9.6
Index of Biotic Integrity	50	50	48
Eastern Corn Belt Plains MWH Criteria			
Modified Index of Well Being	6.2	NA	5.8
Index of Biotic Integrity	24	24	24

NA Headwater site MIwb not applicable.
* Significant departure from applicable biological criterion (more than 4 IBI units; 0.5 Iwb units).
_ Underlined values are in the poor and very poor range.
a QHEI - Qualitative Habitat Evaluation Index.
b Based on MIwb and IBI scores
c River Mile location of tributary confluence with its receiving stream.

Big Darby Creek Upper Tributaries: Flat Branch to Robinson Run

Flat Branch (02-223) (RM78.48) (MWH)

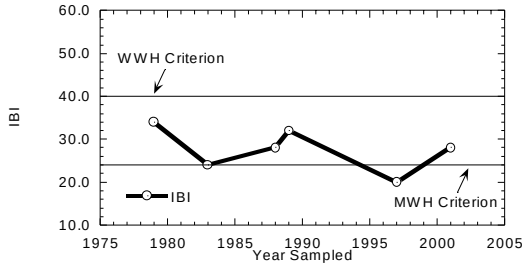
A total of 479 fish representing 19 species and one hybrid were collected from two sites within the Flat Branch subwatershed during the 2001 sampling. Fish community performance was judged very poor at the upstream site and poor at the mouth. Reduced habitat quality obviously contributed greatly to the diminished biological performance (i.e., QHEIs of 25.5 and 36.5, respectively). However, there were indications that other factors were further suppressing community performance. Only five species of fish with fairly few individuals were collected from the upstream site. Three of the five species present fell into the tolerant category. The black striped topminnow were also present and, although not categorized as tolerant, they are morphologically adapted for utilizing the thin layer of oxygen-rich water at the atmosphere-water interface. This makes these fish well suited for occupying habitats that are characterized by periodic or continuous oxygen depletion.

Flat Branch, has also been documented to be the source of water quantity and quality problems. Scouring flows disrupt habitat through stream channel destabilization and disrupt both benthic flora and macroinvertebrate fauna. Flat Branch has also been documented to be the source of water quantity and quality problems. Although Flat Branch accounts for less than 3% of the total watershed area of Big Darby Creek, it has been measured to contribute more than 11% percent of the total watershed flood flows (OSU, 2003). During normal flows, Flat Branch accounts for 88% of the flow at its confluence with Big Darby Creek even though it covers only 70% of the drainage area at that point.

Flat Branch was also found to have elevated concentrations of several metals (i.e., Al, Fe, Zn) when compared to upstream Big Darby Creek sites (i.e., RMs 82.3 and 79.9). Measured high concentrations of aluminum persisted into Big Darby Creek downstream. Persistent turbidity was also noted as a problem in Flat Branch which would disrupt many ecological processes including photosynthesis and biotic interactions mediated by visual cues.

One sampling location in Flat Branch, approximately RM 0.8 - CR 150, has been repeatedly sampled during the period spanning 1979 through 2001 for a variety of reasons (Figure B.8.1.6). When first sampled in 1979 fish community performance was in the fair range, recording an IBI of 34. Habitat quality at that time was obviously contributing to the observed community (i.e., QHEI = 28.5). There has been a trend of gradual and steady decline over the years. Construction activities associated with the re-routing of US Rt. 33 and bridge replacement of CR 150 were significant stressors particularly in 1997 (Figure B.8.1.6).

Figure B.8.1.6. Index of Biotic Integrity Scores recorded on Flat Branch at Union Co. Rd. 150, 1979 - 2001.



Habitat quality has improved somewhat at RM 0.8, now recording a QHEI of 36.5. Follow-up monitoring to determine the effectiveness of controlling the identified hydromodification and water chemistry problems should be conducting during the next monitoring cycle.

Little Darby Creek (Logan Co.) (02-251) (RM 78.34) (Undesignated/EWH + CWH Recommended)
A total of 2,782 fish representing 21 species of fish were collected from the two sites sampled in this subwatershed in 2001. Fish community performance was judged to be excellent with many representatives of specialized groups suggesting a diverse and stable stream environment (i.e., IBIs - 55 and 50). There were a high number of headwater species present. These species are only present in perennial streams and are generally indicative of ground water contribution. These include the southern redbelly dace and mottled sculpin. The large number of simple lithophilic spawning species document the relatively un-embedded nature of the streambed. Little Darby Creek has consistently scored highly over the years sampled. However, the headwaters did not score quite as well in 1988, which was one of the most severe droughts on record. Although still judged of excellent quality in 2001 there were indications of a community under stress towards the mouth of this small stream. The IBI has declined seven points from sampling conducted in 1989. Large lot residential development that has occurred more recently may be the cause of this stress. Additionally, short reach channelization has occurred in spots unleashing finer sediments which are being flushing downstream through the system. This warrants close attention and some concern for the ability of this stream to maintain its very high quality fish community. (See habitat discussion in Section B.6).

The significant presence of the obligate coldwater mottled sculpin both historically and at both sites sampled in the current survey (i.e., ~ 12% numerically) coupled with the significant presence of coldwater macroinvertebrate taxa has resulted in the recommendation that Little Darby Creek also be designated as Coldwater Habitat (CWH).

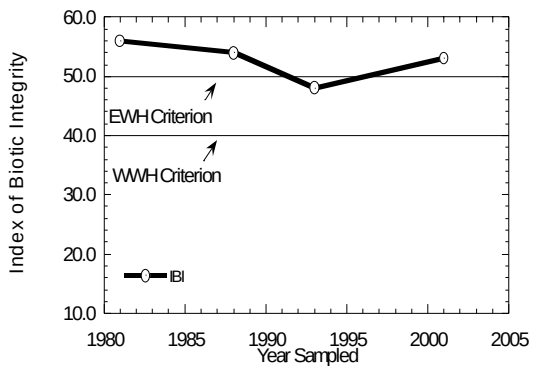
U. T. to Big Darby Creek (02-361) (RM 74.91) (Undesignated/EWH Recommended)
This small unnamed tributary is located on the west side of Big Darby Creek and confluences about half a mile upstream from the mouth of Spain Creek. Quite a few species of fish were collected in this very small 3.9 sq./mi. drainage area stream. A total of 1,281 individuals representing 14 species of fish were collected in 2001. The high number of darter and sculpin species, simple lithophilic spawning species, minnow species and other positive metric results yielded an IBI of 50, in the excellent range. This high of an IBI score coupled with a rather modest QHEI score suggests that the hydrology of this stream may be augmented with good ground water inflow. The very high number of mottled sculpins and fairly high numbers of southern redbelly dace and blacknose dace further support this conclusion.

Fish community sampling in this small stream was first conducted in 2001 and, therefore, trends in the fish community performance beyond those mentioned in the main section cannot be made.

Spain Creek (02-222) (RM 74.3) (WWH +CWH RM 4.0 upstream/EWH + CWH Recommended RM 4.0 downstream)

A total of 2,722 fish representing 27 species of fish were collected from the three sites sampled in 2001. The large number of intolerant species and species with specialized feeding or spawning requirements documented the high environmental quality present at the two downstream sites, RM 3.7 - Gilbert Rd and RM 0.1 - Cratty Rd. These sites scored in the excellent range in 2001 (Figure B.8.1.7). There have been several sampling efforts conducted at these sites over the years and these sites have consistently met EWH criteria since 1981. The site upstream at RM 5.7 - Lewisburg Rd. had not been sampled prior to 2001. Its IBI score of 44 fell just below the EWH threshold. Habitat quality at this site although fairly good was not judged of as high a quality as that found further downstream and is probably the explanation for the marginally lower IBI scores measured there. As a result of this site not fully meeting EWH criteria, the existing WWH aquatic life use designation will be retained for this portion of Spain Creek.

Figure B.8.1.7. Index of Biotic Integrity Scores in lower Spain Creek, 1981 -2001.



Mottled sculpin, an obligate coldwater fish, was also a significant component of all sites sampled within Spain Creek ranging from 17 percent of the catch at RM 5.7 to 1.63 percent downstream from the North Lewisburg WWTP. Southern redbelly dace, although not classified as a coldwater taxon, are an obligate coolwater taxon and the high number of them in concert with the high percentages of mottled sculpin and supporting coldwater macroinvertebrate assemblage result in the recommendation of Cold Water Habitat for the entire length of Spain Creek.

The sampling site at Cratty Rd., RM 0.1, has been sampled periodically since 1981. Although IBI scores have always exceeded the criterion for the existing WWH aquatic life use designation and exceeded or marginally met the criterion for the recommended EWH aquatic life use. There does appear to be a slight pattern of decline. The North Lewisburg WWTP was experiencing problems throughout the 1990s with numerous permit violations. The WWTP is undergoing an extensive series of upgrades including reducing the infiltration and inflow problems in the WWTP collection system, repairs to the WWTP, implementing good house keeping practices, higher certification of the plant operators and other beneficial projects.

Pleasant Run (02-221) (RM72.01) (EWH)

A total of 1,378 fish representing 21 different species of fish were collected from the two sites sampled in Pleasant Run during 2001 field season. Fish communities fully meeting the Exceptional Warmwater Habitat Criteria were documented at both sites. The downstream site yielded an IBI score of 58 which ranks it in the 99th percentile of all sites evaluated in Ohio.

This site has consistently scored in the exceptional range since first sampled in 1988. This was a noteworthy accomplishment since it also yielded an IBI score of 58 during the drought of 1988, the most severe drought on record in central Ohio. Many other streams in central Ohio that normally do not dry up were reduced to isolated pools that summer. The cool water temperatures detected during that sampling were strong indications of the significant contribution of ground water to the base flow of this stream. Additionally, the presence of southern redbelly dace and mottled sculpin, two species that require perennial flow and cooler water temperatures, in abundance further support this conclusion. Relatively recent channel work in the downstream reaches of this stream has resulted in declines in habitat quality putting the stream at risk for continued support of the high quality biological communities.

Unnamed tributary to Big Darby Creek ((02-369) (RM 69.40) (Undesignated/WWH Recommended)

A total of 200 individuals representing 14 species of fish were collected from this small direct tributary to Big Darby in 2001. The confluence of this stream with Big Darby Creek is just upstream from the Collins Rd. bridge and Milford Center in Union County. The fish communities scored solidly in the good range for the IBI (i.e., 44) fully meeting the criterion for the WWH aquatic life use and were reflective of the relatively good habitat documented at this site (i.e., QHEI = 64.5).

This unnamed tributary was first sampled in 2001 and, therefore, historical trends can not be developed.

Hay Run (02-220) (RM 67.6) (Undesignated/EWH Recommended)

A total of 280 individuals of 17 species of fish were collected from the one site sampled in 2001. This previously unsampled tributary to Big Darby Creek confluences approximately 0.5 miles upstream from Milford Center from the west side. Habitat quality has been modestly compromised by historical channelization and adjacent agricultural land conservation practices implemented with limited erosion best management practices. This yielded a QHEI of 52.5. Despite this less than optimal habitat quality the high number of species collected, the high number of environmentally sensitive taxa, darters and sculpins, simple lithophilic spawners and insectivores coupled with low numbers or percentages of organisms that do well in disrupted environments still yielded an IBI of 54. This community fully met EWH criteria. There appears to be factors in this stream that are augmenting habitat quality to permit instream biological performance solidly in the EWH range. Again, groundwater contribution from the Cable moraine is the suspected source. The abundance of mottled sculpin and variety and abundance of darters reflect the perennial nature of this stream.

Hay Run was first sampled in 2001. Aside from the observation of obligate coldwater taxa that require cold water year round and, therefore, directly indicating the perennial nature of this stream comparison with previous sampling to develop trends could not be conducted.

Prairie Run (02-219) (RM 63.84) (Undesignated/LRW Recommended)
The very dry conditions encountered in the summer of 2001 had rendered Prairie Run dry at the designated sampling site during most of the field season. As a consequence sampling was not conducted during that year. Sampling in 2002 yielded a community that was strongly suggestive of a community repopulating a desiccated area. Of the fish captured at the site most were pioneering and tolerant species. Pioneering species are those species that re-invade areas after a period of stress is reduced or eliminated. The particularly high percentage found at this site point to recent or frequent disruptions to water resource quality at this site. Additionally, the relative number metric had few individuals left after subtracting out the tolerant individuals. The relatively high number of species collected were a testament to the proximity of a high quality repopulation source - the mainstem of Big Darby Creek.

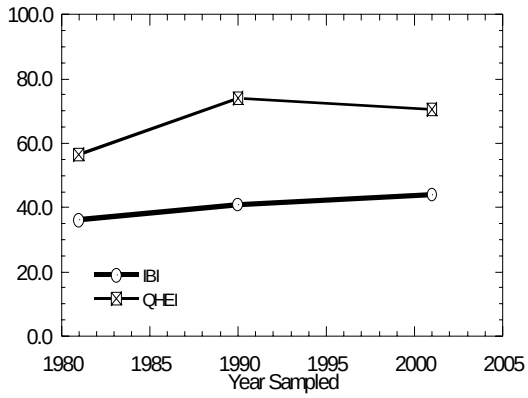
Buck Run (02-209) (RM 63.74) (WWH)
A total of 418 fish representing 28 species of fish were collected from the three sites sampled during the summer of 2001. The upstream site at RM - 10.4, Allen Center - Pottersburg Rd., yielded a poor fish community (i.e., IBI = 26), while RM 7.8, SR 245, yielded only a marginally better fish community with an IBI of 28. Degraded habitat was definitely a contributing factor to the reduced performance documented at the upstream site. However, the extremely low number of individuals, characteristic headwater species, sensitive species and minnow species coupled with very high percentages of tolerant species and pioneering species suggest stream dessication and poor water chemistry contributed to the depressed fish community. Pioneering species are those species that re-invade areas after a period of stress is reduced or eliminated. The particularly high percentage found at this site point to recent or frequent disruptions to water resource quality at this site and there were indications of water chemistry problems at this site (i.e., high TSS at 75th to >95th percentile vs. ECBP background).

The QHEI at RM 7.8 was 55.5 which falls into the range requiring closer analysis to determine the potential of the segment to support WWH biological communities. Intermittency and slightly increased siltation and embeddedness were the factors lowering the QHEI. However, the absence of channelization, moderate sinuosity, the absence of high influence modified habitat attributes coupled with a preponderance of positive habitat attributes suggest a site capable of supporting WWH biological communities. As mentioned above, the WWH level of performance was not reached at this site. Similar to RM 10.4, the extremely low number of individuals and the lack of characteristic headwater species, sensitive species and minnow species coupled with very high percentages of tolerant species and pioneering species lowered the IBI score. The only metrics showing improvement were the percent of insectivores and the number of species, but many of these additional species were only found in low abundance. There were further indications of water chemistry related stress within this segment. Low dissolved oxygen was a documented problem with a value violating the WWH dissolved oxygen minimum WQS (3.69 mg/l) measured here. Grab water samples frequently do not catch the lowest dissolved oxygen values since these most frequently occur in the pre-dawn hours well before grab water sampling occurs; however, these values were found during the later morning hours suggesting a chronic oxygen deficit. Ammonia and nitrite were at potentially chronically toxic concentrations (i.e., >

95th percentile vs. ECBP background), and TSS and other nutrient parameters were also very elevated (i.e., > 90th percentile vs. ECBP background) in some samples.

The site at the mouth of Buck Run supported much higher quality instream habitat and this was reflected in improved fish community scores. The IBI of 44 met WWH criteria. However, the MIwb of 7.14 was only fair in quality. This site appears to fall under the influence of the backwaters of Big Darby Creek. This site was also sampled in 1981 and 1990. There appears to be a very gradual trend of increasing quality over time that follows the pattern seen in habitat quality (Figure B.8.1.8).

Figure B.8.1.8. Index of Biotic Integrity and Qualitative Habitat Evaluation Index scores at the mouth of Buck Run,1981, 1990 and 2001.



In contrast to the improvements seen over time at the mouth, sites located in the headwaters of Buck Run have undergone the opposite trend. Sampling locations at Allen Center-Pottersburg Rd. and SR 245 have declined in recent years (Figures B.8.1.9 and B.8.1.10). Declines in habitat quality contributed to the decline in fish community performance as well as the water chemistry problems detailed above. Although there have been modest declines in habitat quality at RM 7.8, SR 245, over time low dissolved oxygen concentrations and other water chemistry problems likely played a greater role in the declining fish community performance.

Figure B.8.1.9. Index of Biotic Integrity and Qualitative Habitat Evaluation Index scores at RM 10.4, Allen Center - Pottersburg Rd. in Buck Run, 1981, 1990 and 2001.

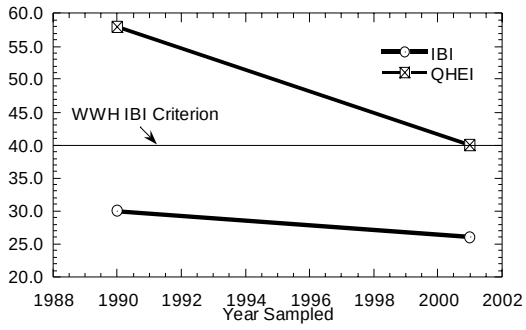
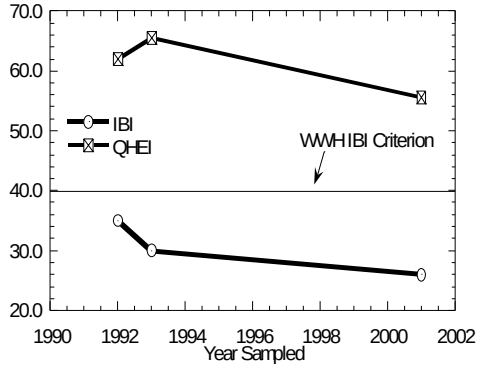


Figure B.8.1.10. Index of Biotic Integrity and Qualitative Habitat Evaluation Index scores at RM 7.8, R 245, in Buck Run, 1981, 1990 and 2001.



Robinson Run (02-207) (RM 53.69) (WWH)

Two sites were sampled in Robinson Run in 2001. A total of only 104 individuals representing 15 species were collected from these two sites. The instream habitat at both sites held the potential to support a much higher quality fish community than that sampled (i.e., mean QHEI - 67). The habitat holds the potential to support a fish community in the very good range.

The upstream site had not been previously sampled. Only ten species of fish in very low numbers were collected at this site in 2001. Community composition was unusual for this type of situation (i.e., low number of species and individuals). If the situation were due to dessication or chronic stress the expectation would be for a preponderance of pioneering and tolerant species and individuals. That was not the case here. Although representatives of those species were present, species like grass pickerel and striped shiner which are normally expected in larger sized streams were also present. Inspection of the water chemistry data revealed high Fecal coliform and E. coli numbers with very elevated Fecal streptococcus values also recorded. Organic enrichment was also reflected in the dissolved oxygen values measured. Datasonde™ continuous monitoring data revealed dissolved oxygen concentrations approaching the 4.0 mg/l WWH minimum D.O. concentration value. Nutrient enrichment was also a problem at this site particularly with nitrate and nitrite exceeding the 95th percentile of background conditions in the ECBP. TKN and ammonia were also very elevated exceeding the the 90th percentile. Although these stressors might have contributed to the problem, indications were that additional factors were present. Inspection of the spill record revealed that in May, 2000 a spill occurred at approximately RM 3.2 just upstream. Although the material and quantity of the spilled material is unknown this may very well be a contributing source of stress to the measured impact. Depressed fish community scores extended to the mouth. The fish community at the mouth site appeared to be under periodic stress. Sampling results in 1992 were variable with a fair community sampled in the early season and a good community documented in September. There was a significant increase in number of species (i.e., seven more), three more sensitive species, a doubling in the percent simple lithophils and an order of magnitude greater number of non-tolerant fish individuals collected. It appears that the fish community in September was responding to the cessation of stress and re-invading the area probably from adjacent high quality Big Darby Creek. The fish community documented in 2001 was more severely impacted with considerably fewer fish species collected, fewer headwater species, fewer sensitive species, darter and sculpin species, fewer simple lithophilic species and reduced number of intolerant individuals. The only metric showing improvement was an increase in the percentage of insectivores.

Robinson Run should be re-evaluated in detail to determine the causes and sources contributing to the impairment documented historically and in 2001.

Big Darby Creek Middle Tributaries: Sweeny Run to Little Darby Creek

Sweeney Run (02-357) (RM 52.11) (Undesignated/WWH Recommended)

A total of 122 individuals representing 10 species of fish were collected at the site just upstream from the mouth of Sweeney Run in 2001. Despite the slightly sub- optimal habitat found at this site (i.e., QHEI = 58) an IBI of 46, which is in the very good range, was recorded. Darters, which in most cases represent high quality habitat, accounted for almost seventy percent of the catch at this site with rainbow darters accounting for over 50 percent. The one metric showing the greatest departure from regional expectations was the very low number of headwater species. The appropriate presence of headwater species indicate permanent habitat (i.e., water availability) coupled with low environmental stress. The disappearance of these species suggest periodic dessication or environmental stress. Longtime residents of the Plain City area have noted the tendency for Sweeney Run's riffles to dry during droughts.

The proximity of the mouth of this tributary to a portion of Big Darby Creek that supports a high quality and diverse fish fauna undoubtedly plays a strong role in repopulation of lower Sweeney Run after periods of stress.

Sweeney Run was not sampled prior to 2001. It is not possible, therefore, to document trends other than those detailed above.

Sugar Run (02-206) (RM 50.92) (WWH/MWH Recommended)

A total of 370 fish representing 26 species were collected between July and October, 2001. A cumulative distance of 0.5 km. was sampled at the four sites evaluated.

Bluntnose minnow (22.5%), blackstripe topminnow (14.2%), and bluegill sunfish (10.6%) numerically dominated the catch. The bluntnose minnow is a highly intolerant species, the bluegill sunfish is a moderately tolerant species and the blackstripe topminnow although not categorized as a tolerant species is morphologically adapted for utilizing the thin layer of oxygen-rich water at the atmosphere-water interface. This adaptation makes these fish well suited for occupying habitats that are characterized by periodic or continuous oxygen depletion. Aggregated with other species categorized as highly or moderately intolerant yielded a total percentage of "tolerant" species approaching 70% of the community clearly demonstrating the disrupted condition of the majority of Sugar Run.

In Sugar Run fish communities ranged in quality from poor adjacent to the Rolling Meadows Golf Course (RM 7.5) to good at the site adjacent to the Forest Grove Cemetery at Cemetery Pike (RM 0.5). Fish community quality displayed a distinct trend of improving quality with downstream distance (Figure B.8.1.11). Habitat quality followed a very similar pattern (Figure B.8.1.12).

An IBI of 26 was recorded at both headwater sites (i.e., RM 7.5 - adjacent to the Rolling Meadows Golf Course and RM 7.0 - Taylor Rd.). Habitat was a strong contributing factor to the

Figure B.8.1.11. Longitudinal trend in the Index of Biotic Integrity in Sugar Run, 2001.

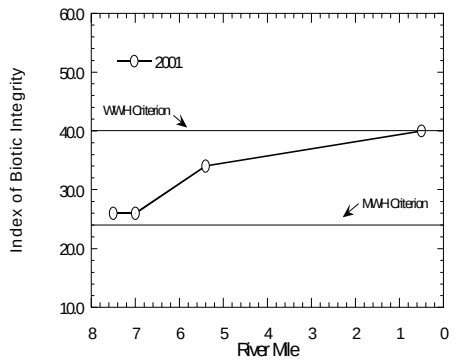
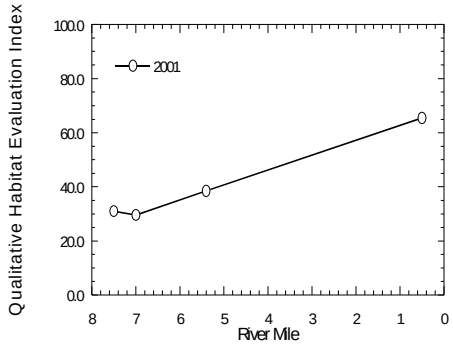


Figure B.8.1.12. Longitudinal trend in the Qualitative Habitat Evaluation Index in Sugar Run, 2001.



poor performance measured at the upstream site. Almost all of the high influence modified attributes were documented including: silt/muck substrates (which would contribute to the disappearance of darter and sculpin species, simple lithophils, and sensitive species), the absence of functional sinuosity, sparse cover, and inadequate residual pool volume which would directly contribute to the loss of headwater species and higher percentage of pioneering species. Moderate influence, modified habitat attributes were also significant including the absence of riffles, overall embeddedness, poor development and slow current velocity. Chemical water quality was also adversely influencing fish community quality. TSS, TKN, nitrates, and TP concentrations were equal to or exceeded the ECBP background 90th or 95th percentile concentrations. This highly enriched condition led to low dissolved oxygen concentrations as a result of algal respiration and its consequent effects.

Habitat quality was even poorer at RM 7.0 largely as a result of the lack of recovery from channelization. All other habitat attributes were similar to RM 7.5 and adverse. Water quality was also an issue inhibiting community performance. The water present in the stream channel was turbid and stained brown. Dissolved oxygen was low with a minimum concentration of 2.88 mg/l recorded. A value this low represents a violation of the minimum MWH D.O. criterion of $\geq$ 3.0 mg/l. Nutrient concentrations were similar or higher than those found upstream with increased NH_3 and nitrate concentrations.

Fish community performance improved significantly into the fair range (i.e., IBI = 34) at RM 5.4, downstream from St. Rt. 42. Habitat was of marginally higher quality than found at the upstream sites (i.e., QHEI = 38.5 vs. ~ 30) and was judged responsible for some of the improvement. However, habitat still had not improved to a level suitable for supporting WWH communities at RM 5.4. improved water quality resulting from the beneficial effects of the 60 ft. wide woody riparian buffer and more natural stream channel upstream from U.S. Rt. 42 also contributed to the improvement. However, low flows, elevated nutrient concentrations, bacterial

inputs, and embedded substrate conditions were factors stymieing the fish communities from meeting WWH criteria.

Despite the plethora of problems documented in the headwaters of the Sugar Run subwatershed the fish community at RM 0.5 fully met the WWH criteria. Habitat quality had improved dramatically into the range expected to support WWH communities (i.e., QHEI = 65.5). Although modified historically, the channel has shown definite progress in recovery. Siltation and embeddedness were reduced revealing coarse cobble gravel substrates with the variety and amount of cover and the residual pool volume also increased compared with upstream sites.

The good community present here was directly related to improved habitat quality, less silt, lowered nutrient loadings, and a more consistent instream dissolved oxygen regime.

Historical Trends

Sugar Run has been subjected to more stresses, impacts and changes per unit area than any other subwatershed within the Big Darby Creek study area. These changes have provided an opportunity to observe the shifts in community quality associated with a variety of water quality impacts, subsequent improvements associated with the cessation of those impacts, the impact of gradual habitat impairment, and the attendant interruption of improving quality (Figures B.8.1.13 and B.8.1.14).

Figure B.8.1.13. Longitudinal trend in the Index of Biotic Integrity in Sugar Run in 1981, 1990, 1992, 1995 and 2001.

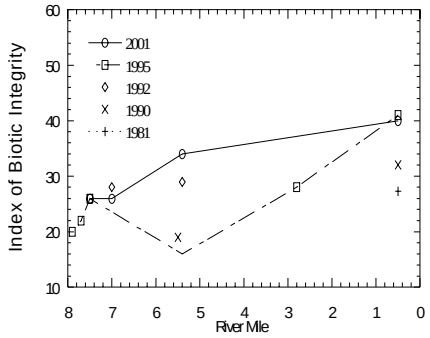
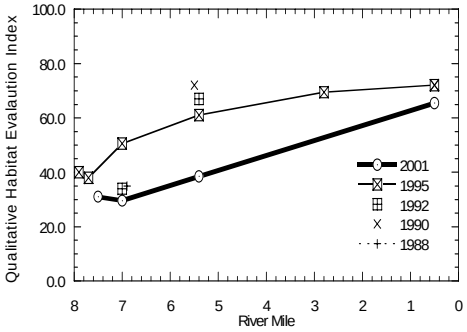


Figure B.8.1.14. Longitudinal trend in the Qualitative Habitat Evaluation Index in Sugar Run in 1988, 1990, 1992, 1995 and 2001.



Previous studies have documented severe water quality impacts and fish kills emanating from Sugar Creek's very headwaters. In July of 1993, an Ohio EPA Division of Emergency and Remedial Response (DERR) On Site Coordinator (OSC) measured toxic concentrations of ammonia instream and depressed concentrations of dissolved oxygen. The source was traced upstream to a farm at the very headwaters that had "fertilizer" incorrectly applied to some Conservation Reserve Program (CRP) land just prior to a heavy rain. The fish kill extended well

downstream, beyond the discharges of the New California and Kimberly Woods WWTPs (these facilities no longer operate). Additionally during the course of the investigation it was discovered that the farm that was the source of the "fertilizer" has had this fertilizer applied repeatedly in the past. This has not resulted in reports of fish kills; however, it may have resulted in some of the nutrient enrichment that has been observed instream. Additional CRP land in the area probably has had this fertilizer applied, also. The "fertilizer" was actually identified as wash water from two process lines at a local manufacturer of lawn chemicals that was collected into lagoons, then pumped into containers, tested and then land applied based on the measured concentration of NH3. Also, during the course of the investigation of this spill, a dairy operation was discovered that had severe problems with manure management. Approximately five acre-feet of unincorporated manure were discovered adjacent to Sugar Run. Indeed, the individual who reported the July 1993 fish kill has reported other kills, which when investigated, turned out to be manure run-off problems. Nutrient enrichment, in the very headwaters of this stream, are a chronic problem. This assessment was made in the mid-1990s. Although many changes have occurred in the upper watershed (e.g., the dairy operation has been moved to another portion of the watershed and a golf course now has a significant presence) nutrient enrichment still remains a significant problem ten years later (Table B.3.2).

Slightly downstream are two small tributaries that at the time of the 1992/1993 intensive survey received uncontrolled leachate outbreaks from the Hershberger Landfill. Testing from a remedial investigation detected volatile and semivolatile organic compounds in the tributaries near the landfill, although none were detected in Sugar Run (Ohio EPA 1996). The potential for contamination reaching Sugar Run was significant. This landfill accepted municipal and industrial wastes including paint, coolants, solvents, oil, caustics, fly ash, sludges, fertilizers, herbicides and pesticides.

As a result of that investigation, numerous complaints, and follow-up investigations the Hershberger Landfill was eventually capped and formally closed. This closure included the installation of a perimeter leachate collection system with any collected liquid hauled off site for treatment and disposal. A survey was conducted in 1995 to determine the efficacy of these measures to protect Sugar Run. Based on aquatic biological sampling results from 1995 and surface and sediment data from 1992, the Hershberger Landfill did not have a detectable influence on Sugar Run (Ohio EPA, 1996).

Impacts associated with discharges from the New California Interim and Kimberly Woods WWTPs were also a concern in the past. Episodes of poor water quality have been documented in Sugar Run upstream from the tributary that receives effluent from the New California Interim and Kimberly Woods WWTPs. As mentioned above these have been sufficient to cause fish kills in the past. Exacerbating the problem was the poor quality of the instream and riparian habitat found in this segment (i.e., QHEI = 39). It was a grass lined, agricultural ditch with no riparian vegetation and fine sediments lining the stream bed. The recurrence of nutrient rich runoff from poorly managed livestock operations and improperly applied "fertilizer" were frequent enough in combination with inadequately treated septic system discharges and the poor aquatic habitat to prevent meeting biological criteria for the then existing WWH aquatic life use

designation. In 1992 biological sampling within this segment at River Mile 6.8 - Taylor Rd. yielded fish communities predominated by tolerant, omnivorous and pioneering species. The IBI of 28 fell well short of meeting the WWH criterion of 40.

Sampling was conducted in the vicinity of US Rt. 42 to document any impact associated with the New California WWTP and Kimberly Woods WWTP in 1992. Despite a significant improvement in instream and riparian habitat, to a level that should easily support WWH use designation (i.e., QHEI = 61.0), the fish communities performed in the fair range (IBI = 30). Some of this impact may be attributable to a delayed impact from a dissolved oxygen sag associated with the livestock run-off, but the majority of the difference probably represented additional impact associated with these two small, WWTPs. Fish sampling at this site in 1990 corroborates this observation. Fish community performance was much poorer in 1990, yielding an IBI of only 19. Modest improvements at the New California Woods WWTP since 1990 had yielded modest improvements in the fish community.

There are strong indications that the impact from this area extended downstream. Sampling results from a site near the mouth in 1990 had shown only marginal improvement since 1981 (i.e., from IBI = 28 to 31) despite having adequate habitat for supporting warmwater biological communities. This documents long term impairment of this stream. It is interesting to note that habitat quality at this site has been improving over time. There have been some observed changes in land use practices in the intervening years, most notably a reduction in the amount of livestock upstream. This has yielded a reduction in the amount of silt and its attendant problems detected instream.

Sampling in 1995 in the very headwaters of Sugar Run (i.e., RMs 7.9, 7.5 and 7.0) also documented poor fish community performance with a large proportion of pollution tolerant species present. At that point in time the upper reaches of Sugar Run were characterized as channelized with a degraded riparian corridor, with nutrient enriched condition which were at time documented as toxic. This was associated with land application of fertilizer and manure. Gray water septic conditions were also observed at one location in the very headwaters adjacent to a dairy farm.

U.T. to Sugar Run (02-358) (RM 7.39) (Undesignated/MWH Recommended)
This small, unnamed tributary confluences with Sugar Run almost at its headwaters, close to where it crosses under US Rt 33. Its catchment is a mix of rowcrop agriculture and drainage from the freeway. The stream is a channelized, shallow and mostly pooled watercourse with very low flow and slow current due to its gradient and modified channel. The banks were grassed or lined with rip rap. Some areas had slumped banks. The entire length has been petitioned under the County Ditch Law and is maintained in this altered state to support agricultural drainage. This is reflected in the very low QHEI of 27 recorded at RM 0.1. Modified Warmwater Habitat is the recommended aquatic life use for this currently undesignated stream.

A total of 183 individuals representing nine species of fish were collected in 2001, the first time this stream had been sampled. This yielded an IBI of 30 which fully met the criterion for the recommended MWH aquatic life use.

Nutrients delivered from adjacent fields via overland runoff and tile drainage plus an open canopy has led to the development of extensive algal blooms which form thick mats on the streambed. These are flushed downstream during floods exporting nutrients and oxygen demanding substances to Sugar Run thereby contributing to the high nutrients and low dissolved oxygen problems documented there.

Worthington Ditch (02-356) (RM 50.62) (Undesignated/WWH Recommended)
Worthington Ditch, a direct tributary to the Big Darby Creek mainstem, discharges from the west only a short distance downstream from the confluence with Sugar Run. It was first sampled in 2001 upstream from the Plain City Georgesville Rd. bridge. Two hundred twenty-one fish representing 10 fish species were collected yielding an IBI of 24. This poor community performance, which meets the criterion for the recommended MWH aquatic life use, reflected the altered conditions of the instream habitat (i.e., QHEI = 46.5) (Figures B.8.1.15 and B.8.1.16).

Figure B.8.1.15. Worthington Ditch upstream from Plain City -Georgesville Rd.

Figure B.8.1.16. Worthington Ditch downstream from Plain City - Georgesville Rd.

Ballenger-Jones Ditch (02-355) (RM 49.68) (Undesignated/WWH Recommended)
This approximately six mile long tributary on the west side of Big Darby Creek originates about two miles south of Plain City. It flows almost directly east and confluences with Big Darby Creek at the intersection of Amity Pike Rd. and Plain City - Georgesville Rd. and just upstream from Amity. The streams flows through ground moraine its entire length. Land use although primarily row crop agriculture has significant number of large lot residences as well horse stables. The Jonathan Alder High School campus is also situated in this small subwatershed.

Ballenger-Jones Ditch was first sampled in 2001 at RM 0.4. A total of 397 individuals representing 16 species of fish were collected yielding an IBI of 40. This falls in the good range and meets the criterion for the recommended WWH aquatic life use. Although where sampled most of the riparian vegetation had been removed, the stream channel still retained a preponderance of positive Warmwater Habitat attributes which yielded a very good QHEI of 69.0. The fish community reflected that intact habitat (Figure B.8.1.17).

Discussions with the local landowner revealed that the land lying between Plain City - Georgesville Rd. and Big Darby Creek had recently been bought by ODNR and would be protected from development (Figure B.8.1.18). Upstream, however, is under considerable pressure to convert from agriculture to large lot residential and this stream may be subject to those stressors in the future.

Figure B.8.1.17. Ballenger-Jones Ditch upstream from SR 142, 2001.

Figure B.8.1.18. Ballenger Jones Ditch downstream from SR 142, 2001.

<u>Fitzgerald Ditch</u> (02-272) (RM 44.96) (Undesignated/WWH Recommended)
Another tributary originating from the western side of Big Darby Creek confluences with Big Darby Creek 0.5 mile upstream from the Lucas Rd./Beach Rd. Suspension Bridge. Much of the upper reaches of Fitzgerald Ditch have been channel modified. Lower reaches (i.e., ~ RM 1.5 downstream) have been modified to a much lesser degree. The instream habitat evaluation conducted downstream from St Rt 142 yielded a QHEI of 56.4 (Figures B.8.1.19 and B.8.1.20). Moderate influence negative habitat attributes were the main factors resulting in the slightly less than optimal habitat.

The one sample collected in 2001 up and downstream from the Plain City Georgesville Rd. bridge yielded 699 individuals representing nine species of fish. This sample location was also a short distance downstream from the Canaan Community MHP WWTP (i.e., a couple of hundred yards) which meets its permit limits most of the time, but due to deteriorating equipment will need to be replaced within the next five years. The high percentage of omnivores and tolerant fishes and the shift away from sensitive species and insectivores point to a moderate level

nutrient enrichment stressor. The large number and percentage of stonerollers, a species of minnow that scrapes algae off of the streambed, collected at this site also support the diagnosis of a moderate nutrient enrichment problem.

Figure B.8.1.19. Fitzgerald Ditch upstream from Plain City-Georgesville Rd.

Figure B.8.1.20. Fitzgerald Ditch downstream Plain-City Georgesville Rd.

Portions of the lower half of the segment went to interstitial flow partially due to the nature of the streambed materials and the underlying geology and partly due to the drought conditions seen during the summer of 2001. This also was reflected in the fish community results with no headwater species present and a high percentage of pioneering species (i.e., ~ 50 percent) present. Replacement of the WWTP in the future coupled with proper operation and maintenance should result in fish communities meeting the WWH criterion at this site.

This segment of Fitzgerald Ditch has not previously been sampled. A portion upstream in the vicinity of US Rt. 42, however, was sampled in 1994 in response to a spill investigation. A spill of ammonia had virtually eliminated all aquatic life for several hundred yards downstream from the point of the spill.

Discussions with the downstream landowner at the time had revealed that this episode was not the only time that chemicals had been spilled into Fitzgerald Ditch.

Little Darby Creek 02-210 (RM 34.1) (EWH)

A total of 11,608 individuals representing 53 species of fish and four hybrids were collected from 10 sites along the mainstem of Little Darby Creek in the summer of 2001 and supplemented with a three additional samples during the summer of 2002. Fish community performance ranged from fair (IBI = 35) at Wing Rd. downstream from the Mechanicsburg WWTP to exceptional (IBI = 54, MIwb = 10.0) downstream from Chuckery at RM 26.6 (Table B.8.1.1, Figures B.8.1.24 and B.8.1.25). In general, fish community performance was suppressed in the headwaters particularly in the vicinity of Mechanicsburg with a trend of gradual improvement towards the mouth. Fish communities fully met or marginally met EWH criteria downstream of Chuckery to the mouth.

In its very headwaters Big Darby Creek is strongly influenced by ground water with measured water temperatures near 56º F. The fish community at Allison Rd., RM 41.2, in 2002 strongly reflected that influence. Mottled sculpin, an obligate coldwater fish species comprised approximately 64% of the total catch with 332 individuals collected (Figure B.8.1.21). The total catch at this site was 522 fish representing nine species of fish.

Figure B.8.1.21. Mottled sculpin, an obligate coldwater fish species collected downstream from Allison Rd., RM 41.2, in 2002.

This is a very high gradient (i.e., > 40ft./mi.) small drainage area (i.e., 3.3 sq. mi.) sampling site that is strongly influenced not only by its adjacent landuse (Figure B.8.1.23) but by the catchment immediately upstream (Figure B.8.1.22). Immediately upstream from Allison Rd. is a large livestock pasture that has no riparian buffer and allowing unrestricted access of the livestock to the stream channel. This has led to false bank formation and the transport of silt and fines downstream smothering substrates and increasing embeddedness. In contrast the land abutting the sampling location has been protected by enrollment in the wetland reserve program.

Figure B.8.1.22. Fish sampling site in Little Darby Creek upstream from Allison Rd., RM 41.2 in 2001.

Figure B.8.1.23. Fish sampling site in Little Darby Creek downstream from Allison Rd., RM 41.2 in 2001.

Figure B.8.1.24. Longitudinal trend in the Index of Biotic Integrity in Little Darby Creek, 2001/2002.

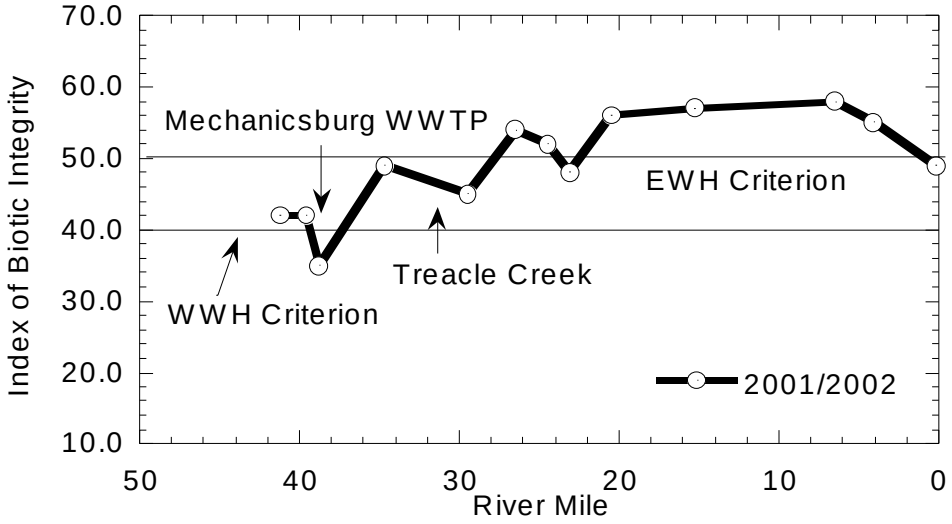
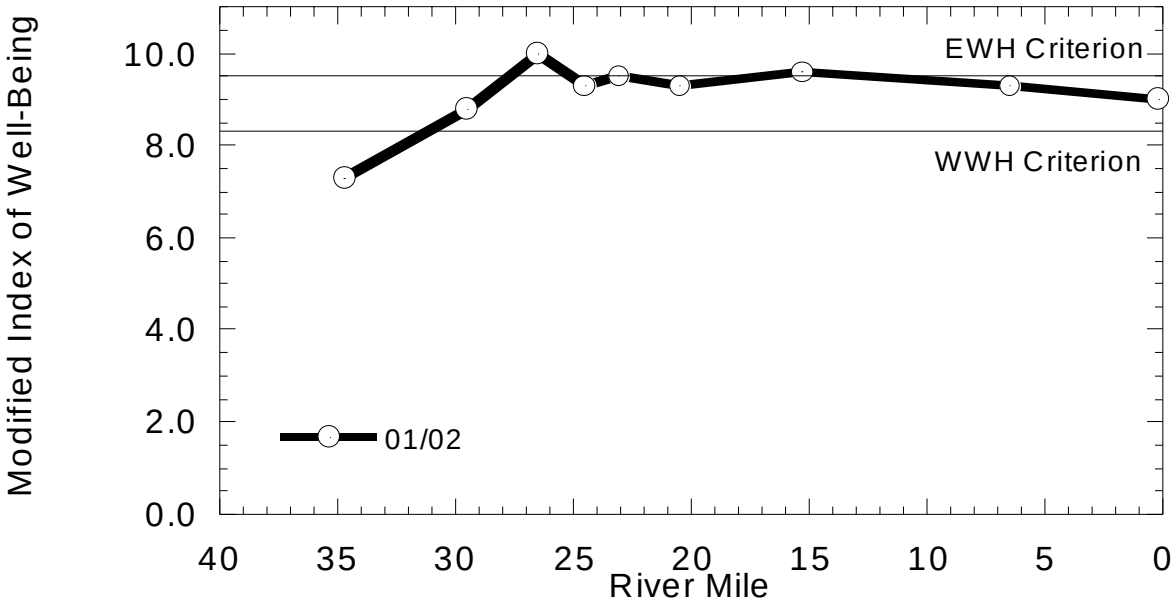


Figure B.8.1.25. Longitudinal trends in the Modified Index of Well Being in Little Darby Creek, 2001 and 2002.



The intact riparian buffer has permitted the development of very good instream habitat with the only modified habitat attributes the previously mentioned siltation and embeddedness. Numerous springs were also noted emanating from the stream banks within the sampling zone.

The next sampling site was downstream of St. Rt. 29 , RM 39.6, where Little Darby Creek winds southeast and east just south of most of Mechanicsburg. This site was also downstream from the confluence with Clover Run and just downstream from a fertilizer / feed distributor storage facility and an open pasture with unrestricted access of livestock to the stream (Figures B.8.1.26 and B.8.1.27). Fish community scores although solidly in the good range (i.e., IBI = 42) did not meet the EWH criterion of 50.

Figure B.8.1.26. Free access livestock pasturage upstream from Mechanicsburg, RM 39.6, 2001.

Figure B.8.1.27. Instream habitat in Little Darby Creek upstream from Mechanicsburg, RM 39.6, 2001.

This portion of Little Darby Creek has been subject to spills in the past which have resulted in substantial fish kills. One spill of liquid fertilizer to this segment was documented on December 17, 1987. It was responsible for the second largest recorded kill in the entire Big Darby Creek watershed. Other spills and kills have been reported from the same facility in the past and in intervening years. The absence of sensitive species and the high percentage of tolerant species point to a fish community on the mend. Mottled sculpin comprise almost forty percent of the catch revealing that ground water is still a significant component of the flow in this reach diluting the effect of any contributed stressor. If cool ground water flow was not present and, therefore, the mottled sculpin not a component of this community IBI scores would be very much lower. The macroinvertebrates met their respective EWH biocriterion suggesting that the impairment occurred in the past, probably one or two years previously (which is the typical recovery period for the macroinvertebrates). Currently indications in the water chemistry and macroinvertebrate response pattern point towards nutrient enrichment as the present problem. Containment of any spills from the fertilizer / feed distributor storage facility and scrupulous house keeping to prevent small scale runoff problems from this facility coupled with livestock exclusion from the stream channel and re-establishment of the riparian area will protect and restore the EWH communities at this location and downstream as well.

The next site sampled was downstream from the Wing Rd. bridge, RM 38.8. In contrast to the macroinvertebrate sampling location at this site, which was situated in between the outfall from the Mechanicsburg WWTP and an untreated bypass pipe from the WWTP, the fish sampling location was downstream from both. The macroinvertebrates performed in the EWH range. The fish community, however, performed in the fair range with an IBI of only 35. Habitat quality was not a contributing factor. In fact, instream habitat, where evaluated, was excellent yielding a QHEI of 82.0, which on a segment level would be more than capable of supporting EWH biological communities. Clearly discharges from the bypass pipe was resulting in a significant and adverse impact to the fish communities in Little Darby Creek. Little Darby Creek should be re-evaluated after the bypass pipe has been sealed and the Mechanicsburg WWTP upgraded.

Fish community scores improved at Irwin Rd., RM 34.7, marginally meeting the EWH criterion with a mean IBI of 49. Habitat where evaluated was excellent yielding a QHEI of 82.5 (Figures B.8.1.28 and B.8.1.29). The high quality of the available instream habitat coupled with the assimilative capacity of the stream and distance from the Mechanicsburg WWTP and bypass discharge had resulted in most of the IBI metrics rebounding into the EWH range.

Figure B.8.1.28. Little Darby Creek at Irwin Rd., RM 34.7, upstream view, 2001.

Figure B.8.1.29. Little Darby Creek at Irwin Rd., RM 34.7, downstream view, 2001.

The fish community upstream from Axe Handle Rd., RM 29.5, dropped below the EWH range in 2001. Habitat quality was determined to be in the high-good range with a QHEI of 66.5. This location had supported EWH fish communities. Sampling conducted in 1997 had yielded 28 species of fish and excellent fish index scores (i.e., IBI = 54 and MIwb = 9.3). The loss of intolerant species and the fairly low number on non-tolerant individuals were the metrics showing the greatest deviation from expectations. Problems associated with nutrient enrichment and its consequent negative effects on dissolved oxygen appear to be strong candidates for the depressed fish community results. Continuous dissolved oxygen monitoring has revealed dissolved oxygen dropping below EWH minimums upstream from the bridge. Additionally, the downstream reaches of Treacle Creek, whose confluence is immediately upstream, are also

plagued at times by depressed dissolved oxygen concentrations. The combined effect is deleterious to the fish community at this locale.

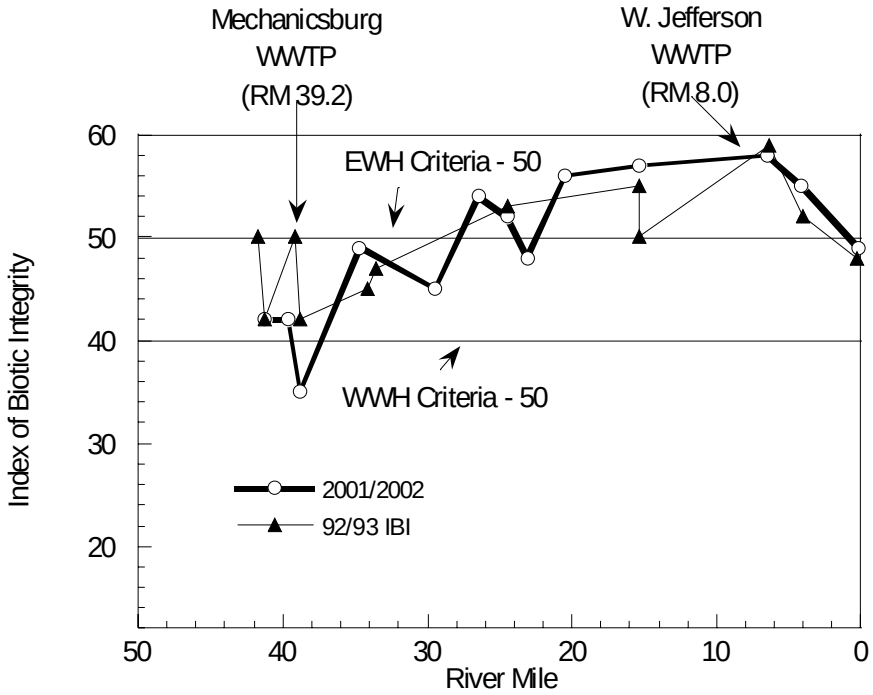
The site at RM 24.5, downstream from Chuckery, although in an area, having less than ideal habitat conditions (i.e., QHEI = 58) yielded excellent fish community scores (Figure B.8.1.30). A wide, mature forested buffer was present adjacent to and upstream from the sampling location. The riparian canopy extended over most of the stream shading it from the sun and as a consequence nutrient enrichment linked problems were not evident (e.g., no extensive algal mats).

Figure B.8.1.30. Little Darby Creek downstream from Chuckery, RM 24.5, 2002.

Fish community scores in general gradually increased with increasing downstream distance towards the mouth. The major exception to this pattern was the site just upstream from the confluence with Big Darby Creek which is marginally meeting EWH criteria. This site is located in an area that prior to the mid 1990s was impounded by a dam across the mouth of Little Darby Creek. Although the dam has disintegrated and much of the debris removed many large chunks of concrete remain serving as grade control structures limiting the ability of the stream channel to establish a natural pattern in this lower reach. As sediments are flushed and more natural features develop this portion of Little Darby Creek is expected to perform at levels comparable to those found just upstream.

Various portions of the Little Darby Creek mainstem have been repeatedly sampled since 1979. It is, therefore, possible to examine long term trends in fish community performance. The current survey and the survey conducted in 1992 and augmented with sampling in 1993 had the most complete coverage and, therefore, will be examined here. Patterns in fish community performance were fairly similar in both time periods (Figure B.8.1.31). In general, there is a pattern of increasing fish community performance from the vicinity of Mechanicsburg where it was in the mid WWH range to just downstream from West Jefferson where performance reached some of the highest levels recorded in the state. Downstream from West Jefferson performance then tailed off towards the mouth. As mentioned previously, habitat quality played a very significant underlying role in setting the potential performance of the biological communities with spills and altered water chemistry interrupting the pattern. There were significant interruptions in that pattern of improvement during both time periods and noteworthy differences between the years. In the vicinity of Mechanicsburg in 1992-93 the pasture separating the two upstream sites resulted in a significant decline in performance with an almost immediate rebound a short distance downstream. The now identified bypass from the Mechanicsburg WWTP yielded a similar decline to the pasture. In 2001 and 2002 fish community scores at Allison Rd. downstream from the previously mentioned pasture were identical, the next site downstream which showed a rebound in 1992/3 showed no improvement and the site downstream from the

Figure B.8.1.31. Longitudinal trends in the Index of Biotic Integrity on the mainstem of Little Darby Creek in 1992/1993 and 2001/2002.



Mechanicsburg WWTP bypass pipe plummeted even further. Clearly contamination emanating from Mechanicsburg and the Mechanicsburg WWTP outfall and bypass have resulted in significant additional impairment since 1993.

The pattern of improvement in 1992/3 was fairly steady with no significant excursions downstream to the vicinity of West Jefferson. In contrast in 2001/2002 declines were noted at RM 29.5 downstream from the confluence with Treacle Creek at Axe Handle Rd. and at RM 23.1 downstream from Finley - Guy Rd. Neither of these sites were sampled during the earlier time period and may represent patterns that were present then. There were indications of that possibility at the downstream impact area. The IBI score at RM 24.5, Rosedale-Plain City Rd., although revealing the start of the decline in 2001/2002 was virtually identical to the value recorded previously.

The declines noted downstream from the West Jefferson WWTP were very similar in both time periods. The West Jefferson WWTP has long had a problem with infiltration and inflow problems with its collection system frequently resulting in a loss of solids and other loadings violations during rain events. West Jefferson is currently adding an equalization basin and is developing plans to deal with its infiltration and inflow problem. Follow-up monitoring should be conducted to determine the effectiveness of these measures and whether or not fish

communities rebound to levels seen upstream from town and that reflect the potential of the extremely high quality habitat present in the lower reaches of Little Darby Creek.

Little Darby Creek Tributaries

Clover Run (02-218) (RM 39.8) (EWH)

This small tributary originates in the very headwaters of Little Darby Creek and confluences with it immediately south of Mechanicsburg (Figure B.8.1.32). Previously unsampled by the Ohio EPA Clover Run yielded 465 individuals of eight different species of fish at the one sample site in 2001. Although currently designated as Exceptional Warmwater Habitat the sampling site yielded a good headwater Warmwater Habitat fish community (i.e., IBI = 36). Creek chubs predominated numerically. The relative high number of blacknose dace and mottled sculpin suggest perennial pools and cool water potential from ground water sources. The habitat evaluated at the site also suggest WWH potential for Clover Run absent other mitigating factors.

Figure B.8.1.32. Clover Run at Maple Grove Cemetery, 2001.

Lake Run (02-216) (RM 36.9) (EWH/EWH Retained)

This small tributary originates just north of Mechanicsburg. It flows through the Cable end moraine and has a couple of glacial kettle lakes situated on it or that drain to it. Lake Run has also not been sampled by the Ohio EPA previously. Sampling at RM 0.90 in 2001 yielded 309 individuals of 21 different fish species and an IBI of 42, well within the WWH range. Habitat in Lake Run is significantly better than in Clover Run with a QHEI of 71.0 (Figure B.8.1.33). It had been channelized historically and almost recovered from that impact. Siltation from the construction of a golf course a short distance upstream has resulted in increased sedimentation and stream bed embeddedness with a concomitant shift in community structure. This included a loss of sensitive species and an increase of tolerant and pioneering species. If erosion control measures are implemented upstream, reducing the contribution of additional

Figure B.8.1.33. Lake Run at at SR 4, 2001.

sediment, (given the relatively steep local gradient of >16 ft./mi.) stream bed fines should be flushed relatively quickly resulting in improved habitat quality and the potential for EWH performance. This stream should be monitored during the next survey cycle to determine if this short term disturbance has masked its full potential.

Jumping Run (02-217 (RM 3.9) (EWH/WWH Recommended)

Jumping Run is a very small stream which is tributary to Lake Run in its headwaters. Although possessing a similar local gradient to Lake Run, the segment sampled was much different than that found in Lake Run (Figure B.8.1.34). Significant portions of the sampling zone consisted of relatively deep pools with deposits of mucky silts and slow current velocities. These characteristics yielded habitat that were judged to be capable of supporting WWH biological communities. Sampling in 2001 at RM 0.3, downstream from State Route 559, yielded a total of 185 fish representing 10 different species of fish. The resultant IBI of 30, a significant departure from the WWH criterion, although reflective of some of the modified habitat attributes also suggests problems with water chemistry. The reduced number of darters/sculpins and simple lithophils can be attributed to the predominance of pools and increased embeddedness. The total absence of headwater species and sensitive species and the shift to a high percentage of tolerant fishes, omnivorous species and particularly pioneering species suggest a nutrient enrichment problem that might be intermittent in nature. Although inspection of the water chemistry data revealed elevated TSS, nitrate and TKN above background reference conditions many other tributaries in the vicinity had higher values.

Figure B.8.1.34. Jumping Run at SR 559, 2001. Note the siltation in the lower half of the photo.

Macroinvertebrate communities met the WWH criterion. Ohio EPA macroinvertebrate community evaluation methods minimize habitat-related differences and can be more indicative of chemical water quality improvements or impairments. Given the short life spans and accelerated repopulation potential of the macroinvertebrate populations, the fact that they fully meet WWH criteria supports the conclusion that the problem is episodic.

Sampling of Jumping Run in 2001 was the first time it was evaluated and, therefore, historical trends cannot be developed beyond the response patterns described above.

Treacle Creek (02-213) (RM 31.3) (EWH)

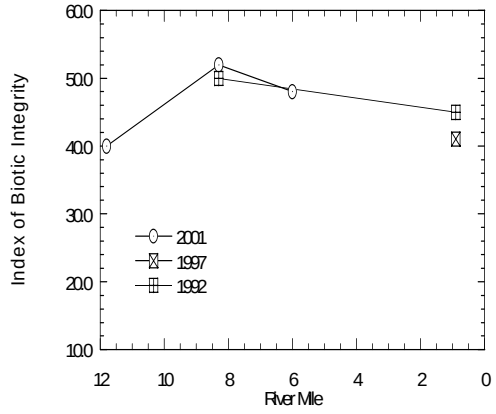
Fish were collected from three locations in Treacle Creek (i.e., RM 11.8, downstream Mechanicsburg-Bellefontaine Rd., RM 8.3, upstream from Eagle Rd. and RM 6.0, at State Route 161) in 2001 yielding a total of 2015 individuals representing 25 species of fish. Fish

community performance ranged from an IBI of 40 at the upstream site, which is a significant departure from the EWH criterion (i.e., IBI = 50) to meeting or marginally meeting the criteria at both of the other sites sampled. Ideally sampling would have also been conducted at RM 0.8, Winget Rd. to replicate historical sampling efforts.

Habitat within the segment evaluated, although in the very good range (i.e., segment mean QHEI = 67.2), averaged somewhat less than would normally be expected for this level of biological community performance (i.e., EWH performance typically expected $\geq$ mean QHEI of 75). Cooler water temperatures (i.e., a measured 53º F.) strongly suggest ground water inflow that would ameliorate the impacts of water quality perturbations and permit higher than expected performance.

Fish community performance at RM 11.38, Mechanicsburg - Bellefontaine Rd., resulted in fewer than expected sensitive species and an elevated percentage of tolerant and pioneering individuals were found leading to the partial attainment of the EWH use. As mentioned above, habitat (although solidly in the WWH range with a QHEI of 67.5) did possess some modified habitat attributes including low sinuosity, fair development, and elevated embeddedness in the riffle and overall that would tend to favor tolerant species and reduce the number of sensitive species. The high number of pioneering individuals, the cooler water temperatures and the very good macroinvertebrate communities point to a temporal water quality problem rather than stream dessication. Inspection of the water chemistry results revealed very high concentrations of ammonia exceeding the 95th percentile of background concentration as well as other nitrogen based nutrients at elevated concentrations.

Figure B.8.1.35. Longitudinal and historical trends in the Index of Biotic Integrity at sites sampled in Treacle Creek in 1992, 1994 and 2001.



Sampling results from Eagle Rd. were essentially the same as those found in 1992 (Figure B.8.1.35). The trend at Winget Rd. documented between 1992 and 1997 was one of decline. Sampling in 2001 would have determined if that pattern had continued or if improvements had taken place.

Howard Run (02-215) (RM 5.4) (EWH)

A small tributary to Treacle Creek, Howard Run, has a drainage area of only 2.72 sq. mi. A total of 519 fish representing 13 species of fish were collected at the site upstream from McMahill Rd. revealing a very high quality headwater stream (i.e., IBI = 52) (Figure B.8.1.36).

Figure B.8.1.36. Howard Run at McMahill Rd., RM 0.5, 2001.

The local gradient at the site sampled was 13.27 ft./mi. falling in the moderate range. This is less than the gradient for the whole stream which fell in the high range. The site had a mix of positive and negative habitat attributes yielding a QHEI of 55.5. Only one high influence, modified habitat attribute was noted - low sinuosity. However, the site was recovering from historical channelization and given the steep overall gradient of the stream there is sufficient energy for this site to revert to the high quality habitat present in the rest of the stream. Indeed, the upstream end of the zone has developed fairly good meanders as a consequence of the good gradient present. A fair amount of peat and filamentous algae was present on the coarse substrates with some dark silt also covering the bottom. Shrubs (10 ft.) and grass (25 ft. wide) comprised the narrow riparian corridor. Siltation lowered quality modestly. Cooler water and the closed canopy appeared to have ameliorated the impacts from NPS inputs and permitted the high level of performance documented at this site.

Proctor Run (02-214) (RM 3.69) (EWH)

A total of 2,016 individuals representing 29 fish species were collected from the three sites sampled in Proctor Run in 2001. Similar to Treacle Creek, the upstream sampling site - RM 4.9, upstream from Park Road yielded slightly lowered fish community scores, in this case an IBI of 42 ,which was a significant departure from the criteria of the existed designated use, EWH. This was largely due to an increased percentage of tolerant and omnivorous species. Habitat was not a significant factor in this aberration. However, raw sewage from septic systems was noted upstream as well as elevated TSS, ammonia, and TP concentrations that exceeded the 75th and 90th percentile vs. ECBP background values.

Again, similar to Treacle Creek, sampling sites in the downstream reaches either met or marginally met EWH criteria supporting the appropriateness of the existing EWH use designation. Good ground water contribution was strongly indicated. Although habitat quality was in the range that very good or high range WWH communities would be predicted (i.e., mean segment QHEI = 69.8) the fish community that we documented was in the exceptional range.

Fish community sampling was also conducted at McMahill Rd., RM 0.5 in 1992. The IBI of 53 was virtually identical to the value recorded in 2001. Habitat scores were also very similar. Proctor Run appears to have a stable fish community.

Barron Creek (02-212) (RM 24.4) (EWH/WWH Recommended)

Barron Creek, a direct tributary to Little Darby Creek, confluences just downstream from the Rosedale- Plain City Rd. bridge in Madison County. A large percentage of Barron Creek is under maintenance conducted by the Madison County Engineer Office. This includes the segment that was sampled downstream from the Rosedale - Plain City Rd. bridge over Barron Creek. Despite habitat reflective of the maintained nature of the stream channel (i.e., QHEI = 44.5) the fish community did very well in 2001 (Figure B.8.1.37). The 552 fish representing 14 different species produced an IBI of 48, in the very good range and demonstrating marginal EWH performance. The breakdown of IBI metrics was very unusual. It scored low for the number of headwater, sensitive and darter/sculpins species and very high for the rest of the metrics. Inspection of the composition of the actual catch revealed an assemblage of fish species that favor rooted aquatic vegetation and that would be expected to inhabit clear water, vegetated, prairie streams (e.g., central mudminnow, grass pickerel, tadpole madtom and to a lesser extent hornyhead chub). Groundwater inputs which maintained fairly cool water temperatures was the suspected ameliorating factor buoying up fish community performance.

Figure B.8.1.37. Barron Creek at Rosedale-Plain City Rd., RM 2.1, 2001.

Barron Creek has not been previously sampled by the Ohio EPA. No trends other than the patterns described above were developed.

Wamp Ditch (02-363) (RM 23.0)
(Undesignated/MWH Recommended)

Wamp Ditch, a small direct tributary to Little Darby Creek, is one of the few that drain into Little Darby Creek from the east. Sampling in 2001 at Finley-Guy Rd. resulted in a very disappointing catch. Only 37 individuals representing 4 species were collected despite a full sampling effort. The consequent IBI of 30, was in the fair range and would have been poorer if not for the predominance of grass pickerel in the catch.

Figure B.8.1.38. Wamp Ditch at Vogelburg Rd., RM 0.1, 2001. Note the shape of the bank.

Similar to Barron Creek which discharges to Little Darby Creek 1.4 mile upstream from the

west, a significant portion of Wamp Ditch is under maintenance by the Madison County Engineer's Office (Figure B.8.1.38). However, in this case the ameliorating effects of ground water augmentation did not appear as effective in reducing the impacts associated with the adjacent landuse, instream habitat degradation and water chemistry problems. Habitat quality as measured by the QHEI was identical at sites in both streams (i.e., QHEIs = 45.5) yet in the case of Wamp Ditch the IBI was reflective of the diminished habitat quality and the attendant water quality problems associated with that stressor and adjacent pasturage. No water chemistry sampling was conducted in Wamp Ditch in 2001. Future monitoring should be conducted to determine the relative contribution of these stressors to the impairment documented.

Spring Fork (02-211) (RM 17.46) (EWH)

A total of five sites were slated to be sampled in Spring Fork during the 2001 field season. Unfortunately, sampling was accomplished at only three sites in 2001. Access to the historically sampled site at Lafayette - Plain City Rd. (RM 0.9) was not granted and the site at RM 10.1, upstream from Guy-Cemetery Rd. was not sampled in 2001 and subsequently picked up in 2002. With the exception of the site at RM 10.1, upstream from Guy-Cemetery Rd., all sites in Spring Fork both historically and during the more recent sampling effort had mean IBIs that marginally or fully met EWH criteria (Figure B.8.1.39). These results reinforce the appropriateness of the existing aquatic life use designation to support EWH fish communities (Table A.15 , Figures B.8.1.39 and B.8.1.40). Spring Fork at Guy - Cemetery Rd. yielded an IBI of 40 which although meeting WWH criteria represented a significant departure from the EWH criterion and survey results at all other sites sampled in the subwatershed. The high percentage of tolerant species and pioneering species and the low numbers of insectivores accounted for almost all of the difference between samples. The high percentage of these types of species coupled with the very high quality macroinvertebrate community documented at this site in 2001 strongly suggest a temporal impairment that probably was not too severe in nature.

Figure B.8.1.39. Longitudinal and temporal patterns in the Index of Biotic Integrity in Spring Fork, 1992, 2001, and 2002.

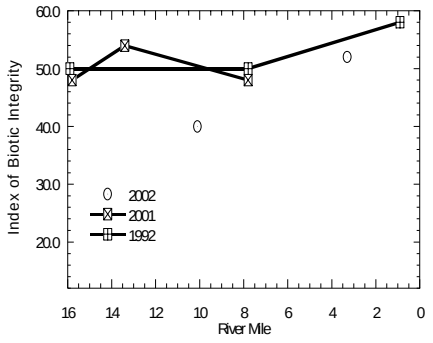
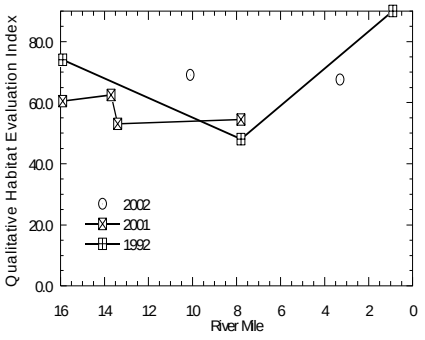


Figure B.8.1.40. Longitudinal and temporal patterns in the Qualitative Habitat Evaluation Index in Spring Fork, 1992, 2001, and 2002.



Inspection of Qualitative Habitat Evaluation Index scores reveal that habitat quality, at least historically, has been high in the very upper reaches and towards the mouth with lesser and varying quality in the mid reaches (Figure B.8.1.40). At shift in land use practice at RM 15.9, Wren Rd., has resulted in significant decline in habitat quality (i.e., from a QHEI of 74 in 1992 to a 60 in 2001). The site at RM 7.8, upstream Rosedale - Milford Center Rd., in contrast, had impacted habitat quality and had improved modestly in the intervening years as a result of changes in land use practices adjacent to the stream and flushing of sediments from the sampling zone. The point to this is that Spring Fork can recover in time from habitat impacts due to the gradient of the stream and the type of sediments present but that it is requires protection of the riparian buffer to accomplish that goal.

Bales Ditch (02-362) (RM 3.64) (Undesignated/WWH Recommended)

Bales Ditch, a small tributary to Spring Fork, originates in ground moraine and flows in a general easterly direction confluencing with Spring Fork close to Plumwood, Ohio. First sampled in 2001 the site at RM 0.4, upstream from Rosedale Milford Center Rd., yielded 301 individuals representing 21 species of fish. This richness of species is exceptional for a stream having just over 5.0 miles of drainage area. The majority of the other metrics comprising the IBI also suggested an exceptional fish community and totaled an IBI score of 50. The only metric showing a significant deviation from expectation was the percentage of pioneering species which was high at 56 percent.

The local gradient at the site sampled was 17.86 ft./mi. placing it in the moderate - high range. The stream appears to possess the potential energy to recover from habitat disruptions and to transport and expel fine sediments and thus improve. Habitat quality was judged very good at the time of evaluation (QHEI = 70). A moderately wide to wide riparian buffer coupled with an undisturbed stream channel, moderately high gradient and glacial till yielded a diverse and moderately stable stream channel. The habitat was judged to be easily capable of supporting a WWH aquatic biological community.

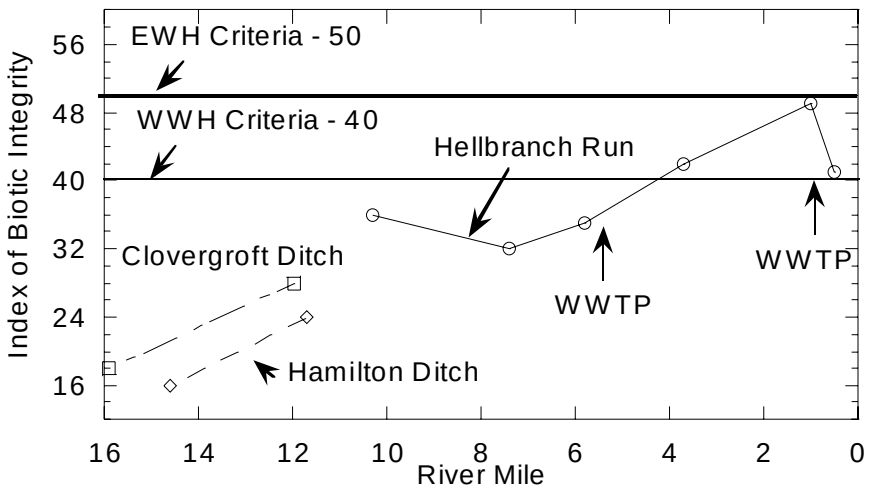
This sampling represents the first evaluation of Bales Ditch biologically and, therefore, it was not possible to discuss historical trends.

Hellbranch Run (02-204) (RM 26.1) (WWH)

Sixteen sampling events were accomplished in the Hellbranch Run subwatershed which included its two source streams, Clover Groff Ditch and Hamilton Ditch. A total of 5,782 fish representing 35 species of fish and three hybrids were collected from the cumulative distance sampled of 2.4 km.

Bluntnose minnow (17.21%), a very tolerant species were the most abundant fish collected along with creek chub and stoneroller following at 12.42% and 10.5%, respectively. In general there was a trend of gradual improvement in fish community condition from the very headwaters of the source tributaries towards the mouth of Hellbranch Run (Figure B.8.1.41). The upstream sites in the tributaries Hamilton Ditch and Clover Groff Ditch had fish communities in the very poor and poor range, respectively (Table B.8.1.1). A combination of severely altered instream

Figure B.8.1.41. Index of Biotic Integrity scores in Clover Groff Ditch, Hamilton Ditch and Hellbranch Run, in 2001.



habitat and poor water chemistry were the causes of impairment in both streams (Table B.3.2, Figures B.8.1.42 and B.8.1.43). Habitat in Hamilton Ditch improved marginally (i.e., QHEI of 36.5 vs. 21.0 upstream) as did fish community performance towards its mouth (IBI of 24 vs 16 upstream). However, it still remained in the poor range, which is understandable since habitat remained a significant stressor. In contrast the habitat in lower Clover Groff Ditch, RM 0.8, greatly improved into the range felt capable of supporting WWH communities (i.e., QHEI = 61.5). Despite this significant improvement in the potential of the habitat fish communities only improved into the low fair range. Obviously, water quality is still an important factor suppressing fish community performance at the mouth of Clover Groff Ditch. A logical source of this impact was the Cypress Wesleyan School WWTP at RM 1.30 only 0.5 mile upstream. Compliance inspections have revealed operational problems at this WWTP with discharge flows twice the WWTP's capacity. This facility has been directed to tie in Columbus sewer system to eliminate the discharge. During the interim, the School has refurbished the sand filters and chlorine contact tank, as well as adding a flow meter.

Also contributing to water chemistry problems in lower Clover Groff Ditch was leachate from failing on-site septic systems and other NPS nutrient inputs (Figures B.8.1.44 and B.8.1.45). Elevated *E. coli* concentrations were also a problem which may have resulted from the septic systems and/or a livestock breeding operation a short distance upstream. All nutrient parameters including TKN, ammonia, nitrite, and TP were commonly measured at concentrations greater than the 75th percentile level when compared to ECBP background conditions with the highest recorded NH_3 and TP concentrations greater than the 90th percentile of ECBP background concentrations. Elimination of the WWTP and efforts to bring the septic systems into compliance should improve instream water chemistry and subsequently biological community performance.

Figure B.8.1.42. Clover Groff Ditch upstream from Roberts Rd., RM 4.7. Note the uniform channel cross section and the almost total absence of variability in instream structure.

Figure B.8.1.43. Clover Groff Ditch, RM 4.7 Roberts Rd. Note the algal mats documenting nutrient enrichment.

Figure B.8.1.44. Clover Groff Ditch, RM 4.7 Roberts Rd. storm water runoff problems. Note algal mats at outfall and very turbid waters from upstream.

Figure B.8.1.45. Clover Groff Ditch upstream from Roberts Rd., RM 4.7. Note poor quality septage directly reaching stream.

Biological condition in the very headwaters of Hellbranch Run, although improved from values recorded at the downstream sites in its source tributaries, still only marginally and partially met WWH criteria. Habitat was, obviously, a factor in the suppressed performance with a QHEI of only 39.5 recorded there. The improved biological performance did point towards improved water quality condition and perhaps ground water augmentation given that the biological performance was higher than the evaluated habitat would normally deliver. The presence of mottled sculpins, an obligate coldwater taxa, not only here but in increased numbers at all sites downstream support this observation. At this site, however, there still were indications of elevated stress, particularly the total absence of intolerant species, the noteworthy high percentage of tumors, lesions and deformities (i.e., 13.5% and 9.2%) found during both samplings. Additionally, the preponderance of small individuals in everything except for the tolerant species suggests a community recovering from fairly recent stressful conditions. Nutrient concentrations were elevated with TSS, ammonia, nitrate greater than the 75th percentile of ECBP reference concentrations and TKN and TP greater than the 90th percentile of ECBP reference conditions.

Shifts in biological performance at the next site downstream RM 7.4 - Kunz Rd. were mixed. The was some improvement in the Modified Index of Well Being. Inspection of its four contributing components revealed the weights were more evenly distributed than upstream, not as biased by large tolerant species such as carp. The IBI score declined into the fair range largely as a result of the increase in percentage of tolerant species and omnivores and a decline in the percentage of top carnivores present. Habitat quality had improved (i.e., QHEI = 51.0) although coarse substrate embeddedness and siltation were still stressors. Nutrient inputs were also decreased from upstream with most samples falling into the median range compared to ECBP background conditions rather than higher percentiles ranges.

Habitat quality at RM 5.8 had improved into the WWH range with a QHEI of 65.5. Despite these improvements fish community scores remained very similar to those measured at Kunz Rd. This site was immediately downstream from the Oakhurst Knolls WWTP and the Oakhurst Golf Course. Again nutrient enrichment was a problem, but at a reduced level from upstream. One grab water sample had total phosphorus at 0.3 mg/l which was greater than the 95th percentile of ECBP reference conditions with TKN and TP concentrations consistently exceeding the 75th percentile of ECBP reference levels. Additionally, *E. coli* bacteria counts here were elevated and at higher values than other Hellbranch Run sample sites. Previous to 2002, Oakhurst Knolls WWTP had difficulties with excessive I&I. The collection system was delivering more than five times the design hydraulic flow of the WWTP. This resulted in untreated sewage reaching the stream during rain events. Although the Oakhurst Knolls WWTP does a good job during dry weather flows any rain greater than 1 inch produces severe inflow and infiltration to its sewer system delivering more than four times the flow that it can treat resulting in untreated waste reaching the stream. The Franklin County Sanitary Engineer's office determination that the Oakhurst Knolls subdivision had excessive inflow and infiltration, lead to man hole rehabilitation and trunkline repairs. The work was completed in 2002 resulting in dramatically reduced I/I during rain events. In addition, the County has allocated funds to televise the lateral connections and hopefully remove remaining infiltration and/or inflow sources. Due to the

previous condition of the collection system, the vestiges of the I&I problems in the degraded fish community in Hellbranch Run downstream of this source are evident. The Oakhurst Golf Course also abutted the stream along both shorelines. Runoff from the golf course may also be affecting the biological communities downstream. Fertilizers, fungicides/herbicides and pesticides applied to the golf course have the potential to run off into Hellbranch Run.

Habitat scores from Beatty Rd. to the mouth were documented to be in the range suitable for supporting EWH biological communities (Figure B.8.1.46). The fish communities responded to this habitat improvement marginally attaining EWH criteria at the sites at Beatty Rd., RM 3.7 and Lambert Rd., RM 1.0. A short distance downstream at RM 0.5, immediately downstream from the Timberlake WWTP fish community scores dropped back into the WWH range. The impact probably would have been greater had the effluent from the WWTP been a larger percentage of stream flow (Figure B.8.1.47). Deposits of decaying sewage sludge has been noted on repeated sampling visits to this site. The Timberlake WWTP is under the Director's final Findings and Orders to tie into a regional WWTP by 2005. Expectations are that this will result in improved fish community performance in lower Hellbranch Run and the criteria for EWH aquatic life use being fully met.

Figure B.8.1.46. Instream and riparian habitat quality present at Beatty-Orders Rd., RM 3.7 in Hellbranch Run, 2001.

Figure B.8.1.47. Sludge and gray water discharged from the Timberlake WWTP.

Concern over the effects of suburbanization on the Hellbranch subwatershed and subsequent impacts to its receiving waters, one of the highest quality portions of Big Darby Creek has resulted in Hellbranch Run, Clover Groff Ditch and Hamilton Ditch being sampled repeatedly over time. The results of this sampling have been mixed, with some areas of improvement and some notable declines (Figures B.8.1.49 and B.8.1.50).

Figure B.8.1.48. Longitudinal trends in the Index of Biotic Integrity in Hellbranch Run, 1992/93, 1997, and 2001.

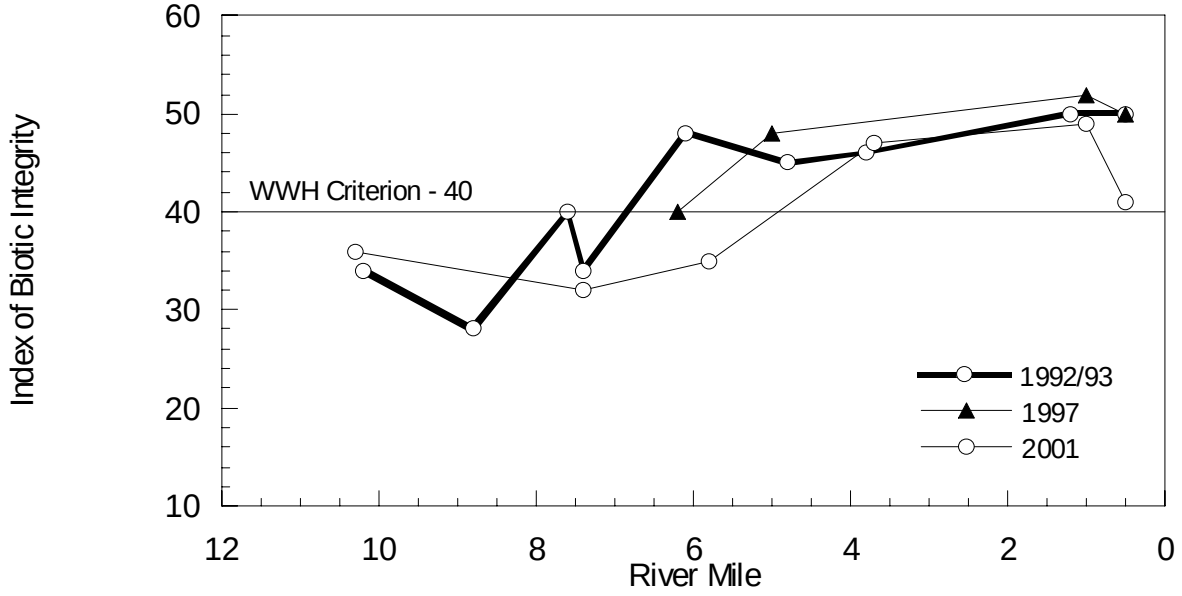


Figure B.8.1.49. Index of Biotic Integrity Scores in Clover Groff Ditch, 1992, 1993, 1997, 2001.

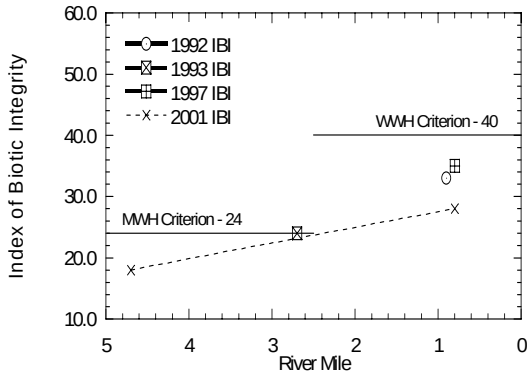
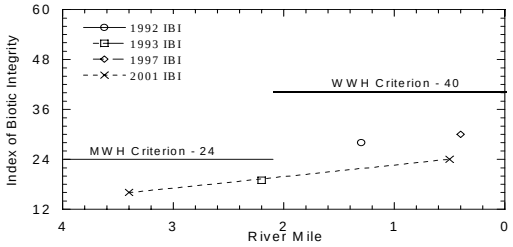


Figure B.8.1.50. Index of Biotic Integrity Scores in Hamilton Ditch, 1992, 1993, 1997, 2001.



Clover Groff Ditch and Hamilton Ditch have proven in the last decade to be classic examples of the impacts associated with suburbanization and development. First sampled in 1992 towards their respective mouths revealed fish communities in the fair range. Concerned about these results, sampling was conducted in 1993 closer the headwaters of both watercourses to determine whether the impairments seen were coming from upstream sources. This sampling revealed communities in the very poor range. Clearly what was happening in the upstream reaches was causing problems downstream. Sampling during the current study has documented extremely poor conditions in the very headwater reaches that are the result of both water chemistry problems and further declines in habitat quality. The declines at the mouth sites in both Clover Groff Ditch and Hamilton Ditch were predictable given the fast pace of development. Initiatives that deal with the source of the problem (i.e., the upland landuses that contribute excess water, nutrients, herbicides, etc.) have the best chance of reversing the declines.

In the mainstem of Hellbranch Run most of the sites that matched up over the years sampled had fairly similar scores (Figure B.8.1.48). Major discrepancies were noticed in the mid reaches and at the very mouth. The problems associated with the Timberlake WWTP, RM 0.5, although long running have gotten worse in recent years. This WWTP is under orders to tie into a regional WWTP by 2005 and this drop should be eliminated. The decline in the mid reaches can be attributed to declines in water chemistry. Samples collected in 1992 and 1993 at RM 6.1 and 6.2, respectively, were taken upstream from the Oakhurst Knolls WWTP in the vicinity of the Oakhurst County Club golf course. Despite having habitat in the poor range a fish community in the good to very good range was found. Five years later in 1997 fish communities in essentially the same location plummeted eight points on the IBI despite no difference in habitat quality. The site sampled in 2001 was moved a few tenths of a mile downstream to ensure it was downstream from the Oakhurst Knolls WWTP. Habitat quality there was suitable for supporting WWH biological communities (i.e., QHEI = 65.5) which was a significant improvement from previous sites in the same vicinity yet community scores declined further. The cumulative effects of upstream water chemistry problems coupled with the wet weather discharges from the Oakhurst Knolls WWTP has resulted in further declines.

Smith Ditch (02-353) (RM 31.69)
(Undesignated/EWH Recommended)

A total of 1,520 fish representing 20 species of fish were collected from the two sites sampled in Smith Ditch in 2001. Distinctly different fish communities were collected from the two sites. The upstream site at RM 2.1, at Georgesville - Wrightsville Rd. had many characteristics of a high quality headwater stream (Figure B.8.1.51). It yielded eight minnow species, four headwater species which are species that require perennial flow and cool water. It also had five darter and sculpin species and eight simple lithophilic spawning species coupled with a relatively low

Figure B.8.1.51. Habitat quality of Smith Ditch, 2002.

abundances of tolerant, pioneering species and omnivorous species. This community had an IBI of 52 which is in the excellent range. In contrast, the downstream site at RM 0.3, Biggert Rd. yielded a far poorer fish community with an IBI of only 28 which places it at the low end of the fair range. While the total number of species was adequate, reduced numbers of individuals coupled with a shift away from high quality headwater and sensitive species towards more tolerant and pioneering species made the difference. Field notes indicate that this site should have been a classic good intermittent stream with very deep pools, strong ground water influence and a wooded riparian corridor. The low number of fish was noteworthy with low D.O. from groundwater a suspected source.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in Smith Ditch. As a consequence it was not possible to determine long term trends in Smith Ditch.

Tributary to Smith Ditch (02-354) (RM 0.2)
(Undesignated/WWH Recommended)
A total of 385 fish representing 12 different fish species were collected from the one site sampled in this truly headwater stream (i.e., drainage area - 0.9 mi^2) (Figure B.8.1.52). Despite the high percentage of tolerant individuals present at this site it scored in the excellent range. This was due to the large number of species, possessing five minnow species, darters and sculpins, five simple lithophilic spawning species, a very low percentage of omnivores, a high percentage of insectivorous species and a high number of individuals for the size of stream sampled.

Figure B.8.1.52. Habitat quality present in U.T. to Smith Ditch, 2002.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in this unnamed tributary to Smith Ditch. As a consequence it was not possible to determine long term trends in this small tributary.

Gay Run (02-298) (RM 26.48)
(Undesignated/WWH Recommended)
A total of 606 fish representing 11 species of fish were collected from the one site sampled in Gay Run in 2001 (Figure B.8.1.53). The downstream site at Harrisburg-Georgesville Rd. was completely dry during the scheduled sampling. Many of the small streams entering the lower Big

Figure B.8.1.53. Gay Run at Boyd Rd., 2001.

Darby Creek, particularly the ones confluencing from the west are losing streams (i.e., they change from overland flow to interstitial flow) as they enter the alluvium and outwash along the mainstem. Numerically predominant species at the upstream site sampled were the creek chub (32.01%), green sunfish (22.61%), central stoneroller (13.20%) and blacknose dace (11.22%). The high percentage of tolerant fish and pioneering species and the absence of sensitive species lowered the IBI score marginally. However, the majority of the metrics scored very well yielding an IBI of 46 in the very good range. Although there is direct evidence that the headwaters periodically are not connected to its receiving stream there is also evidence that the pools are perennial and do not warm up and go stagnant. Central mottled sculpins are obligate coolwater species and several were found in this sampling location. Similarly southern redbelly dace are headwater species and require perennial pools. For that reason this stream has been recommended to be designated as WWH.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in Gay Run. As a consequence it was not possible to determine long term trends in Gay Run.

Springwater Run (02-203) (RM 24.0) (Undesignated/WWH Recommended/)

This small tributary flows through the middle of the unsewered village of Harrisburg. A total of 1,086 fish representing 11 fish species were collected at the one site sampled in 2001. Blacknose dace (51.01%) and creek chub (25.69%) were the numerically predominant species collected. Despite the obvious nutrient enrichment problems (Figure B.8.1.54) observed at the location sampled the fish community was still able to score an IBI of 50, in the excellent range. Groundwater influence had obviously ameliorated stress associated with nutrient enrichment locally with numerous mottled sculpins and a handful of southern redbelly dace affirming that observation.

Figure B.8.1.54. Springwater Run downstream from SR 6. Note the strands of filamentous green algae.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in Springwater Run. As a consequence it was not possible to determine long term trends in Springwater Run.

Tributary to Big Darby Creek (02-352) (RM 23.77) (Undesignated/LRW Recommended)

A total of only 37 individuals representing three species of fish were collected from the one site sampled in this very small stream in 2001. Due to the low number of individuals collected the computer generated IBI score was low end adjusted and yielded a score in the poor range. Flow in this stream was only slightly greater than interstitial at the time sampled. Although there were

small seeps present along the stream there was strong evidence that the stream dries up on occasion, in particular the predominance of pioneering species in the catch.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in this unnamed tributary to Big Darby Creek. As a consequence it was not possible to determine long term trends in this tributary.

Tributary to Big Darby Creek (02-270) (RM 20.2) (Undesignated/WWH Recommended)
A total of 356 individuals representing 13 species of fish were collected from the one site sampled in 2001. Creek chub (36.8%) and mottled sculpin, a coolwater, headwater species (24.44%) were the most numerous fish species present. The low number of sensitive species present and the high percentage of tolerant species were the two metrics that prevented the fish community from reaching the excellent range. An analysis of instream and riparian habitat support the observation that this stream is capable of supporting very good to exceptional fish communities. As it was the large number of species for the size of stream, the number of darter and sculpin species, high percentage of simple lithophils, low percentage of omnivores, high percentage of insectivores and the low incidence of external anomalies suggest an aquatic community on the verge of the exceptional range. Expectations are that when the Clark's Lakes Subdivision is tied into the PCI Regional WWTP water quality will improve and we will see commensurate improvements in the biological communities.

Greenbrier Creek (02-202) (RM 16.75) (Undesignated/WWH Recommended)
Two sites were sampled in Greenbrier Creek in 2001. A total of 2,474 individuals representing 15 species of fish were collected. Instream and riparian habitat was slightly poorer upstream than downstream, but averaged well with the range capable of supporting WWH fish communities. That was what was documented at these two sites with the downstream site having the higher quality habitat and marginally scoring in the exceptional warmwater habitat range (Figure B.8.1.55).

Figure B.8.1.55. Greenbrier Creek, 2002.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in Greenbrier Creek. As a consequence it was not possible to determine long term trends in this tributary.

Georges Creek (02-201) (RM 14.4) (Undesignated/WWH Recommended)
A total of 1,861 fish representing six species of fish were collected from the one site sampled in Georges Creek in 2001. Southern redbelly dace, a headwater species were the most numerous

fish collected at 51.26% which is a very unusual occurrence. Creek chub and stonerollers accounted for 13.7%. The low number of sensitive species and low percentage of insectivorous species were the two metrics which prevented the IBI from being fully in the exceptional range.

The sampling effort conducted in 2001 represented the first evaluation of fish community performance in Georges Creek. As a consequence it was not possible to determine long term trends in this tributary.

Lizard Run (02-273) (RM 12.93) (Undesignated/LRW Recommended)
This small stream was found to be dry when it was attempted to be sampled in mid-summer of 2001. Several subsequent attempts also revealed Lizard Run to be dry. It appears to be a true ephemeral stream that only flows during rain events and snow melt. As mentioned in the physical habitat discussion (Section B.6), the underlying glacial geology results in Lizard Run becoming a losing stream precluding perennial surface flow and thus naturally limited resulting the LRW use designation.

B.8.2 Drainage Area Relationships

Traditionally the Ohio EPA Ecological Assessment Section has evaluated biological community performance in a longitudinal fashion in keeping with the river continuum concept (Vannote et al., 1980) and the fact that rivers are flowing systems and as a consequence stressors tend to impact resource quality in an upstream to downstream fashion. However, aggregating sites with similar drainage areas and examining the graphics to determine similarities in performance and commonalities in causes and sources of impairment might assist in the implementation of control strategies. To that end analyses of the performance of the fish communities at sites aggregated into similar drainage area ranges in the Big Darby Creek watershed during the 2001 and 2002 field season are presented below (Table B.8.2.1).

In general it was found that, as expected, mean cumulative number of species and mean number of sensitive fish species increased with drainage area supporting the basic premise of the river continuum concept (Figures B.8.2.1 and B.8.2.2). Mean IBI, showed a somewhat different pattern (Figure B.8.2.3).

Figure B.8.2.1. Mean cumulative number of species collected at sites within the Big Darby watershed aggregated by drainage area.

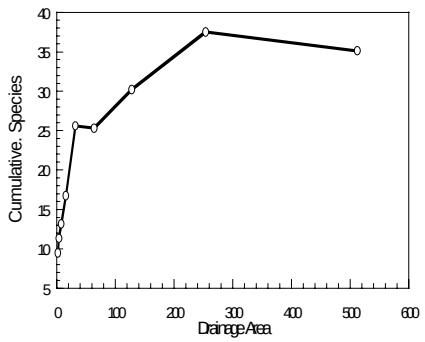
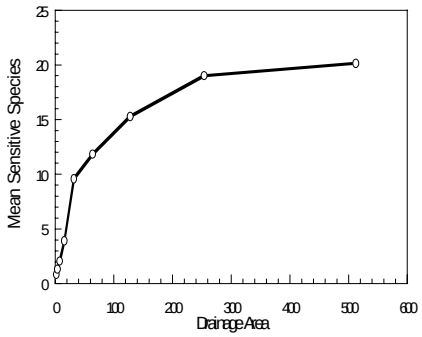


Figure B.8.2.2. Mean number of sensitive species collected at sites within the Big Darby watershed aggregated by drainage area.



Sites with a drainage area of less than two square miles in the Big Darby Creek watershed yielded fairly high IBIs. Excluding the one site that had a severe problem with nutrient enrichment resulted in a mean IBI of 48.8 which is in the range of Exceptional Warmwater Habitat performance. Prior to the 2001/2002 sampling effort and this analysis, the assumption was that sites in this drainage area range would include some of the most habitat disrupted sites sampled as well as some of the most pristine sites due to the ease that they could be disrupted as well as protected. Mean habitat quality was less than what typically would be expected to support the very good quality of fish communities present. Mean IBIs were noticeably lower at sites falling in the drainage area ranges of 2 - 4 mi^2, 4 - 8 mi^2 and 8 - 16 mi^2. In many cases the low IBI scores coincided with segments having poor instream habitat as reflected by low QHEI

scores. Many of these sites had additional stressors adversely affecting fish community performance. Mean IBI increased significantly up to the drainage area range of 64 - 128 mi^2 and leveled off thereafter. Mean MIwb, where applicable, was in the marginal EWH range from 32 - 64 mi^2 up until the drainage area of 128 - 256 mi^2 and fully met the EWH criterion at larger drainage areas (Figure B.8.2.4).

Figure B.8.2.3. Mean IBI scores at sites sampled in the Big Darby Creek watershed in 2001/2002.

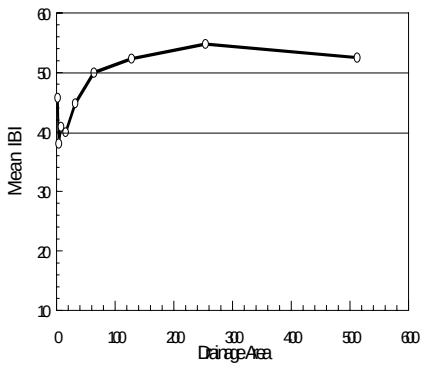
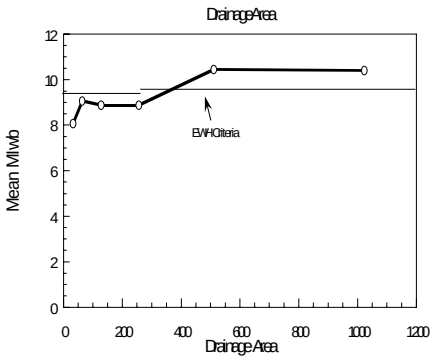


Figure B.8.2.4. Mean MIwb scores at sites sampled in the Big Darby Creek watershed in 2001/2002 aggregated into drainage area ranges.



Drainage Area Range: <2mi^2

Six sites were sampled that had a drainage area of less than two square miles. Three of the sites have been sampled in the past and have existing WWH aquatic life use designations. One of these sites, Big Darby Creek - RM 82.5, has shown improved performance and is in a segment recommended to be upgraded to EWH. The other three sites based on the 2001 sampling results are being recommended for the WWH use designation. None of these sites are in non-attainment of applicable criteria or threatened. Landuse at this scale showed wide variability. One site was immediately downstream from a very small town, another had highway run-off as the major stressor, another was situated in a wooded rural large lot area, etc. This makes it difficult to generate commonalities other than at this size of a subwatershed it is not unusual for one landuse or stressor to predominate.

Drainage Area Range: 2 - 4 mi^2

A total of 14 sites were sampled in 2001 that had drainage areas of 2 - 4 mi^2. The final breakdown of designated aquatic life uses was EWH - 6, WWH - 4, MWH - 3 and LRW - 1. Many of the sites fell in segments that had not been previously sampled. Some these sites had been assigned designations in the 1978 standards without accompanying biological surveys, some of these use designations which were based on Best Professional Judgement have proven to be accurate and some were judged inappropriate and recommended for re-designation.

Poor habitat as reflected in low QHEI scores was a strong contributing element to the poor performance of the fish community at 35.7% (i.e., 5 of 14) of these sites. All five of these sites (i.e., Flat Branch - RM 3.2, Prairie Run - RM 0.3, Hamilton Ditch - 3.4, Hamilton Ditch - RM 0.5 and Clover Groff Ditch - RM 4.7) have been subjected to channelization and have shown little recovery from the effects of that stressor. All five possessed the following list of high and moderate Modified Habitat Attributes including: channelized or no recent recovery, silt/muck substrates, no sinuosity, no cover, little residual pool volume, heavy/moderate siltation, fair/poor development, no fast current, high overall embeddedness and the absence of functional riffles. Many sites had additional negative attributes.

Intermittency was also a known contributing factor in the poor performance found at Prairie Run - RM 0.3.

The extremely degraded biological communities documented in Hamilton Ditch and Clover Groff Ditch, although undoubtedly suppressed by the very poor habitat encountered, strongly suggested a toxic response. Both habitat quality and community performance has declined since sampled in 1992/1993. However, scores this low have always been very uncommon and now are even rarer and normally only associated with a chemical impact. Chemical results from the 2001/2002 monitoring did not provide any definitive answers as to which parameters might be causing/contributing to the problem. The more residential nature of these two subwatersheds broadens the range of chemicals that might be delivered to the stream which might be an intermittent or episodic problem.

Non-attainment of criteria was also seen in a few locations where habitat did not appear to be a major stressor. Jumping Run - RM 0.3 in the Little Darby Creek subwatershed is currently designated as EWH and based on the evaluation of instream habitat from 2001 was judged to have adequate habitat to support WWH biological communities. It has, therefore, been recommended to be re-designated to WWH. Despite having adequate habitat to support WWH communities it only yielded an IBI of 30. The high percentage of pioneering species, the high percentage of tolerant and omnivorous species coupled with the absence of sensitive species and headwater species and the relatively low number of individuals that are pollution intolerant point to a relatively recent toxic event that the biological community is just recovering from. This segment may have recently been exposed to a spill possibly organic in nature. High fecal coliform and *E. coli* bacteria counts were measured in this small stream which also point to contamination from animal waste and organic enrichment

The upstream site on Proctor Run - RM 4.9, upstream from Park Rd. had habitat judged suitable/capable of supporting the EWH aquatic life use designation yet yielded an IBI of 42. Two metrics, the percentage of the community comprised of tolerant fishes and omnivores, are responsible for the departure from EWH criteria. The relatively low number of intolerant individuals as well as the previously mentioned shifts point to modest nutrient enrichment. The high number of white suckers, never a good sign, also points to nutrient enrichment. Water chemistry results support an elevated nutrient problem with ammonia values exceeding the 90th percentile of ECBP background concentrations. Total phosphorus and TSS values exceeded the

75th percentile of ECBP background concentrations. Some of the nitrate and TKN values were elevated exceeding the median ECBP background concentration.

Although this section is primarily an exercise to identify patterns in sources of stress and causes of impacts the Big Darby Creek watershed possesses some features which facilitate the propagation of EWH communities particularly in the Little Darby Creek subwatershed. These very same features also seem to be able to ameliorate stresses that would result in greater biological declines in similar streams in the ECBP or support a higher level of biological community performance than would be found at sites with comparable habitat quality in other ECBP streams. The inflow of ground water to the stream channel is probably the main beneficial factor. Ground water typically is cooler than surface water runoff and has fewer contaminants than tile drainage and surface water. Additionally in the Little Darby Creek subwatershed end moraines and particularly the boulder belt of the Cable moraine provide adequate gradient for flushing contributed sediments, coarse substrates which engender high quality habitat as well as a large aquifer to provide good ground water inflow.

Drainage Area Range: 4 - 8 mi^2

A total of 24 sites fell into the drainage area range of 4 - 8 mi^2 (Table B.8.2.1). Of this number 9 were designated EWH, 13 were designated WWH and 3 were designated MWH. Additionally, two of the EWH sites were also dual-classified as CWH.

Similar to the sites in the range of 2 - 4 mi^2, many of these sites were in segments that had not previously been assessed. Therefore, quite a few have new designations and a number have been recommended for re-designation as a result of a more accurate determination of their potential and the performance of the resident biological communities (Table B.8.2.1). Half of the sites had biological communities performing at levels that were deemed appropriate to their current or recommended aquatic life use. Hydromodification was a pervasive negative influence at sites in this drainage area range.

Drainage Area Range: 8 - 16 mi^2

A total of 13 sites fell into the drainage area range of 8 - 16 mi^2 (Table B.8.2.1). Of this number 9 were designated EWH, 2 were designated WWH and 2 were designated MWH. Additionally, two of the EWH sites were also dual-classified as CWH.

Unlike many of the sites with smaller drainage areas most of the sites within the 8 - 16 mile range fell within segments that has previously been sampled. As a consequence, only two of the sites had recommended use changes. In the case of the site on Sugar Run (RM 7.0) recognition of the pervasiveness of the habitat disruptions in the upper reaches of Sugar Run and that these same reaches are now being maintained by the Union County Soil and Water Conservation District has led to it being recommended as MWH. In contrast improvements in wastewater treatment at the North Lewisburg WWTP has allowed biological communities in Spain Creek to improve to the EWH level and lead to the recommendation to change the use from WWH to EWH.

The majority of the remaining sites fell within the Little Darby Creek subwatershed with most of them meeting or marginally meeting applicable biological criteria. These sites possessed good to very good habitat, but it appeared that the ground water influence was still enhancing community performance. Sites that didn't meet criteria were found in the vicinity of Mechanicsburg and the Mechanicsburg WWTP discharge, at the mouth of Flat Branch, at the mouth of Hamilton Ditch and in the mid reaches of Sugar Run and Spring Fork. A very wide range of stressors were responsible for the less than expected performance.

Drainage Area Range: 16 - 32 mi^2

A total of nine sites were sampled in 2001 that had drainage areas that fell in the range of 16 to 32 sq. mi (Table B.8.2.1). The majority of the sites had either previously been sampled or were situated in a stream segment that had been sampled. As a consequence there were no recommendations for changes to the existing designated use for any of these sites. Five of the sites were designated EWH, four were designated WWH with no sites designated at less than the Clean Water Act goal level (i.e., MWH or LRW).

The two sites in Big Darby Creek (i.e., RM 78.4 and 76.6) were located immediately downstream from the confluence with Flat Branch and were adversely impacted by or recovering from hydromodification, problems with metals, nutrient enrichment and low dissolved oxygen.

The other three EWH designated sites although meeting EWH criteria fell in the marginal range. Little Darby Creek at RM 34.7, Irwin Rd. was in a stream segment that appeared to be recovering from the impacts associated with the Mechanicsburg WWTP a bypass pipe. There also was a small stream that received manure and other dairy wastes a relatively short distance upstream. The dairy waste problem and the bypass have been resolved. Currently Ohio EPA is working with Mechanicsburg to bring the WWTP into compliance. Biological communities downstream from these various sources of stress should show improvement if these problems are adequately addressed. Treacle Creek at SR 161 - Irwin was downstream from an area of open pasturage which had resulted in an increase in the number of fine sediments in the streambed. Recent removal of the limited wooded buffer along one bank will probably result in further habitat declines. Additionally nutrient concentrations were very high with elevated fecal coliform counts high as well. The last EWH site in this drainage area range Spring Fork at Rosedale - Milford Center Rd., RM 7.8, also had problems with substrate embeddedness and excessive nutrients and bacterial levels, the highest of any site within Spring Fork.

Sugar Run at Cemetery Pike, RM 0.5, was the only WWH site within this drainage area range that fully met criteria being in an area that had largely recovered from channelization and the nutrient enrichment problems evident upstream. The other three sites only partially met criteria due to a mix of habitat impairments and nutrient enrichment.

Many of the sites in this drainage area range appear to be threatened. They are currently marginally meeting the criteria of their respective designated uses with NPS associated stressors the reason for less than expected performance. There are indications that NPS conditions may worsen (e.g., removal of riparian vegetation) causing further declines. In contrast, point source

related stressors that are currently causing problems are being managed and expected to result in localized improvements.

Drainage Area Range: 32 - 64 mi^2

A total of only five sites fell within the drainage area range of 32 to 64 sq. mi. in 2001 (Table B.8.2.1). As in the drainage area range of 16 - 32 sq. mi. all sites within this range either were sites that had been previously sampled or that fell within segments that had been sampled and, therefore, there were no recommended changes in designated uses. One site in Spring Fork was designated EWH, the other four sites which were in the mid reaches of Hellbranch Run were designated WWH.

Spring Fork at RM 3.3 downstream from SR 38 fully met the EWH criteria despite less than optimal EWH habitat indicating ground water influences were ameliorating the negative effects of stressors. The sites within Hellbranch Run increased in instream biological performance with increasing downstream distance and drainage area which roughly coincided with improvements in habitat quality (Table B.8.2.1). The upstream site was downstream from a small WWTP and probably was impacted by that source. The next two sites had very high quality instream and riparian habitat and biological performance improved into the very good range. Improvements planned in the upper portions of this tributary coupled with improvements in the existing package WWTPs may be enough to result in improvements in instream biological performance to EWH levels. The downstream site was situated downstream from a chronically noncompliant package WWTP that is currently under DFFOs for abandonment and required to tie into a regional WWTP. The biological communities at this site declined from values recorded at the two sites immediately upstream. Expectations are that elimination of the small package WWTP will result in rapid improvement of communities into the EWH range. The mouth of Hellbranch Run discharges to one of the most diverse reaches of Big Darby Creek, an excellent repopulation source for a stream segment rebounding from impairment.

Sites falling within this drainage area range either are meeting their respective criteria or are impaired by WWTPs. Plans are underway to remediate those problems.

Drainage Area Range: 64 - 128 mi^2

A total of ten sites fell within the drainage area range of 64 to 128 sq. mi. in 2001 and 2002 (Table B.8.2.1). The sites were evenly split between upper reaches of Big Darby Creek and mid reaches of Little Darby Creek. All sites were designated EWH based on previous sampling. This survey re-affirmed the accuracy of those previous designations.

Two sites on the mainstem of Big Darby Creek fully met EWH criteria (with one index scores each in the marginal range). The other three sites either didn't meet criteria or only partially met criteria (i.e., one index score was outside of range). At one site the source of impairment was unknown but appeared to be episodic with a quarry operation a possible source based on proximity. The downstream sites partially meeting appeared to be associated with the fish kill that occurred in 2000 coupled with more recent nutrient enrichment problems emanating from Buck Run.

One site in Little Darby Creek at RM 29.5, Axe Handle Rd. downstream from the confluence with Treacle Creek, was impaired by nutrient enrichment and low dissolved oxygen problems. This is a recent occurrence revealing deterioration from previous surveys. The rest of the sites further downstream either fully or marginally met EWH criteria. Habitat quality largely fell into the WWH range (i.e., segment mean QHEI = 61.4) again suggesting the ameliorating effects associated with ground water contribution.

Spills and nutrient enrichment appear to be the key factors adversely affecting fish community structure and function at this drainage area range.

Drainage Area Range: 128 - 256 mi^2

A total of ten sites fell within the drainage area range of 128 - 256 sq. mi. in 2001 (Table B.8.2.1). All sites were designated EWH based on multiple previous surveys and, therefore, there were no recommendation for aquatic life use changes. Eight of the ten sites were located along the mainstem of Big Darby Creek in its mid reaches with two sites from the mid reaches of Little Darby Creek.

All Big Darby Creek sites fully met the EWH IBI and MIwb criteria with the exception of the two sites downstream from the Plain City WWTP. Loss of biosolids and subsequent depressed dissolved oxygen concentrations were felt to be the cause of the modestly depressed fish community scores. The Village of Plain City is currently dealing with this particular issue. Plain City is discussing the need to expand the size of the plant. Therefore, this segment warrants close attention in the future to see if the remediation is effective and that growth of Plain City and increase in the size of the WWTP doesn't cause further declines.

The two Little Darby Creek sites were upstream from West Jefferson and the West Jefferson WWTP. Both sites were evaluated to have extremely high quality riparian and instream habitat. The biota sampled there reflected that high quality. However, landuse in the watershed draining to this segment is rapidly changing from agricultural landuses to commercial/light industrial/warehousing. Such development typically results in hardening of the land surface and attendant runoff related problems leading to declines of this extremely high quality resource. Some adverse impact may have already taken place to the segment that currently hosts some of the rarer bivalve mussels. This segment was subject to a large diesel fuel spill last winter. Future monitoring should include this segment in order to ensure continuation of its existing high quality.

Sites in this drainage area range appear to be stressed or at risk by WWTPs and growth.

Drainage Area Range: 256 - 512 mi^2

Four sites fell into this drainage area range. All were mainstem sites on Big Darby Creek designated as EWH. All fully met their respective EWH criteria with some of the highest scores recorded anywhere in the state. There are several good reasons for the presence of this particularly high diversity and productivity. The most significant factor is the extremely high quality instream and riparian habitat (i.e., mean QHEI for this segment = 88.1). A significant

percentage of Big Darby Creek along both shorelines is protected from the vicinity of Lucas Rd./Beach Rd. near RM 45.5 at least downstream to the vicinity of Darbydale with an almost contiguous wooded riparian buffer.

Drainage Area Range: >512 mi^2

Seven sites from the lower reaches of Big Darby Creek had drainage areas that exceeded 512 sq. mi. (Figure B.8.2.1). All sites fully met their respective EWH criteria again displaying some very high values reflective of the exceptionally high diversity and production emanating from lower Big Darby Creek. Habitat quality is the factor driving this incredible diversity with mean segment QHEI of 81. In this grouping of sites there was one site that suggested that there are problems developing. The site at RM 8.4 although marginally meeting the EWH criteria was significantly lower than sites that bracketed it. Just upstream from this site was a small tributary that was highly nutrient enriched. Large mats of algae coated the bottom of its channel where the canopy was open enough to permit sunlight to reach the waters surface. This source of stress needs to be remediated before the trend continues and results in an impairment of the biota.

The downstream most reach has had some shoreline work done to repair eroding banks. A levee was moved a large distance back from the stream to allow the stream to develop natural meander patterns. Both habitat quality and aquatic community performance are expected to improve over time.

Sites in this drainage area range are supporting very high quality aquatic communities largely as a result of the high quality water draining from upstream and the high quality habitat present within the stream channel, which in turn is strongly and positively influenced by its high quality riparian buffer. There are indications based on shifts seen in the mussel fauna that this segment is at risk as a result of destabilization of the substrates.

Table B.8.2.1. Drainage area relationships of fish community attributes from the Big Darby Creek watershed based on sampling conducted in 2001 and 2002. Sites that were sampled in 2002 are in bold.

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: <2 mi^2											
Big Darby Creek	82.5	1.3	EWH-R CWH-R	14	1	1799	NA	52	NA	68.0	Excell.
Trib - Smith Ditch	0.2	0.9	EWH-R	12	1	770	NA	50	NA	67.0	Excell.
Gay Run	2.2	1.2	WWH-R	11	0	1212	NA	46	NA	66.5	Very Good
Springwater Run	0.8	1.8	WWH	11	3	2172	NA	50	NA	48.5	Excell.
U.T.- B. Darby Creek (RM 23.7)	0.1	0.8	WWH-R	3	0	74	NA	30	NA	61.5	Fair
Georges Creek	0.5	1.0	WWH	6	0	3722	NA	46	NA	61.0	Very Good
Maximum		**1.8**	**EWH - 2**	**14**	**3**	**3722**		**52**		**68.0**	
Minimum		**0.8**	**WWH - 4**	**3**	**0**	**74**		**30**		**48.5**	
Mean (N=6)		**1.2**	**MWH - 0**	**9.5**	**0.83**	**1624.8**	**NA**	**45.7**	**NA**	**62.1**	
Drainage Area Range: 2-4 mi^2											
Flat Branch	3.2	3.3	MWH	5	0	245	NA	26	NA	25.5	Poor
L. Darby Cr. (Logan Co.)	3.5	2.4	EWH-R CWH-R	18	2	1417	NA	55	NA	71.5	Excell.
L. Darby Cr. (Logan Co.)	0.4	3.9	EWH-R CWH-R	19	3	1926	NA	50	NA	68.0	Excell.
U.T. to BDC (RM 74.91)	0.2	3.9	EWH-R	14	1	1281	NA	50	NA	62.5	Excell.
Spain Creek	5.7	3.5	WWH CWH-R	10	1	832	NA	44	NA	66.0	Good
Prairie Run	0.3	3.0	LRW - R	10	1	145	NA	28	NA	23.0	Fair
L. Darby Cr.	41.2	3.3	EWH CWH-R	9	2	870	NA	48	NA	70.0	Very Good

Continued.

Table B.8.2.1. Continued.

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: 2-4 mi^2											
Jumping Run	0.3	2.4	WWH-R	10	0	370	NA	30*	NA	63.0	Fair
Howard Run	0.5	2.6	EWH	13	3	1038	NA	52	NA	55.5	Excell.
Proctor Run	4.9	3.9	EWH	19	3	844	NA	42*	NA	71.5	Good
Hamilton Ditch	3.4	3.4	MWH	5	0	180	NA	16*	NA	21.0	Very Poor
	0.5	9.4	WWH	8	1	198	NA	24*	NA	36.5	Poor
Clover Groff Ditch	4.7	3.8	MWH	7.0	0	196	NA	18*	NA	22.0	Poor
Maximum		**3.9**	**EWH- 6**	**19**	**3**	**1926**		**55**		**21**	
Minimum		**2.4**	**WWH - 3**	**5**	**0**	**180**		**16**		**71.5**	
Mean (N = 14)		**3.7**	**MWH- 3**	**11.3**	**1.3**	**785.7**		**38.1**		**51.6**	
Drainage Area Range: 4-8 mi^2											
Big Darby Creek	79.2	5.6	EWH -R CWH-R	24	4	1298	NA	48^{NS}	NA	64.5	Very Good
Spain Creek	3.7	6.0	EWH -R CWH-R	17	3	1361	NA	56	NA	72.0	Excell.
Pleasant Run	4.6	4.5	EWH	16	2	1586	NA	54	NA	72.0	Excell.
U.T. to BDC (RM 69.4)	0.2	4.6	WWH-R	14	3	400	NA	44	NA	64.5	Good
Hay Run	0.3	5.8	EWH - R	17	5	494	NA	54	NA	52.5	Excell.
Buck Run	10.4	5.1	WWH	8	0	300	NA	26*	NA	40.0	Poor
Sweeny Run	0.1	4.0	WWH-R	10	2	244	NA	46	NA	58.0	Very Good
Sugar Run	7.5	4.1	MWH-R	6	0	153	NA	26	NA	31.0	Poor
U.T. to Sugar Run	0.1	5.0	MWH-R	9	0	549	NA	30	NA	27.0	Fair

Continued.

Table B.8.2.1. Continued.

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: 4-8 mi^2											
Worthington Ditch	0.2		WWH	10	1	442	NA	24*	NA	58.0	Poor
Ballenger-Jones Ditch	0.4	6.0	WWH-R	16	3	794	NA	40	NA	69.0	Good
Fitzgerald Ditch	0.5	5.1	WWH	9	1	1398	NA	32*	NA	56.5	Fair
Lake Run	0.9	6.0	EWH	21	2	618	NA	42*	NA	71.0	Good
Treacle Creek	11.8	5.7	EWH	13	2	1216	NA	40*	NA	67.5	Good
Barron Creek	2.1	4.9	WWH-R	13	2	1104	NA	48	NA	44.5	Very Good
Wamp Ditch	0.1	4.8	WWH -R	4	0	92.5	NA	30*	NA	45.5	Fair
Spring Fork	15.8	4.3	EWH	14	3	1372	NA	48^{NS}	NA	60.5	Very Good
Bales Fork	0.4	5.2	WWH-R	21	6	602	NA	50	NA	70.0	Excell.
Smith Ditch	2.1	5.9	EWH-R	18	3	2802	NA	52	NA	77.5	Excell.
Smith Ditch	0.3	6.7	EWH-R	13	2	245.4	NA	28*	NA	73.0	Fair
Clover Groff Ditch	0.8	6.7	WWH	13	3	358	NA	28*	NA	61.5	Fair
U.T. to B. D. C. (RM20.2)	0.8	4.3	WWH-R	13	1	712	NA	44	NA	77.5	Good
Greenbriar Creek	2.7	4.4	WWH	13	1	1222	NA	44	NA	57.0	Good
	1.3	7.0	WWH	13	2	3726	NA	46	NA	74.5	Very Good
Maximum		**7.0**	**EWH - 9**	**24**	**6**	**3726**		**54**		**77.5**	
Minimum		**4.3**	**WWH - 13**	**4**	**0**	**92.5**		**24**		**27.0**	
Mean (N = 24)		**4.8**	**MWH - 3**	**13.2**	**2.0**	**926.7**	**NA**	**40.8**	**NA**	**60.2**	
Drainage Area Range: 8-16 mi^2											
Flat Branch	0.8	13.9	MWH	18	1	389	NA	28*	NA	36.5	Fair
Spain Creek	0.1	9.1	EWH - R	26	9	1500	NA	53	NA	76.0	Excell.
Pleasant Run	0.5	9.4	EWH	20	6	958	NA	58	NA	59.5	Excell.

Continued.

Table B.8.2.1. Continued.

Drainage Area Range: 8-16 mi^2

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Sugar Run	7.0	9.5	MWH-R	14	0	453	NA	26	NA	29.5	Poor
	5.4	11.0	WWH	13	0	132	NA	34*	NA	38.5	Fair
L. Darby Cr.	39.6	9.4	EWH CWH-R	12	3	880	NA	42*	NA	69.5	Very Good
	38.8	13.2	EWH CWH-R	13	4	1106	NA	35*	NA	82.0	Marg. Good
Treacle Creek	8.3	10.3	EWH	22	7	1748	NA	52	NA	67.5	Excell.
Proctor Run	3.1	9.1	EWH	22	8	2070	NA	48^{NS}	NA	65.0	Very Good
	1.6	10.0	EWH	19	7	1118	NA	52	NA	73.0	Excell.
Spring Fork	13.7	8.2	EWH	22	6	2656	NA	54	NA	62.5	Excell.
Spring Fork	10.1	14	EWH	20	5	855	NA	40*	NA	69.0	Good
Hamilton Ditch	0.5	9.4	WWH	8	1	198	NA	24*	NA	36.5	Poor
Maximum		**14**	**EWH - 9**	**26**	**9**	**2656**		**54**		**82**	
Minimum		**8.2**	**WWH - 2**	**8**	**0**	**92**		**24***		**36.5**	
Mean (N = 13)		**10.4**	**MWH - 2**	**16.7**	**3.9**	**910.4**	**NA**	**39.9**	**NA**	**59.3**	

Drainage Area Range: 16-32 mi^2

Big Darby Creek	78.4	19.4	EWH	29	8	368	NA	37*	NA	63.5	Marg Good
	76.6	32	EWH	34	12	1474	11	43*	8.9^{NS}	73.5	V. Gd-Good
Buck Run	0.1	29	WWH	20	5	255	8.9	44	7.1*	70.5	Fair-Good
Sugar Run	0.5	19.4	WWH	15	4	204	NA	40	NA	65.5	Good
L. Darby Creek	34.7	25.9	EWH	23	13	813		49^{NS}		82.5	Very Good
Treacle Creek	6.0	17.0	EWH	20	6	940	NA	48^{NS}	NA	66.5	Very Good
Spring Fork	7.8	19.3	EWH	17	6	708	NA	48^{NS}	NA	54.5	Very Good
Hellbranch Run	10.3	23.7	WWH	17	4	254	NA	36^{NS}	6.8*	39.5	Mg. Good
	7.4	27.9	WWH	21	5	739	6.8	32*	8.2	51.0	Fair -Mg. Gd

Continued.

Table B.8.2.1. Continued.

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: 16-32 mi^2											
Maximum		**32**	**EWH - 5**	**34**	**13**	**1474**	**11**	**48^{NS}**	**8.9^{NS}**	**82.5**	
Minimum		**17**	**WWH - 4**	**15**	**5**	**204**	**6.8**	**32***	**7.1***	**39.5**	
Mean (N = 9)		**23.7**	**MWH - 0**	**21.8**	**7**	**639.4**	**8.9**	**41.6**	**8.1**	**63.0**	
Drainage Area Range: 32-64 mi^2											
Spring Fork	3.3	32	EWH	29	12	1986	28.0	52	9.8	67.5	Excell.
Hellbranch Run	5.8	30.5	WWH	22	6	924	15.48	35*	8.2	65.5	Fair -Mg. Gd
	3.7	32.6	WWH	26	9	1333	13.42	47	9.0	83.5	V. Good
	1.0	35.3	WWH	27	12	823	13.9	49	9.2	84.5	V.Good
	0.5	35.4	WWH	24	9	1243	10.8	41	9.1	83.5	Good-V.Good
Maximum		**35.4**	**EWH - 1**	**29**	**6**	**1986**	**28**	**52**	**9.8**	**65.5**	
Minimum		**30.5**	**WWH - 4**	**22**	**12**	**823**	**10.8**	**35***	**8.2**	**84.5**	
Mean (N = 5)		**33.2**	**MWH - 0**	**25.6**	**9.6**	**1261.8**	**16.3**	**44.8**	**9.1**	**76.9**	
Drainage Area Range: 64-128 mi^2											
Big Darby Creek	69.5	69	EWH	27	11	671	19.0	52	9.2^{NS}	70.5	V.Gd-Excel.
	68.1	81	EWH	18	9	410	7.1	44*	8.3*	-	Good
	66.0	**83**	**EWH**	**29**	**11**	**1273**	**8.4**	**52**	**9.2^{NS}**	**74.5**	**V.Gd-Excel.**
	63.8	89	EWH	26	11	1003	7.2	49^{NS}	8.2*	80.5	Good-V.Gd
Big Darby Creek	62.5	121	EWH	27	11	608	29.3	47^{NS}	7.5*	83.5	Fair-V. Good
Little Darby Creek	29.5	70	EWH	19	12	173	20.9	45*	8.8*	66.5	Good

Continued

Table B.8.2.1. Continued.

Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: 64-128 mi^2											
Little Darby Creek	**26.6**	**72**	**EWH**	**29**	**12**	**833.5**	**22.48**	**54**	**10**	**58.0**	**Excell.**
	24.5	83	EWH	24	11	440	68.2	52	9.3^{NS}	62.5	V.Gd - Excel.
	23.1	**89**	**EWH**	**28**	**11**	**681**	**42.39**	**48^{NS}**	**9.5**	**55.5**	**V.Gd-Excel.**
	20.5	**98**	**EWH**	**26**	**14**	**718.5**	**10.7**	**56**	**9.3^{NS}**	**64.5**	**Excel.-V. Gd**
Maximum		**121**	**EWH - 10**	**29**	**14**	**1273**	**68.2**	**44***	**7.5***	**83.5**	
Minimum		**70**	**WWH - 0**	**18**	**11**	**173**	**7.1**	**56**	**10**	**55.5**	
Mean (N = 10)		**85.5**	**MWH - 0**	**25.3**	**11.8**	**681.1**	**23.6**	**50.0**	**8.9**	**65.1**	
Drainage Area Range: 128-256 mi^2											
Big Darby Creek	54.2	136	EWH	34	14	774	19.2	53	9.2^{NS}	83.5	Excel.-V.Good
	53.9	136	EWH	28	12	980	19.7	52	9.4	93.0	Excell.
	52.5	150	EWH	30	13	953	12.2	51	9.1^{NS}	-	V.Gd-Excel.
	52.0	150	EWH	25	13	890	13.1	43*	8.8*	81.0	Good
	49.5	171	EWH	28	11	553	40.9	48^{NS}	8.3*	76.0	M.Gd.-V.Gd
	42.0	240	EWH	31	15	1454	35.7	55	9.9	81.5	Excell.
Big Darby Creek	38.9	247	EWH	29	15	739	24.2	51	9.0*	82.5	V.Gd.-Excel.
	34.1	253	EWH	41	23	1281	22.3	55	10.1	93.5	Excell.
Little Darby Creek	15.3	151	EWH	27	17	858	20.4	57	9.6	95.5	Excell.
	6.5	163	EWH	29	20	848	17.3	58	9.3^{NS}	95.5	Excel. - V. Good
Maximum		**253**	**EWH - 10**	**41**	**23**	**1454**	**40.9**	**58**	**10**	**95.5**	
Minimum		**136**	**WWH - 0**	**25**	**11**	**553**	**12.2**	**42***	**7.5***	**81.5**	
Mean (N = 10)		**179.7**	**MWH - 0**	**30.2**	**15.3**	**933.0**	**22.5**	**52.3**	**8.9**	**89.7**	

Continued.

Table B.8.2.1. Continued.											
Stream Name	RM	Drain Area	Aquatic Life Use	Cum Sp.	Sen. Sp.	Rel No.	Rel Wt.	IBI	MIwb	QH EI	Nar. Eval.
Drainage Area Range: 256-512 mi^2											
Big Darby Creek	29.1	449	EWH	45	20	603	137	55	10.8	86.0	Excell.
	26.1	496	EWH	28	16	425	14.0	56	9.4	94.5	Excell.
	23.8	498	EWH	36	19	707	181	55	10.2	87.5	Excell.
	22.8	505	EWH	41	21	827	254	53	11.4	84.5	Excell.
Maximum		**505**	**EWH - 4**	**45**	**21**	**827**	**254**	**56**	**11.4**	**94.5**	
Minimum		**450**	**WWH - 0**	**28**	**16**	**425**	**14.0**	**53**	**9.4**	**84.5**	
Drainage Area Range: 256-512 mi^2											
Stream Name	RM	Drain. Area	Aquatic Life Use	Cum Sp.	Sensi t. Sp.	Rel No.	Rel Wt	IBI	MIwb	QHEI	Narrat. Eval.
Mean (N = 4)		**487.3**	**MWH - 0**	**37.5**	**19**	**640.5**	**146.5**	**54.7**	**10.4**	**88.1**	
Drainage Area Range: >512 mi^2											
Big Darby Creek	18.7	513	EWH	36	16	516	171	52	10.5	85	Excell.
	15.7	529	EWH	35	22	1482	56	56	10.5	88.5	Excell.
	13.4	534	EWH	42	24	991	141	52	10.8	85.5	Excell.
	10.4	537	EWH	32	21	610	25.9	56	9.6	85.0	Excell.
	8.4	544	EWH	27	20	1010	61.3	48^{ns}	9.4	69.5	Excell.
	3.1	552	EWH	41	20	694	206	54	11.0	82.0	Excell.
	0.3	555	EWH	33	18	1229	196	50	11.0	71.5	Excell.
Maximum		**555**	**EWH - 7**	**42**	**24**	**1482**	**206**	**56**	**11.0**	**88.5**	
Minimum		**513**		**27**	**16**	**516**	**56**	**48**	**9.4**	**69.5**	
Mean (N = 7)		**537.7**		**35.1**	**20.14**	**933.1**	**122.5**	**52.5**	**10.4**	**81**	

B.8.3 Fish Tissue Samples

The specific objective for the collection of fish tissue samples from Big Darby Creek was to establish the concentration of PCBs, chlorinated pesticides, and bioaccumulative metals (i.e., mercury, selenium, cadmium, arsenic, lead) in edible portions of fish. A total of 86 fish tissue samples were collected from 12 locations on the mainstem of Big Darby Creek, five locations from Little Darby Creek and two locations on Hellbranch Run (Table B.8.3.1). The majority of fish tissue samples collected were edible portion samples consisting of either skin-off or skin-on fillet composites (Table B.8.3.2). A few whole body samples were collected as a result of the determination that fillet composites would result in inadequate amounts of tissue necessary for analysis. Species analyzed included common carp, rock bass, smallmouth bass, yellow bullhead, channel catfish, largemouth bass, spotted bass, black crappie, flathead catfish, freshwater drum, white crappie (Table B.8.3.2).

The following sections discuss the contaminants that have been documented in fish tissue samples in the past. Consumption restriction categories applied to individual fish tissue samples are discussed. Although these samples fit into particular consumption risk categories, fish consumption advisories are issued as a result of a complex risk assessment process. Exact procedures for evaluating fish tissue contaminant data and assigning fish tissue consumption advisories can be found at Ohio EPA 2004.

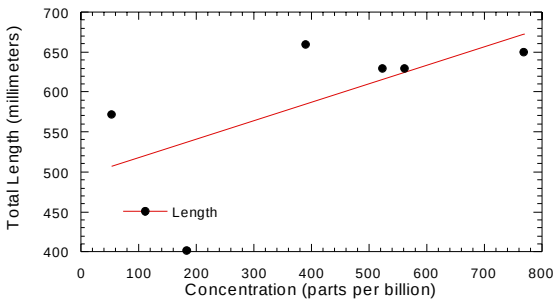
Polychlorinated biphenyls

Polychlorinated biphenyls (PCBs) are group of 209 discrete chemical compounds, called congeners, in which one to ten chlorine atoms are attached to the biphenyl molecule. In the United States PCBs were widely used and in large amounts during the period spanning 1930 to 1977. They were used as dielectric fluids in capacitors and transformers, in printing inks, pesticides, and have had many other industrial and commercial uses. The same chemical and physical stability which made them valuable commercially has had the consequence of making them persistent in the environment. The lipophilic (i.e., fat soluble) character of PCB compounds coupled with their persistence has resulted in them bioaccumulating in animal tissue.

In the United States PCBs were commonly produced as complex mixtures under the trade name of Arochlor. Specific mixtures were identified based on their percent chlorine content. Typically the higher the percent substitution (i.e., more chlorine atoms) the longer the mixture persists in the environment. In keeping with that observation Arochlor 1254 and 1260, the mixtures with the highest percentage of chlorine atoms, were the only PCB mixtures detected in samples.

Polychlorinated biphenyls (PCBs) were detected in 13 of the 86 fish tissue samples analyzed from the Big Darby Creek watershed (Tables B.8.3.3 and B.8.3.4). The total PCB detection rate of 15.1% was much lower than the reported historical statewide detection rate of 97.6 % (Ohio EPA, 1992). Common carp accounted for six of the 13 PCB detections. The mean length of carp that were contaminated with PCBs was 564.9 mm (~ 22.2 inches). There was a strong relationship between increasing body length of the fish analyzed and increasing PCB body

Figure B.8.3.1. Concentration of PCBs in carp collected from the Big Darby Creek watershed compared to total fish body length.



burden or concentration (Figure B.8.3.1). This is not unexpected. Typically larger fish are older and have had a longer period of time to consume food items that may have been contaminated and, therefore, build up a higher body burden. However, this condition can be altered when fish live in areas that are grossly polluted or pristine. Most of the carp samples analyzed that had PCB concentrations fell within the one meal a month range (Tables B.8.3.3 and B.8.3.4).

Channel catfish accounted for three of the reported detections of PCBs. Concentrations ranged from 67.9 and 177 ug/kg PCBs, which are in the one meal a week range to 613 ug/kg PCBs which is in the one meal a month range (Table B.8.3.3). The sole flathead catfish with detectable PCBs had a fairly high level of contamination (i.e., 1048 ug/kg PCBs which would place it in the one meal per two month category). Admittedly, this was a fairly large fish at 945 mm/10750 g (~ 37.2 inches/~ 23.7 lbs.) and probably an older fish. Aging of flathead catfish of comparable size from the Mississippi River revealed them to be in the range of 13 - 16 years of age (Barnickol and Starrett, 1951; Paruch, 1979).

The impact of consumption of fish contaminated with PCBs from the Big Darby Creek watershed on wildlife is unknown. Studies have revealed that values as low as 640 ug/kg have caused reproductive failure in piscivorous animals (USEPA, 1992). Further the International Joint Commission has established a target concentration of 100 ug/kg total PCB in fish tissue to protect piscivorous wildlife. Two of the detected values exceeded the 640 ug/kg concentration. Ten of the thirteen detections exceeded the 100 ug/kg IJC wildlife protection value. This represents about 12 percent of all of the samples analyzed. However, samples taken were deliberately chosen to represent what would be expected to be kept by an angler and tended towards larger fish. Smaller fish are generally more numerous and would be more likely to be a constituent of piscivore's diet. The large fish comprising this set of fish tissue samples represents the worst case scenario for the diet of a fish eating predator.

Chlordane

Chlordane, another contaminant detected in Big Darby Creek fish, is a chlorinated hydrocarbon which was widely used for termite and ant control and for agricultural uses such as insect control for crops (Ohio EPA, 1992). Chlordane was detected in 12 of the 86 samples analyzed (~ 14%). The highest detected chlordane concentration of 137.8 ug/kg fell far below the 500 ug/kg threshold concentration for shifting the recommendation from the unrestricted consumption to one meal per week consumption level. The mean chlordane concentration of 33.3 ug/kg was far

below the median statewide concentration of 190 ug/kg recorded for data preceding 1994 (Ohio EPA, 1994).

DDT

DDT, a widely used pesticide, was banned from use in the United States in 1972. However, DDT and its metabolites DDE and DDD persist in the environment and are known to bioaccumulate (Ware, 1978).

DDT (total) was detected in 16 of 86 fish tissue samples (~ 18.6%) from the Big Darby Creek watershed in 2001. One value of 534.9 ug/kg from a carp sample at RM 63.8, upstream from Streng Rd., exceeded the unrestricted consumption threshold of 500 ug/kg (Table B.8.3.3 and B.8.3.4). All other detections were well below the fish tissue concentration criterion of 200 ug/kg established by the state of New York to be protective of piscivorous wildlife (USEPA, 1992).

Dieldrin

Dieldrin was widely used in the United States from 1950 to 1974 as a broad spectrum pesticide, primarily on termites and other soil-dwelling insects. It was also used on a variety of crops including corn. The toxicity of this persistent pesticide lead to the ban of production and most major uses in 1974 and industry voluntarily stopped all uses in 1987 (USEPA, 1992). Dieldrin has been classified by USEPA as a probable human carcinogen (IRIS, 1992) and has been identified as a human neurotoxin (ATSDR, 1987). Dieldrin is also a metabolite of aldrin; therefore, the environmental concentrations of dieldrin can be the result of the cumulative use of both aldrin and dieldrin (Schmitt et al., 1990).

Dieldrin was detected in 8 of the 86 fish tissue samples (~ 9.3 %) from the Big Darby Creek watershed. Two of the samples (i.e, 48.4 and 48.8 ug/kg) closely approached the 50 ug/kg no restriction consumption threshold. One sample, was the previously mentioned large flathead catfish from RM 13.4 on the mainstem of Big Darby Creek, that had very elevated levels of PCBs. Other values of dieldrin were less and did not approach 120 ug/kg which the state of New York has established as the dietary limit to protect piscivorous wildlife (USEPA, 1992).

Fish from the Big Darby Creek watershed were also analyzed for contamination by heavy metals that bioaccumulate or are persistent in fish tissue. None of the metals were present in the analyzed fish tissue samples at concentrations approaching levels that would require restriction in consumption with the exception of mercury (Tables B.8.3.3 and B.8.3.4).

Mercury

Mercury accounts for the issuance of more fish consumption advisories nationally and locally than PCBs or any other compound. It has been used in the manufacture of batteries, lamps, thermostats and other electrical devices as well as a fungicide in interior and exterior paints. Mercury is present in naturally occurring minerals and is released by natural degassing processes and from the burning of fossil fuels (USEPA, 1992). The amount of mercury in the atmosphere

has increased by roughly 1.5 percent per year over the past decade. Major sources are coal combustion, waste incineration, manufacturers and metal processing (Clean Air Network and Environmental Council of States, 2001). Mercury like PCBs is persistent in the environment and bioaccumulates as it passes up the food chain.

Mercury was measured above detection limits in all of the fish samples analyzed from the Big Darby Creek watershed. Five samples did fall below the threshold of 50 ug/kg for no restriction of consumption. However, three of these samples were whole body or whole body composites. Mercury unlike PCBs is found in muscle tissue and, therefore, whole body samples will yield slightly lower weighted concentrations of mercury. The majority of the fish tissue samples fell within the one meal per week range (between $\geq$ 50 ug/kg and $\leq$220 ug/kg total PCBs). Half of the samples that fell in the higher category of the one meal per month range (between $\geq$ 221 ug/kg and $\leq$1009 ug/kg total PCBs) were clustered in the vicinity of Plain City extending from RM 54.0, downstream from Ranco Inc., to RM 49.5, upstream from Amity Pike. Again the one large flathead catfish had the highest concentration of mercury at 619 ug/kg and was collected at RM 13.4.

The U.S. Fish and Wildlife Service has found that mercury contamination levels should not exceed 100 ug/kg to protect piscivorous birds and 1,100 ug/kg to protect piscivorous mammals against bioaccumulation (Eisler, 1987). Using these breakpoints 27 of the 86 Big Darby Creek watershed fish tissue samples (i.e., 31.3%) did not pose risk to piscivorous birds or wildlife. The balance of the samples (i.e., 59 of the 86 or 68.6%) fell into the range that if routinely consumed adversely affect piscivorous birds but not other piscivorous wildlife. Again the fish tissue samples analyzed were from fish larger than would be normal constituents of piscivorous bird or wildlife diets, but do point to a concern that warrants further investigation.

State of Ohio Fish Consumption Advisories

Based on data that is largely contained in this report the Ohio Department of Health has issued the fish consumption advisories listed below current through 2004.

1. US 42 (Plain City) to Alkire Road (Georgesville)
   (Franklin, Madison, and Union Counties)

Channel Catfish	1 Meal/month	Mercury, PCBs

2. Alkire Rd. (Georgesville) to mouth (Scioto River)
   (Franklin and Pickaway Counties)

Common Carp	1 Meal/month	PCBs, Mercury
Channel Catfish	1 Meal/month	PCBs
Freshwater Drum $\geq$20"	1 Meal/month	Mercury

Determination of the need to issue a consumption advisory is a complex, risk based procedure with minimum data requirements. If adequate data are judged to be available (i.e., enough samples of fish falling within required size ranges and with an adequate number of sampling locations within a given stream segment) a risk assessment analysis can be conducted. In the

process contaminant concentrations are plotted against river position in an upstream to downstream fashion. A linear regression is performed to determine the trend in contaminant concentrations. From that plot and knowledge of potential sources of contamination or obstacles to fish movement coupled with established maximum allowable concentrations judgements are made where to place the endpoints of an advisory. Therefore, although data from the 2002 fish tissue sampling collections and a discussion of their relation concentrations are presented here, readers should bear in mind the detailed process followed to establish a consumption advisory.

Table B.8.3.1. Fish Tissue sampling locations in the Big Darby Creek watershed, 2002.

Sample Locat./ River Mile	Sample Number	Lat./Long.	Landmark	County	USGS 7.5 min Quad. Map
Big Darby Creek					
76.6	36-2002	40 14 57/83 32 07	Ust. N. Lewisburg Rd	Union	North Lewisburg
	37-2002				
63.8	33-2002	40 09 30/83 23 46	Streng Rd.	Union	Milford Center
	34-2002				
	35-2002				
54.00	38-2002	40 07 25/83 16 23	Ust. SR 42	Union	Plain City
	39-2002				
	40-2002				
49.5	196-2002	40 04 06/83 17 27	Ust. Amity Pike	Franklin	Plain City
	197-2002				
	198-2002				
	199-2002				
	200-2002				
	201-2002				
	202-2002				
42.0	203-2002	39 58 59/83 14 58	Ust. High Free Pike	Franklin	Galloway
	204-2002				
	205-2002				
	206-2002				
40.7	192-2002	39 58 08/ 83 14 45	Adj. Camp Ken-Jockety	Franklin	Galloway
	193-2002				
	194-2002				
	195-2002				
38.9	41-2002	39 56 50/83 14 08	Dst. SR 40	Franklin	Galloway
	42-2002				
	43-2002				
34.1	88-2002	39 53 36/83 13 03	Ust. L. Darby Creek	Franklin	Galloway
	89-2002				
	90-2002				

Continued

Table B.8.3.1. Continued

Sample Locat./ River Mile	Sample Number	Lat./Long.	Landmark	County	USGS 7.5 min Quad. Map
Big Darby Creek					
29.0	91-2002	39 51 00/83 11 08	Adj. Darbydale	Franklin	Harrisburg
	92-2002				
	93-2002				
	94-2002				
	95-2002				
	250-2002				
19.1	233-2002	39 45 11/83 08 52	Ust. Scioto-Darby Rd.	Pickaway	Harrisburg
	234-2002				
	235-2002				
	236-2002				
	237-2002				
13.4	226-2002	39 42 01/83 39 03	Dst. SR 316	Pickaway	Darbyville
	227-2002				
	228-2002				
	229-2002				
	230-2002				
	231-2002				
	232-2002				
3.2	238-2002	39 37 42/83 00 35	SR 104	Pickaway	SR 104
	239-2002				
	240-2002				
	241-2002				
	242-2002				
	243-2002				
	244-2002				
Little Darby Creek					
29.5	245-2002	40 07 00/83 25 32	Axe Handle Rd.	Union	Plumwood
	246-2002				
	247-2002				
	248-2002				
	249-2002				
24.7	214-2002	40 04 23/83 24 10	P.C. - R.D. Rd.	Madison	Plumwood
	215-2002				
	216-2002				
	217-2002				
	218-2002				
	219-2002				
15.2	220-2002	39 58 18/83 21 16	Dst. SR 42	Madison	West Jefferson
	221-2002				
	222-2002				
	223-2002				

Continued.

Table B.8.3.1. Continued

Sample Locat./ River Mile	Sample Number	Lat./Long.	Landmark	County	USGS 7.5 min Quad. Map
Little Darby Creek					
3.9	189-2002	39 55 05/83 15 26	Roberts Rd.	Madison	West Jefferson
	190-2002				
	191-2002				
0.7	44-2002	39 53 45/83 13 47	Mouth	Franklin	Galloway
	45-2002				
	46-2002				
	47-2002				
Hellbranch Run					
6.0	224-2002	39 53 08/83 09 27	Norton Rd.	Franklin	Galloway
	224-2002	39 53 08/83 09 27	Norton Rd.	Franklin	Galloway
	225-2002				
	207-2002	39 49 47/83 09 36	Lambert Rd.	Franklin	Harrisburg
	208-2002				
1.0	209-2002	39 49 47/83 09 36	Lambert Rd.	Franklin	Harrisburg
	210-2002				
	211-2002				
	212-2002				
	213-2002				

Table B.8.3.2. Fish tissue sample information for the Big Darby Creek watershed, 2002.

Site	Sample Number	Fish Species	Sample Type	Individual Fish Measurements Total Length(mm)/Weight(grams)
Big Darby Creek				
76.6	36-2002	common carp	WBC	445/1450
	37-2002	asst. crawfish	WBC	counted 24/ total weight
63.8	33-2002	common carp	SOF	625/4000
	34-2002	common carp	SOF	360/755
	35-2002	rock bass	SOFC	180/100,156/80,160/75,130/50,138/50
54.0	38-2002	smallmouth bass	SOFC	355/670 323/440,325/460,310/410,300/350
	39-2002	common carp	SOF	565/2190
	40-2002	rock bass	SOFC	185/140,190/140,173/110,180/130,185/135
49.5	196-2002	common carp	SOF	685/4500
	197-2002	channel catfish	SFF	670/3550
	198-2002	channel catfish	SFF	625/2750
	199-2002	smallmouth bass	SOF	445/1250
	200-2002	smallmouth bass	SOF	385/885
	201-2002	largemouth bass	SOF	385/930
	202-2002	rock bass	SOFC	165/100,190/160,175/160,185/150,180/140
42.0	203-2002	smallmouth bass	SOF	375/720
	204-2002	smallmouth bass	SOFC	376/460, 350/500, 375/720
	205-2002	rock bass	SOFC	215/180,210/205,219/255,203/155,215/230
	206-2002	yellow bullhead	WB	195/115
40.7	192-2002	smallmouth bass	SOF	335/590
	193-2002	yellow bullhead	WB	200/125
	194-2002	rock bass	SOFC	232/280,278/250,215/220/212/225,210/210
	195-2002	smallmouth bass	SOFC	273/270,278/270
38.9	41-2002	largemouth bass	SOF	425/1280
	42-2002	smallmouth bass	SOFC	325/450,322/360,275/280,250/350,275/250
	43-2002	rock bass	SOFC	215/260,225/280,200/160,200/200,195/170
34.1	88-2002	rock bass	SOFC	175/100,170/110,185/150,175/120,165/100, 150/90,165/100
	89-2002	black crappie	WB	235/180
	90-2002	smallmouth bass	SOFC	330/380,305/360, 328/440
29.0	91-2002	smallmouth bass	SOFC	315/400,288/300,315/360
	92-2002	freshwater drum	SOFC	560/2500,505/1900
	93-2002	spotted bass	SOFC	255/230,262/250
	94-2002	common carp	SOFC	650/4000,630/3250
	95-2002	flathead catfish	SFF	510/2650
19.1	233-2002	common carp	SOFC	585/2550,565/2400,565/2700
	234-2002	smallmouth bass	SOFC	295/330,267/238,260/220,262/250
	235-2002	spotted bass	SOFC	315/445,335/570,310/500
	236-2002	rock bass	WBC	180/140,154/79,170/110
	237-2002	channel catfish	SOF	422/730
13.4	226-2002	channel catfish	SOF	485/1400
	227-2002	rock bass	SOFC	160/80,170/110,165/84,170/86
	228-2002	spotted bass	SOF	330/580
	229-2002	flathead catfish	SOF	570/2450

Continued

Table B.8.3.2. Continued.

Site	Sample Number	Fish Species	Sample Type	Individual Fish Measurements Total Length(mm)/Weight(grams)
Big Darby Creek				
13.4	230-2002	freshwater drum	SOF	280/280
	231-2002	common carp	SOFC	654/2800,665,4350
	232-2002	flathead catfish	SOF	945/10750
3.2	238-2002	rock bass	SOFC	182/135,193/155,190/150,174/120,184/130
	239-2002	freshwater drum	SOF	355/500
	240-2002	spotted bass	SOFC	275/305,255/245,255/210
	241-2002	common carp	SOFC	600/2500,660/3500
	242-2002	smallmouth bass	SOFC	286/280, 275/250,260/235,245/185,259/200
	243-2002	channel catfish	SOFC	390/485,395/495,350/320
	244-2002	channel catfish	SOF	570/1750
Little Darby Creek				
29.5	245-2002	rock bass	SOFC	192/140,178/120,178/120,160/100,165/100, 158/100
	246-2002	smallmouth bass	SOF	415/969
	247-2002	common carp	SOF	586/2750
	248-2002	smallmouth bass	SOF	415/969
	249-2002	common carp	SOF	700/4900
24.45	214-2002	smallmouth bass	SOFC	462/1400,465/1100,430/1050,405/900
	215-2002	common carp	SOF	430/1000
	216-2002	common carp	SOF	535/2250
	217-2002	smallmouth bass	SOFC	300/380,290/340,265/250
	218-2002	rock bass	SOFC	200/170,165/100, 170/105,170/100,175/115,180/110,175/115
	219-2002	yellow bullhead	SOF	245/225,230/200,246/230
15.2	220-2002	rock bass	SOFC	190/195,200/210,180/140/175/115,165/100
	221-2002	smallmouth bass	SOFC	370/755,390/930
	222-2002	smallmouth bass	SOFC	340/525,330/485
	223-2002	yellow bullhead	WB	260/285
3.9	189-2002	smallmouth bass	SOFC	380/570,335/490,370/660
	190-2002	rock bass	SOFC	210/239,196/185,180/120,175/115,168/100
	191-2002	smallmouth bass	SOF	430/1150
0.7	44-2002	smallmouth bass	SOFC	240/150,250/210,250/220, 250/220,255/200
	45-2002	rock bass	SOFC	180/130,175/100,190/150,185/140,205/200
	46-2002	yellow bullhead	WBC	255/250,230/190
	47-2002	common carp	SOFC	445/1200,375/575,385/690
Hellbranch Run				
6.0	224-2002	yellow bullhead	WBC	185/100,190/110,200/115,105/100
	225-2002	rock bass	WBC	145/80,143/60,162/78
1.03	207-2002	white crappie	SOF	215/110
	208-2002	white crappie	SOF	275/310

Continued.

Table B.8.3.2. Continued.

Site	Sample Number	Fish Species	Sample Type	Individual Fish Measurements Total Length(mm)/Weight(grams)
Hellbranch Run				
0.9	209-2002	rock bass	SOFC	175/115,160/95,165/105
	210-2002	smallmouth bass	SOFC	290/320,275/270
	211-2002	spotted bass	SOFC	270/278,280/300
	212-2002	common carp	SOFC	335/480,285/320,295/375
	213-2002	yellow bullhead	WBC	210/138,165/70,200,120

SOFC - skin on fillet composite, SFFC - skin off fillet composite, SOF - skin off fillet, SFF - skin off fillet.

Table B.8.3.3. Fish tissue sample results for the Big Darby Creek watershed, 2002. Values falling in the meal per week range are depicted by ^{W}, meal per month by ^{M}, meal per 2 months by ^{2M} and the do not eat category by ^{X}.

Site	Fish Species	PCBs (µg/kg)	DDT (µg/kg)	Chlordane (µg/kg)	Dieldrin (µg/kg)	Mercury (mg/kg)	Selenium (mg/kg)	Lipids (%)
Big Darby Creek								
76.6	common carp	<49.3	<9.9	<9.9	<9.9	0.106^{W}	0.113	2.58
	asst. crayfish	<48.0	<9.6	<9.6	<9.6	<0.022	0.084	1.21
63.8	common carp	<49.1	534.9^{W}	<9.8	21.0	0.210^{W}	0.296	7.39
	common carp	<49.8	48.5	<10.0	<10.0	0.055^{W}	0.272	4.84
	rock bass	<49.8	<10.0	<10.0	<10.0	0.149^{W}	0.296	0.408
54.0	smallmouth bass	<49.2	<9.8	<9.8	<9.8	0.245^{M}	0.368	0.384
	common carp	<48.6	<9.7	<9.7	<9.7	0.287^{M}	0.230	7.15
	rock bass	<49.0	<9.8	<9.8	<9.8	0.138^{W}	0.265	0.343
49.5	common carp	<49.4	16.2	<9.9	<9.9	0.122^{W}	0.274	3.84
	channel catfish	<49.4	33.6	11.7	12.2	0.308^{M}	0.172	3.66
	channel catfish	67.9^{W}	63.7	11.3	<9.9	0.374^{M}	0.276	2.36
	smallmouth bass	<49.6	<9.9	<9.9	<9.9	0.341^{M}	0.293	1.53
	smallmouth bass	<49.4	<9.9	<9.9	<9.9	0.255^{M}	0.373	1.22
	largemouth bass	<49.6	<9.9	<9.9	<9.9	0.198^{W}	0.420	1.42
	rock bass	<49.8	<10.0	<10.0	<10.0	0.108^{W}	0.278	0.429
42.0	smallmouth bass	<49.9	<10.0	<10.0	<10.0	0.244^{M}	0.232	0.379
	smallmouth bass	<49.8	<10.0	<10.0	<10.0	0.128^{W}	0.346	1.07
	rock bass	<49.2	<9.8	<9.8	<9.8	0.130^{W}	0.284	0.817
	yellow bullhead	<49.8	<10.0	<10.0	<10.0	0.041	0.156	2.91
40.7	smallmouth bass	<50.0	<10.0	<10.0	<10.0	0.200^{W}	0.341	0.909
	yellow bullhead	<49.6	<9.9	<9.9	<9.9	0.073^{W}	0.272	2.29
	rock bass	<49.3	<9.9	<9.9	<9.9	0.201^{W}	0.264	0.286
	smallmouth bass	<49.5	<9.9	<9.9	<9.9	0.148^{W}	0.453	0.921
38.9	largemouth bass	<49.6	<9.9	<9.9	<9.9	0.379^{M}	0.334	0.496
	smallmouth bass	<48.8	<9.8	<9.8	<9.8	0.182^{W}	0.385	0.546
	rock bass	<49.4	<9.9	<9.9	<9.9	0.147^{W}	0.194	0.237
34.1	rock bass	<49.8	<10.0	<10.0	<10.0	0.112^{W}	0.270	0.498
	black crappie	<50.1	<10.0	<10.0	<10.0	0.079^{W}	0.335	0.351
	smallmouth bass	<48.9	<10.0	<10.0	<10.0	0.232^{M}	0.394	0.568
29.0	smallmouth bass	<49.7	<9.9	<9.9	<9.9	0.206^{W}	0.369	0.457
	freshwater drum	<49.8	<10.0	<10.0	<10.0	0.252^{M}	0.323	3.97
	spotted bass	<49.8	<10.0	<10.0	<10.0	0.200^{W}	0.367	0.428
	common carp	562^{M}	109.6	30.5	46.3	0.143^{W}	0.337	10.6
	common carp	769^{M}	99.4	30.8	28.4	0.180^{W}	0.369	4.83
	flathead catfish	<48.6	<9.7	<9.7	<9.7	0.088^{W}	0.212	3.81
19.1	common carp	53.2^{W}	14.0	<9.9	<49.4	0.150^{W}	0.344	2.7
	smallmouth bass	<49.4	<9.9	<9.9	<9.9	0.117^{W}	0.552	0.78
	spotted bass	<49.2	<9.8	<9.8	<9.8	0.197^{W}	0.331	0.797
	rock bass	<49.5	16.9	<9.9	<9.9	0.079^{W}	0.196	1.74
	channel catfish	<49.6	11.0	15.2	<9.9	0.061^{W}	0.336	6.72
13.4	channel catfish	277^{M}	21.0	<20.0	<20.0	0.131^{W}	0.310	3.88
	rockbass	<49.7	<9.9	<9.9	<9.9	0.87^{W}	0.335	0.368

Continued

Table B.8.3.3. Continued.

Site	Fish Species	PCBs (µg/kg)	DDT (µg/kg)	Chlordane (µg/kg)	Dieldrin (µg/kg)	Mercury (mg/kg)	Selenium (mg/kg)	Lipids (%)
Big Darby Creek								
13.4	spotted bass	<49.9	<10.0	<10.0	<10.0	0.359[M]	0.313	0.499
	flathead catfish	<49.8	<10.0	<10.0	<10.0	0.160[W]	0.218	2.25
	freshwater drum	80.5[W]	<10.0	<10.0	<10.0	0.070[W]	0.428	2.20
	common carp	390[M]	32.1	<9.8	<9.8	0.163[W]	0.351	4.45
	flathead catfish	1048[2M]	74.3	137.8	48.4	0.619[M]	0.150	3.88
3.2	rock bass	<49.8	<10.0	<10.0	<10.0	0.095[W]	0.290	0.379
	freshwater drum	145[W]	<9.9	<9.9	<9.9	0.075[W]	0.383	4.61
	spotted bass	<49.4	<9.9	<9.9	<9.9	0.109[W]	0.330	0.424
	common carp	524[M]	25.0	10.2	<9.9	0.202[W]	0.348	1.69
	smallmouth bass	<49.6	<9.9	<9.9	<9.9	0.121[W]	0.415	0.635
	channel catfish	<49.4	<9.9	<9.9	<9.9	0.051[W]	0.308	11.7
	channel catfish	613[M]	38.9	84	<19.9	0.052[W]	0.169	2.96
Little Darby Creek								
29.5	rock bass	<49.8	<10.0	<10.0	<10.0	0.072[W]	0.415	0.289
	smallmouth bass	<49.3	<9.9	<9.9	<9.9	0.178[W]	0.531	0.838
	common carp	<49.3	13.2	13.9	48.8	0.103[W]	0.448	9.3
	smallmouth bass	<49.7	<9.9	<9.9	<9.9	0.126[W]	0.467	1.05
	common carp	<49.3	<9.9	<9.9	<9.9	0.094[W]	0.398	4.85
24.4	smallmouth bass	<49.7	<9.9	<9.9	<9.9	0.265[M]	0.484	1.38
	common carp	<49.6	<9.9	<9.9	<9.9	0.044[W]	0.340	1.39
	common carp	<49.6	<9.9	<9.9	<9.9	0.046[W]	0.392	5.77
	smallmouth bass	<49.4	<9.9	<9.9	<9.9	0.123[W]	0.591	0.89
	rock bass	<49.7	<9.9	<9.9	<9.9	0.119[W]	0.384	0.368
	yellow bullhead	<49.4	<9.9	<9.9	<9.9	0.110[W]	0.309	1.32
15.2	rock bass	<49.8	<10.0	<10.0	<10.0	0.145[W]	0.318	0.497
	smallmouth bass	<49.6	<9.9	<9.9	<9.9	0.212[W]	0.456	1.22
	smallmouth bass	<49.0	<9.8	<9.8	<9.8	0.133[W]	0.488	0.773
	yellow bullhead	<49.5	<9.9	<9.9	<9.9	0.065[W]	0.263	2.59
3.9	smallmouth bass	<49.5	<9.9	<9.9	<9.9	0.184[W]	0.417	1.50
	rock bass	<49.5	<9.9	<9.9	<9.9	0.157[W]	0.316	0.444
	smallmouth bass	<49.2	<9.8	<9.9	<9.8	0.256[M]	0.395	0.832
0.7	smallmouth bass	<49.5	<9.9	<9.9	<9.9	0.132[W]	0.613	0.604
	rock bass	<49.9	<10.0	<10.0	<10.0	0.102[W]	0.344	0.319
	yellow bullhead	203[W]	<9.8	<9.8	18.7	0.041[W]	0.190	3.33
	common carp	184[W]	<9.8	<9.8	21.4	0.052[W]	0.344	3.41
Hellbranch Run								
6.0	yellow bullhead	<49.3	<9.9	15.6	<9.9	0.049[W]	0.262	3.03
	rock bass	<49.6	<9.9	13.9	<9.9	0.076[W]	0.210	2.46
1.0	white crappie	<49.8	<10.0	<10.0	<10.0	0.089[W]	0.240	0.338
	white crappie	<49.1	<9.8	<9.8	<9.8	0.063[W]	0.262	0.540
	rock bass	<49.8	<10.0	<10.0	<10.0	0.118[W]	0.352	0.587
	small mouth bass	<48.9	<9.8	<9.8	<9.8	0.138[W]	0.442	1.2
	spotted bass	<49.3	<9.9	<9.9	<9.9	0.178[W]	0.398	0.464
	common carp	<49.8	<10.0	24.2	<10.0	0.090[W]	0.312	3.05
	yellow bull head	<49.4	<9.9	<9.9	<9.9	0.097[W]	0.302	2.59

Table B.8.3.4. Select metals, organochlorinated pesticides, PCBs, and percent lipids measured in fish tissue collected from the Big Darby Creek watershed, 2002. Values falling in the meal per week range are depicted by ^{W}, meal per month by ^{M}, meal per 2 months by ^{2M} and the do not eat category by ^{X}.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	76.6	76.6	63.8	63.8	63.8	54.0
Sample Number	36-2002	37-2002	33-2002	34-2002	35-2002	38-2002
Fish Species	c.carp	asst. crayfish	c.carp	c.carp	rock bass	s.m. bass
Date Sampled	07/11/02	07/11/02	07/10/02	07/10/02	07/10/02	07/11/02
Mercury (mg/kg)	0.106^{W}	<0.022	0.210^{W}	0.055^{W}	0.149^{W}	0.245^{M}
Arsenic (mg/kg)	<0.038	0.182	<0.037	<0.036	<0.039	<0.035
Cadmium (mg/kg)	0.0309	0.0588	<0.0037	<0.0036	<0.0039	<0.0035
Lead (mg/kg)	0.063	0.066	<0.037	<0.036	<0.039	<0.035
Selenium (mg/kg)	0.113	0.084	0.296	0.272	0.296	0.368
Aldrin (µg/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Alpha-BHC (µg/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Beta-BHC (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
delta - BHC (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
gamma- BHC (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
4,4'-DDD (ug/kg)	<9.9	<9.6	18.9	<10.0	<10.0	<9.8
4,4'-DDE (ug/kg)	<9.9	<9.6	516	48.5	<10.0	<9.8
4,4'-DDT (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Dieldrin (ug/kg)	<9.9	<9.6	21.0	<10.0	<10.0	<9.8
Endosulfan I (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Endosulfan II (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Endosulfan sulfate (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Endrin (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Heptachlor (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Heptachlor epoxide (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Methoxychlor (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Mirex (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Hexachlorobenzene (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
alpha-chlordane (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
gamma-chlordane (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
Oxychlordane (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
cis - Nonachlor (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
trans-Nonachlor (ug/kg)	<9.9	<9.6	<9.8	<10.0	<10.0	<9.8
PCB - 1016 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1221 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1232 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1242 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1248 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1254 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
PCB -1260 (ug/kg)	<49.3	<48.0	<49.1	<49.8	<49.8	<49.2
Lipids %	2.58	1.21	7.39	4.84	0.408	0.384

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	54.0	54.0	49.5	49.5	49.5	49.5
Sample Number	39-2002	40-2002	196-2002	197-2002	198-2002	199-2002
Fish Species	c.carp	rock bass	c.carp	ch. Catfish	ch. Catfish	s.m. bass
Date Sampled	07/11/02	07/11/02	08/21/02	08/21/02	08/21/02	08/21/02
Mercury (mg/kg)	0.287[M]	0.138[W]	0.122[W]	0.308[M]	0.374[M]	0.255[M]
Arsenic (mg/kg)	<0.037	<0.037	<0.034	<0.035	<0.035	<0.039
Cadmium (mg/kg)	0.0044	<0.0037	<0.0034	<0.0035	<0.0035	<0.0039
Lead (mg/kg)	<0.037	<0.037	<0.034	<0.035	<0.035	<0.039
Selenium (mg/kg)	0.230	0.265	0.274	0.172	0.276	0.373
Aldrin (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Alpha-BHC (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Beta-BHC (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
delta - BHC (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
gamma- BHC (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
4,4'-DDD (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
4,4'-DDE (ug/kg)	<9.7	<9.8	16.2	33.6	63.7	<9.9
4,4'-DDT (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Dieldrin (ug/kg)	<9.7	<9.8	<9.9	12.2	<9.9	<9.9
Endosulfan I (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Endosulfan II (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Endosulfan sulfate (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Endrin (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Heptachlor (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Heptachlor epoxide (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Methoxychlor (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Mirex (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Hexachlorobenzene (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
alpha-chlordane (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
gamma-chlordane (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
Oxychlordane (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
cis - Nonachlor (ug/kg)	<9.7	<9.8	<9.9	<9.9	<9.9	<9.9
trans-Nonachlor (ug/kg)	<9.7	<9.8	<9.9	11.7	11.3	<9.9
PCB - 1016 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1221 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1232 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1242 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1248 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1254 (ug/kg)	<48.6	<49.0	<49.5	<49.5	<49.6	<49.6
PCB -1260 (ug/kg)	<48.6	<49.0	<49.5	<49.5	67.9	<49.6
Lipids %	7.15	0.343	3.84	3.66	2.36	1.53

Continued.

Table B.8.3.4. Continued

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	49.5	49.5	49.5	42.0	42.0	42.0
Sample Number	200-2002	201-2002	202-2002	203-2002	204-2002	205-2002
Fish Species	s.m. bass	l.m. bass	rock bass	s.m. bass	s.m. bass	rock bass
Date Sampled	08/21/02	08/21/02	08/21/02	08/21/02	08/21/02	08/21/02
Mercury (mg/kg)	0.341[M]	0.198[W]	0.108[W]	0.244[M]	0.128[W]	0.130[W]
Arsenic (mg/kg)	<0.038	<0.038	<0.039	<0.034	<0.038	<0.039
Cadmium (mg/kg)	<0.0038	<0.0038	<0.0039	<0.0034	<0.0038	<0.0039
Lead (mg/kg)	<0.038	<0.038	<0.039	<0.034	<0.038	<0.039
Selenium (mg/kg)	0.293	0.420	0.278	0.232	0.346	0.284
Aldrin (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Alpha-BHC (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Beta-BHC (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
delta - BHC (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
gamma- BHC (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
4,4'-DDD (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
4,4'-DDE (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
4,4'-DDT (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Dieldrin (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Endosulfan I (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Endosulfan II (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Endosulfan sulfate (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Endrin (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Heptachlor (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Heptachlor epoxide (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Methoxychlor (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Mirex (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
<9.8 Hexachlorobenzene	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
alpha-chlordane (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
gamma-chlordane (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
Oxychlordane (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
cis - Nonachlor (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
trans-Nonachlor (ug/kg)	<9.9	<9.9	<10.0	<10.0	<10.0	<9.8
PCB - 1016 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1221 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1232 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1242 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1248 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1254 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
PCB -1260 (ug/kg)	<49.4	<49.6	<49.8	<49.9	<49.8	<49.2
Lipids %	1.22	1.42	0.429	0.379	1.07	0.817

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	42.0	40.7	40.7	40.7	40.7	38.9
Sample Number	206-2002	192-2002	193-2002	194-2002	195-2002	41-2002
Fish Species	yellow bh	s.m. bass	yellow bh	rock bass	s.m. bass	l.m. bass
Date Sampled	08/21/02	08/21/02	08/21/02	08/21/02	08/21/02	07/11/02
Mercury (mg/kg)	0.041	0.200[W]	0.073[W]	0.201[W]	0.148[W]	0.379[M]
Arsenic (mg/kg)	<0.037	<0.040	<0.039	<0.038	<0.039	<0.035
Cadmium (mg/kg)	0.0144	<0.0040	0.0213	<0.0038	<0.0039	<0.0035
Lead (mg/kg)	<0.037	<0.040	<0.039	<0.038	<0.039	<0.035
Selenium (mg/kg)	0.156	0.341	0.272	0.264	0.453	0.334
Aldrin (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Alpha-BHC (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Beta-BHC (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
delta - BHC (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
gamma- BHC (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
4,4'-DDD (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
4,4'-DDE (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
4,4'-DDT (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Dieldrin (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Endosulfan I (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Endosulfan II (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Endosulfan sulfate (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Endrin (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Heptachlor (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Heptachlor epoxide (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Methoxychlor (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Hexachlorobenzene (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
alpha-chlordane (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
gamma-chlordane (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
Oxychlordane (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
cis - Nonachlor (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
trans-Nonachlor (ug/kg)	<10.0	<10.0	<9.9	<9.9	<9.9	<9.9
PCB - 1016 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1221 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1232 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1242 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1248 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1254 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
PCB -1260 (ug/kg)	<49.8	<50.0	<49.6	<49.3	<49.5	<49.6
Lipids %	2.91	0.909	2.29	0.286	0.921	0.496

Continued

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	38.9	38.9	34.1	34.1	34.1	29.0
Sample Number	42-2002	43-2002	88-2002	89-2002	90-2002	91-2002
Fish Species	s.m. bass	rock bass	rock bass	bl. crappie	s.m. bass	s.m. bass
Date Sampled	07/11/02	07/11/02	07/23/02	07/23/02	07/23/02	07/23/02
Mercury (mg/kg)	0.182[W]	0.147[W]	0112[W]	0.079[W]	0.232[M]	0.026
Arsenic (mg/kg)	<0.036	<0.036	<0.036	<0.039	<0.039	<0.036
Cadmium (mg/kg)	<0.0036	<0.0036	<0.0036	.0.0039	<0.0039	<0.0036
Lead (mg/kg)	<0.036	<0.036	<0.036	.0.039	<0.039	<0.036
Selenium (mg/kg)	0.385	0.194	0.270	0.335	0.394	0.369
Aldrin (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Alpha-BHC (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Beta-BHC (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
delta - BHC (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
gamma- BHC (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
4,4'-DDD (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
4,4'-DDE (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
4,4'-DDT (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Dieldrin (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Endosulfan I (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Endosulfan II (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Endosulfan sulfate (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Endrin (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Heptachlor (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Heptachlor epoxide (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Methoxychlor (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Hexachlorobenzene (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
alpha-chlordane (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
gamma-chlordane (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
Oxychlordane (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
cis - Nonachlor (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
trans-Nonachlor (ug/kg)	<9.8	<9.9	<10.0	<10.0	<10.0	<9.9
PCB - 1016 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1221 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1232 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1242 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1248 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1254 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
PCB -1260 (ug/kg)	<48.8	<49.4	<49.8	<50.1	<49.8	<49.7
Lipids %	0.546	0.237	0.498	0.351	<49.8	0.457

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	29.0	29.0	29.0	29.0	29.0	19.1
Sample Number	92-2002	93-2002	94-2002	358-02	95-2002	233-2002
Fish Species	F.W. drum	spotted bass	c.carp	c.carp	flathead c. f.	c.carp
Date Sampled	07/23/02	07/23/02	07/23/02	07/23/02	07/23/02	08/27/02
Mercury (mg/kg)	0.252[M]	0.200[W]	0.143[W]	0.180[W]	0.088[W]	0.150[W]
Arsenic (mg/kg)	<0.040	<0.038	<0.038	<0.035	<0.037	<0.039
Cadmium (mg/kg)	<0.0040	0.0048	0.0104	0.0512	<0.0037	0.0140
Lead (mg/kg)	<0.040	<0.038	<0.038	<0.035	<0.037	0.049
Selenium (mg/kg)	0.323	0.367	0.337	0.369	0.212	0.344
Aldrin (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Alpha-BHC (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Beta-BHC (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
delta - BHC (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
gamma- BHC (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
4,4'-DDD (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
4,4'-DDE (ug/kg)	<10.0	<10.0	63.3	71.0	<9.7	14.0
4,4'-DDT (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Dieldrin (ug/kg)	<10.0	<10.0	46.3	28.4	<9.7	<9.9
Endosulfan I (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Endosulfan II (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Endosulfan sulfate (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Endrin (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Heptachlor (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Heptachlor epoxide (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Methoxychlor (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Mirex (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Hexachlorobenzene (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
alpha-chlordane (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
gamma-chlordane (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
Oxychlordane (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
cis - Nonachlor (ug/kg)	<10.0	<10.0	<19.9	<10.0	<9.7	<9.9
trans-Nonachlor (ug/kg)	<10.0	<10.0	30.5	30.8	<9.7	<9.9
PCB - 1016 (ug/kg)	<49.8	<49.8	<99.4	<50.0	<48.7	<49.4
PCB -1221 (ug/kg)	<49.8	<49.8	<99.4	<50.0	<48.7	<49.4
PCB -1232 (ug/kg)	<49.8	<49.8	<99.4	<50.0	<48.7	<49.4
PCB -1242 (ug/kg)	<49.8	<49.8	<99.4	<50.0	<48.7	<49.4
PCB -1248 (ug/kg)	<49.8	<49.8	<99.4	<50.0	<48.7	<49.4
PCB -1254 (ug/kg)	<49.8	<49.8	369[M]	363[M]	<48.7	<49.4
PCB -1260 (ug/kg)	<49.8	<49.8	193[M]	406[M]	<48.7	53.2[W]
Lipids %	3.97	0.428	10.6	483	3.81	2.70

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	19.1	19.1	19.1	19.1	13.4	13.4
Sample Number	234-2002	235-2002	236-2002	237-2002	226-2002	227-2002
Fish Species	s.m. bass	spot. bass	rock bass	ch. Catfish	ch. Catfish	rock bass
Date Sampled	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02
Mercury (mg/kg)	0.117[W]	0.197[W]	0.079[W]	0.061[W]	0.131[W]	0.087[W]
Arsenic (mg/kg)	<0.039	<0.039	<0.039	<0.039	<0.039	<0.039
Cadmium (mg/kg)	<0.0039	0.0040	0.0156	<0.0039	0.0050	<0.0039
Lead (mg/kg)	<0.039	<0.039	<0.039	<0.039	<0.039	<0.039
Selenium (mg/kg)	0.552	0.331	0.196	0.336	0.310	0.335
Aldrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Alpha-BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Beta-BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
delta - BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
gamma- BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
4,4'-DDD (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
4,4'-DDE (ug/kg)	<9.9	<9.8	16.9	11.0	21.0	<9.9
4,4'-DDT (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Dieldrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Endosulfan I (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Endosulfan II (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Endosulfan sulfate (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Endrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	21.0	<9.9
Heptachlor (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Heptachlor epoxide (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Methoxychlor (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Mirex (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Hexachlorobenzene (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
alpha-chlordane (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
gamma-chlordane (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
Oxychlordane (ug/kg)	<9.9	<9.8	<9.9	15.2	<20.0	<9.9
cis - Nonachlor (ug/kg)	<9.9	<9.8	<9.9	<9.9	<20.0	<9.9
trans-Nonachlor (ug/kg)	<9.9	<9.8	<9.9	14.9	<20.0	<9.9
PCB - 1016 (ug/kg)	<49.4	<49.2	<49.5	<49.6	<99.8	<49.7
PCB -1221 (ug/kg)	<49.4	<49.2	<49.5	<49.6	<99.8	<49.7
PCB -1232 (ug/kg)	<49.4	<49.2	<49.5	<49.6	<99.8	<49.7
PCB -1242 (ug/kg)	<49.4	<49.2	<49.5	<49.6	<99.8	<49.7
PCB -1248 (ug/kg)	<49.4	<49.2	<49.5	<49.6	<99.8	<49.7
PCB -1254 (ug/kg)	<49.4	<49.2	<49.5	<49.6	152[M]	<49.7
PCB -1260 (ug/kg)	<49.4	<49.2	<49.5	<49.6	125[M]	<49.7
Lipids %	0.780	0.797	1.74	6.72	8.85	0.368

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	13.4	13.4	13.4	13.4	13.4	3.2
Sample Number	228-2002	229-2002	230-2002	231-2002	232-2002	238-2002
Fish Species	spotted bass	F.H. cat	F.W. Drum.	c.carp	F.H. cat	rock bass
Date Sampled	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02
Mercury (mg/kg)	0.359	0.160	0.070	0.163	0619	0.087
Arsenic (mg/kg)	<0.039	<0.039	<0.039	<0.039	<0.038	<0.039
Cadmium (mg/kg)	<0.0039	<0.0039	<0.0039	0.0114	<0.0038	<0.0039
Lead (mg/kg)	<0.039	<0.039	<0.039	<0.039	<0.038	<0.039
Selenium (mg/kg)	0.313	0.218	0.428	0.351	0.150	0.335
Aldrin (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Alpha-BHC (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Beta-BHC (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
delta - BHC (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
gamma- BHC (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
4,4'-DDD (ug/kg)	<10.0	<10.0	<10.0	<9.8	18.8	<10.0
4,4'-DDE (ug/kg)	<10.0	<10.0	<10.0	32.1	55.5	<10.0
4,4'-DDT (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Dieldrin (ug/kg)	<10.0	<10.0	<10.0	<9.8	48.4	<10.0
Endosulfan I (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Endosulfan II (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Endosulfan sulfate (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Endrin (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Heptachlor (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Heptachlor epoxide (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Methoxychlor (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
Hexachlorobenzene (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
alpha-chlordane (ug/kg)	<10.0	<10.0	<10.0	<9.8	32.8	<10.0
gamma-chlordane (ug/kg)	<10.0	<10.0	<10.0	<9.8	20.7	<10.0
Oxychlordane (ug/kg)	<10.0	<10.0	<10.0	<9.8y	11.4	<10.0
cis - Nonachlor (ug/kg)	<10.0	<10.0	<10.0	<9.8	<9.9	<10.0
trans-Nonachlor (ug/kg)	<10.0	<10.0	<10.0	18.1	72.9	<10.0
PCB - 1016 (ug/kg)	<49.9	<49.8	<49.9	<49.1	<49.6	<49.8
PCB -1221 (ug/kg)	<49.9	<49.8	<49.9	<49.1	<49.6	<49.8
PCB -1232 (ug/kg)	<49.9	<49.8	<49.9	<49.1	<49.6	<49.8
PCB -1242 (ug/kg)	<49.9	<49.8	<49.9	<49.1	<49.6	<49.8
PCB -1248 (ug/kg)	<49.9	<49.8	<49.9	<49.1	<49.6	<49.8
PCB -1254 (ug/kg)	<49.9	<49.8	80.5[W]	177[M]	487[2M]	<49.8
PCB -1260 (ug/kg)	<49.9	<49.8	<49.9	213[M]	561[2M]	<49.8
Lipids %	0.499			4.45	3.88	0.379

Continued.

Table B.8.3.4. Continued.

Stream	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby	Big Darby
Sample Location	3.2	3.2	3.2	3.2	3.2	3.2
Sample Number	239-2002	240-2002	241-2002	242-2002	243-2002	244-2002
Fish Species	F.W. Drum	spott bass	c.carp	s.m. bass	ch. Cat	ch. Cat
Date Sampled	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02
Mercury (mg/kg)	0.075[W]	0.109[W]	0.202[W]	0.121[W]	0.051[W]	0.052[W]
Arsenic (mg/kg)	<0.034	<0.035	<0.038	<0.038	<0.037	<0.037
Cadmium (mg/kg)	<0.0034	<0.0035	0.0456	<0.0038	<0.0037	<0.0037
Lead (mg/kg)	<0.034	<0.035	<0.038	<0.038	<0.037	<0.037
Selenium (mg/kg)	0.383	0.330	0.348	0.415	0.308	0.169
Aldrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Alpha-BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Beta-BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
delta - BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
gamma- BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
4,4'-DDD (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
4,4'-DDE (ug/kg)	<9.9	<9.9	25.0	<9.9	<9.9	38.9
4,4'-DDT (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Dieldrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Endosulfan I (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Endosulfan II (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Endosulfan sulfate (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Endrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Heptachlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Heptachlor epoxide (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Methoxychlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
Hexachlorobenzene (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
alpha-chlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	25.6
gamma-chlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	25.6
Oxychlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
cis - Nonachlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<19.9
trans-Nonachlor (ug/kg)	<9.9	<9.9	10.2	<9.9	<9.9	35.8
PCB - 1016 (ug/kg)	<49.6	<49.4	<49.3	<49.6	<49.4	<99.7
PCB -1221 (ug/kg)	<49.6	<49.4	<49.3	<49.6	<49.4	<99.7
PCB -1232 (ug/kg)	<49.6	<49.4	<49.3	<49.6	<49.4	<99.7
PCB -1242 (ug/kg)	<49.6	<49.4	<49.3	<49.6	<49.4	<99.7
PCB -1248 (ug/kg)	<49.6	<49.4	<49.3	<49.6	<49.4	<99.7
PCB -1254 (ug/kg)	145[W]	<49.4	176[M]	<49.6	<49.4	401[M]
PCB -1260 (ug/kg)	<49.6	<49.4	348[M]	<49.6	<49.4	212[M]
Lipids %	4.61	0.424	1.69	0.635	2.96	11.7

Continued.

Table B.8.3.4. Continued.

Stream	L. Darby	L. Darby	L. Darby	L. Darby	L. Darby	L. Darby
Sample Location	29.5	29.5	29.5	29.5	29.5	24.45
Sample Number	245-2002	246-2002	247-2002	248-2002	249-2002	214-2002
Fish Species	rock bass	s.m. bass	c.carp	s.m. bass	c.carp	s.m. bass
Date Sampled	08/27/02	08/27/02	08/27/02	08/27/02	08/27/02	08/22/02
Mercury (mg/kg)	0.072[W]	0.126[W]	0.094[W]	0.178[W]	0.103[W]	0.265[M]
Arsenic (mg/kg)	<0.037	<0.039	<0.038	0.050	<0.036	<0.039
Cadmium (mg/kg)	<0.0037	<0.0039	0.0071	<0.0036	0.0039	<0.0039
Lead (mg/kg)	<0.037	<0.039	<0.038	<0.036	<0.036	<0.039
Selenium (mg/kg)	0.415	0.467	0.398	0.531	0.448	0.484
Aldrin (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Alpha-BHC (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Beta-BHC (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
delta - BHC (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
gamma- BHC (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
4,4'-DDD (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
4,4'-DDE (ug/kg)	<10.0	<9.9	13.2	<9.9	14.4	14.4
4,4'-DDT (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Dieldrin (ug/kg)	<10.0	<9.9	48.8	<9.9	<9.9	<9.9
Endosulfan I (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Endosulfan II (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Endosulfan sulfate (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Endrin (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Heptachlor (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Heptachlor epoxide (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Methoxychlor (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Hexachlorobenzene (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
alpha-chlordane (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
gamma-chlordane (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
Oxychlordane (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
cis - Nonachlor (ug/kg)	<10.0	<9.9	<9.9	<9.9	<9.9	<9.9
trans-Nonachlor (ug/kg)	<10.0	<9.9	13.9	<9.9	<9.9	<9.9
PCB - 1016 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1221 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1232 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1242 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1248 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1254 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
PCB -1260 (ug/kg)	<49.8	<49.3	<49.3	<49.7	<49.3	<49.3
Lipids %	0.289	0.838	9.3	1.05	4.85	1.38

Continued.

Table B.8.3.4. Continued.

Stream	L. Darby	L. Darby	L. Darby	L Darby	L. Darby	L. Darby
Sample Location	24.45	24.45	24.45	24.45	24.45	15.2
Sample Number	215-2002	216-2002	217-2002	218-2002	219-2002	220-2002
Fish Species	c.carp	c.carp	s.m. bass	rock bass	yellow b.h.	Rock bass
Date Sampled	08/22/02	08/22/02	08/22/02	08/22/02	08/22/02	08/22/02
Mercury (mg/kg)	0.044	0.046	0.123[W]	0.119[W]	0.110[W]	0.145[W]
Arsenic (mg/kg)	<0.038	<0.038	0.044	<0.038	<0.039	<0.039
Cadmium (mg/kg)	<0.0038	<0.0038	<0.0039	<0.0038	<0.0039	<0.0039
Lead (mg/kg)	<0.038	<0.038	<0.039	<0.038	<0.039	<0.039
Selenium (mg/kg)	0.340	0.392	0.591	0.384	0.309	0.318
Aldrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Alpha-BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Beta-BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
delta - BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
gamma- BHC (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
4,4'-DDD (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
4,4'-DDE (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
4,4'-DDT (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Dieldrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Endosulfan I (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Endosulfan II (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Endosulfan sulfate (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Endrin (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Heptachlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Heptachlor epoxide (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Methoxychlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Mirex (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Hexachlorobenzene (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
alpha-chlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
gamma-chlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
Oxychlordane (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
cis - Nonachlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
trans-Nonachlor (ug/kg)	<9.9	<9.9	<9.9	<9.9	<9.9	<10.0
PCB - 1016 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1221 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1232 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1242 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1248 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1254 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
PCB -1260 (ug/kg)	<49.6	<49.6	<49.4	<49.7	<49.4	<49.8
Lipids %		5.77	0.89	0.368	1.32	0.497

Continued.

Table B.8.3.4. Continued.

Stream	L. Darby	L. Darby	L. Darby	L. Darby	L. Darby	L. Darby
Sample Location	15.2	15.2	15.2	3.9	3.9	3.9
Sample Number	221-2002	222--2002	223-2002	189-2002	190-2002	191-2002
Fish Species	s.m. bass	s.m. bass	yellow b.h..	s.m. bass	rock bass	s.m. bass
Date Sampled	08/22/02	08/22/02	08/22/02	08/21/02	08/21/02	08/21/02
Mercury (mg/kg)	0.212[W]	0.133[W]	0.065[W]	0.184[W]	0.157[W]	0.256[M]
Arsenic (mg/kg)	<0.039	<0.038	<0.039	<0.039	<0.038	<0.038
Cadmium (mg/kg)	<0.0039	<0.0038	<0.0039	<0039	<0038	<0.0038
Lead (mg/kg)	<0.039	<0.038	<0.039	<0.039	<0.038	<0.038
Selenium (mg/kg)	0.456	0.448	0.263	0.417	0.316	0.395
Aldrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Alpha-BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Beta-BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
delta - BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
gamma- BHC (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
4,4'-DDD (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
4,4'-DDE (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
4,4'-DDT (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Dieldrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Endosulfan I (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Endosulfan II (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Endosulfan sulfate (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Endrin (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Heptachlor (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Heptachlor epoxide (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Methoxychlor (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Mirex (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Hexachlorobenzene (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
alpha-chlordane (ug/kg)	<9.9	<9.8	15.6	<9.9	<9.9	<9.8
gamma-chlordane (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
Oxychlordane (ug/kg)	<9.9	<9.8	<9.9	<9.9	<9.9	<9.8
cis - Nonachlor (ug/kg)	<9.9	<9.8	9.9	<9.9	<9.9	<9.8
trans-Nonachlor (ug/kg)	<9.9	<9.8	27.4	<9.9	<9.9	<9.8
PCB - 1016 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1221 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1232 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1242 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1248 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1254 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
PCB -1260 (ug/kg)	<49.6	<49.0	<49.3	<49.5	<49.3	<49.2
Lipids %	1.22	0.773	2.59	0.832	0.444	1.50

Continued.

Table B.8.3.4. Continued.

Stream	L. Darby	L. Darby	L. Darby	L. Darby	Hellbranch	Hellbranch
Sample Location	0.7	0.7	0.7	0.7	6.0	6.0
Sample Number	44-2002	45-2002	46-2002	47-2002	224-2002	225-2002
Fish Species	s.m. bass	rock bass	yellow b.h.	c.carp	yellow b.h.	Rock bass
Date Sampled	07/15/02	07/11/02	07/11/02	07/11/02	08/22/02	08/22/02
Mercury (mg/kg)	0.132[W]	0.102[W]	0.041	0.052[W]	0.049	0.076[W]
Arsenic (mg/kg)	<0.037	<0.037	<0.036	<0.037	<0.039	<0.038
Cadmium (mg/kg)	<0.0037	<0.0037	0.0160	<0.0037	0.0426	0.0253
Lead (mg/kg)	<0.037	<0.037	<0.036	<0.037	<0.039	0.046
Selenium (mg/kg)	0.613	0.344	0.190	0.344	0.262	0.210
Aldrin (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Alpha-BHC (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Beta-BHC (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
delta - BHC (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
gamma- BHC (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
4,4'-DDD (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
4,4'-DDE (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
4,4'-DDT (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Dieldrin (ug/kg)	<9.9	<10.0	18.7	21.4	<9.9	<9.9
Endosulfan I (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Endosulfan II (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9. 9	<9.9
Endosulfan sulfate (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Endrin (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Heptachlor (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Heptachlor epoxide (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Methoxychlor (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Mirex (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Hexachlorobenzene (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
alpha-chlordane (ug/kg)	<9.9	<10.0	<9.8	<9.8	15.6	<9.9
gamma-chlordane (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
Oxychlordane (ug/kg)	<9.9	<10.0	<9.8	<9.8	<9.9	<9.9
cis - Nonachlor (ug/kg)	<9.9	<10.0	<9.8	<9.8	9.9	<9.9
trans-Nonachlor (ug/kg)	<9.9	<10.0	<9.8	<9.8	27.4	13.9
PCB - 1016 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
PCB -1221 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
PCB -1232 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
PCB -1242 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
PCB -1248 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
PCB -1254 (ug/kg)	<49.5	<49.9	203[W]	184[W]	<49.3	<49.6
PCB -1260 (ug/kg)	<49.5	<49.9	<49.1	<48.8	<49.3	<49.6
Lipids %	0.604	0.319	3.33	0.344	3.03	2.46

Continued.

Table B.8.3.4. Continued.

Stream	Hellbranch	Hellbranch	Hellbranch	Hellbranch	Hellbranch	Hellbranch
Sample Location	1.0	1.0	1.0	1.0	1.0	1.0
Sample Number	207-2002	208-2002	209-2002	210-2002	211-2002	212-2002
Fish Species	white crappie	wh.crappie	rock bass	s.m. bass	spotted bass	c.carp
Date Sampled	08/22/02	08/22/02	08/22/02	08/22/02	08/22/02	08/22/02
Mercury (mg/kg)	0.089[W]	0.063[W]	0.118[W]	0.138[W]	0.178[W]	0.090[W]
Arsenic (mg/kg)	<0.039	<0.039	<0.040	<0.039	<0.039	<0.039
Cadmium (mg/kg)	0.0049	0.0077	<0.0040	0.0042	<0.0039	0.0040
Lead (mg/kg)	<0.039	<0.039	0.040	<0.039	<0.039	<0.039
Selenium (mg/kg)	0.240	0.262	0.352	0.442	0.398	0.312
Aldrin (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Alpha-BHC (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Beta-BHC (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
delta - BHC (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
gamma- BHC (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
4,4'-DDD (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
4,4'-DDE (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
4,4'-DDT (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Dieldrin (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Endosulfan I (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Endosulfan II (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Endosulfan sulfate (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
<10.0 Endrin (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Heptachlor (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Heptachlor epoxide (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Methoxychlor (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Mirex (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Hexachlorobenzene (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
alpha-chlordane (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
gamma-chlordane (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
Oxychlordane (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
cis - Nonachlor (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	<10.0
trans-Nonachlor (ug/kg)	<10.0	<9.8	<10.0	<9.8	<9.9	24.2
PCB - 1016 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
PCB -1221 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
PCB -1232 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
PCB -1242 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
PCB -1248 (ug/kg)	<49.8	<49.1	<49.8	,<48.9	<49.3	<49.8
PCB -1254 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
PCB -1260 (ug/kg)	<49.8	<49.1	<49.8	<48.9	<49.3	<49.8
Lipids %	0.338	0.540	0.587	1.2	0.464	3.05

Continued.

Table B.8.3.4. Continued.

Stream	Hellbranch					
Sample Location	1.0					
Sample Number	213-2002					
Fish Species	yellow b.h.					
Date Sampled	08/22/02					
Mercury (mg/kg)	0.097[W]					
Arsenic (mg/kg)	<0.039					
Cadmium (mg/kg)	0.0470					
Lead (mg/kg)	<0.039					
Selenium (mg/kg)	0.302					
Aldrin (ug/kg)	<9.9					
Alpha-BHC (ug/kg)	<9.9					
Beta-BHC (ug/kg)	<9.9					
delta - BHC (ug/kg)	<9.9					
gamma- BHC	<9.9					
4,4'-DDD (ug/kg)	<9.9					
4,4'-DDE (ug/kg)	<9.9					
4,4'-DDT (ug/kg)	<9.9					
Dieldrin (ug/kg)	<9.9					
Endosulfan I (ug/kg)	<9.9					
Endosulfan II (ug/kg)	<9.9					
Endosulfan sulfate (ug/kg)	<9.9					
Endrin (ug/kg)	<9.9					
Heptachlor (ug/kg)	<9.9					
Heptachlor epoxide (ug/kg)	<9.9					
Methoxychlor (ug/kg)	<9.9					
Mirex (ug/kg)	<9.9					
Hexachlorobenzene (ug/kg)	<9.9					
alpha-chlordane (ug/kg)	<9.9					
gamma-chlordane (ug/kg)	<9.9					
Oxychlordane (ug/kg)	<9.9					
cis -Nonachlor (ug/kg)	<9.9					
trans-Nonachlor (ug/kg)	11.5					
PCB - 1016 (ug/kg)	<49.4					
PCB -1221 (ug/kg)	<49.4					
PCB -1232 (ug/kg)	<49.4					
PCB -1242 (ug/kg)	<49.4					
PCB -1248 (ug/kg)	<49.4					
PCB -1254 (ug/kg)	<49.4					
PCB -1260 (ug/kg)	<49.4					
Lipids %	2.36					

Table B.8.3.5. Summary of Ohio Fish Consumption Limits - Draft Last Updated 02/11/02

Chemical Name	RfD Mg/Kg/Day	No Restrict.	MAXIMUM ALLOWANCE In µg/kg FOR ONE MEAL PER:				FDA Action Level
			WEEK	MONTH	TWO MONTHS	DO NOT EAT	
Aldrin	0.00003	30	131	300	~~1,135~~	>300	300
Arsenic	0.0003	150	656	2,838	5,676	>5676	
Cadmium	0.001	500	2,188	9,459	18,919	>18919	
Chlordane	0.0005	~~500~~	~~2,188~~	~~9,459~~	~~18,919~~	>300	300
DDT, DDD, DDE	0.0005	500	2,188	5,000	~~18,919~~	>5,000	5,000
Dieldrin	0.00005	50	220	300	~~1,999~~	>300	300
Endosulfan	0.006	6,000	26,250	113,514	227,027	>227,027	
Endrin	0.0003	300	~~1,313~~	~~5,676~~	~~11,351~~	>300	300
Heptachlor	0.0005	~~500~~	~~2,188~~	~~9,459~~	~~18,919~~	>300	300
Heptachlor Epoxide	0.000013	13	57	246	300	>300	300
Hexachlorobenzene	0.0008	800	3,500	15,135	30,270	>30,270	
Lead (1)	6 ug/Day	86	375	1,622	3,243	>3243	
Lindane	0.0003	300	1,313	5,676	11,351	>11351	
Methoxychlor	0.005	5,000	21,875	94,545	189,189	>189,189	
Mirex	0.0002	~~200~~	~~875~~	~~3,784~~	~~7,568~~	>100	100
Methyl Mercury	0.0001	50	220	1,000	1,999	>1,999	
PCBs – Total (2)	0.00005	50	220	1,000	1,999	>1,999	2,000
SAS 305	0.05	50,000	218,750	945,946	1,891,892	>1,891,892	
SAS 310	0.0286	28,600	125,125	541,081	1,082,162	>1,891	
Selenium	0.005	2,500	10,938	47,297	94,545	>94,545	
Toxaphene (3)	0.00025	250	1,094	4,730	5,000	>5,000	5,000

Note: With the exception of Lead, PCBs, and Toxaphene, all updates were made from IRIS Toxnet searches.
(1) USFDA Total Tolerable Daily Intake. (2) Great Lakes Sport Fish Advisory Task Force. (3) EPA Office of Pesticide Programs

Important – ***If any value in the above table exceeds the FDA Action Level, the Action Level overrides that value.***

Section C. Appendices

List of Tables in Section C

C.1 Water Chemistry C.1

C.2 Physical Habitat C.2

C.3 Mussel Species Richness Maps C.3

TABLES IN SECTION C

C.1.1. Results of water column field parameter and selected metal sampling conducted in the Big Darby Creek Mainstem during June-September, 2001.

C.1.2. Results of water column metal sampling conducted in the Big Darby Creek Mainstem during June-September, 2001.

C.1.3. Results of water column nutrient sampling conducted in the Big Darby Creek Mainstem during June-September, 2001.

C.1.4. Results of water column field parameter and selected metal sampling conducted in Big Darby Creek Tributaries during June-September, 2001.

C.1.5. Results of water column metal sampling conducted in Big Darby Creek Tributaries during June-September, 2001.

C.1.6. Results of selected metals, selected field parameters and bacteriological samples conducted in Big Darby Creek Tributaries during June-September, 2001.

C.1.7. Results of water column nutrient sampling conducted in the Big Darby Creek Tributaries during June-September, 2001.

C.1.8. Results of water column field parameter sampling conducted in the Little Darby Creek Mainstem during June-September, 2001.

C.1.9. Results of water column metals sampling conducted in the Little Darby Creek Mainstem during June-September, 2001.

C.1.10. Results of water column selected metals, selected field parameter and bacteriological sampling conducted in the Little Darby Creek Mainstem during June-September, 2001.

C.1.11. Results of water column nutrient sampling conducted in the Little Darby Creek Mainstem during June-September, 2001.

C.1.12. Results of water column field parameter and selected metal sampling conducted in the Little Darby Creek Tributaries during June-September, 2001.

C.1.13. Results of water column metals sampling conducted in the Little Darby Creek Tributaries during June-September, 2001.

C.1.14. Results of selected metals, selected field parameters and bacteriological sampling conducted in Little Darby Creek Tributaries during June-September, 2001.

C.1.15. Results of water column nutrient sampling conducted in Little Darby Creek Tributaries during June-September, 2001.

C.2.1. Qualitative Habitat Evaluation Index (QHEI) Scores for sites evaluated in the Big Darby Creek Watershed during 2001 and 2002.

C.3.1. A Selection of various Mussel Species Richness Maps as related to certain Physical, Chemical, or Biological Parameters and some Individual Mussel Species Distribution Maps from the preliminary report of: Trends in freshwater Mussel Populations in the Big Darby Creek: A GIS Approach.

Appendix C.1 Water Chemistry

Appendix Table C.1.1. Results of water column field parameter and selected metal sampling conducted in the Big Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are <u>underlined</u>. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Mainstem

		Field Parameters											
RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
STORET #	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
82.50	0702	NA	18.50	NA	8.22		2	460	23	232	74	93	<u>30</u>
	0716	NA	22.50	9.90	8.31		<u>2</u>	538	11	200	80	97	<u>30</u>
	0730	NA	23.50	7.30	8.09		<u>2</u>	530	7	244	71	88	<u>30</u>
	0827	NA	22.00	8.60	8.08		<u>2</u>	614	16	756	78	97	<u>30</u>
	0910	NA	19.00	8.40	7.73		2.7	356	39	2030	77	61	<u>30</u>
	Mean	0	21.1	8.55	8.09	0	2.14	499.6	19.2	692	76	87.2	30
79.20	0702	NA	17.90	NA	8.14		2	486	12	453	87	88	<u>30</u>
	0716	NA	19.40	8.40	8.25		<u>2</u>	472	8	200	89	89	<u>30</u>
	0730	NA	21.00	6.70	7.96		<u>2</u>	480	8	263	86	81	<u>30</u>
	0827	NA	18.50	7.40	8.06		<u>2</u>	492	16	512	94	94	<u>30</u>
	0910	NA	18.50	7.40	7.81		2.6	348	79	3480	83	58	<u>30</u>
	Mean	0	19.06	7.48	8.04	0	2.12	455.6	24.6	982	87.8	82	30
78.40	0702	NA	18.80	NA	8.11		2.3	346	64	3240	72	50	<u>30</u>
	0716	NA	19.40	6.70	8.17		<u>2</u>	480	6	391	81	78	<u>30</u>
	0730	NA	22.50	6.30	7.96		<u>2</u>	369	29	1350	56	45	<u>30</u>
	0827	NA	21.90	7.30	8.28		2.2	288	44	1920	51	43	<u>30</u>
	0910	NA	21.50	7.00	7.91		4	228	63	3510	49	28	<u>30</u>
	Mean	0	20.82	6.83	8.09	0	2.5	342.2	41.2	2082	61.8	48.8	30
76.60	0702	NA	19.00	NA	8.11		<u>2</u>	434	24	996	93	64	<u>30</u>
	0716	NA	20.00	6.70	8.17		<u>2</u>	432	11	424	92	75	<u>30</u>
	0730	NA	22.50	6.30	7.96		<u>2</u>	346	29	1260	63	45	<u>30</u>
	0827	NA	22.00	7.30	8.28		2.4	384	56	1830	71	53	<u>30</u>
	0910	NA	20.30	7.00	7.91		4.2	254	105	4550	65	35	<u>30</u>
	Mean	0	20.76	6.83	8.09	0	2.52	370	45	1812	76.8	54.4	30

Big Darby Creek Mainstem

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
STORET #	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
69.40	0702	620	19.38	11.62	7.91	126.5	2.0	420	19	686	117	84	30
	0716	NA	20.81	10.94	7.61	123.9	2.0	425	15	473	109	72	30
	0730	603	22.11	6.38	7.92	73.8	2.0	396	41	1150	101	65	30
	0827	NA	NA	NA	NA	NA	2.0	380	44	1380	91	60	30
	0910	583	20.97	6.91	7.89	77.2	2.2	334	89	3640	103	60	30
	Mean	602	20.82	8.96	7.83	100.4	2.04	391	41.6	1466	104	68.2	30
63.80	0702	598	19.57	7.50	7.94	81.9	2.0	444	23	645	110	90	30
	0716	NA	21.31	7.70	8.00	86.9	2.0	434	10	310	103	76	30
	0730	543	22.12	6.56	7.65	75.3	2.0	382	24	678	95	66	30
	0827	559	21.61	8.30	7.96	94.4	2.0	376	11	450	85	59	30
	0910	NA	21.04	7.22	NA	81.2	2.0	378	15	496	94	67	30
	Mean	567	21.13	7.46	7.89	83.94	2	402.8	16.6	516	97.4	71.6	30
62.50	0702	593	20.48	6.17	7.92	69.1	2.0	420	22	616	101	82	30
	0716	NA	21.98	6.24	7.91	71.5	2.0	446	10	440	103	77	30
	0730	591	22.75	5.65	7.63	65.7	2.0	402	25	866	98	67	30
	0827	591	21.22	6.05	7.78	68.3	2.0	402	14	560	89	62	30
	0910	NA	21.72	6.72	NA	76.4	2.0	383	19	573	92	66	30
	Mean	592	21.63	6.17	7.81	70.2	2	410.6	18	611	96.6	70.8	30
54.20	0702	576	21.26	6.38	8.00	72.0	2.0	398	41	1180	97	79	30
	0716	NA	23.06	7.47	8.02	87.2	2.0	428	33	712	98	75	30
	0730	568	23.55	5.74	7.71	67.8	2.0	408	34	1050	96	67	30
	0827	531	22.12	6.52	7.85	74.5	2.0	354	24	842	85	59	30
	0910	NA	22.19	6.90	NA	79.1	2.0	376	10	336	83	60	30
	Mean	558	22.44	6.6	7.9	76.12	2	392.8	28.4	824	91.8	68	30
53.90	0702	582	21.48	6.64	8.01	75.3	2.0	404	40	1130	96	78	30
	0716	NA	23.48	7.39	8.03	86.9	2.0	440	20	760	99	75	30
	0730	609	23.64	6.02	7.77	71.2	2.0	408	29	1060	95	66	30
	0827	544	22.54	7.06	7.85	81.7	2.0	366	27	934	87	59	30
	0910	NA	22.78	7.56	NA	87.7	2.0	378	10	372	82	58	30

Big Darby Creek Mainstem

RM STORET #	Date mmdd	Field Parameters Cond µmhos	Temp °C	D.O. mg/l	pH S.U.	D.O. % sat	BOD_5 mg/l	TDS mg/l	TSS mg/l	Al µg/l	Ba µg/l	Ca mg/l	Cr µg/l
	Mean	578	22.78	6.93	7.92	80.56	2	399.2	25.2	851	91.8	67.2	30
52.10	0703	606	19.87	8.29	NA	91.1	2.0	420	17	703	83	77	30
	0717	683	23.48	8.32	8.04	98.1	2.7	434	23	650	101	79	30
	0731	677	24.23	6.38	7.93	76.2	3.3	1090	17	470	73	108	30
	0828	NA	NA	NA	NA	NA	16	1540	42	465	87	68	30
	0911	571	20.70	7.33	8.02	81.8	2.0	382	36	980	91	64	30
	Mean	634	22.07	7.58	8	86.8	5.2	773.2	27	654	87	79.2	30
52.05 E	*0703*	*1998*	*18.63*	*9.24*	*NA*	*99.5*	*2.4*	*1460*	*9*	*200*	*64*	*130*	*30*
	0717	*2937*	*20.76*	*8.58*	*7.73*	*96.8*	*10*	*1950*	*6*	*200*	*64*	*158*	*30*
	0731	*2254*	*22.07*	*8.19*	*7.76*	*94.5*	*6.1*	*1500*	*9*	*200*	*61*	*131*	*30*
	0828	*NA*	*NA*	*NA*	*NA*	*NA*	*2.0*	*681*	*13*	*378*	*57*	*142*	*30*
	0911	*2377*	*20.19*	*8.95*	*7.82*	*99.6*	*19*	*1630*	*49*	*483*	*47*	*131*	*30*
	Mean	*2392*	*20.41*	*8.74*	*7.77*	*97.6*	*7.9*	*1444*	*17.2*	*292*	*58.6*	*138*	*30*
52.00	0703	1300	19.53	8.45	NA	92.4	2.0	888	15	439	75	102	30
	0717	1237	22.84	7.83	7.96	91.3	10	1230	26	598	99	92	30
	0731	1006	23.80	7.06	7.92	83.7	2.0	448	29	988	94	69	30
	0828	NA	NA	NA	NA	NA	13	1170	43	294	55	141	30
	0911	1071	20.57	7.93	7.94	88.5	2.8	616	30	807	79	80	30
	Mean	1154	21.69	7.82	7.94	88.98	5.96	870.4	28.6	625	80.4	96.8	30
49.50	0703	690	19.97	7.35	7.97	81.0	2.0	494	23	855	81	85	30
	0717	828	22.48	5.87	8.02	67.9	2.3	536	16	434	101	94	30
	0731	740	23.72	7.10	7.86	84.0	2.0	472	17	657	89	73	30
	0828	686	21.99	6.16	7.85	70.6	3.0	472	15	632	83	75	30
	0911	639	20.58	6.86	7.67	NA	2.0	452	29	878	81	68	30
	Mean	717	21.75	6.67	7.87	75.88	2.26	485.2	20	691	87	79	30
42.00	0703	677	20.83	8.54	8.09	95.8	2.0	482	20	614	81	83	30
	0717	748	22.15	7.18	8.08	82.5	3.2	518	22	503	88	86	30
	0731	741	23.55	8.70	7.88	102.2	2.0	502	16	634	83	78	30
	0828	699	21.87	7.79	8.02	89.1	2.0	494	10	494	82	79	30

Big Darby Creek Mainstem

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
STORET #	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0911	686	19.67	8.32	7.82	NA	2.0	520	7	372	80	83	30
	Mean	710	21.61	8.11	7.98	92.4	2.24	503.2	15	523	82.8	81.8	30
34.10	0703	683	21.18	10.46	8.31	118.3	3.8	464	25	791	81	74	30
	0717	773	22.80	6.50	8.11	75.7	7.9	510	17	629	98	90	30
	0731	705	24.70	8.37	7.93	101.3	2.0	462	29	848	80	69	30
	0828	721	23.59	8.37	8.16	98.8	2.0	488	16	655	82	70	30
	0911	697	20.68	9.47	7.93	NA	2.0	478	7	274	80	72	30
	Mean	716	22.59	8.63	8.09	98.53	3.54	480.4	18.8	639	84.2	75	30
27.00	0706	697	21.68	9.61	8.13	109.4	2.0	458	10	222	87	78	30
	0719	742	22.38	9.43	7.84	108.9	2.0	506	11	307	100	82	30
	0802	698	25.17	8.61	7.94	104.8	2.0	438	21	626	100	84	30
	0830	752	22.33	9.38	8.13	107.9	2.0	472	11	352	95	75	30
	0914	692	19.03	8.94	8.21	96.6	2.0	476	10	268	92	78	30
	Mean	716	22.12	9.19	8.05	105.5	2	470	12.6	355	94.8	79.4	30
23.80	0706	671	20.43	7.87	7.84	87.5	2.0	534	10	258	87	78	30
	0719	752	23.07	7.31	8.03	85.5	2.0	488	7	222	97	81	30
	0802	722	24.57	7.42	7.96	89.0	2.0	432	22	558	101	80	30
	0830	683	21.74	8.41	8.07	96.0	2.0	464	10	265	88	68	30
	0914	673	18.90	7.88	8.12	85.0	2.0	484	12	314	95	76	30
	Mean	700	21.74	7.78	8	88.6	2	480.4	12.2	323	93.6	76.6	30
22.92 E	*0706*	*1156*	*23.06*	*8.38*	*7.23*	*98.1*	*2.0*	*732*	*5*	*200*	*15*	*25*	*30*
	0719	*1183*	*24.43*	*8.01*	*7.67*	*96.3*	*2.0*	*746*	*5*	*200*	*15*	*25*	*30*
	0802	*1227*	*26.02*	*8.22*	*7.55*	*101.6*	*2.0*	*706*	*5*	*200*	*15*	*25*	*30*
	0830	*1129*	*23.97*	*8.34*	*7.10*	*99.3*	*2.0*	*742*	*5*	*200*	*15*	*23*	*30*
	0914	*1075*	*21.96*	*8.65*	*7.75*	*99.2*	*2.0*	*726*	*5*	*200*	*15*	*25*	*30*
	Mean	*1154*	*23.89*	*8.32*	*7.46*	*98.9*	*2*	*730.4*	*5*	*200*	*15*	*24.6*	*30*
22.80	0706	678	20.71	7.36	7.83	82.2	2.0	488	12	291	86	76	30
	0719	765	23.28	6.86	8.06	80.6	2.0	490	12	271	95	81	30
	0802	751	25.04	6.12	7.95	77.9	2.0	448	21	585	92	72	30

Big Darby Creek Mainstem

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
STORET #	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0830	692	22.21	7.46	7.96	85.8	2.0	478	9	256	86	67	30
	0914	696	19.75	7.44	8.02	81.6	2.0	488	16	460	94	72	30
	Mean	716	22.2	7.05	7.96	81.62	2	478.4	14	373	90.6	73.6	30
19.10	0706	673	20.88	8.39	7.94	94.0	2.2	444	14	312	85	74	30
	0719	773	23.40	7.92	8.16	93.3	2.0	498	16	302	95	81	30
	0802	NA	NA	NA	NA	NA	2.0	422	20	562	87	70	30
	0830	712	22.36	8.62	8.12	99.5	2.0	482	10	284	88	67	30
	0914	702	19.41	8.15	8.03	88.8	2.0	494	10	303	94	71	30
	Mean	715	21.51	8.27	8.06	93.9	2.04	468	14	353	89.8	72.6	30
13.40	0706	672	21.39	11.19	8.13	126.0	4.1	446	23	370	86	74	30
	0719	759	23.22	7.87	8.13	92.1	2.0	488	12	306	97	82	30
	0802	NA	NA	NA	NA	NA	2.0	400	20	555	87	70	30
	0830	685	22.61	9.32	8.14	107.9	2.0	482	8	268	90	69	30
	0914	670	19.41	8.44	8.03	92.0	2.0	474	9	241	92	71	30
	Mean	697	21.66	9.21	8.11	104.5	2.42	458	14.4	348	90.4	73.2	30
3.10	0706	652	21.97	11.51	8.11	131.6	4.1	410	17	224	80	69	30
	0719	749	22.40	8.73	8.21	102.7	2.0	478	10	270	99	85	30
	0802	NA	NA	NA	NA	NA	2.0	400	24	631	84	66	30
	0830	703	23.24	10.02	8.20	117.6	2.0	470	9	222	95	71	30
	0914	669	19.66	8.85	8.07	96.7	2.0	464	9	214	91	72	30
	Mean	693	21.82	9.78	8.15	112.2	2.42	444.4	13.8	312	89.8	72.6	30

Appendix Table C.1.2. Results of water column metal sampling conducted in the Big Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and *italic* print in the river mile indicates an effluent sample.

Big Darby Creek Mainstem

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
STORET #	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
82.50	0702	10	422	421	46	33	40	3	14	3040	10	0.2	2
	0716	10	456	407	52	38	40	2	12	4360	11	0.2	2
	0730	14	405	453	45	41	40	3	25	3750	10	0.2	2
	0827	10	407	1200	40	66	40	3	43	3290	10	0.2	2
	0910	10	259	2910	26	67	40	8	17	1120	14	0.2	2
	Mean	10.8	390	1078	41.8	49	40	3.8	22.2	3112	11	0.2	2
79.20	0702	10	393	785	42	54	40	3	22	4850	169	0.2	2.2
	0716	10	391	426	41	39	40	2	12	4840	10	0.2	2
	0730	10	363	576	39	42	40	3	23	4380	10	0.2	2
	0827	10	391	866	38	52	40	3	15	4160	10	0.2	2.6
	0910	10	231	5100	21	97	40	6	17	2040	25	0.2	2
	Mean	10	354	1551	36.2	56.8	40	3.4	17.8	4054	44.8	0.2	2.16
78.40	0702	10	211	4560	21	76	40	14	30	2450	27	0.2	2.9
	0716	10	335	577	34	43	40	9	30	3950	10	0.2	2
	0730	10	186	1990	18	48	40	13	49	1820	12	0.2	2
	0827	10	165	2540	14	64	40	10	23	1070	20	0.2	2
	0910	10	107	4860	9	74	40	8	21	539	22	0.2	2
	Mean	10	201	2905	19.2	61	40	10.8	30.6	1966	18.2	0.2	2.18
76.60	0702	10	271	1320	27	41	40	17	36	2630	11	0.2	2.3
	0716	10	331	575	35	49	40	6	19	2900	10	0.2	2
	0730	10	191	1800	19	57	40	12	41	1770	10	0.2	2
	0827	10	210	2420	19	80	40	15	31	1460	19	0.2	2
	0910	10	137	6370	12	105	40	8	22	864	30	0.2	2
	Mean	10	228	2497	22.4	66.4	40	11.6	29.8	1925	16	0.2	2.06
69.40	0702	10	362	1120	37	46	40	4	13	4560	10	0.2	2

Big Darby Creek Mainstem

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0716	10	320	824	34	50	40	7	23	4660	10	0.2	2
	0730	10	282	1760	29	76	40	8	25	3800	10	0.2	2.2
	0827	10	257	1950	26	91	40	8	30	3180	12	0.2	2.4
	0910	10	269	5130	29	173	40	7	28	3670	19	0.2	2
	Mean	10	298	2157	31	87.2	40	6.8	23.8	3974	12.2	0.2	2.12
63.80	0702	10	381	931	38	44	40	3	12	4540	10	0.2	2
	0716	10	342	505	37	42	40	4	18	5720	10	0.2	2
	0730	10	276	1040	27	57	40	8	22	4040	10	0.2	2.6
	0827	10	254	657	26	51	40	7	25	3690	10	0.2	2.2
	0910	10	291	719	30	53	40	6	21	4320	10	0.2	2.7
	Mean	10	309	770	31.6	49.4	40	5.6	19.6	4462	10	0.2	2.3
62.50	0702	10	353	846	36	46	40	3	15	4410	10	0.2	2.1
	0716	10	345	628	37	46	40	4	19	5240	11	0.2	2.4
	0730	10	278	1150	27	64	40	8	29	3890	10	0.2	2.3
	0827	10	270	738	28	57	40	7	32	3810	12	0.2	2.8
	0910	10	284	784	29	58	40	6	23	4100	10	0.2	3
	Mean	10	306	829	31.4	54.2	40	5.6	23.6	4290	10.6	0.2	2.52
54.20	0702	10	337	1510	34	55	40	3	14	4250	10	0.2	2.2
	0716	10	344	917	38	48	40	4	18	5030	10	0.2	2.4
	0730	10	295	1400	31	57	40	5	23	4100	10	0.2	2.1
	0827	10	250	1020	25	52	40	6	20	3740	10	0.2	3.2
	0910	10	257	448	26	47	40	7	25	3850	10	0.2	2
	Mean	10	297	1059	30.8	51.8	40	5	20	4194	10	0.2	2.38
53.90	0702	10	339	1390	35	51	40	3	15	4290	10	0.2	2.3
	0716	10	344	978	38	49	40	4	20	4700	10	0.2	2.7
	0730	10	292	1450	31	54	40	5	23	4070	10	0.2	2.4
	0827	10	250	1150	25	54	40	6	22	3680	10	0.2	2.6
	0910	10	252	465	26	43	40	7	29	3800	10	0.2	2
	Mean	10	295	1087	31	50.2	40	5	21.8	4108	10	0.2	2.4
52.10	0703	10	340	876	36	31	40	4	20	3690	10	0.2	2
	0717	10	350	799	37	41	40	4	20	641	10	0.2	2.2

Big Darby Creek Mainstem

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0731	10	304	1240	32	45	40	5	31	3970	16	0.2	2.2
	0828	10	289	599	29	29	40	5	27	3480	10	0.2	2.6
	0911	10	279	1160	29	52	40	7	27	4190	10	0.2	2.5
	Mean	10	312	935	32.6	39.6	40	5	25	3194	11.2	0.2	2.3
52.05 E	*0703*	*10*	*547*	*110*	*54*	*27*	*40*	*9*	*383*	*27100*	*12*	*0.2*	*2*
	0717	*10*	*654*	*163*	*63*	*45*	*40*	*13*	*474*	*36000*	*13*	*0.2*	*2*
	0731	*10*	*533*	*156*	*50*	*42*	*40*	*10*	*329*	*22200*	*23*	*0.2*	*2*
	0828	*13*	*573*	*449*	*53*	*29*	*40*	*9*	*328*	*23700*	*40*	*0.2*	*2.3*
	0911	*16*	*549*	*499*	*54*	*39*	*40*	*13*	*393*	*25600*	*46*	*0.2*	*2*
	Mean	*11.8*	*571*	*275*	*54.8*	*36.4*	*40*	*10.8*	*381*	*26920*	*26.8*	*0.2*	*2.06*
52.00	0703	10	436	564	44	31	40	6	152	14200	13	0.2	2.2
	0717	10	403	736	42	44	40	5	74	10100	10	0.2	2
	0731	10	451	547	44	43	40	8	241	16700	17	0.2	2
	0828	10	570	353	53	29	40	9	336	24700	39	0.2	2
	0911	10	340	918	34	47	40	8	108	9090	10	0.2	2.5
	Mean	10	440	624	43.4	38.8	40	7.2	182	14958	17.8	0.2	2.14
49.50	0703	10	365	1020	37	36	40	3	26	8000	11	0.2	2
	0717	10	408	544	42	44	40	4	36	8760	11	0.2	2.1
	0731	10	322	814	34	39	40	4	37	4860	10	0.2	2.5
	0828	10	315	761	31	37	40	6	34	7780	16	0.2	2.7
	0911	10	293	1090	30	59	40	7	40	5600	10	0.2	2.9
	Mean	10	341	846	34.8	43	40	4.8	34.6	7000	11.6	0.2	2.44
42.00	0703	10	360	720	37	29	40	3	23	11400	10	0.2	2
	0717	10	384	607	41	33	40	3	24	23800	19	0.2	2
	0731	10	351	770	38	35	40	4	25	16000	10	0.2	2.2
	0828	10	354	539	38	28	40	5	30	17000	13	0.2	2.6
	0911	10	372	374	40	32	40	4	28	20000	10	0.2	2
	Mean	10	364	602	38.8	31.4	40	3.8	26	17640	12.4	0.2	2.16
34.10	0703	10	345	721	39	33	40	3	28	10400	10	0.2	2
	0717	10	398	764	42	42	40	4	36	12600	18	0.2	2
	0731	10	308	1070	33	48	40	4	30	10100	10	0.2	2.6

Big Darby Creek Mainstem

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0828	10	315	746	34	33	40	5	43	13000	11	0.2	2.7
	0911	10	324	258	35	23	40	5	43	13100	12	0.2	3.4
	Mean	10	338	712	36.6	35.8	40	4.2	36	11840	12.2	0.2	2.54
27.00	0706	10	351	250	38	17	40	3	24	6420	10	0.2	2
	0719	10	365	338	39	21	40	3	30	7990	10	0.2	2.1
	0802	10	358	790	36	42	40	3	25	7590	10	0.2	2.8
	0830	10	327	405	34	30	40	4	34	10100	10	0.2	2
	0914	10	343	335	36	25	40	5	41	10900	10	0.2	2.1
	Mean	10	349	424	36.6	27	40	3.6	30.8	8600	10	0.2	2.2
23.80	0706	10	351	248	38	18	40	3	26	6600	10	0.2	2
	0719	10	359	242	38	19	40	3	31	9210	10	0.2	2
	0802	10	340	804	34	38	40	3	24	5810	10	0.2	2.7
	0830	10	306	327	33	22	40	4	36	11500	10	0.2	2
	0914	10	338	402	36	27	40	5	39	13100	10	0.2	2.1
	Mean	10	339	405	35.8	24.8	40	3.6	31.2	9244	10	0.2	2.16
22.92 E	*0706*	*10*	*198*	*50*	*33*	*10*	*40*	*11*	*179*	*8670*	*26*	*0.2*	*2*
	0719	*10*	*190*	*50*	*31*	*10*	*40*	*9*	*175*	*9880*	*30*	*0.2*	*2*
	0802	*10*	*186*	*93*	*30*	*10*	*40*	*9*	*169*	*7180*	*25*	*0.2*	*2*
	0830	*10*	*177*	*61*	*29*	*10*	*40*	*11*	*164*	*7180*	*27*	*0.2*	*2*
	0914	*10*	*198*	*50*	*33*	*10*	*40*	*11*	*172*	*9340*	*22*	*0.2*	*2*
	Mean	*10*	*190*	*60.8*	*31.2*	*10*	*40*	*10.2*	*172*	*8450*	*26*	*0.2*	*2*
22.80	0706	10	346	329	38	22	40	3	28	6590	10	0.2	2
	0719	10	359	351	38	22	40	3	33	8030	10	0.2	2.3
	0802	10	316	797	33	43	40	3	30	5500	12	0.2	2
	0830	10	295	348	31	26	40	4	36	10200	10	0.2	2
	0914	10	328	572	36	33	40	5	44	12600	10	0.2	2
	Mean	10	329	479	35.2	29.2	40	3.6	34.2	8584	10.4	0.2	2.06
19.10	0706	10	337	372	37	24	40	3	27	6380	10	0.2	2
	0719	10	359	391	38	25	40	3	36	7550	10	0.2	2
	0802	10	306	771	32	35	40	4	29	5560	10	0.2	2.7
	0830	10	295	384	31	24	40	4	40	9800	10	0.2	2.1

Big Darby Creek Mainstem

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
STORET #	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	0914	10	326	374	36	26	40	5	49	11400	10	0.2	3.6
	Mean	10	325	458	34.8	26.8	40	3.8	36.2	8138	10	0.2	2.48
13.40	0706	10	337	522	37	29	40	3	28	6560	10	0.2	2
	0719	10	361	430	38	23	40	3	32	8710	10	0.2	2
	0802	10	298	800	30	33	40	3	26	4620	11	0.2	2.5
	0830	10	300	348	31	28	40	4	36	9710	15	0.2	2
	0914	10	326	331	36	23	40	5	43	9000	10	0.2	3.2
	Mean	10	324	486	34.4	27.2	40	3.6	33	7720	11.2	0.2	2.34
3.10	0706	10	325	288	37	23	40	3	26	5170	10	0.2	2
	0719	10	373	356	39	24	40	3	28	6720	10	0.2	2
	0802	10	288	879	30	35	40	3	25	4320	10	0.2	2.5
	0830	10	309	297	32	22	40	3	35	8850	10	0.2	2.1
	0914	10	324	290	35	18	40	4	43	7260	10	0.2	3.4
	Mean	10	324	422	34.6	24.4	40	3.2	31.4	6464	10	0.2	2.4

Appendix Table C.1.3. Results of water column nutrient sampling conducted in the Big Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Mainstem

RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
82.50	0702	0.02	0.05	0.65	91.1	0.29	0.05
	0716	0.02	0.05	0.14	147	0.23	0.05
	0730	0.02	0.05	0.1	120	0.41	0.05
	0827	0.02	0.05	0.1	133	0.47	0.051
	0910	0.074	0.077	0.96	58.1	1.22	0.476
	Mean	0.0308	0.0554	0.39	109.84	0.524	0.1354
79.20	0702	0.02	0.05	0.31	81.3	0.32	0.05
	0716	0.02	0.05	0.16	93.4	0.21	0.05
	0730	0.02	0.05	0.12	105	0.45	0.05
	0827	0.02	0.05	0.21	87.3	0.31	0.05
	0910	0.043	0.05	0.61	70	0.61	0.092
	Mean	0.0246	0.05	0.282	87.4	0.38	0.0584
78.40	0702	0.071	0.05	0.62	53.9	0.74	0.135
	0716	0.02	0.05	0.56	84	0.42	0.113
	0730	0.022	0.05	0.3	55.1	0.53	0.073
	0827	0.027	0.05	0.3	45.9	0.41	0.182
	0910	0.051	0.05	0.25	34.4	0.47	0.172
	Mean	0.0382	0.05	0.406	54.66	0.514	0.135
76.60	0702	0.024	0.05	1.02	65.9	0.74	0.05
	0716	0.02	0.05	1.04	67	1	0.05
	0730	0.02	0.05	0.49	49.2	0.43	0.05
	0827	0.02	0.05	0.26	63	0.6	0.157
	0910	0.061	0.05	0.61	37.8	0.66	0.297
	Mean	0.029	0.05	0.684	56.58	0.686	0.1208
69.40	0702	0.029	0.05	3.03	62.7	0.36	0.054

Big Darby Creek Mainstem							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0716	0.02	0.05	1.24	66.3	0.37	0.077
	0730	0.02	0.05	0.85	55.5	0.48	0.074
	0827	0.02	0.05	0.46	55.6	0.47	0.052
	0910	0.027	0.05	0.56	60.3	0.52	0.196
	Mean	0.0232	0.05	1.228	60.08	0.44	0.0906
63.80	0702	0.044	0.05	6.30	65	0.55	0.05
	0716	0.02	0.05	0.98	79.1	0.41	0.05
	0730	0.02	0.053	1.25	73.4	0.48	0.062
	0827	0.02	0.05	0.40	65.2	0.55	0.078
	0910	0.02	0.05	0.39	64	0.56	0.061
	Mean	0.0248	0.0506	1.864	69.34	0.51	0.0602
62.50	0702	0.038	0.05	4.32	63	0.51	0.07
	0716	0.02	0.05	1.04	75.9	0.36	0.063
	0730	0.022	0.054	1.21	76.6	0.52	0.07
	0827	0.02	0.05	0.46	67.5	0.59	0.061
	0910	0.02	0.05	0.37	65	0.60	0.05
	Mean	0.024	0.0508	1.48	69.6	0.516	0.0628
54.20	0702	0.033	0.05	4.11	60.1	0.39	0.06
	0716	0.02	0.05	1.37	72.7	0.47	0.084
	0730	0.021	0.05	1.72	68.7	0.58	0.088
	0827	0.02	0.05	0.55	63.7	0.20	1.75
	0910	0.02	0.05	0.38	63.2	0.66	0.05
	Mean	0.0228	0.05	1.626	65.68	0.46	0.4064
53.90	0702	0.035	0.05	4.05	61.8	0.46	0.06
	0716	0.02	0.05	1.46	75.1	0.37	0.068
	0730	0.024	0.052	1.72	69.5	0.52	0.091
	0827	0.02	0.05	0.60	64.9	0.29	0.124
	0910	0.02	0.05	1.03	66.6	0.67	0.05
	Mean	0.0238	0.0504	1.772	67.58	0.462	0.0786
52.10	0703	0.022	0.05	6.13	51.9	0.43	0.082
	0717	0.02	0.05	1.21	77.6	0.52	0.097

Big Darby Creek Mainstem							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0731	0.02	0.05	1.74	67.4	0.63	0.092
	0828	0.054	0.05	1.10	145	0.56	0.141
	0911	0.02	0.05	0.37	66.5	0.61	0.166
	Mean	0.0272	0.05	2.11	81.68	0.55	0.1156
	0703	*0.090*	*0.233*	*0.24*	*168*	*1.74*	*0.297*
	0717	*0.173*	*12.80*	*0.12*	*232*	*16.7*	*1.06*
52.05 E	*0731*	*0.370*	*0.614*	*2.61*	*191*	*1.54*	*0.303*
	0828	*0.02*	*0.31*	*7.58*	*56.2*	*1.74*	*1.75*
	0911	*0.129*	*0.954*	*13.0*	*207*	*2.22*	*3.41*
	Mean	*0.1564*	*2.9822*	*4.71*	*170.84*	*4.788*	*1.364*
	0703	0.083	0.131	3.61	105	1.37	0.158
	0717	0.211	1.54	1.08	163	2.95	0.204
52.00	0731	0.249	0.329	2.45	146	1.12	0.226
	0828	0.044	0.314	7.60	116	1.55	1.65
	0911	0.035	0.227	3.32	91.5	0.20	0.05
	Mean	0.1244	0.5082	3.612	124.3	1.438	0.4576
	0703	0.024	0.05	4.01	91.4	0.56	0.071
	0717	0.02	0.05	1.03	109	0.55	0.09
49.50	0731	0.02	0.05	1.52	67.8	0.52	0.106
	0828	0.02	0.05	0.75	98.4	0.48	0.158
	0911	0.02	0.05	0.70	82.9	0.59	0.133
	Mean	0.0208	0.05	1.602	89.9	0.54	0.1116
	0703	0.025	0.05	3.30	86.3	0.39	0.05
	0717	0.02	0.05	0.89	117	0.48	0.069
42.00	0731	0.02	0.05	1.59	103	0.37	0.05
	0828	0.02	0.05	0.70	110	0.43	0.05
	0911	0.02	0.05	0.56	109	0.40	0.05
	Mean	0.021	0.05	1.408	105.06	0.414	0.0538
	0703	0.02	0.05	2.91	79.9	0.85	0.085
34.10	0717	0.02	0.05	1.43	100	0.66	0.118
	0731	0.02	0.05	1.98	82.6	0.52	0.122

Big Darby Creek Mainstem							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0828	0.02	0.05	0.80	97.3	0.47	0.124
	0911	0.02	0.05	0.44	87.9	0.45	0.09
	Mean	0.02	0.05	1.512	89.54	0.59	0.1078
27.00	0706	0.02	0.05	3.20	73	0.81	0.052
	0719	0.02	0.05	1.56	81	0.45	0.082
	0802	0.02	0.05	1.89	57.7	0.40	0.143
	0830	0.02	0.05	0.73	81.8	0.39	0.062
	0914	0.02	0.05	0.60	96.4	0.44	0.068
	Mean	0.02	0.05	1.596	77.98	0.498	0.0814
23.80	0706	0.02	0.05	3.14	70	0.42	0.063
	0719	0.02	0.05	1.51	77.9	0.39	0.121
	0802	0.02	0.05	1.85	53.5	0.20	0.218
	0830	0.02	0.05	0.67	79.7	0.35	0.059
	0914	0.02	0.05	0.54	96.8	0.49	0.05
	Mean	0.02	0.05	1.542	75.58	0.37	0.1022
22.92 E	*0706*	*0.044*	*0.108*	*11.9*	*258*	*1.23*	*6.15*
	0719	*0.023*	*0.075*	*8.50*	*212*	*1.37*	*5.15*
	0802	*0.039*	*0.090*	*6.73*	*199*	*0.83*	*4.89*
	0830	0.028	0.072	13.4	*204*	*1.13*	*7.05*
	0914	*0.025*	*0.105*	*11.8*	*212*	*1.25*	*6.09*
	Mean	*0.0318*	*0.09*	*10.466*	*217*	*1.162*	*5.866*
22.80	0706	0.021	0.05	3.01	72.5	0.50	0.134
	0719	0.02	0.05	1.55	81.9	0.46	0.215
	0802	0.02	0.05	1.92	57.4	0.20	0.294
	0830	0.02	0.05	0.83	80.7	0.39	0.216
	0914	0.02	0.05	0.71	98.5	0.46	0.157
	Mean	0.0202	0.05	1.604	78.2	0.402	0.2032
19.10	0706	0.02	0.05	2.83	70.2	0.27	0.255
	0719	0.02	0.05	1.63	82.1	0.46	0.222
	0802	0.02	0.05	2.00	54.3	0.20	0.29
	0830	0.02	0.05	1.01	81.1	0.40	0.238

Big Darby Creek Mainstem							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0914	0.02	0.05	0.84	92.3	0.37	0.556
	Mean	0.02	0.05	1.662	76	0.34	0.3122
13.40	0706	0.022	0.05	2.52	68	0.53	0.063
	0719	0.02	0.05	1.75	81.9	0.56	0.136
	0802	0.02	0.05	2.10	49.4	0.46	0.154
	0830	0.02	NA	NA	75.5	NA	NA
	0914	0.02	0.05	0.73	81.3	0.49	0.127
	Mean	0.0204	0.05	1.775	71.22	0.51	0.12
3.10	0706	0.02	0.05	2.52	67.8	0.54	0.097
	0719	0.02	0.05	2.07	83	0.57	0.108
	0802	0.02	0.05	1.99	49	0.25	0.155
	0830	0.02	0.05	1.06	76	0.39	0.098
	0914	0.02	0.05	1.04	79.9	0.40	0.292
	Mean	0.02	0.05	1.736	71.14	0.43	0.15

Appendix Table C.1.4. Results of water column field parameter and selected metal sampling conducted in Big Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Basin

		Field Parameters											
RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
HELLBRANCH RUN (WWH)													
10.10	0706	700	18.00	6.70	7.76	70.8	2.0	430	19	576	94	65	30
	0719	804	21.98	7.62	7.67	87.2	2.0	528	41	1190	107	59	30
	0802	669	23.53	6.48	7.74	76.4	2.0	428	16	664	97	58	30
	0830	596	20.13	5.80	7.74	63.9	2.0	374	16	620	98	58	30
	0914	602	16.70	7.75	7.88	80.0	2.0	438	31	915	109	62	30
	Mean	674	20.1	6.9	7.8	75.7	2	440	24.6	793	101	60.4	30
7.40	0706	663	18.63	7.39	7.86	79.3	2.0	420	6	207	84	63	30
	0719	712	21.97	8.07	7.63	92.2	2.0	462	8	231	87	58	30
	0802	680	23.81	8.13	7.75	95.4	2.0	408	5	266	103	71	30
	0830	587	20.23	7.49	7.79	82.8	2.0	356	9	348	95	56	30
	0914	628	16.54	7.49	7.88	78.0	2.0	470	7	232	100	67	30
	Mean	654	20.2	7.7	7.8	85.5	2	423	7	257	93.8	63	30
5.80	0706	470	18.16	7.75	7.87	82.1	2.0	466	5	200	88	69	30
	0719	802	21.48	8.03	7.63	91.2	2.0	526	5	200	94	70	30
	0802	826	22.89	8.08	7.83	94.3	2.0	428	6	255	83	72	30
	0830	626	20.19	7.50	7.79	82.9	2.0	352	6	264	86	55	30
	0914	648	16.26	6.96	7.91	71.1	2.0	500	5	200	94	69	30
	Mean	674	19.8	7.7	7.8	84.3	2	454	5.4	224	89	67	30
3.70	0706	741	18.32	8.59	8.07	91.9	2.0	460	5	200	83	69	30
	0719	940	21.58	9.27	7.77	105.5	2.0	602	5	200	97	71	30
	0802	650	23.29	8.45	7.89	99.8	2.0	426	5	200	91	78	30
	0830	584	20.24	8.70	7.95	96.4	2.0	360	5	200	76	52	30
	0914	657	16.86	8.46	8.10	87.4	2.0	480	5	200	99	70	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	Mean	714	20.1	8.7	8	96.2	2	466	5	200	89.2	68	30
0.90	0706	725	17.85	9.50	8.01	100.3	2.0	458	5	200	89	70	30
	0719	737	20.07	8.88	7.75	98.0	2.0	492	5	200	118	78	30
	0802	331	22.57	9.35	7.95	108.2	2.0	415	5	200	93	76	30
	0830	583	19.20	9.02	7.90	97.5	2.0	346	5	200	85	56	30
	0914	620	15.93	8.14	8.03	82.6	2.0	436	8	303	109	72	30
	Mean	599	19.1	9	7.9	97.3	2	429	5.6	221	98.8	70.4	30
0.50	0706	717	17.97	3.60	7.71	37.8	3.8	498	5	200	91	71	30
	0719	855	21.24	8.42	7.70	95.1	2.0	568	14	200	113	78	30
	0802	613	22.56	9.73	7.97	112.7	2.0	448	5	200	91	76	30
	0830	335	19.74	8.68	7.90	95.3	2.0	400	5	233	85	58	30
	0914	695	16.59	8.47	8.04	87.1	2.0	502	5	200	108	75	30
	Mean	643	19.6	7.8	7.9	85.6	2.4	483	6.8	207	97.6	71.6	30
GEORGES RUN (WWH)													
0.50	0706	732	21.58	12.58	7.92	143.0	2.0	480	5	200	82	97	30
	0719	790	24.82	12.93	8.17	156.2	2.0	526	5	200	90	108	30
	0802	NA	NA	NA	NA	NA	2.0	464	5	200	85	96	30
	0830	731	21.00	10.72	8.08	120.5	2.0	534	5	200	79	101	30
	0914	616	16.36	8.98	8.02	91.7	2.0	528	6	200	81	108	30
	Mean	717	20.9	11	8	128	2	506	5.2	200	83.4	102	30
GREENBRIER CREEK (WWH)													
2.70	0706	628	17.21	8.85	7.91	92.2	2.0	446	5	200	82	72	30
	0719	700	20.38	8.06	8.03	89.5	2.0	462	5	200	87	78	30
	0802	696	22.37	8.78	8.22	101.4	2.0	423	5	200	84	79	30
	0830	888	19.10	8.91	8.07	96.6	2.0	618	5	200	92	82	30
	0914	679	15.23	3.07	7.72	30.6	2.6	490	8	200	92	81	30
	Mean	718	18.9	7.5	8	82.1	2.1	488	5.6	200	87.4	78.4	30
1.30	0706	615	19.11	10.54	7.86	NA	2.0	409	18	640	83	78	30
	0719	Dry creekbed											
	0802	NA	NA	NA	NA	NA	2.0	398	5	200	82	75	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0830	719	21.28	12.21	8.12	137.9	2.0	489	5	200	90	83	30
	0914												
	Mean	667	20.2	11	8	138	2	432	9.33	347	85	78.7	30
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 20.20 (Not Designated)													
0.80 U	0706	698	16.15	8.54	7.64	84.9	2.0	495	5	200	93	82	30
	0719	847	19.93	7.01	7.90	77.3	2.0	548	7	202	109	93	30
	0802	803	21.91	6.35	7.75	72.5	2.0	472	5	200	87	66	30
	0830	881	19.01	8.05	7.84	87.0	2.0	596	5	200	100	80	30
	0914	875	16.01	6.87	7.87	69.7	2.0	626	6	200	110	93	30
	Mean	821	18.6	7.4	7.8	78.3	2	547	5.6	200	99.8	82.8	30
SPRINGWATER RUN (WWH)													
0.20	0706	434	20.63	12.45	8.29	138.8	2.0	566	5	200	77	85	30
	0719	1379	22.13	13.77	7.99	158.7	2.0	918	5	200	114	112	30
	0802	628	22.74	10.25	8.05	119.1	2.0	418	5	200	76	76	30
	0830	1420	20.25	12.80	8.01	139.0	2.0	894	5	200	110	114	30
	0914	1201	15.83	10.38	7.94	105.3	2.0	856	5	200	95	100	30
	Mean	1012	20.3	12	8.1	132	2	730	5	200	94.4	97.4	30
CLOVER GROFF DITCH (MWH, WWH)													
4.70	0706	517	18.54	5.32	7.60	56.8	2.1	338	9	322	94	58	30
	0719	549	22.88	7.06	7.49	82.1	2.0	366	11	284	104	54	30
	0802	515	24.84	4.90	7.73	59.1	2.0	350	5	256	100	54	30
	0830	457	21.15	5.93	7.66	66.9	2.3	321	6	284	97	52	30
	0914	314	16.17	5.74	7.81	58.3	3.4	250	21	964	75	43	30
	Mean	470	20.7	5.8	7.7	64.6	2.4	325	10.4	422	94	52.2	30
0.80	0706	642	17.92	7.27	7.73	76.8	2.0	402	8	213	94	61	30
	0719	577	22.03	8.85	7.62	101.5	2.0	390	8	234	84	52	30
	0802	613	24.08	6.87	7.73	81.9	2.0	442	5	200	82	50	30
	0830	691	20.37	7.31	7.80	81.2	2.0	380	6	210	88	56	30
	0914	563	16.51	7.65	7.83	78.5	2.0	408	5	208	82	51	30
	Mean	617	20.2	7.6	7.7	84	2	404	6.4	213	86	54	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
HAMILTON DITCH (MWH, WWH)													
3.40	0706	927	15.76	6.91	7.76	69.7	2.0	604	96	1960	130	95	30
	0719	908	20.84	4.56	7.43	51.0	8.6	582	150	2350	170	95	30
	0802	763	21.77	7.43	7.73	84.0	2.0	528	5	200	108	91	30
	0830	689	17.89	6.70	7.90	70.9	2.0	516	20	395	110	90	30
	0914	576	13.95	6.79	7.76	65.9	3.8	464	17	1060	102	75	30
	Mean	773	18	6.5	7.7	68.3	3.7	539	57.6	1193	124	89.2	30
0.50	0706	959	16.28	6.26	7.61	63.8	2.0	584	5	200	103	89	30
	0719	1380	20.71	4.15	7.42	46.2	2.0	894	8	240	175	109	30
	0802	1009	21.38	10.43	7.41	118.3	2.0	590	13	362	114	88	30
	0830	871	18.63	5.29	7.65	58.6	2.0	532	8	309	115	89	30
	0914	824	14.68	5.98	7.61	59.1	2.0	630	9	429	120	82	30
	Mean	1009	18.3	6.4	7.5	69.2	2	646	8.6	308	125	91.4	30
SMITH DITCH (Not Designated)													
2.10 U	0706	686	17.55	9.40	8.01	98.4	2.0	412	5	200	77	78	30
	0719	645	20.15	11.26	7.85	124.2	2.0	437	5	200	93	80	30
	0802	651	22.40	9.50	8.05	109.7	2.0	422	5	200	87	90	30
	0830	769	19.07	9.33	7.88	100.9	2.0	488	10	269	117	95	30
	0914	631	15.74	9.20	8.08	92.8	2.0	462	5	200	110	89	30
	Mean	676	19	9.7	8	105	2	444	6	214	96.8	86.4	30
UNNAMED TRIBUTARY TO SMITH DITCH (Not Designated)													
0.10 U	0706	594	16.29	9.39	8.11	97.8	2.0	384	5	200	90	77	30
	0719	559	19.31	12.03	7.95	130.7	2.0	396	5	200	97	81	30
	0802	532	21.54	9.57	8.04	108.7	2.0	338	5	200	98	77	30
	0830	231	19.23	10.75	8.25	116.1	2.0	360	5	200	85	69	30
	0914	491	15.55	10.27	8.23	103.3	2.0	348	5	200	90	76	30
	Mean	481	18.4	10	8.1	111	2	365	5	200	92	76	30
FITZGERALD DITCH (Not Designated)													
0.50 U	0703	611	18.43	10.69	8.28	119.1	2.0	435	5	200	68	67	30
	0717	502	21.11	7.29	7.99	82.1	8.1	350	13	269	47	48	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0731	978	23.58	17.18	8.21	203.0	2.0	646	5	200	63	82	30
	0828	872	21.22	10.85	8.13	122.7	2.2	600	15	212	77	79	30
	0911	1220	18.87	12.74	7.82	NA	2.0	960	5	200	46	123	30
	Mean	837	20.6	12	8.1	132	3.3	598	8.6	216	60.2	79.8	30
YUTZY DITCH (Not Designated)													
0.40 U	0703	660	17.35	11.09	8.17	115.9	2.0	468	5	200	80	86	30
	0717	709	20.11	4.41	7.82	48.8	3.6	450	5	200	76	65	30
	0731	735	22.50	9.14	7.88	105.2	2.0	484	5	200	81	73	30
	0828	794	21.01	7.74	7.96	87.0	2.0	530	5	200	78	64	30
	0911	893	16.99	6.78	7.61	NA	2.0	588	5	200	84	73	30
	Mean	758	19.6	7.8	7.9	89.2	2.3	504	5	200	79.8	72.2	30
BALLENGER-JONES DITCH (Not Designated)													
0.20 U	0703	616	17.46	10.82	8.17	113.3	2.0	438	5	200	75	79	30
	0717	667	21.11	4.26	42.9	47.9	2.0	432	5	200	89	61	30
	0731	741	23.05	12.06	7.76	141.1	2.0	470	5	200	86	78	30
	0828	678	21.10	7.73	7.89	87.1	2.0	440	5	200	86	65	30
	0911	707	17.54	4.27	7.44	NA	2.0	494	5	200	91	67	30
	Mean	682	20.1	7.8	15	97.4	2	455	5	200	85.4	70	30
WORTHINGTON DITCH (Not Designated)													
0.20 U	0703	612	16.92	9.48	7.93	98.1	2.0	440	5	200	73	86	30
	0717	665	19.23	3.67	7.61	39.8	2.0	452	5	200	81	72	30
	0731	800	21.07	8.70	7.76	97.9	2.0	552	5	200	83	87	30
	0828	704	19.44	6.94	7.77	75.7	2.0	498	5	200	83	78	30
	0911	693	15.46	5.31	7.45	NA	2.0	528	22	200	86	88	30
	Mean	695	18.4	6.8	7.7	77.9	2	494	8.4	200	81.2	82.2	30
SWEENY RUN (Not Designated)													
0.10 U	0703	627	16.87	10.10	NA	104.2	2.0	468	5	216	69	83	30
	0717	808	20.58	6.06	7.67	67.6	2.0	520	9	225	79	74	30
	0731	763	21.73	9.98	8.06	113.8	2.0	510	5	200	85	88	30
	0828	NA	NA	NA	NA	NA	2.0	514	5	200	88	85	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0911	1978	20.24	6.36	7.78	70.9	6.9	1270	11	268	69	57	30
	Mean	1044	19.9	8.1	7.8	89.1	3	656	7	222	78	77.4	30
SUGAR RUN (MWH, WWH)													
7.50	0703	709	16.20	7.95	NA	81.1	2.0	566	5	266	60	85	30
	0717	793	19.99	6.02	7.62	66.4	2.0	684	5	318	64	82	30
	0731	1310	20.93	3.46	7.42	38.7	2.0	894	5	200	70	99	30
	0828	NA	19.86	3.13	7.31	34.6	2.0	856	7	551	60	90	30
	0911	933	14.85	4.10	7.53	40.7	4.5	874	75	1380	68	145	30
	Mean	936	18.4	4.9	7.5	52.3	2.5	775	19.4	543	64.4	100	30
7.00	0703	631	16.75	7.15	NA	73.8	2.0	512	12	655	64	82	30
	0717	868	22.12	7.86	7.67	90.4	2.0	616	34	1540	87	73	30
	0731	1371	22.94	4.25	7.57	49.6	2.0	862	11	449	82	96	30
	0828	894	20.36	2.88	7.33	31.9	2.0	612	20	1220	64	68	30
	0911	937	19.12	4.12	7.57	45.0	2.0	638	72	2190	100	75	30
	Mean	940	20.3	5.3	7.5	58.1	2	648	29.8	1211	79.4	78.8	30
5.40	0703	614	18.42	7.51	NA	79.6	2.0	474	31	1980	65	68	30
	0717	1152	21.46	8.07	7.66	91.7	3.2	762	10	334	90	103	30
	0731	990	21.69	4.49	7.55	51.2	2.0	704	20	1190	88	80	30
	0828	NA	NA	NA	NA	NA	2.2	676	27	1930	80	75	30
	0911	1169	18.99	5.68	7.75	62.0	3.1	790	9	294	93	91	30
	Mean	981	20.1	6.4	7.7	71.1	2.5	681	19.4	1146	83.2	83.4	30
0.50	0703	571	18.43	7.67	NA	81.9	2.0	424	31	1730	66	68	30
	0717	726	21.55	7.74	7.97	87.9	3.0	460	21	502	77	84	30
	0731	830	22.95	6.41	7.81	74.8	2.0	576	8	386	78	85	30
	0828	NA	NA	NA	NA	NA	2.0	485	12	430	74	71	30
	0911	808	18.75	5.73	7.95	62.4	2.0	550	15	548	76	69	30
	Mean	734	20.4	6.9	7.9	76.8	2.2	499	17.4	719	74.2	75.4	30
ROBINSON RUN (WWH)													
2.10	0702	783	19.71	7.11	7.78	77.9	2.8	568	29	1780	71	63	30
	0716	NA	19.18	8.19	8.19	88.7	2.9	678	7	200	66	74	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0730	822	21.77	6.21	7.62	70.8	2.0	570	12	344	57	67	30
	0827	1066	20.50	7.63	7.81	85.2	2.0	730	5	200	61	79	30
	0910	NA	20.70	6.04	NA	68.4	2.0	1200	5	200	92	100	30
	Mean	890	20.4	7	7.9	78.2	2.3	749	11.6	545	69.4	76.6	30
0.70	0702	629	19.37	7.79	7.87	84.8	3.1	460	65	3490	68	52	30
	0716	NA	20.74	8.25	7.82	92.1	2.0	732	5	200	67	95	30
	0730	786	21.58	7.82	7.71	88.9	2.0	550	6	200	51	61	30
	0827	1075	20.47	8.74	7.85	97.3	2.0	794	5	200	66	98	30
	0910	NA	21.00	7.44	NA	83.2	2.0	984	10	275	84	118	30
	Mean	830	20.6	8	7.8	89.3	2.2	704	18.2	873	67.2	84.8	30
BUCK RUN (WWH)													
10.40	0702	816	20.15	4.96	7.26	NA	4.1	510	56	1850	98	68	30
	0716	NA	20.79	6.61	7.32	74.5	2.0	918	22	700	127	84	30
	0730	918	21.31	5.61	7.65	63.4	2.0	600	24	1160	87	63	30
	0827	491	20.99	8.04	7.52	90.3	2.9	405	81	3960	64	44	30
	0910	556	19.62	7.40	7.73	80.9	3.4	378	56	2660	52	40	30
	Mean	695	20.6	6.5	7.5	77.3	2.9	562	47.8	2066	85.6	59.8	30
7.80	0702	1079	18.78	3.69	7.23	48.9	2.1	716	31	878	108	85	30
	0716	NA	19.81	7.22	7.19	77.3	2.6	700	32	825	102	77	30
	0730	464	21.23	5.44	7.65	61.7	2.0	912	18	540	99	82	30
	0827	NA	NA	NA	NA	NA	2.0	538	26	959	76	63	30
	0910	394	19.10	6.64	7.60	71.7	5.0	358	50	6630	63	31	30
	Mean	646	19.7	5.7	7.4	64.9	2.7	645	31.4	1966	89.6	67.6	30
5.00	0702	860	19.07	5.11	7.44	55.3	2.2	618	52	1690	95	105	30
	0716	NA	22.29	6.80	7.44	78.4	3.9	711	49	1210	102	110	30
	0730	700	22.11	3.52	7.59	40.3	2.0	452	28	542	61	67	30
	0827	NA	NA	NA	NA	NA	2.0	518	17	777	70	65	30
	0910	483	19.99	6.02	7.66	66.3	4.0	356	59	2670	55	44	30
	Mean	681	20.9	5.4	7.5	60.1	2.8	531	41	1378	76.6	78.2	30
0.10	0702	651	19.00	5.07	7.49	55.4	2.2	476	19	650	70	73	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0716	NA	21.06	6.61	7.80	73.7	2.1	516	21	630	93	77	30
	0730	772	22.51	4.74	7.52	54.8	2.0	537	32	828	70	66	30
	0827	890	21.06	4.40	7.46	49.7	2.4	604	27	753	80	69	30
	0910	NA	20.46	6.07	NA	67.3	2.4	360	33	1070	60	51	30
	Mean	771	20.8	5.4	7.6	60.2	2.2	499	26.4	786	74.6	67.2	30
HAY RUN (WWH)													
0.20	0702	585	16.09	14.55	7.62	147.8	2.0	426	5	200	100	96	30
	0716	NA	17.71	12.78	7.58	134.5	NA	NA	NA	245	115	101	30
	0730	678	18.49	8.37	7.80	89.4	2.0	508	5	200	104	102	30
	0827	NA	NA	NA	NA	NA	2.0	502	7	200	116	95	30
	0910	615	17.60	8.07	7.75	84.6	2.0	468	5	200	112	91	30
	Mean	626	17.5	11	7.7	114	2	476	5.5	209	109	97	30
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 69.40 (Not Designated)													
0.40 U	0702	589	15.78	15.81	7.91	159.7	2.0	450	5	200	110	97	30
	0716	NA	19.48	13.53	7.72	147.6	2.0	442	7	205	109	79	30
	0730	677	20.56	7.97	7.93	88.9	2.0	490	5	313	113	87	30
	0827	NA	NA	NA	NA	NA	2.0	446	9	278	108	74	30
	0910	586	19.11	8.15	7.79	88.1	2.0	438	9	286	96	77	30
	Mean	617	18.7	11	7.8	121	2	453	7	256	107	82.8	30
PLEASANT RUN (EWH)													
4.10	0702		15.60		8.08		2	434	6	200	104	92	30
	0716		17.00	8.30	8.10		2	464	6	200	115	99	30
	0730		18.00	7.70	8.09		2	460	5	200	115	97	30
	0827		21.00	7.60	7.98		2	468	5	200	120	100	30
	0910		16.70	8.00	7.39		2	420	5	200	111	87	30
	Mean	0	17.7	7.9	7.9	0	2	449	5.4	200	113	95	30
0.50	0702		16.10		8.30		2	396	5		105	83	30
	0716		20.50	7.20	8.18		2	410	5		116	72	30
	0730		21.20	7.40	8.14		2	394	5		117	72	30
	0827		20.50	7.50	8.21		2	388	16		120	70	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0910		19.50	7.60	7.49		2	334	5		104	62	30
	Mean	0	19.6	7.4	8.1	0	2	384	7.2	0	112	71.8	30
SPAIN CREEK (WWH)													
5.70	0702			6.10	6.83		2	370	10		128	83	30
	0716		14.90	5.40	6.98		2	409	5		170	89	30
	0730		16.90	4.80	7.45		2	394	6		158	85	30
	0827		16.00	5.40	7.46		2	408	5		165	92	30
	0910		18.30	7.00	7.47		3.7	264	205		106	49	30
	Mean	0	16.5	5.7	7.2	0	2.3	369	46.2	0	145	79.6	30
3.70	0702			7.80	7.45		2	368	21		118	79	30
	0716		18.50	6.20	7.72		2	390	5		121	80	30
	0730		19.30	6.20	8.02		2	378	7		125	81	30
	0827		19.00	6.20	8.10		2	428	5		129	85	30
	0910		17.50	6.60	7.97		2.5	324	56		122	67	30
	Mean	0	18.6	6.6	7.9	0	2.1	378	18.8	0	123	78.4	30
0.10	0702			8.20	7.66		2	462	5		105	81	30
	0716		19.80	7.20	7.81		2	494	5		112	77	30
	0730		21.50	6.40	8.07		2	468	5		110	75	30
	0827		20.00	7.40	8.18		2	470	5		101	75	30
	0910		19.00	8.20	8.25		2	374	27		110	77	30
	Mean	0	20.1	7.5	8	0	2	454	9.4	0	108	77	30
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 74.91 (Not Designated)													
0.20 U	0702			7.40	7.66		2	436	6		100	87	30
	0716		18.60	8.20	7.86		2	418	5		103	84	30
	0730		20.70	6.80	8.50		2	400	10		104	84	30
	0827		20.00	7.50	8.20		2	428	9		103	84	30
	0910		18.00	7.60	8.25		2.2	362	18		95	67	30
	Mean	0	19.3	7.5	8.1	0	2	409	9.6	0	101	81.2	30
LITTLE DARBY CREEK (Logan County, Not Designated)													

Big Darby Creek Basin

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
3.50 U	0702		17.70		8.23		2	424	5		111	93	30
	0716		19.50	8.60	8.33		2	474	5		114	88	30
	0730		21.00	7.80	8.19		2	412	7		120	89	30
	0827		19.20	7.40	8.06		2	438	20		126	93	30
	0910		18.20	7.50	7.30		2.5	378	20		108	71	30
	Mean	0	19.1	7.8	8	0	2.1	425	11.4	0	116	86.8	30
0.40 U	0702		18.00		8.30		2	394	5		106	85	30
	0716		19.40	8.00	8.25		2	406	5		108	81	30
	0730		21.20	7.30	8.16		2	384	5		108	76	30
	0827		20.00	6.40	8.08		2	410	5		106	77	30
	0910		21.00	8.20	7.78		3.1	282	43		93	50	30
	Mean	0	19.9	7.5	8.1	0	2.2	375	12.6	0	104	73.8	30
FLAT BRANCH (MWH)													
3.20	0702			8.60	7.44		2	300	111		68	42	30
	0716		28.10	8.40	7.59		2	526	47		132	60	30
	0730		26.40	8.10	8.00		2	440	21		79	59	30
	0827		25.00	9.40	8.10		2	276	14		40	39	30
	0910		21.00	5.60	7.70		4.1	192	26		35	24	30
	Mean	0	25.1	8	7.8	0	2.4	347	43.8	0	70.8	44.8	30
2.20	0702			4.40	7.30		2.6	220	113		57	28	30
	0716		22.20	3.80	7.44		2	408	24		71	43	30
	0730		25.00	5.00	7.77						64	42	30
	0827		22.50	7.00	7.98		2.1	260	5		50	37	30
	0910		20.50	6.60	7.92		3.8	188	41		37	25	30
	Mean	0	22.6	5.4	7.7	0	2.6	269	45.8	0	55.8	35	30
0.80	0702			5.40	7.44		2	247	74	4460	56	30	30
	0716		21.00	3.80	7.60		2	432	42	2500	76	42	30
	0730		23.00	5.00	787		2	347	41	1820	53	38	30
	0827		22.50	6.80	7.97		2	258	46	2370	45	35	30
	0910		20.50	5.20	8.25		3.7	228	48	3300	48	29	30

Big Darby Creek Basin

RM	Date	Field Parameters Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	Mean	0	21.8	5.2	164	0	2.3	302	50.2	2890	55.6	34.8	30
UNNAMED TRIBUTARY TO FLAT BRANCH AT RM 1.50 (Not Designated)													
0.10 U	0702			9.00	7.69		2	448	29	1300	42	43	30
	0716		25.80	9.60	8.00		2	474	16	1720	46	33	30
	0730		25.40	5.20	7.73		2	454	12	494	41	40	30
	0827		24.00	6.80	7.92		2	386	34	1080	46	46	30
	0910		21.00	4.30	7.82		3.8	292	50	4860	57	35	30
	Mean	0	24.1	7	7.8	0	2.4	411	28.2	1891	46.4	39.4	30

Appendix Table C.1.5. Results of water column metal sampling conducted in Big Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Basin

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
STORET #	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
HELLBRANCH RUN (WWH)													
10.10	0706	10	273	876	27	48	40	3	47	2230	10	0.2	3.1
	0719	10	250	1840	25	95	40	4	85	3230	12	0.2	3.7
	0802	10	248	1030	25	68	40	4	45	2680	10	0.2	4.2
	0830	10	240	928	23	60	40	4	33	4210	10	0.2	3.1
	0914	10	258	1360	25	76	40	4	52	4520	10	0.2	3
	Mean	10	254	1207	25	69.4	40	3.8	52.4	3374	10.4	0.2	3.42
7.40	0706	10	264	319	26	20	40	3	45	2060	10	0.2	2.4
	0719	10	256	342	27	43	40	3	58	2220	10	0.2	2.8
	0802	10	284	387	26	42	40	3	44	2510	10	0.2	3.9
	0830	10	226	556	21	49	40	3	33	3000	10	0.2	2.8
	0914	10	283	388	28	42	40	4	53	3240	10	0.2	2.6
	Mean	10	263	398	25.6	39.2	40	3.2	46.6	2606	10	0.2	2.9
5.80	0706	10	292	173	29	18	40	3	53	2350	10	0.2	3
	0719	10	306	161	32	47	40	4	75	3040	10	0.2	2.9
	0802	10	291	395	27	55	40	4	59	2700	10	0.2	3.3
	0830	10	220	408	20	47	40	4	37	2580	10	0.2	3.0
	0914	10	288	208	28	32	40	5	101	4260	10	0.2	3.2
	Mean	10	279	269	27.2	39.8	40	4	65	2986	10	0.2	3.08
3.70	0706	10	296	131	30	10	40	3	53	2230	10	0.2	2
	0719	10	305	135	31	26	40	4	91	3830	10	0.2	3
	0802	10	306	445	27	32	40	3	36	2480	10	0.2	3.4
	0830	10	212	285	20	24	40	3	40	2360	10	0.2	3
	0914	10	290	170	28	24	40	4	62	3810	10	0.2	2.7
	Mean	10	282	233	27.2	23.2	40	3.4	56.4	2942	10	0.2	2.82

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
0.90	0706	10	294	129	29	12	40	3	50	2120	10	0.2	2
	0719	10	322	286	31	45	40	3	50	2150	10	0.2	2.1
	0802	10	301	294	27	20	40	3	33	2120	10	0.2	3
	0830	10	222	222	20	16	40	3	35	2040	10	0.2	2.2
	0914	10	295	508	28	31	40	3	47	2760	10	0.2	2.1
	Mean	10	287	288	27	24.8	40	3	43	2238	10	0.2	2.28
0.50	0706	10	301	142	30	15	40	3	64	2100	10	0.2	2
	0719	10	322	367	31	113	40	4	74	2060	10	0.2	2
	0802	10	301	292	27	21	40	3	42	2040	10	0.2	3.2
	0830	10	231	367	21	19	40	3	50	2010	10	0.2	2.1
	0914	10	307	178	29	19	40	4	78	2730	10	0.2	2.3
	Mean	10	292	269	27.6	37.4	40	3.4	61.6	2188	10	0.2	2.32
GEO													
0.50	0706	10	436	88	47	10	40	3	11	323	10	0.2	2
	0719	10	476	133	50	12	40	3	9	337	10	0.2	2
	0802	10	408	197	41	15	40	3	8	283	10	0.2	2
	0830	10	429	114	43	10	40	3	8	302	10	0.2	2
	0914	10	476	246	50	10	40	4	9	347	10	0.2	2
	Mean	10	445	156	46.2	11.4	40	3.2	9	318	10	0.2	2
GREENBRIER CREEK (WWH)													
2.70	0706	10	328	141	36	10	40	3	32	2220	10	0.2	2
	0719	10	347	69	37	10	40	2	35	2390	10	0.2	2
	0802	10	341	162	35	10	40	2	21	1760	10	0.2	2
	0830	10	357	167	37	10	40	4	73	2900	10	0.2	2
	0914	10	355	288	37	97	40	4	54	2740	10	0.2	2.7
	Mean	10	346	165	36.4	27.4	40	3	43	2402	10	0.2	2.14
1.30	0706	10	347	1020	37	64	40	2	23	1920	10	0.2	2
	0719	No Flow, Creek Dry											
	0802	10	323	271	33	15	40	2	20	1620	10	0.2	2
	0830	10	360	203	37	33	40	3	39	2360	10	0.2	2

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	Mean	10	343	498	35.7	37.3	40	2.33	27.3	1967	10	0.2	2
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 20.20 (Not Designated)													
0.80 U	0706	10	353	262	36	34	40	3	50	2940	10	0.2	2
	0719	10	389	361	38	45	40	3	59	2670	10	0.2	2.4
	0802	10	296	349	32	75	40	4	61	3220	10	0.2	4.1
	0830	10	336	356	33	37	40	5	83	4000	10	0.2	2.5
	0914	10	397	455	40	44	40	5	95	3830	10	0.2	3.8
	Mean	10	354	357	35.8	47	40	4	69.6	3332	10	0.2	2.96
SPRINGWATER RUN (WWH)													
0.20	0706	10	348	118	33	13	40	2	68	1430	10	0.2	2
	0719	10	444	90	40	20	40	4	154	2720	10	0.2	2.7
	0802	10	293	270	25	14	40	3	37	1010	10	0.2	2.5
	0830	10	437	159	37	33	40	4	148	2450	10	0.2	2
	0914	10	390	55	34	16	40	4	178	2080	10	0.2	2.5
	Mean	10	382	138	33.8	19.2	40	3.4	117	1938	10	0.2	2.34
CLOVER GROFF DITCH (MWH, WWH)													
4.70	0706	10	235	600	22	53	40	4	25	2180	10	0.2	3.5
	0719	10	230	606	23	99	40	4	32	2720	10	0.2	4.2
	0802	10	225	484	22	99	40	4	25	2750	10	0.2	4.7
	0830	10	212	539	20	51	40	4	22	2390	10	0.2	2.2
	0914	10	165	1550	14	47	40	4	20	1300	10	0.2	2.2
	Mean	10	213	756	20.2	69.8	40	4	24.8	2268	10	0.2	3.36
0.80	0706	10	259	371	26	32	40	3	42	2730	14	0.2	3.6
	0719	10	220	390	22	34	40	4	41	2570	10	0.2	3.5
	0802	10	224	340	24	49	40	4	43	2620	10	0.2	5
	0830	10	234	386	23	29	40	3	34	5880	10	0.2	2.9
	0914	10	210	384	20	28	40	3	56	5320	10	0.2	3.5
	Mean	10	229	374	23	34.4	40	3.4	43.2	3824	10.8	0.2	3.7
HAMILTON DITCH (MWH, WWH)													
3.40	0706	10	377	2780	34	140	40	3	72	2220	21	0.2	5.6
	0719	10	373	3890	33	785	40	7	77	2430	28	0.2	30.6

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0802	10	367	349	34	79	40	3	45	2370	10	0.2	5
	0830	10	356	645	32	85	40	3	41	2800	10	0.2	3.1
	0914	10	302	1630	28	97	40	4	48	2560	10	0.2	3.8
	Mean	10	355	1859	32.2	237	40	4	56.6	2476	15.8	0.2	9.62
0.50	0706	10	362	261	34	37	40	2	74	2160	10	0.2	7.0
	0719	10	441	1090	41	360	40	4	155	4680	10	0.2	6.0
	0802	10	360	608	34	127	40	3	61	3250	10	0.2	4.9
	0830	10	346	490	30	185	40	3	52	2970	10	0.2	3.7
	0914	10	332	750	31	266	40	5	101	3670	10	0.2	5.1
	Mean	10	368	640	34	195	40	3.4	88.6	3346	10	0.2	5.34
SMITH DITCH (Not Designated)													
2.10 U	0706	10	351	214	38	21	40	2	22	1140	10	0.2	2
	0719	10	356	210	38	38	40	2	20	1400	10	0.2	2
	0802	10	377	290	37	34	40	2	20	1090	10	0.2	2.3
	0830	10	402	494	40	82	40	2	22	1630	10	0.2	2.2
	0914	10	383	468	39	59	40	3	27	1680	10	0.2	3.2
	Mean	10	374	335	38.4	46.8	40	2.2	22.2	1388	10	0.2	2.34
UNNAMED TRIBUTARY TO SMITH DITCH (Not Designated)													
0.10 U	0706	10	336	133	35	10	40	2	11	582	10	0.2	2
	0719	10	350	66	36	10	40	2	9	361	10	0.2	2
	0802	10	320	66	31	12	40	3	10	612	10	0.2	2
	0830	10	304	50	32	10	40	2	11	578	10	0.2	2
	0914	10	330	86	34	10	40	2	10	677	10	0.2	2
	Mean	10	328	80.2	33.6	10.4	40	2.2	10.2	562	10	0.2	2
FITZGERALD DITCH (Not Designated)													
0.50 U	0703	10	336	64	41	10	40	2	20	4440	10	0.2	2
	0717	10	227	360	26	17	40	3	27	4540	35	0.2	2
	0731	10	365	128	39	11	40	8	66	11800	17	0.2	4
	0828	10	358	322	39	16	40	8	71	12000	28	0.2	5.3
	0911	10	505	50	48	10	40	10	143	19900	26	0.2	4.3
	Mean	10	358	185	38.6	12.8	40	6.2	65.4	10536	23.2	0.2	3.52

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
YUTZY DITCH (Not Designated)													
0.40 U	0703	10	392	100	43	10	40	2	19	2290	10	0.2	2
	0717	10	348	65	45	10	40	2	36	2940	20	0.2	2
	0731	10	343	70	39	10	40	7	33	3800	10	0.2	4.6
	0828	10	316	98	38	10	40	7	74	6030	12	0.2	4.6
	0911	10	372	68	46	10	40	6	82	4920	10	0.2	4.3
	Mean	10	354	80.2	42.2	10	40	4.8	48.8	3996	12.4	0.2	3.5
BALLENGER-JONES DITCH (Not Designated)													
0.20 U	0703	10	366	108	41	10	40	2	17	3640	10	0.2	2
	0717	10	346	129	47	89	40	3	34	8040	12	0.2	3.5
	0731	10	359	171	40	26	40	3	29	6370	10	0.2	3.2
	0828	10	306	114	35	17	40	3	41	11000	10	0.2	4.8
	0911	10	336	280	41	104	40	4	53	7870	10	0.2	4.4
	Mean	10	343	160	40.8	49.2	40	3	34.8	7384	10.4	0.2	3.58
WORTHINGTON DITCH (Not Designated)													
0.20 U	0703	10	384	73	41	10	40	2	13	2330	10	0.2	2
	0717	10	361	55	44	12	40	2	30	4260	13	0.2	2.3
	0731	10	390	87	42	11	40	4	42	4990	10	0.2	3.8
	0828	10	343	145	36	17	40	5	40	5530	10	0.2	4
	0911	10	401	252	44	46	40	4	39	6450	10	0.2	5.9
	Mean	10	376	122	41.4	19.2	40	3.4	32.8	4712	10.6	0.2	3.6
SWEENY RUN (Not Designated)													
0.10 U	0703	10	372	257	40	12	40	2	26	2130	10	0.2	2.
	0717	10	329	372	35	132	40	3	68	3090	17	0.2	2
	0731	10	384	211	40	16	40	5	33	2910	10	0.2	2.7
	0828	10	360	340	36	24	40	5	28	2730	10	0.2	3.3
	0911	10	237	560	23	104	40	7	394	4740	11	0.2	3.3
	Mean	10	336	348	34.8	57.6	40	4.4	110	3120	11.6	0.2	2.66
SUGAR RUN (MWH, WWH)													
7.50	0703	10	332	389	29	22	40	9	58	565	10	0.2	3.3
	0717	10	386	460	44	274	40	8	90	1720	10	0.2	4.1

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0731	10	391	460	35	112	40	17	144	1390	10	0.2	6.8
	0828	10	356	734	32	51	40	12	136	1360	10	0.2	5.5
	0911	10	605	2230	59	424	40	9	47	5950	10	0.2	5.8
	Mean	10	414	855	39.8	177	40	11	95	2197	10	0.2	5.1
7.00	0703	10	320	864	28	26	40	6	40	546	10	0.2	2.7
	0717	10	359	2050	43	336	40	4	58	1650	12	0.2	2.8
	0731	10	384	728	35	139	40	11	152	1560	10	0.2	5.3
	0828	10	260	1590	22	101	40	8	98	848	10	0.2	4.4
	0911	10	323	3060	33	419	40	11	101	1220	12	0.2	4.1
	Mean	10	329	1658	32.2	204	40	8	89.8	1165	10.8	0.2	3.86
5.40	0703	10	273	2560	25	35	40	6	45	599	13	0.2	2.3
	0717	10	451	437	47	89	40	5	81	1760	10	0.2	2.1
	0731	10	323	1830	30	178	40	8	93	1660	10	0.2	2.9
	0828	10	294	2590	26	89	40	9	102	1290	12	0.2	3.4
	0911	10	359	430	32	169	40	11	143	1750	10	0.2	4.5
	Mean	10	340	1569	32	112	40	7.8	92.8	1412	11	0.2	3.04
0.50	0703	10	277	2320	26	35	40	4	37	824	11	0.2	2.1
	0717	10	350	656	34	81	40	5	39	1270	29	0.2	2.1
	0731	10	352	566	34	82	40	5	49	1520	10	0.2	2
	0828	10	292	655	28	61	40	10	54	1320	10	0.2	4.5
	0911	10	288	632	28	49	40	9	81	1440	10	0.2	3.1
	Mean	10	312	966	30	61.6	40	6.6	52	1275	14	0.2	2.76
ROBINSON RUN (WWH)													
2.10	0702	10	264	2200	26	36	40	6	87	1570	16	0.2	2.7
	0716	10	358	310	42	115	40	5	85	2550	10	0.2	3.1
	0730	10	278	672	27	52	40	9	82	2180	10	0.2	3.1
	0827	10	358	313	39	60	40	7	110	3040	10	0.2	4.1
	0910	10	456	220	50	116	40	11	256	3980	10	0.2	4
	Mean	10	343	743	36.8	75.8	40	7.6	124	2664	11.2	0.2	3.4
0.70	0702	14	229	4770	24	67	40	6	65	1380	17	0.2	3.1
	0716	10	431	262	47	65	40	5	77	4980	10	0.2	2.5

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0730	10	259	480	26	40	40	8	74	2210	10	0.2	3.8
	0827	10	426	339	44	55	40	6	87	3760	10	0.2	4
	0910	10	542	752	60	152	40	8	133	10200	10	0.2	4.4
	Mean	10.8	377	1321	40.2	75.8	40	6.6	87.2	4506	11.4	0.2	3.56
BUCK RUN (WWH)													
10.40	0702	10	256	2700	21	645	40	12	86	559	11	0.2	3.0
	0716	10	325	1100	28	545	40	16	186	834	10	0.2	3
	0730	10	240	1700	20	89	40	18	96	650	13	0.2	2
	0827	10	168	5430	14	87	40	10	56	324	33	0.2	2.3
	0910	10	158	3780	14	64	40	9	60	369	19	0.2	2
	Mean	10	229	2942	19.4	286	40	13	96.8	547	17.2	0.2	2.46
7.80	0702	10	340	1560	31	887	40	10	120	1450	11	0.2	3.9
	0716	10	320	1540	31	544	40	9	113	2260	10	0.2	3.1
	0730	10	328	883	30	168	40	13	182	1820	10	0.2	2
	0827	10	240	1450	20	157	40	13	90	988	13	0.2	2.2
	0910	10	123	7270	11	111	40	9	36	529	25	0.2	2
	Mean	10	270	2541	24.6	373	40	10.8	108	1409	13.8	0.2	2.64
5.00	0702	10	443	2200	44	257	40	5	44	5760	10	0.2	3
	0716	10	489	1750	52	73	40	5	45	6580	10	0.2	3.2
	0730	10	295	909	31	131	40	5	42	3630	10	0.2	2.4
	0827	10	253	1030	22	111	40	10	71	2040	10	0.2	2.6
	0910	10	184	3860	18	104	40	7	36	742	11	0.2	2
	Mean	10	333	1950	33.4	135	40	6.4	47.6	3750	10.2	0.2	2.64
0.10	0702	10	322	902	34	101	40	5	41	3280	10	0.2	3.2
	0716	10	353	912	39	77	40	5	42	4510	10	0.2	2.6
	0730	10	280	1150	28	114	40	7	72	3170	10	0.2	3.5
	0827	10	288	1010	28	170	40	8	86	3370	12	0.2	3.7
	0910	10	201	1440	18	112	40	7	39	1740	10	0.2	2.7
	Mean	10	289	1083	29.4	115	40	6.4	56	3214	10.4	0.2	3.14
HAY RUN (WWH)													
0.20	0702	10	404	238	40	13	40	2	6	6300	10	0.2	2

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0716	10	429	500	43	15	40	2	8	10800	10	0.2	2.5
	0730	10	424	167	41	10	40	2	7	9090	10	0.2	2
	0827	10	406	477	41	46	40	2	8	11700	10	0.2	5.3
	0910	10	380	326	37	33	40	3	8	11400	13	0.2	3.9
	Mean	10	409	342	40.4	23.4	40	2.2	7.4	9858	10.6	0.2	3.14
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 69.40 (Not Designated)													
0.40 U	0702	10	403	194	39	14	40	2	7	6230	10	0.2	2
	0716	10	370	322	42	10	40	2	9	9880	10	0.2	2
	0730	10	386	426	41	50	40	2	10	8830	10	0.2	2
	0827	10	354	331	41	25	40	2	11	11900	10	0.2	2.9
	0910	10	336	514	35	111	40	3	10	8920	10	0.2	2
	Mean	10	370	357	39.6	42	40	2.2	9.4	9152	10	0.2	2.18
PLEASANT RUN (EWH)													
4.10	0702	10	382	396	37	20	40	2	7	4300	10	0.2	2
	0716	10	416	304	41	25	40	2	6	8250	10	0.2	2
	0730	10	407	223	40	23	40	2	8	6510	17	0.2	2
	0827	10	410	323	39	20	40	2	5	6300	10	0.2	2
	0910	10	365	338	36	15	40	3	6	5820	10	0.2	2
	Mean	10	396	317	38.6	20.6	40	2.2	6.4	6236	11.4	0.2	2
0.50	0702	10	360	298	37	11	40	2	5	6840	10	0.2	2
	0716	10	340	166	39	15	40	2	6	6870	10	0.2	2
	0730	10	336	224	38	17	40	2	8	7610	18	0.2	2
	0827	10	327	230	37	17	40	2	6	7090	10	0.2	2.1
	0910	10	291	269	33	16	40	2	6	7160	10	0.2	2
	Mean	10	331	237	36.8	15.2	40	2	6.2	7114	11.6	0.2	2.02
SPAIN CREEK (WWH)													
5.70	0702	10	360	774	37	82	40	2	5	2620	10	0.2	2.8
	0716	10	387	550	40	131	40	2	6	4300	10	0.2	3.4
	0730	10	373	768	39	124	40	2	6	3880	10	0.2	3.6
	0827	10	382	750	37	128	40	2	5	3600	18	0.2	4.4
	0910	10	213	5840	22	142	40	6	5	714	56	0.2	2.3

Big Darby Creek Basin													
RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
STORET #	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Mean	10	343	1736	35	121	40	2.8	5.4	3023	20.8	0.2	3.3
3.70	0702	10	333	1170	33	47	40	3	6	2390	13	0.2	2.5
	0716	10	356	333	38	31	40	2	6	3390	10	0.2	2
	0730	10	355	397	37	37	40	2	6	3340	16	0.2	2
	0827	10	360	327	36	35	40	2	6	3460	15	0.2	2.3
	0910	10	287	2810	29	84	40	5	5	1870	23	0.2	2.4
	Mean	10	338	1007	34.6	46.8	40	2.8	5.8	2890	15.4	0.2	2.24
0.10	0702	10	355	211	37	18	40	3	33	7090	10	0.2	2
	0716	10	345	175	37	25	40	3	46	10000	10	0.2	2.4
	0730	10	331	268	35	27	40	4	45	9020	11	0.2	2
	0827	10	327	222	34	24	40	3	33	7560	30	0.2	2.7
	0910	10	332	865	34	38	40	3	9	3960	11	0.2	2
	Mean	10	338	348	35.4	26.4	40	3.2	33.2	7526	14.4	0.2	2.22
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 74.91 (Not Designated)													
0.20 U	0702	10	378	269	39	15	40	2	7	2990	10	0.2	2
	0716	10	370	302	39	15	40	2	6	2850	10	0.2	2
	0730	10	366	297	38	16	40	2	6	2810	10	0.2	2
	0827	10	366	353	38	15	40	2	6	2960	41	0.2	2
	0910	10	287	1260	29	28	40	6	7	2050	16	0.2	2
	Mean	10	353	496	36.6	17.8	40	2.8	6.4	2732	17.4	0.2	2
LITTLE DARBY CREEK (Logan County, Not Designated)													
3.50 U	0702	10	389	342	38	17	40	2	7	1380	10	0.2	2
	0716	10	372	345	37	17	40	2	5	1470	10	0.2	2
	0730	10	383	415	39	21	40	2	5	1600	10	0.2	2
	0827	10	384	549	37	29	40	2	5	1660	10	0.2	2
	0910	46	297	1760	29	37	40	7	11	1100	11	0.2	2
	Mean	17.2	365	682	36	24.2	40	3	6.6	1442	10.2	0.2	2
0.40 U	0702	10	369	171	38	10	40	2	8	2270	10	0.2	2
	0716	10	359	103	38	10	40	2	7	2310	10	0.2	2
	0730	10	342	138	37	10	40	2	8	2430	16	0.2	2
	0827	10	345	156	37	12	40	2	8	2610	10	0.2	2

Big Darby Creek Basin

RM STORET #	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0910	10	215	3820	22	69	40	6	8	1290	19	0.2	2
	Mean	10	326	878	34.4	22.2	40	2.8	7.8	2182	13	0.2	2
FLAT BRANCH (MWH)													
3.20	0702	10	158	6370	13	120	40	18	23	804	29	0.2	2.1
	0716	10	244	3370	23	164	40	33	54	1500	65	0.2	2.1
	0730	10	234	1870	21	67	40	23	34	951	20	0.2	2
	0827	10	147	1520	12	27	40	13	18	473	28	0.2	2
	0910	10	93	2510	8	33	40	10	8	248	25	0.2	2
	Mean	10	175	3128	15.4	82.2	40	19.4	27.4	795	33.4	0.2	2.04
2.20	0702	10	111	6780	10	125	40	15	20	1040	35	0.2	2.2
	0716	10	181	2200	18	331	40	20	50	1760	27	0.2	3.4
	0730	10	175	3310	17	95	40	19	30	1790	24	0.2	2
	0827	81	146	3070	13	59	40	12	19	676	31	0.2	2
	0910	10	100	3170	9	49	40	9	10	643	26	0.2	2
	Mean	24.2	143	3706	13.4	132	40	15	25.8	1182	28.6	0.2	2.32
0.80	0702	10	116	6330	10	105	40	14	27	922	43	0.2	2
	0716	10	171	3580	16	143	40	20	64	804	38	0.2	3.1
	0730	10	148	2590	13	65	40	14	53	904	26	0.2	2.9
	0827	10	133	2860	11	71	40	12	26	478	32	0.2	2
	0910	10	109	4480	9	66	40	8	21	526	32	0.2	2
	Mean	10	135	3968	11.8	90	40	13.6	38.2	727	34.2	0.2	2.4
UNNAMED TRIBUTARY TO FLAT BRANCH AT RM 1.50 (Not Designated)													
0.10 U	0702	10	173	2040	16	66	40	2	97	595	12	0.2	8
	0716	10	144	2870	15	159	40	2	110	530	10	0.2	8.2
	0730	10	162	1180	15	43	40	2	110	580	23	0.2	5.4
	0827	10	164	1660	12	69	40	2	72	518	18	0.2	3.6
	0910	10	128	6600	10	81	40	6	31	394	36	0.2	2
	Mean	10	154	2870	13.6	83.6	40	2.8	84	523	19.8	0.2	5.44

Appendix Table C.1.6. Results of selected metals, selected field parameters and bacteriological samples conducted in Big Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
HELLBRANCH RUN (WWH)										
10.10	0706	0.2	2	2	630	936	1060	202	74	20
	0719	0.2	2	2	1130	1110	1260	172	143	10
	0802	0.2	2	2	670	580	850	174	71.2	19
	0830	0.2	2	2	927	1270	1000	169	51.8	10
	0914	0.2	2	2	530	470	530	174	85.4	17
	Mean	0.2	2	2	777.4	873.2	940	178.2	85.1	15.2
7.40	0706	0.2	2	2	1060	1030	1410	206	71.7	17
	0719	0.2	2	2	330	470	790	184	100	10
	0802	0.2	2	2	270	300	500	188	70.5	16
	0830	0.2	2	2	190	210	450	156	54.7	10
	0914	0.2	2	2	400	320	750	190	90.9	17
	Mean	0.2	2	2	450	466	780	184.8	77.6	14
5.80	0706	0.2	2	2	2400	2200	920	226	82.8	20
	0719	0.2	2	2	2000	2000	750	231	112	10
	0802	0.2	2	2	730	773	390	191	73.8	16
	0830	0.2	2	2	190	230	330	159	56.5	10
	0914	0.2	2	2	250	340	560	191	110	17
	Mean	0.2	2	2	1114	1108.6	590	199.6	87	14.6
3.70	0706	0.2	2	2	270	40	150	237	83.1	20
	0719	0.2	2	2	230	220	360	218	164	10
	0802	0.2	2	2	120	280	430	210	61.5	22
	0830	0.2	2	2	250	170	580	155	61.8	10
	0914	0.2	2	2	580	618	300	191	97.3	17

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	Mean	0.2	2	2	290	265.6	364	202.2	93.5	15.8
0.90	0706	0.2	2	2	10	270	130	231	81.8	14
	0719	0.2	2	2	180	140	200	245	91.8	10
	0802	0.2	2	2	350	400	2800	213	58.2	19
	0830	0.2	2	2	270	210	620	162	59.3	10
	0914	0.2	2	2	1030	1150	1460	217	80.4	11
	Mean	0.2	2	2	368	434	1042	213.6	74.3	12.8
0.50	0706	0.2	2	2	670	718	580	234	104	17
	0719	0.2	2	2	160	250	290	247	126	10
	0802	0.2	2	2	100	310	360	207	74.2	16
	0830	0.2	2	2	80	110	250	166	83.7	10
	0914	0.2	2	2	10	10	50	222	125	14
	Mean	0.2	2	2	204	279.6	306	215.2	103	13.4
GEORGES RUN (WWH)										
0.50	0706	0.2	2	2	1000	240	210	288	29.2	11
	0719	0.2	2	2	180	220	790	308	29	10
	0802	0.2	2	2	250	290	510	282	26.9	10
	0830	0.2	2	2	150	110	290	300	26.4	10
	0914	0.2	2	2	30	90	380	313	27	10
	Mean	0.2	2	2	322	190	436	298.2	27.7	10.2
GREENBRIER CREEK (WWH)										
2.70	0706	0.2	2	2	400	673	630	240	58.1	14
	0719	0.2	2	2	710	782	3000	266	72.9	10
	0802	0.2	2	2	570	655	2600	264	44.4	19
	0830	0.2	2	2	470	360	1000	267	141	10
	0914	0.2	2	2	460	618	3000	267	90.1	11
	Mean	0.2	2	2	522	617.6	2046	260.8	81.3	12.8
1.30	0706	0.2	2	2	250	270	390	257	45.5	14
	0719	Dry creekbed								
	0802	0.2	2	2	540	745	2000	258	42.6	10

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0830	0.2	2	2	70	290	910	248	75	10
	0914	Dry creekbed								
	Mean	0.2	2	2	286.6667	435	1100	254.3333	54.4	11.3
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 20.20 (Not Designated)										
0.80 U	0706	0.2	2	2	300	340	370	303	73.6	14
	0719	0.2	2	2	510	430	1290	329	98.6	10
	0802	0.2	2	2	220	270	40	250	94.2	19
	0830	0.2	2	2	490	560	930	297	136	10
	0914	0.2	2	2	3000	3700	4400	347	144	10
	Mean	0.2	2	2	904	1060	1406	305.2	109	12.6
SPRINGWATER RUN (WWH)										
0.20	0706	0.2	2	2	3000	2200	470	258	110	20
	0719	0.2	2	2	340	580	1370	290	258	10
	0802	0.2	2	2	480	718	850	216	61.8	16
	0830	0.2	2	2	260	13500	610	326	245	10
	0914	0.2	2	2	590	1130	2800	261	276	14
	Mean	0.2	2	2	934	3625.6	1220	270.2	190	14
CLOVER GROFF DITCH (MWH, WWH)										
4.70	0706	0.2	2	2	1210	1320	1900	169	36.2	33
	0719	0.2	2	2	2000	1700	3100	157	47.7	11
	0802	0.2	2	2	450	380	2150	155	34.8	19
	0830	0.2	2	2	5150	5900	3050	142	29.7	10
	0914	0.2	2	2	3550	5200	9820	122	29.6	14
	Mean	0.2	2	2	2472	2900	4004	149	35.6	17.4
0.80	0706	0.2	2	2	595	585	1800	193	62.8	17
	0719	0.2	2	2	740	773	1310	158	67.9	11
	0802	0.2	2	2	590	580	425	157	70.5	19
	0830	0.2	2	2	255	255	555	167	51.2	11
	0914	0.2	2	2	300	10	980	135	95.9	20
	Mean	0.2	2	2	496	440.6	1014	162	69.7	15.6

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
HAMILTON DITCH (MWH, WWH)										
3.40	0706	0.2	2.6	2	2700	3300	6700	269	118	17
	0719	0.2	2.8	2	2900	1700	3100	262	150	18
	0802	0.2	2	2	1100	1060	3350	282	70.2	13
	0830	0.2	2	2	968	1600	1750	288	68.2	10
	0914	0.2	2	2	9630	18000	12300	226	78	17
	Mean	0.2	2.28	2	3459.6	5132	5440	265.4	96.9	15
0.50	0706	0.2	2	2	650	982	1350	282	124	17
	0719	0.2	2	2	670	855	860	301	288	10
	0802	0.2	2	2	NA	NA	NA	296	110	13
	0830	0.2	2	2	918	745	1140	270	94.8	14
	0914	0.2	2	2	570	900	3200	225	166	20
	Mean	0.2	2	2	702	870.5	1637.5	274.8	157	14.8
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 31.69 (Not Designated)										
2.10 U	0706	0.2	2	2	770	827	780	273	46.4	11
	0719	0.2	2	2	400	570	1000	291	45.8	10
	0802	0.2	2	2	250	250	910	274	47.1	13
	0830	0.2	2	2	120	110	210	279	49.9	10
	0914	0.2	2	2	2100	3500	3100	278	55.8	10
	Mean	0.2	2	2	728	1051.4	1200	279	49	10.8
UNNAMED TRIBUTARY TO UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 31.69 (Not Designated)										
0.10 U	0706	0.2	2	2	290	290	280	287	17.8	11
	0719	0.2	2	2	330	220	540	289	16.6	10
	0802	0.2	2	2	150	240	550	255	19	10
	0830	0.2	2	2	350	190	480	253	22.5	10
	0914	0.2	2	2	300	440	1050	265	18.5	10
	Mean	0.2	2	2	284	276	580	269.8	18.9	10.2
FITZGERALD DITCH (Not Designated)										
0.50 U	0703	0.2	2	2	936	1060	1210	226	52.2	10
	0717	0.2	2	2	4400	6000	73000	142	50.2	44

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0731	0.2	2	2	340	270	570	237	123	10
	0828	0.2	2	2	500	600	1160	215	112	20
	0911	0.2	2	2	NA	NA	NA	306	210	10
	Mean	0.2	2	2	1544	1982.5	18985	225.2	109	18.8
YUTZY DITCH (Not Designated)										
0.40 U	0703	0.2	2	2	540	718	740	282	49.7	13
	0717	0.2	2	2	3500	1500	3500	272	83.1	19
	0731	0.2	2	2	110	180	630	268	74	10
	0828	0.2	2	2	130	180	620	271	124	23
	0911	0.2	2	2	NA	NA	NA	280	162	14
	Mean	0.2	2	2	1070	644.5	1372.5	274.6	98.6	15.8
BALLENGER-JONES DITCH (Not Designated)										
0.20 U	0703	0.2	2	2	790	918	670	283	40.3	10
	0717	0.2	2	2	670	2000	1800	270	66.6	10
	0731	0.2	2	2	410	1800	920	285	59.1	10
	0828	0.2	2	2	120	170	700	275	72.2	17
	0911	0.2	2	2	NA	NA	NA	260	101	10
	Mean	0.2	2	2	497.5	1222	1022.5	274.6	67.8	11.4
WORTHINGTON DITCH (Not Designated)										
0.20 U	0703	0.22	2	2	340	220	750	300	32.8	10
	0717	0.2	2	2	130	70	620	287	67.9	10
	0731	0.2	2	2	400	230	460	314	75.6	10
	0828	0.2	2	2	150	170	720	291	77.1	20
	0911	0.2	2	2	NA	NA	NA	330	76.1	11
	Mean	0.2	2	2	255	172.5	637.5	304.4	65.9	12.2
SWEENY RUN (Not Designated)										
0.10 U	0703	0.2	2	2	6200	636	4200	292	48.4	42
	0717	0.2	2	2	2200	1700	4600	312	70.2	10
	0731	0.2	2	2	1800	2100	4100	99.5	60.9	39
	0828	0.2	2	2	7000	12500	4700	286	55.3	20

Big Darby Creek Basin										
RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0911	0.2	2	2	NA	NA	NA	259	428	17
	Mean	0.2	2	2	4300	4234	4400	249.7	133	25.6
SUGAR RUN (MWH, WWH)										
7.50	0703	0.2	2	2	180	265	1060	209	102	24
	0717	0.2	2	2	35	115	515	27.6	163	28
	0731	0.2	2	2	365	375	400	218	268	36
	0828	0.2	2	2	270	155	275	199	248	33
	0911	0.2	2	2	NA	NA	NA	219	54	14
	Mean	0.2	2	2	212.5	227.5	562.5	174.52	167	27
7.00	0703	0.2	2	2	465	600	1800	204	73.3	24
	0717	0.2	2	2	720	769	335	180	103	13
	0731	0.2	2	2	380	235	390	194	283	36
	0828	0.2	2	2	395	250	605	175	162	36
	0911	0.2	2	2	NA	NA	NA	184	169	20
	Mean	0.2	2	2	490	463.5	782.5	187.4	158	25.8
5.40	0703	0.2	2	2	2600	2100	4900	164	76.5	18
	0717	0.2	2	2	360	280	140	210	135	13
	0731	0.2	2	2	340	460	880	144	158	19
	0828	0.2	2	2	760	1800	6600	184	167	30
	0911	0.2	2	2	NA	NA	NA	189	227	20
	Mean	0.2	2	2	1015	1160	3130	178.2	153	20
0.50	0703	0.2	2	2	600	1200	2000	168	65.4	13
	0717	0.2	2	2	200	200	410	222	74.2	19
	0731	0.2	2	2	200	200	350	187	84.8	20
	0828	0.2	2	2	460	470	1190	201	86.7	23
	0911	0.2	2	2	NA	NA	NA	156	138	14
	Mean	0.2	2	2	365	517.5	987.5	186.8	89.8	17.8
ROBINSON RUN (WWH)										
2.10	0702	0.2	2	2	4200	3500	11000	130	141	33
	0716	0.2	2	2	NA	664	510	210	146	21[b]

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0730	0.2	2	2	390	260	1450	167	140	23
	0827	0.2	2	2	390	618	930	203	187	27
	0910	0.2	2	2	10	90	520	175	383	30
	Mean	0.2	2	2	1247.5	1026.4	2882	177	199	26.8
0.70	0702	0.2	2	2	3600	4000	15900	124	107	24
	0716	0.2	2	2	NA	450	240	251	112	18_b
	0730	0.2	2	2	210	120	540	168	130	17
	0827	0.2	2	2	150	220	870	231	158	33
	0910	0.2	2	2	800	60	810	251	175	18
	Mean	0.2	2	2	1190	970	3672	205	136	22
BUCK RUN (WWH)										
10.40	0702	0.2	2	2	355	360	125	182	128	27
	0716	0.2	2	2	NA	470	110	172	335	10
	0730	0.2	2	2	964	794	1260	132	163	20
	0827	0.2	2	2	5550	8000	28000	105	84.3	20
	0910	0.2	2	2	6150	6320	30000	94.4	96.6	26
	Mean	0.2	2	2	3254.75	3188.8	11899	137.08	161	20.6
7.80	0702	0.2	2	2	100	70	120	208	219	30
	0716	0.2	2	2	NA	65	165	200	185	27
	0730	0.2	2	2	240	220	680	153	325	15
	0827	0.2	2	2	395	450	690	146	140	10
	0910	0.2	2.7	2	7900	8090	47000	78.2	58.8	35
	Mean	0.2	2.14	2	2158.75	1779	9731	157.04	186	23.4
5.00	0702	0.2	2	2	590	655	710	267	68.8	21
	0716	0.2	2	2	NA	20	80	277	68.2	18
	0730	0.2	2	2	240	370	430	168	63.3	10
	0827	0.2	2	2	270	480	590	154	123	14
	0910	0.2	2	2	22000	10100	69000	121	57.4	29
	Mean	0.2	2	2	5775	2325	14162	197.4	76.1	18.4
0.10	0702	0.2	2	2	4600	4450	4200	214	69.6	21

Big Darby Creek Basin										
RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0716	0.2	2	2	NA	110	30	246	75.7	15_b
	0730	0.2	2	2	1100	778	930	162	118	17
	0827	0.2	2	2	2500	2750	1380	165	148	23
	0910	0.2	2	2	796	827	30000	137	62.8	27
	Mean	0.2	2	2	2249	1783	7308	184.8	94.8	20.6
HAY RUN (WWH)										
0.20	0702	0.2	2	2	650	682	1220	280	16.2	12
	0716	0.2	2	2	NA	510	550	NA	NA	10
	0730	0.2	2	2	140	210	440	207	16.4	10
	0827	0.2	2	2	430	590	1160	301	14.3	10
	0910	0.2	2	2	1010	1190	2100	257	15.4	10
	Mean	0.2	2	2	557.5	636.4	1094	261.25	15.6	10.4
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 69.40 (Not Designated)										
0.40 U	0702	0.2	2	2	3600	5400	3600	282	24.5	10
	0716	0.2	2	2	NA	1060	1410	268	25.8	10
	0730	0.2	2	2	330	280	1190	155	30.8	10
	0827	0.2	2	2	360	510	1200	267	25.5	10
	0910	0.2	2	2	1260	2000	46000	260	26.3	10
	Mean	0.2	2	2	1387.5	1850	10680	246.4	26.6	10
PLEASANT RUN (EWH)										
4.10	0702	0.2	2	2	2200	3000	5300	282	19.3	
	0716	0.2	2	2		864	1000	303	14.5	10
	0730	0.2	2	2	460	560	1260	302	16.1	10
	0827	0.2	2	2	140	190	700	332	12.3	10
	0910	0.2	2	2	2800	2900	6200	297	14.9	10
	Mean	0.2	2	2	1400	1502.8	2892	303.2	15.4	10
0.50	0702	0.2	2	2	2500	3100	7600	272	16.4	15
	0716	0.2	2	2		745	2300	274	15.2	10
	0730	0.2	2	2	610	691	1220	255	15.1	10
	0827	0.2	2	2	330	550	910	251	12.5	10

Big Darby Creek Basin

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0910	0.2	2	2	480	510	8000	220	13.1	10
	Mean	0.2	2	2	980	1119.2	4006	254.4	14.5	11
SPAIN CREEK (WWH)										
5.70	0702	0.2	2	2	390	655	440	313	9.3	10
	0716	0.2	2	2		590	610	343	7.4	10
	0730	0.2	2	2	927	1120	790	330	8.6	10
	0827	0.2	2	2	520	490	720	348	7.5	
	0910	0.2	2.9	2	5200	5800	6000	173	8.6	15
	Mean	0.2	2.18	2	1759.25	1731	1712	301.4	8.28	11.3
3.70	0702	0.2	2	2	1000	1130	4000	287	11.8	12
	0716	0.2	2	2		600	640	314	9.1	10
	0730	0.2	2	2	690	791	1330	299	10.3	11
	0827	0.2	2	2	500	530	2000	327	10.9	14
	0910	0.2	2	2	4800	3800	34000	248	8.3	12
	Mean	0.2	2	2	1747.5	1370.2	8394	295	10.1	11.8
0.10	0702	0.2	2	2	2400	2600	1270	311	43.9	10
	0716	0.2	2	2		873	330	312	69	10
	0730	0.2	2	2	1030	982	690	294	63.4	10
	0827	0.2	2	2	864	1070	580	302	47.2	10
	0910	0.2	2	2	4200	5400	5700	269	14.5	10
	Mean	0.2	2	2	2123.5	2185	1714	297.6	47.6	10
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 74.91 (Not Designated)										
0.20 U	0702	0.2	2	2	760	991	2000	278	22.3	10
	0716	0.2	2	2		736	3200	288	20.3	10
	0730	0.2	2	2	460	480	1460	274	21.4	10
	0827	0.2	2	2	330	470	1000	285	21.9	11
	0910	0.2	2	2	5400	5500	42000	212	18.7	15
	Mean	0.2	2	2	1737.5	1635.4	9932	267.4	20.9	11.2
LITTLE DARBY CREEK (Logan County, Not Designated)										
3.50 U	0702	0.2	2	2	680	727	2200	293	16.5	10

Big Darby Creek Basin										
RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0716	0.2	2	2		955	980	290	11.6	10
	0730	0.2	2	2	900	480	1430	285	11.3	17
	0827	0.2	2	2	720	1230	2300	314	10.9	10
	0910	0.2	2	2	10	10	1800	222	24.4	15
	Mean	0.2	2	2	577.5	680.4	1742	280.8	14.9	12.4
0.40 U	0702	0.2	2	2	882	1240	710	273	20	10
	0716	0.2	2	2		190	600	263	17.4	10
	0730	0.2	2	2	330	240	590	266	17.6	10
	0827	0.2	2	2	210	350	760	292	17.2	11
	0910	0.2	2	2	2800	600	43000	168	14.6	15
	Mean	0.2	2	2	1055.5	524	9132	252.4	17.4	11.2
FLAT BRANCH (MWH)										
3.20	0702	0.2	2.8	2	2400	2300	820	98.9	49.9	24
	0716	0.2	2	2		220	160	137	125	12
	0730	0.2	2	2	350	330	560	126	66.6	14
	0827	0.2	2	2	10800	22000	21000	98	33.2	23
	0910	0.2	2	2	42000	430	105000	57.6	14.3	24
	Mean	0.2	2.16	2	13887.5	5056	25508	103.5	57.8	19.4
2.20	0702	0.2	3.3	2	5200	6550	8100	75	34	15
	0716	0.2	2	2		70	550	135	56.3	12
	0730	0.2	2	2	855	1160	2600			10
	0827	0.2	2	2	21000	20000	23000	95.9	27.7	20
	0910	0.2	2	2	37000	29000	87000	61.2	14.4	24
	Mean	0.2	2.26	2	16013.75	11356	24250	91.775	33.1	16.2
0.80	0702	0.2	3.4	2	3800	4500	5000	83.3	45.8	12
	0716	0.2	2	2		320	240	121	112	19
	0730	0.2	2	2	570	882	860	98.6	86.6	14
	0827	0.2	2	2	2200	5200	5700	93.6	41	17
	0910	0.2	2	2	8910	30000	31000	73.1	29.8	77
	Mean	0.2	2.28	2	3870	8180.4	8560	93.92	63	27.8

Big Darby Creek Basin										
RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
UNNAMED TRIBUTARY TO FLAT BRANCH AT RM 1.50 (Not Designated)										
0.10 U	0702	0.2	2	2	210	200	120	151	151	10
	0716	0.2	2	2		30	50	125	173	31
	0730	0.2	2	2	460	390	510	162	162	29
	0827	0.2	2	2	80	220	60	107	107	20
	0910	0.2	2.2	2	35000	22000	89000	41	41	30
	Mean	0.2	2.04	2	8937.5	4568	17948	117.2	127	24

Appendix Table C.1.7. Results of water column nutrient sampling conducted in the Big Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
HELLBRANCH RUN (WWH)							
10.10	0706	0.024	0.05	1.75	56.7	0.78	0.104
	0719	0.023	0.084	0.77	61.9	1.02	0.209
	0802	0.02	0.084	0.66	59	0.62	0.134
	0830	0.021	0.05	0.66	60.8	0.47	0.259
	0914	0.02	0.05	0.35	67.9	0.67	0.092
	Mean	0.0216	0.0636	0.838	61.26	0.712	0.1596
7.40	0706	0.02	0.05	2.01	51.3	0.77	0.122
	0719	0.02	0.05	0.44	56.2	0.75	0.114
	0802	0.02	0.05	0.89	55.7	0.54	0.102
	0830	0.02	0.05	0.69	56.8	0.56	0.081
	0914	0.02	0.05	0.38	66.4	0.66	0.085
	Mean	0.02	0.05	0.882	57.28	0.656	0.1008
5.80	0706	0.025	0.05	2.16	56.6	0.86	0.137
	0719	0.02	0.05	0.60	67.2	0.80	0.15
	0802	0.02	0.05	1.53	52.1	0.76	0.215
	0830	0.02	0.05	1.17	53.5	0.67	0.147
	0914	0.02	0.05	2.16	62.6	0.78	0.307
	Mean	0.021	0.05	1.524	58.4	0.774	0.1912
3.70	0706	0.02	0.05	2.12	54.9	0.79	0.103
	0719	0.02	0.05	1.09	66.7	0.95	0.144
	0802	0.02	0.06	1.20	51.1	0.80	0.115
	0830	0.02	0.05	0.81	49.5	0.59	0.111
	0914	0.02	0.05	0.81	62.2	0.69	0.135
	Mean	0.02	0.052	1.206	56.88	0.764	0.1216

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
0.90	0706	0.02	0.05	1.83	52.2	0.63	0.078
	0719	0.02	0.05	0.66	60.5	0.44	0.05
	0802	0.02	0.05	1.24	49.2	0.62	0.117
	0830	0.02	0.05	0.78	45.3	0.49	0.087
	0914	0.02	0.05	0.53	60.3	0.43	0.05
	Mean	0.02	0.05	1.008	53.5	0.522	0.0764
0.50	0706	0.047	0.079	1.82	55.5	0.80	0.192
	0719	0.041	0.24	0.66	61.8	0.93	0.372
	0802	0.02	0.05	1.63	48.8	0.52	0.296
	0830	0.02	0.05	1.18	46.8	0.58	0.210
	0914	0.031	0.257	1.36	61.6	0.98	0.356
	Mean	0.0318	0.1352	1.33	54.9	0.762	0.2852
GEORGES RUN (WWH)							
0.50	0706	0.02	0.05	1.25	93.9	0.20	0.055
	0719	0.02	0.05	0.10	114	0.44	0.05
	0802	0.02	0.05	0.17	71	0.27	0.05
	0830	0.02	0.05	0.10	110	0.38	0.05
	0914	0.02	0.05	0.10	114	0.26	0.05
	Mean	0.02	0.05	0.344	100.58	0.31	0.051
GREENBRIER CREEK (WWH)							
2.70	0706	0.02	0.05	7.57	41.8	0.78	0.114
	0719	0.02	0.05	0.48	53.2	0.42	0.094
	0802	0.02	0.05	4.23	34.1	0.20	0.216
	0830	0.02	0.05	1.25	55.7	0.63	0.119
	0914	0.02	0.067	0.15	54.2	0.52	0.143
	Mean	0.02	0.0534	2.736	47.8	0.51	0.1372
1.30	0706	0.02	0.05	3.67	42.7	0.40	0.095
	0719			Dry creekbed			
	0802	0.02	0.05	3.75	34.2	0.27	0.125
	0830	0.02	0.05	0.25	62.4	0.30	0.05
	0914						

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	Mean	0.02	0.05	2.55666667	46.4333333	0.32333333	0.09
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 20.20 (Not Designated)							
	0.02	0.05	1.68	48.2	0.55	0.157	
0.80 U07 06	0719	0.02	0.05	0.87	46.7	0.52	0.115
	0802	0.228	0.529	1.38	35.8	1.16	0.208
	0830	0.042	0.05	1.65	43.1	0.74	0.207
	0914	0.02	0.05	1.22	45.8	0.68	0.197
	Mean	0.072	0.4718	10.664	34.39	0.6514	0.18175
SPRINGWATER RUN (WWH)							
0.20	0706	0.02	0.05	2.62	63.8	0.71	0.174
	0719	0.02	0.05	1.39	119	0.99	0.190
	0802	0.02	0.05	1.02	45.2	0.35	0.220
	0830	0.02	0.05	1.50	89.6	0.75	0.174
	0914	0.02	0.05	2.94	90.5	0.57	0.197
	Mean	0.02	0.05	1.894	81.62	0.674	0.191
CLOVER GROFF DITCH (MWH, WWH)							
4.70	0706	0.031	0.097	0.60	64.8	0.75	0.05
	0719	0.029	0.149	0.36	75.8	0.85	0.08
	0802	0.02	0.10	0.45	73.9	0.54	0.067
	0830	0.026	0.278	0.41	74.2	0.33	0.912
	0914	0.05	0.162	0.74	44.9	0.83	0.05
	Mean	0.0312	0.1572	0.512	66.72	0.66	0.2318
0.80	0706	0.024	0.05	0.87	63.9	0.57	0.077
	0719	0.02	0.05	0.50	60.9	0.79	0.10
	0802	0.034	0.082	0.56	60.4	0.78	0.137
	0830	0.035	0.050	0.59	68.4	0.48	0.35
	0914	0.044	0.105	0.91	58	0.88	0.095
	Mean	0.0314	0.0674	0.686	62.32	0.7	0.1518
HAMILTON DITCH (MWH, WWH)							
3.40	0706	0.047	0.075	1.90	62.3	0.91	0.226
	0719	0.059	0.40	0.61	55.8	1.61	0.443

Big Darby Creek Basin

RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0802	0.04	0.073	1.21	51.9	0.76	0.281
	0830	0.037	0.053	0.99	52.9	0.64	0.227
	0914	0.05	0.058	0.90	51.6	0.65	0.249
	Mean	0.0466	0.1318	1.122	54.9	0.914	0.2852
0.50	0706	0.028	0.05	3.43	54.8	0.58	0.137
	0719	0.037	0.142	0.99	74.7	1.34	0.269
	0802	0.043	0.068	0.85	51.6	0.78	0.197
	0830	0.030	0.059	0.64	46.4	0.64	0.237
	0914	0.02	0.073	0.28	67.5	0.94	0.226
	Mean	0.0316	0.0784	1.238	59	0.856	0.2132
SMITH DITCH (Not Designated)							
2.10 U	0706	0.02	0.05	2.54	41.1	0.41	0.054
	0719	0.02	0.05	0.27	52	0.35	0.05
	0802	0.02	0.05	2.02	33.1	0.20	0.236
	0830	0.02	0.05	0.26	56.4	0.22	0.05
	0914	0.02	0.05	0.33	57.5	0.38	0.05
	Mean	0.02	0.05	1.084	48.02	0.312	0.088
UNNAMED TRIBUTARY TO SMITH DITCH (Not Designated)							
0.10 U	0706	0.02	0.05	1.93	44.9	0.20	0.055
	0719	0.02	0.05	0.88	54.2	0.31	0.05
	0802	0.02	0.05	0.94	34	0.20	0.05
	0830	0.02	0.05	0.52	40	0.20	0.05
	0914	0.02	0.05	0.29	46.9	0.24	0.05
	Mean	0.02	0.05	0.912	44	0.23	0.051
FITZGERALD DITCH (Not Designated)							
0.50 U	0703	0.021	0.05	11.4	44.4	0.68	0.111
	0717	0.033	0.10	3.10	50.5	1.20	0.236
	0731	0.02	0.05	4.66	93.3	0.94	0.502
	0828	0.02	0.215	4.22	78.2	1.30	0.693
	0911	0.02	0.05	4.26	151	0.87	1.38
	Mean	0.0228	0.093	5.528	83.48	0.998	0.5844

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
YUTZY DITCH (Not Designated)							
0.40 U	0703	0.030	0.05	13.0	31.6	0.80	0.05
	0717	0.02	0.05	0.11	32.3	1.28	0.077
	0731	0.02	0.05	0.73	38.7	0.72	0.064
	0828	0.02	0.05	0.10	26.2	1.08	0.091
	0911	0.02	0.05	0.10	24	0.92	0.05
	Mean	0.022	0.05	2.808	30.56	0.96	0.0664
BALLENGER-JONES DITCH (Not Designated)							
0.20 U	0703	0.036	0.05	9.17	30.6	0.57	0.05
	0717	0.02	0.05	0.24	38.3	0.98	0.101
	0731	0.02	0.05	0.74	39.6	0.59	0.128
	0828	0.02	0.05	0.10	25.7	0.71	0.089
	0911	0.02	0.05	0.10	33.6	0.69	0.05
	Mean	0.0232	0.05	2.07	33.56	0.708	0.0836
WORTHINGTON DITCH (Not Designated)							
0.20 U	0703	0.033	0.05	10.3	29.1	0.61	0.074
	0717	0.022	0.05	1.16	32.8	0.85	0.059
	0731	0.02	0.05	1.27	35.5	0.57	0.151
	0828	0.02	0.05	1.45	27.9	0.71	0.182
	0911	0.02	0.059	0.48	25	0.76	0.128
	Mean	0.023	0.0518	2.932	30.06	0.7	0.1188
SWEENY RUN (Not Designated)							
0.10 U	0703	0.029	0.05	11.2	31.8	0.54	0.080
	0717	0.02	0.05	0.10	72.8	0.70	0.129
	0731	0.022	0.05	2.39	43.9	0.62	0.217
	0828	0.071	0.053	4.66	43	1.19	0.222
	0911	0.039	2.55	0.10	147	3.95	0.76
	Mean	0.0362	0.5506	3.69	67.7	1.4	0.2816
SUGAR RUN (MWH, WWH)							
7.50	0703	0.036	0.05	4.72	75.6	1.47	0.139
	0717	0.02	0.057	0.10	145	1.59	0.093

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0731	0.02	0.08	0.10	131	1.77	0.31
	0828	0.02	0.05	0.20	99.2	1.50	0.313
	0911	0.02	0.05	0.10	344	0.76	0.25
	Mean	0.0232	0.0574	1.044	158.96	1.418	0.221
7.00	0703	0.057	0.05	8.34	68.3	0.98	0.100
	0717	0.02	0.05	0.10	156	1.01	0.07
	0731	0.02	0.05	0.10	133	1.51	0.131
	0828	0.036	0.074	0.38	69	1.50	0.238
	0911	0.02	0.111	0.10	102	1.27	0.10
	Mean	0.0306	0.067	1.804	105.66	1.254	0.1278
5.40	0703	0.074	0.066	6.66	67.5	1.10	0.134
	0717	0.021	0.194	0.64	195	1.42	0.136
	0731	0.025	0.090	0.43	165	0.66	0.123
	0828	0.042	0.089	0.63	93.8	1.33	0.188
	0911	0.022	0.095	0.10	123	1.20	0.11
	Mean	0.0368	0.1068	1.692	128.86	1.142	0.1382
0.50	0703	0.057	0.05	4.81	70.5	0.68	0.061
	0717	0.02	0.05	0.79	86.5	0.92	0.067
	0731	0.02	0.056	0.32	128	0.64	0.102
	0828	0.02	0.05	0.32	76	0.97	0.110
	0911	0.02	0.08	0.10	99.6	1.15	0.58
	Mean	0.0274	0.0572	1.268	92.12	0.872	0.184
ROBINSON RUN (WWH)							
2.10	0702	0.14	0.112	6.01	103	1.34	0.083
	0716	0.02	0.083	0.10	136	0.90	0.142
	0730	0.024	0.05	1.15	103	1.16	0.12
	0827	0.02	0.05	0.10	121	1.12	0.06
	0910	0.02	0.063	0.16	227	1.20	0.077
	Mean	0.0448	0.0716	1.504	138	1.144	0.0964
0.70	0702	0.08	0.05	1.54	88.1	0.83	0.115
	0716	0.02	0.05	0.25	199	1.10	0.083

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0730	0.022	0.064	1.32	98.5	1.11	0.111
	0827	0.02	0.05	0.36	160	0.85	0.08
	0910	0.2	0.05	0.30	282	0.90	0.059
	Mean	0.0684	0.0528	0.754	165.52	0.958	0.0896
BUCK RUN (WWH)							
10.40	0702	0.025	0.05	0.10	79.2	0.68	0.05
	0716	0.02	0.05	0.10	140	0.96	0.05
	0730	0.027	0.091	0.37	105	0.86	0.056
	0827	0.082	0.05	0.20	61.6	0.65	0.148
	0910	0.047	0.05	0.22	61.8	0.65	0.11
	Mean	0.0402	0.0582	0.198	89.52	0.76	0.0828
7.80	0702	0.025	0.31	0.12	101	1.05	0.065
	0716	0.02	0.123	0.10	122	0.97	0.05
	0730	0.02	0.079	0.18	167	0.89	0.051
	0827	0.02	0.075	0.19	89	0.86	0.066
	0910	0.114	0.05	0.89	43.4	0.92	0.25
	Mean	0.0398	0.1274	0.296	104.48	0.938	0.0964
5.00	0702	0.02	0.05	0.10	153	0.50	0.05
	0716	0.02	0.05	0.10	220	0.54	0.052
	0730	0.021	0.076	0.18	113	0.69	0.05
	0827	0.02	0.054	0.10	97.3	0.74	0.051
	0910	0.043	0.05	0.56	62.7	1.30	0.26
	Mean	0.0248	0.056	0.208	129.2	0.754	0.0926
0.10	0702	0.031	0.072	0.73	90.7	0.71	0.072
	0716	0.02	0.05	0.64	102	0.63	0.068
	0730	0.021	0.107	0.68	111	0.96	0.073
	0827	0.02	0.084	0.36	107	1.17	0.085
	0910	0.02	0.05	1.75	51	1.08	0.05
	Mean	0.0224	0.0726	0.832	92.34	0.91	0.0696
HAY RUN (WWH)							
0.20	0702	0.039	0.05	12.4	63.5	0.45	0.05

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0716	NA	0.05	2.18	NA	0.23	0.05
	0730	0.02	0.05	2.73	94.1	0.41	0.05
	0827	0.022	0.05	0.39	106	0.32	0.05
	0910	0.024	0.05	0.59	99.5	0.52	0.054
	Mean	0.02625	0.05	3.658	90.775	0.386	0.0508
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 69.40 (Not Designated)							
0.40 U	0702	0.038	0.05	11.0	55.5	0.20	0.321
	0716	0.025	0.05	4.53	77.6	0.24	0.05
	0730	0.02	0.05	2.70	80.8	0.53	0.05
	0827	0.02	0.05	0.10	83.4	0.37	0.05
	0910	0.039	0.05	0.91	65.4	0.72	0.086
	Mean	0.0284	0.05	3.848	72.54	0.412	0.1114
PLEASANT RUN (EWH)							
4.10	0702	0.02			56.8		
	0716	0.038	0.05	1.03	75.9	0.25	0.05
	0730	0.02	0.05	0.61	67.9	0.29	0.05
	0827	0.02	0.05	0.46	64.5	0.20	0.05
	0910	0.02	0.05	1.00	60.9	0.23	0.05
	Mean	0.0236	0.05	0.775	65.2	0.2425	0.05
0.50	0702	0.02	0.05	3.55	54.5	0.42	0.05
	0716	0.042	0.05	0.88	71.8	0.27	0.05
	0730	0.02	0.05	0.47	70.5	0.25	0.05
	0827	0.02	0.05	0.26	64.3	0.21	0.05
	0910	0.02	0.05	0.19	60.7	0.20	0.05
	Mean	0.0244	0.05	1.07	64.36	0.27	0.05
SPAIN CREEK (WWH)							
5.70	0702	0.02	0.05	0.82	30.6	0.3	0.05
	0716	0.02	0.05	0.89	34.8	0.26	0.05
	0730	0.02	0.05	0.86	32.9	0.25	0.05
	0827	0.02			27.2		
	0910	0.07	0.05	2.42	18.1	0.75	0.142

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	Mean	0.03	0.05	1.2475	28.72	0.39	0.073
3.70	0702	0.022	0.05	1.92	28.8	0.35	0.05
	0716	0.02	0.05	1.05	38.9	0.26	0.05
	0730	0.02	0.05	0.97	37.2	0.28	0.05
	0827	0.02	0.208	0.78	34.8	0.33	0.05
	0910	0.022	0.05	0.81	27.4	0.58	0.128
	Mean	0.0208	0.0816	1.106	33.42	0.36	0.0656
0.10	0702	0.104	0.123	1.64	41.8	0.51	0.151
	0716	0.048	0.05	1.18	54.3	0.80	0.211
	0730	0.082	0.269	0.97	50.1	0.70	0.140
	0827	0.041	0.05	1.21	43.6	0.68	0.210
	0910	0.02	0.05	0.72	38.9	0.39	0.085
	Mean	0.059	0.1084	1.144	45.74	0.616	0.1594
UNNAMED TRIBUTARY TO BIG DARBY CREEK AT RM 74.91 (Not Designated)							
0.20 U	0702	0.023	0.05	5.47	43.3	0.27	0.05
	0716	0.02	0.05	4.76	51.4	0.27	0.059
	0730	0.02	0.05	4.02	49.3	0.31	0.05
	0827	0.02	0.05	3.41	48.5	0.36	0.05
	0910	0.029	0.05	4.24	40.5	0.81	0.313
	Mean	0.0224	0.05	4.38	46.6	0.404	0.1044
LITTLE DARBY CREEK (Logan County, Not Designated)							
3.50 U	0702	0.02	0.05	2.8	54.2	0.37	0.05
	0716	0.036	0.05	2.22	57.1	0.25	0.05
	0730	0.02	0.05	1.61	54.6	0.27	0.05
	0827	0.02	0.05	0.48	48.9	0.22	0.106
	0910	0.07	0.05	3.39	39.4	1.02	0.177
	Mean	0.0332	0.05	2.1	50.84	0.426	0.0866
0.40 U	0702	0.02	0.05	1.83	53	0.38	0.05
	0716	0.025	0.05	1.03	56.2	0.24	0.05
	0730	0.02	0.05	0.78	53.2	0.32	0.05
	0827	0.02	0.05	0.10	45.5	0.2	0.254

Big Darby Creek Basin							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0910	0.046	0.05	1.45	33.8	0.78	0.223
	Mean	0.0262	0.05	1.038	48.34	0.384	0.1254
FLAT BRANCH (MWH)							
3.20	0702	0.074	0.05	0.23	53.1	0.56	0.05
	0716	0.02	0.05	0.1	102	0.91	0.05
	0730	0.03	0.05	0.22	104	0.5	0.051
	0827	0.022	0.05	0.2	51.9	0.53	0.05
	0910	0.037	0.05	0.44	35.9	0.79	0.274
	Mean	0.0366	0.05	0.238	69.38	0.658	0.095
2.20	0702	0.104	0.116	0.4	35.4	0.58	0.091
	0716	0.02	0.05	0.1	105	0.69	0.109
	0730		0.056	0.28		0.33	0.072
	0827	0.031	0.05	0.31	50.9	0.52	0.07
	0910	0.041	0.05	0.35	38.1	0.66	0.21
	Mean	0.049	0.0644	0.288	57.35	0.556	0.1104
0.80	0702	0.106	0.088	0.39	31.9	0.64	0.091
	0716	0.041	0.079	0.1	65.9	0.9	0.075
	0730	0.023	0.05	0.19	49.4	0.47	0.076
	0827	0.02	0.05	0.21	39.5	0.42	0.07
	0910	0.053	0.05	0.26	34.8	0.63	0.138
	Mean	0.0486	0.0634	0.23	44.3	0.612	0.09
UNNAMED TRIBUTARY TO FLAT BRANCH AT RM 1.50 (Not Designated)							
0.10 U	0702	0.02	0.05	0.1	23.7	0.9	0.064
	0716	0.023	0.05	0.1	30.2	1.18	0.103
	0730	0.02	0.05	0.1	28.2	0.52	0.087
	0827	0.02	0.05	0.1	34.1	0.55	0.05
	0910	0.069	0.05	0.15	37.5	0.57	0.138
	Mean	0.0304	0.05	0.11	30.74	0.744	0.0884

Appendix Table C.1.8. Results of water column field parameter sampling conducted in the Little Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Mainstem

		Field Parameters											
RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
STORET	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
41.20	0705	529	14.06	8.04	7.53	78.2	2.0	428	5	200	155	89	30
	0718	541	13.83	7.10	7.20	68.9	2.0	433	5	200	149	83	30
	0801	NA	14.50	5.90	NA	NA	2.0	432	5	200	166	90	30
	0829	522	13.43	7.53	7.19	72.4	2.0	444	5	200	167	89	30
	0913	540	12.59	8.09	7.50	76.2	2.0	432	5	200	180	96	30
	Mean	533	13.68	7.33	7.36	73.93	2	433.8	5	200	163	89.4	30
39.60	0705	554	15.91	9.32	7.94	94.7	2.0	454	5	200	155	98	30
	0718	589	16.30	7.90	7.80	80.7	2.0	448	6	200	152	92	30
	0801	NA	16.50	7.00	NA	NA	2.0	448	5	200	168	97	30
	0829	469	16.13	9.92	7.73	101.8	2.0	444	5	200	166	93	30
	0913	580	14.53	10.20	8.10	100.7	2.0	448	14	200	185	103	30
	Mean	548	15.87	8.87	7.89	94.48	2	448.4	7	200	165	96.6	30
39.20 E	*0705*	*600*	*20.32*	*9.07*	*7.54*	*100.4*	*7.4*	*740*	*10*	*200*	*55*	*104*	*30*
	0718	*1092*	*21.67*	*5.32*	*7.57*	*60.7*	*22*	*738*	*156*	*1930*	*177*	*100*	*30*
	0801	*NA*	*23.00*	*4.00*	*NA*	*NA*	*2.1*	*752*	*5*	*200*	*39*	*98*	*30*
	0829	*1159*	*22.54*	*5.16*	*7.45*	*59.9*	*4.8*	*763*	*5*	*200*	*37*	*96*	*30*
	0913	*1169*	*21.76*	*3.38*	*7.59*	*38.6*	*8.5*	*742*	*6*	*200*	*36*	*107*	*30*
	Mean	*1005*	*21.86*	*5.39*	*7.54*	*64.9*	*8.96*	*747*	*36.4*	*546*	*68.8*	*101*	*30*
38.80	0705	605	17.92	9.85	8.09	104.0	2.0	446	5	200	158	101	30
	0718	630	17.17	8.06	7.79	83.9	2.0	468	9	200	143	91	30
	0801	NA	18.20	7.50	NA	NA	2.0	470	5	200	165	97	30
	0829	625	17.47	9.91	7.77	103.8	2.0	482	5	200	152	91	30
	0913	619	16.11	9.58	8.11	97.3	2.0	454	5	200	168	101	30
	Mean	620	17.37	8.98	7.94	97.25	2	464	5.8	200	157	96.2	30

Little Darby Creek Mainstem

RM STORET	Date mmdd	Field Parameters Cond µmhos	Temp °C	D.O. mg/l	pH S.U.	D.O. % sat	BOD_5 mg/l	TDS mg/l	TSS mg/l	Al µg/l	Ba µg/l	Ca mg/l	Cr µg/l
34.70	0705	631	19.38	9.17	8.02	100.0	2.0	496	16	414	143	105	30
	0718	634	19.20	7.29	7.73	78.7	2.0	472	14	245	130	88	30
	0801	NA	20.00	6.10	NA	NA	2.0	482	5	200	144	96	30
	0829	648	18.53	7.91	7.68	84.6	2.0	484	10	299	139	92	30
	0913	625	16.34	8.60	8.06	88.0	2.0	466	7	200	151	100	30
	Mean	635	18.69	7.81	7.87	87.83	2	480	10.4	272	141	96.2	30
29.50	0705	673	20.83	9.65	8.15	108.0	2.0	466	12	378	134	100	30
	0718	670	21.95	6.94	8.00	79.2	2.0	456	30	562	127	85	30
	0801	679	23.45	6.77	7.80	79.7	2.0	464	15	366	138	90	30
	0829	646	21.41	6.75	8.06	76.7	2.0	456	11	346	133	83	30
	0913	568	18.84	10.52	7.71	113.3	2.0	386	9	200	136	83	30
	Mean	647	21.3	8.13	7.94	91.38	2	445.6	15.4	370	134	88.2	30
24.50	0705	667	20.23	7.48	8.04	82.8	2.0	470	20	494	131	102	30
	0718	661	22.15	5.41	7.92	62.2	2.0	442	37	914	124	80	30
	0801	707	23.70	6.72	7.75	79.5	2.0	464	25	668	141	97	30
	0829	647	21.00	5.81	8.00	65.3	2.0	470	23	749	137	86	30
	0913	527	18.52	10.14	7.73	108.4	2.0	392	6	217	133	81	30
	Mean	642	21.12	7.11	7.89	79.64	2	447.6	22.2	608	133	89.2	30
15.30	0705	645	20.44	8.52	8.20	94.6	2.0	426	5	256	123	94	30
	0718	645	21.86	7.91	8.13	90.3	2.0	428	7	203	116	75	30
	0801	623	24.24	8.60	7.92	102.8	2.0	414	14	547	124	83	30
	0829	615	21.57	8.74	8.20	99.0	2.0	448	11	224	122	76	30
	0913	572	19.83	15.45	NA	170.0	2.0	412	6	246	134	81	30
	Mean	620	21.59	9.84	8.11	111.3	2	425.6	8.6	295	124	81.8	30
6.50	0705	632	20.75	7.92	8.19	88.5	2.0	446	11	474	117	88	30
	0718	674	23.13	6.98	8.10	81.8	2.0	431	14	444	113	76	30
	0801	581	25.13	7.39	7.94	89.8	2.0	372	5	585	114	74	30
	0829	616	22.47	7.29	8.10	84.3	2.0	418	11	326	116	73	30
	0913	598	21.55	9.61	7.90	109.0	2.0	392	9	210	125	77	30
	Mean	620	22.61	7.84	8.05	90.68	2	411.8	10	408	117	77.6	30

Little Darby Creek Mainstem

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
STORET	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
5.35E	*0705*	*1978*	*19.31*	*9.08*	*8.03*	*99.1*	*3.4*	*1590*	*5*	*200*	*67*	*122*	*30*
	0718	*2325*	*20.57*	*8.55*	*7.05*	*95.8*	*6.1*	*1520*	*11*	*200*	*60*	*107*	*30*
	0801	*2025*	*21.26*	*11.06*	*7.75*	*125.5*	*2.9*	*1320*	*7*	*200*	*65*	*111*	*30*
	0829	*2147*	*21.01*	*8.75*	*7.82*	*98.8*	*2.4*	*1480*	*5*	*200*	*59*	*103*	*30*
	0913	*2106*	*20.29*	*9.95*	*7.65*	*110.8*	*4.9*	*1400*	*5*	*200*	*73*	*108*	*30*
	Mean	*2116*	*20.49*	*9.48*	*7.66*	*106*	*3.94*	*1462*	*6.6*	*200*	*64.8*	*110*	*30*
4.10	0705	647	20.37	7.93	8.16	88.0	2.0	468	9	287	111	87	30
	0718	732	22.67	8.44	8.17	98.0	2.0	480	6	200	106	78	30
	0801	644	24.76	9.19	7.97	110.9	2.0	414	10	365	110	77	30
	0829	669	21.46	8.98	8.13	102.0	2.0	464	5	200	107	74	30
	0913	671	20.48	10.93	7.90	121.6	2.0	450	5	200	120	81	30
	Mean	673	21.95	9.09	8.07	104.1	2	455.2	7	250	111	79.4	30
0.70	0705	653	20.34	8.69	8.19	96.4	2.0	552	7	218	114	90	30
	0718	744	23.37	11.33	8.31	133.3	2.0	492	5	200	100	75	30
	0801	667	26.44	12.64	8.24	157.3	2.0	406	6	239	106	77	30
	0829	696	24.09	15.02	8.57	178.5	2.0	456	8	216	101	71	30
	0913	722	23.32	18.16	8.23	213.4	2.0	456	6	200	108	79	30
	Mean	696	23.51	13.2	8.31	155.8	2	472.4	6.4	215	106	78.4	30

Appendix Table C.1.9. Results of water column metals sampling conducted in the Little Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined.. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Mainstem

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
STORET	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
41.20	0705	10	379	62	38	11	40	2	12	3790	10	0.2	2
	0718	10	355	74	36	12	40	2	12	3780	10	0.2	2
	0801	10	394	77	41	15	40	2	12	4440	10	0.2	2
	0829	10	387	63	40	11	40	2	12	4390	10	0.2	2
	0913	10	400	50	39	13	40	2	13	4590	10	0.2	2
	Mean	10	383	65.2	38.8	12.4	40	2	12.2	4198	10	0.2	2
39.60	0705	10	409	300	40	20	40	3	11	3020	10	0.2	2
	0718	10	374	367	35	21	40	2	9	2730	10	0.2	2
	0801	10	415	292	42	22	40	3	12	3230	10	0.2	2
	0829	10	401	305	41	22	40	3	11	3170	10	0.2	2.4
	0913	10	418	501	39	31	40	3	11	3300	10	0.2	2
	Mean	10	403	353	39.4	23.2	40	2.8	10.8	3090	10	0.2	2.08
39.20 E	*0705*	*10*	*416*	*221*	*38*	*16*	*40*	*10*	*110*	*744*	*49*	*0.2*	*2*
	0718	*78*	*394*	*2720*	*35*	*88*	*40*	*10*	*100*	*772*	*152*	*0.2*	*2.4*
	0801	*60*	*405*	*106*	*39*	*14*	*40*	*12*	*135*	*802*	*50*	*0.2*	*2*
	0829	*10*	*400*	*153*	*39*	*16*	*40*	*11*	*129*	*771*	*32*	*0.2*	*2*
	0913	*10*	*424*	*203*	*38*	*45*	*40*	*10*	*127*	*807*	*40*	*0.2*	*2*
	Mean	*33.6*	*408*	*681*	*37.8*	*35.8*	*40*	*10.6*	*120*	*779*	*64.6*	*0.2*	*2.08*
38.80	0705	10	413	306	39	22	40	3	12	3140	10	0.2	2
	0718	10	375	398	36	26	40	3	17	2880	12	0.2	2
	0801	10	411	365	41	28	40	3	17	3400	10	0.2	2
	0829	10	396	301	41	28	40	3	20	3250	10	0.2	2.3
	0913	10	413	323	39	34	40	3	17	3280	10	0.2	2
	Mean	10	402	339	39.2	27.6	40	3	16.6	3190	10.4	0.2	2.06
34.70	0705	10	431	712	41	49	40	2	13	4420	10	0.2	2

Little Darby Creek Mainstem

RM STORET	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0718	10	364	524	35	61	40	3	13	3940	12	0.2	2.2
	0801	10	413	248	42	54	40	3	17	4960	10	0.2	3.2
	0829	10	411	514	44	38	40	3	16	4980	10	0.2	2.7
	0913	10	418	452	41	37	40	3	15	4990	10	0.2	2.4
	Mean	10	407	490	40.6	47.8	40	2.8	14.8	4658	10.4	0.2	2.5
29.50	0705	10	414	606	40	36	40	2	11	4700	10	0.2	2
	0718	10	369	890	38	70	40	3	13	4910	12	0.2	2.5
	0801	10	389	682	40	63	40	3	11	5790	10	0.2	2.5
	0829	10	376	507	41	55	40	3	15	5020	10	0.2	3
	0913	10	364	416	38	52	40	4	14	5330	11	0.2	2.6
	Mean	10	382	620	39.4	55.2	40	3	12.8	5150	10.6	0.2	2.52
24.50	0705	10	419	725	40	36	40	2	10	4720	14	0.2	2
	0718	10	356	1310	38	73	40	2	12	6330	23	0.2	2.1
	0801	10	407	979	40	62	40	3	14	6150	12	0.2	2.8
	0829	10	384	995	41	70	40	3	16	5980	12	0.2	2.9
	0913	10	350	449	36	45	40	4	14	5680	10	0.2	2.6
	Mean	10	383	892	39	57.2	40	2.8	13.2	5772	14.2	0.2	2.48
15.30	0705	10	404	349	41	14	40	2	11	4630	12	0.2	2
	0718	10	344	303	38	19	40	2	13	6160	10	0.2	2
	0801	10	351	762	35	37	40	4	12	4580	26	0.2	2.9
	0829	10	346	306	38	23	40	3	16	5670	10	0.2	3
	0913	10	371	409	41	37	40	3	16	6120	10	0.2	4.1
	Mean	10	363	426	38.6	26	40	2.8	13.6	5432	13.6	0.2	2.8
6.50	0705	10	388	596	41	27	40	2	13	4610	16	0.2	2
	0718	10	350	576	39	31	40	2	14	4840	14	0.2	2
	0801	10	316	786	32	42	40	3	12	4280	10	0.2	2.2
	0829	10	330	433	36	37	40	3	18	5610	10	0.2	2.7
	0913	10	349	356	38	42	40	3	19	5400	10	0.2	3.5
	Mean	10	347	549	37.2	35.8	40	2.6	15.2	4948	12	0.2	2.48
5.35 E	*0705*	*10*	*506*	*119*	*49*	*10*	*40*	*10*	*411*	*27100*	*53*	*0.2*	*3.9*
	0718	*10*	*444*	*147*	*43*	*10*	*40*	*10*	*340*	*22200*	*62*	*0.2*	*4.0*

Little Darby Creek Mainstem

RM STORET	Date mmdd	Cu µg/l	Hard mg/l	Fe µg/l	Mg mg/l	Mn µg/l	Ni µg/l	K mg/l	Na mg/l	Sr µg/l	Zn µg/l	Hg µg/l	As µg/l
	0801	*18*	*454*	*132*	*43*	*10*	*40*	*9*	*309*	*14500*	*81*	*0.2*	*2.8*
	0829	*10*	*434*	*119*	*43*	*10*	*40*	*10*	*358*	*18000*	*69*	*0.2*	*3.7*
	0913	*15*	*443*	*77*	*42*	*10*	*40*	*10*	*375*	*18800*	*81*	*0.2*	*3.4*
	Mean	*12.6*	*456*	*119*	*44*	*10*	*40*	*9.8*	*359*	*20120*	*69.2*	*0.2*	*3.56*
4.10	0705	10	374	365	38	17	40	2	15	4750	10	0.2	2
	0718	10	351	265	38	14	40	2	25	6330	10	0.2	2
	0801	10	328	510	33	27	40	3	23	4710	10	0.2	2.7
	0829	10	337	240	37	18	40	3	32	5740	10	0.2	3.3
	0913	10	359	141	38	23	40	3	38	6260	10	0.2	3.3
	Mean	10	350	304	36.8	19.8	40	2.6	26.6	5558	10	0.2	2.66
0.70	0705	10	389	245	40	12	40	2	18	4750	10	0.2	2
	0718	10	340	143	37	10	40	2	29	6500	16	0.2	2
	0801	10	332	312	34	19	40	3	24	4520	10	0.2	2.6
	0829	10	330	378	37	17	40	3	34	5410	14	0.2	2.6
	0913	10	358	100	39	10	40	3	48	5810	10	0.2	2.8
	Mean	10	350	236	37.4	13.6	40	2.6	30.6	5398	12	0.2	2.4

Appendix Table C.1.10. Results of water column selected metals, selected field parameter and bacteriological sampling conducted in the Little Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Mainstem

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
STORET #	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
41.20	0705	0.2	2	2	230	250	165	297	22.9	NA
	0718	0.2	2	2	260	240	4200	303	22.3	19
	0801	0.2	2	2	115	65	210	310	22.8	10
	0829	0.2	2	2	70	30	210	305	22.1	10
	0913	0.2	2	2	85	35	800	303	22.3	10
	Mean	0.2	2	2	152	124	1117	303.6	22.48	12.25
39.60	0705	0.2	2	2	1310	1090	1850	316	22.6	10
	0718	0.2	2	2	909	959	2200	334	21.8	10
	0801	0.2	2	2	NA	NA	NA	316	22.7	10
	0829	0.2	2	2	520	718	1000	322	21.4	10
	0913	0.2	2	2	500	490	950	306	21.6	10
	Mean	0.2	2	2	809.75	814.25	1500	318.8	22.02	10
39.20 E	*0705*	*0.2*	*2*	*2*	*1260*	*2250*	*255*	*317*	*164*	*26*
	0718	*0.27*	*8.5*	*2*	*1550*	*1030*	*335*	*322*	*159*	*32*
	0801	*0.2*	*2*	*2*	*780*	*290*	*80*	*324*	*173*	*10*
	0829	*0.2*	*2*	*2*	*570*	*600*	*190*	*317*	*172*	*10*
	0913	*0.2*	*2*	*2*	*1800*	*2500*	*340*	*309*	*172*	*10*
	Mean	*0.214*	*3.3*	*2*	*1192*	*1334*	*240*	*317.8*	*168*	*17.6*
38.80	0705	0.2	2	2	1010	1370	1170	321	24.4	44
	0718	0.2	2	2	1140	1380	3300	336	32.4	10
	0801	0.2	2	2	1010	945	1450	332	29.7	42
	0829	0.2	2	2	580	430	830	324	32.5	10
	0913	0.2	2	2	60	80	300	320	29.3	10
	Mean	0.2	2	2	760	841	1410	326.6	29.66	23.2

Little Darby Creek Mainstem

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
STORET #	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
34.70	0705	0.2	2	2	230	420	450	310	27.1	10
	0718	0.2	2	2	490	600	990	304	26.2	10
	0801	0.2	2	2.1	240	230	280	313	29.6	10
	0829	0.2	2	2	30	60	280	312	26	10
	0913	0.2	2	2	200	210	210	305	26.2	10
	Mean	0.2	2	2.02	238	304	442	308.8	27.02	10
29.50	0705	0.2	2	2	380	520	230	293	25.5	20
	0718	0.2	2	2	2000	1200	2700	303	26.6	10
	0801	0.2	2	2	100	470	310	281	26	16
	0829	0.2	2	2	290	270	530	281	25.6	10
	0913	0.2	2	2	190	150	410	249	23.4	10
	Mean	0.2	2	2	592	522	836	281.4	25.42	13.2
24.50	0705	0.2	2	2	270	460	310	296	26.1	11
	0718	0.2	2.3	2	300	1000	2300	287	26.1	10
	0801	0.2	2	2	210	570	230	284	28.8	13
	0829	0.2	2	2	700	250	370	302	27.1	10
	0913	0.2	2	2	250	190	480	266	25.8	10
	Mean	0.2	2.06	2	346	494	738	287	26.78	10.8
15.30	0705	0.2	2	2	160	220	100	289	27.6	14
	0718	0.2	2	2	220	150	650	292	28.7	53
	0801	0.2	2	2	170	200	200	252	25.3	22
	0829	0.2	2	2	80	150	190	268	28	10
	0913	0.2	2	2	190	200	240	272	27.9	10
	Mean	0.2	2	2	164	184	276	274.6	27.5	21.8
6.50	0705	0.2	2	2	120	160	160	267	29.1	14
	0718	0.2	2	2	140	120	490	286	32.1	10
	0801	0.2	2	2	100	60	70	227	25.5	19
	0829	0.2	2	2	80	100	150	260	30.4	10
	0913	0.2	2	2	150	200	40	260	33.1	10
	Mean	0.2	2	2	118	128	182	260	30.04	12.6

Little Darby Creek Mainstem

RM	Date	Cd	Pb	Se	E coli	Fecal Coliform	Fecal Strep.	Alkalinity	Cl	COD
STORET #	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
5.35E	*0705*	*0.2*	*2*	*2*	*10*	*10*	*10*	*329*	*576*	*23*
	0718	*0.2*	*2*	*2*	*10*	*20*	*60*	*308*	*604*	*24*
	0801	*0.2*	*2*	*2*	*10*	*10*	*100*	*318*	*489*	*31*
	0829	*0.2*	*2*	*2*	*10*	*10*	*90*	*310*	*513*	*17*
	0913	0.2	2	2	*10*	*10*	*490*	*321*	*509*	*23*
	Mean	*0.2*	*2*	*2*	*10*	*12*	*150*	*317.2*	*538.2*	*23.6*
4.10	0705	0.2	2	2	40	80	130	275	35.2	10
	0718	0.2	2	2	180	210	250	293	50.7	10
	0801	0.2	2	2	10	80	160	232	41.6	19
	0829	0.2	2	2	180	180	140	253	52	10
	0913	0.2	2	2	70	60	50	264	59	38
	Mean	0.2	2	2	96	122	146	263.4	47.7	17.4
0.70	0705	0.2	2	2	50	120	80	278	38.1	10
	0718	0.2	2	2	100	160	910	287	56	10
	0801	0.2	2	2	40	30	20	230	42.6	16
	0829	0.2	2	2	60	10	10	252	55.6	10
	0913	0.2	2	2	70	90	170	256	68.5	10
	Mean	0.2	2	2	64	82	238	260.6	52.16	11.2

Appendix Table C.1.11. Results of water column nutrient sampling conducted in the Little Darby Creek Mainstem during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Mainstem

RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
41.20	0705	0.02	NA	NA	42.4	NA	NA
	0718	0.02	0.05	3.67	40.1	0.2	0.05
	0801	0.02	0.05	3.69	45.8	0.2	0.05
	0829	0.02	0.05	3.81	45.4	0.21	0.05
	0913	0.02	0.05	3.74	41.4	0.20	0.05
	Mean	0.02	0.05	3.7275	43.02	0.2025	0.05
39.60	0705	0.02	0.05	2.70	51.6	0.37	0.05
	0718	0.02	0.051	2.42	49.3	0.29	0.05
	0801	0.02	0.05	2.30	52.1	0.29	0.05
	0829	0.02	0.05	2.47	52.3	0.29	0.05
	0913	0.02	0.05	2.52	49.4	0.35	0.05
	Mean	0.02	0.0502	2.482	50.94	0.318	0.05
39.20 E	*0705*	*0.059*	*0.350*	*1.55*	*81*	*2.19*	*1.72*
	0718	*0.057*	*0.683*	*1.28*	*84.7*	*2.72*	*4.72*
	0801	*0.029*	*0.254*	*1.60*	*86.7*	*1.21*	*1.79*
	0829	*0.02*	*0.25*	*1.50*	*83.1*	*1.68*	*1.24*
	0913	*0.037*	*0.759*	*2.09*	*77.9*	*2.14*	*2.18*
	Mean	*0.0404*	*0.4592*	*1.604*	*82.68*	*1.988*	*2.33*
38.80	0705	0.02	0.05	2.48	51.2	0.43	0.05
	0718	0.02	0.087	2.17	51	0.38	0.209
	0801	0.02	0.05	2.14	54.9	0.31	0.130
	0829	0.02	0.054	2.17	53.1	0.33	0.116
	0913	0.02	0.083	2.27	49.7	0.49	0.138
	Mean	0.02	0.0648	2.246	51.98	0.388	0.1286
34.70	0705	0.023	0.05	2.75	73.6	0.38	0.05

Little Darby Creek Mainstem

RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0718	0.022	0.075	1.65	65.2	0.41	0.067
	0801	0.02	0.066	1.28	69.1	0.44	0.052
	0829	0.02	0.07	1.24	70.5	0.43	0.06
	0913	0.02	0.05	1.23	66.4	0.40	0.05
	Mean	0.021	0.0622	1.63	68.96	0.412	0.0558
29.50	0705	0.022	0.05	5.02	69	0.48	0.05
	0718	0.026	0.06	1.73	71	0.45	0.065
	0801	0.02	0.077	1.41	67.3	0.52	0.05
	0829	0.02	0.05	0.75	66.5	0.49	0.05
	0913	0.02	0.05	0.56	55.8	0.49	0.05
	Mean	0.0216	0.0574	1.894	65.92	0.486	0.053
24.50	0705	0.02	0.05	6.04	67.1	0.54	0.051
	0718	0.023	0.062	1.55	70.4	0.38	0.138
	0801	0.02	0.112	2.07	66.9	0.45	0.062
	0829	0.02	0.05	0.72	66.2	0.52	0.05
	0913	0.02	0.05	0.44	60.3	0.48	0.069
	Mean	0.0206	0.0648	2.164	66.18	0.474	0.074
15.30	0705	0.02	0.05	6.07	56.6	0.43	0.05
	0718	0.02	0.05	1.40	62.8	0.51	0.074
	0801	0.02	0.053	2.48	53.6	0.75	0.111
	0829	0.02	0.05	0.61	58.5	0.47	0.072
	0913	0.02	0.05	0.27	61.3	0.48	0.05
	Mean	0.02	0.0506	2.166	58.56	0.528	0.0714
6.50	0705	0.02	0.05	5.97	58.3	0.65	0.078
	0718	0.02	0.05	1.53	63.6	0.50	0.143
	0801	0.02	0.05	2.19	48.6	0.53	0.097
	0829	0.02	0.05	0.40	59	0.48	0.06
	0913	0.02	0.05	0.15	56.4	0.45	0.05
	Mean	0.02	0.05	2.048	57.18	0.522	0.0856
5.35E	*0705*	*0.083*	*0.288*	*8.03*	*94.1*	*1.93*	*1.25*
	0718	*0.061*	*0.262*	*15.7*	*102*	*2.20*	*1.82*

Little Darby Creek Mainstem							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
STORET #	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0801	*0.031*	*0.144*	*12.2*	*87.4*	*1.23*	*1.81*
	0829	*0.123*	*0.201*	*15.2*	*93.3*	*1.60*	*2.49*
	0913	0.614	0.452	15.5	*93.2*	*2.25*	*2.09*
	Mean	*0.1824*	*0.2694*	*13.326*	*94*	*1.842*	*1.892*
4.10	0705	0.02	0.05	5.38	58	0.48	0.052
	0718	0.02	0.05	2.10	63.7	0.42	0.142
	0801	0.02	0.05	2.53	51.3	0.47	0.110
	0829	0.02	0.05	1.08	60.6	0.51	0.128
	0913	0.02	0.05	1.07	57.2	0.57	0.098
	Mean	0.02	0.05	2.432	58.16	0.49	0.106
0.70	0705	0.02	0.05	4.55	58.8	0.39	0.05
	0718	0.02	0.05	2.37	61.8	0.54	0.096
	0801	0.02	0.05	2.44	52.1	0.58	0.091
	0829	0.02	0.05	1.08	60.5	0.59	0.140
	0913	0.02	0.05	1.18	58.2	0.54	0.132
	Mean	0.02	0.05	2.324	58.28	0.528	0.1018

Appendix Table C.1.12. Results of water column field parameter and selected metal sampling conducted in the Little Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Tributaries

		Field Parameters											
RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
SPRING FORK-(EWH)													
15.90	0705	628	19.06	9.23	8.14	99.9	2.0	456	5	200	81	99	30
	0718	484	19.86	8.21	7.92	90.3	2.3	354	21	854	69	64	30
	0801	541	20.63	8.57	7.69	95.5	2.0	395	5	229	74	83	30
	0829	602	18.36	7.13	7.76	75.4	2.0	436	5	200	76	86	30
	0913	592	16.82	11.45	7.33	117.4	2.0	424	5	200	96	102	30
	Mean	569	18.9	8.9	7.8	95.7	2.1	413	8.2	337	79.2	86.8	30
13.40	0705	No sample											
	0718	401	20.11	6.70	7.76	74.0	4.0	308	21	1100	66	47	30
	0801	581	20.72	7.27	7.68	81.2	2.0	410	5	200	83	80	30
	0829	633	18.93	6.87	7.78	74.2	2.0	474	5	200	115	87	30
	0913	625	16.38	10.84	7.47	110.9	2.0	482	5	200	134	103	30
	Mean	560	19	7.9	7.7	85.1	2.5	419	9	425	99.5	79.3	30
7.80	0705	633	20.51	8.82	8.14	98.3	2.0	444	5	200	106	91	30
	0718	539	20.69	7.52	8.09	84.0	2.1	364	32	1210	86	67	30
	0801	588	22.32	7.61	7.87	87.6	2.0	408	8	256	88	80	30
	0829	619	19.65	6.37	7.94	70.0	2.0	444	5	200	114	81	30
	0913	580	17.88	7.50	7.58	79.7	2.0	420	5	200	121	87	30
	Mean	592	20.2	7.6	7.9	83.9	2	416	11	413	103	81.2	30
0.80	0705	642	21.92	11.72	8.17	134.5	2.0	452	7	214	127	90	30
	0718	612	21.40	5.56	7.73	62.9	2.0	420	9	224	126	70	30
	0801	NA	23.50	6.50	NA	NA	2.0	356	24	874	106	63	30
	0829	NA	NA	NA	NA	NA	2.0	454	7	224	145	73	30
	0913	676	18.01	9.07	7.92	96.1	2.0	474	5	200	193	89	30

Little Darby Creek Tributaries

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	Mean	643	21.2	8.2	7.9	97.8	2	431	10.4	347	139	77	30
BALES DITCH (Undesignated)													
0.40 U	0705	673	20.56	9.46	8.10	105.4	2.0	458	5	200	114	97	30
	0718	642	21.33	7.20	7.93	50.2	2.0	434	5	200	106	76	30
	0801	627	23.39	8.45	7.82	99.4	2.0	430	5	200	104	89	30
	0829	566	20.60	7.87	7.90	87.0	2.0	400	5	200	93	73	30
	0913	537	18.22	12.64	7.50	147.3	2.0	376	16	772	121	68	30
	Mean	609	20.8	9.1	7.9	97.9	2	420	7.2	314	108	80.6	30
BARRON CREEK (EWH)													
0.20	0705	742	23.61	8.81	7.97	104.1	2.0	492	20	670	124	102	30
	0718	740	21.80	8.36	7.96	95.5	2.0	500	5	200	114	91	30
	0801	809	26.44	7.15	7.70	89.0	2.0	554	58	1140	142	97	30
	0829	736	22.81	9.92	8.00	115.5	3.0	522	12	355	127	92	30
	0913	508	21.66	22.67	7.81	260.8	2.0	476	10	220	139	99	30
	Mean	707	23.3	11	7.9	133	2.2	509	21	517	129	96.2	30
HOWARD RUN (EWH)													
0.60	0705	712	20.28	9.67	8.06	NA	2.0	458	5	200	128	99	30
	0718	NA	19.75	8.13	7.97	89.3	2.0	442	5	200	120	88	30
	0801	NA	21.59	8.44	8.01	95.9	2.0	456	5	200	130	88	30
	0829	NA	18.93	7.23	8.01	79.3	2.0	482	9	405	139	91	30
	0912	NA	16.95	10.20	7.60	105.6	2.0	446	12	460	130	89	30
	Mean	712	19.5	8.7	7.9	92.5	2	457	7.2	293	129	91	30
LAKE RUN (EWH)													
0.90	0705	455	19.58	8.37	8.09	92.7	2.0	408	5	245	124	84	30
	0718	531	19.02	6.54	7.73	70.6	2.0	394	5	200	130	77	30
	0801	NA	19.00	5.80	NA	NA	2.0	384	8	234	162	80	30
	0829	520	16.59	7.41	7.59	75.9	2.0	406	5	200	177	78	30
	0913	513	14.41	7.59	7.76	74.4	2.0	394	5	200	217	88	30
	Mean	505	17.7	7.1	7.8	78.4	2	397	5.6	216	162	81.4	30
JUMPING RUN (EWH)													

Little Darby Creek Tributaries

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
0.30	0705	588	18.33	8.47	7.91	90.3	2.0	432	5	200	109	99	30
	0718	599	18.60	7.02	7.87	75.3	2.0	436	5	200	104	91	30
	0801	NA	19.00	5.40	NA	NA	2.0	436	5	200	114	94	30
	0829	NA	NA	NA	NA	NA	2.0	454	7	270	113	91	30
	0913	602	15.53	8.01	8.11	80.6	2.0	452	5	200	130	103	30
	Mean	596	17.9	7.2	8	82.1	2	442	5.4	214	114	95.6	30
CLOVER RUN (EWH)													
0.60	0705	602	17.86	8.90	8.08	94.0	2.0	454	5	200	138	101	30
	0718	586	18.48	7.01	7.69	75.0	2.0	440	5	213	126	85	30
	0801	NA	20.00	7.00	NA	NA	2.0	453	5	200	130	94	30
	0829	620	18.13	8.67	7.68	91.6	2.0	462	7	200	141	95	30
	0913	604	15.94	8.59	8.04	87.1	2.0	460	7	200	150	107	30
	Mean	603	18.1	8	7.9	86.9	2	454	5.8	203	137	96.4	30
TREACLE CREEK (EWH)													
11.80	0705	609	18.98	7.69	8.00	NA	2.0	382	5	223	104	82	30
	0718	NA	20.41	6.90	7.91	77.0	2.0	374	12	279	102	71	30
	0801	NA	20.71	5.21	7.86	57.9	2.0	368	9	359	115	74	30
	0829	NA	18.96	5.40	7.86	65.8	2.0	382	6	288	118	73	30
	0912	NA	16.03	9.58	7.59	97.1	2.0	388	5	308	107	83	30
	Mean	609	19	7	7.8	74.5	2	379	7.4	291	109	76.6	30
8.30	0705	639	18.30	8.20	7.99	NA	2.0	434	5	200	130	90	30
	0718	NA	19.45	8.10	7.93	88.0	2.0	442	13	361	131	87	30
	0801	NA	20.91	7.65	7.95	85.9	2.0	417	5	200	135	82	30
	0829	NA	19.20	7.98	7.90	85.6	2.0	434	5	200	135	85	30
	0912	NA	16.50	9.96	7.50	102.4	2.0	492	5	200	142	105	30
	Mean	639	18.9	8.4	7.9	90.5	2	444	6.6	232	135	89.8	30
6.00	0705	653	19.11	9.01	8.04	NA	2.0	430	5	369	129	90	30
	0718	NA	20.64	8.63	8.03	100.0	2.0	534	33	602	128	82	30
	0801	NA	21.96	8.06	8.03	92.2	2.0	396	134	771	134	81	30
	0829	NA	19.33	7.81	8.05	84.8	2.0	410	12	310	125	80	30

Little Darby Creek Tributaries

RM	Date	Cond	Temp	D.O.	pH	D.O.	BOD_5	TDS	TSS	Al	Ba	Ca	Cr
		Field Parameters											
	mmdd	µmhos	°C	mg/l	S.U.	% sat	mg/l	mg/l	mg/l	µg/l	µg/l	mg/l	µg/l
	0912	NA	17.58	11.04	7.59	115.7	2.0	454	5	200	137	96	30
	Mean	653	19.7	8.9	7.9	98.2	2	445	37.8	450	131	85.8	30
0.80	0705	670	22.51	11.50	8.06	NA	2.0	436	20	514	126	93	30
	0718	NA	20.66	6.12	7.77	67.0	2.0	416	43	979	124	79	30
	0801	NA	21.41	5.60	7.67	63.5	2.0	440	33	888	135	86	30
	0829	NA	20.97	5.76	7.71	65.2	2.0	416	29	958	138	81	30
	0912	NA	16.74	8.26	7.36	84.0	2.0	372	13	770	120	74	30
	Mean	670	20.5	7.4	7.7	69.9	2	416	27.6	822	129	82.6	30
PROCTOR RUN (EWH)													
4.90	0705	653	18.05	8.30	7.96	NA	2.0	434	6	229	113	85	30
	0718	NA	18.91	7.62	7.85	82.2	2.0	458	9	200	106	59	30
	0801	NA	20.98	9.00	8.03	101.0	2.0	304	21	652	88	55	30
	0829	NA	17.97	7.72	7.91	81.3	2.0	371	13	393	113	63	30
	0912	NA	16.62	9.80	7.44	100.7	2.0	326	31	411	87	58	30
	Mean	653	18.5	8.5	7.8	91.3	2	379	16	377	101	64	30
3.10	0705	635	21.00	10.65	8.15	NA	2.0	424	5	200	126	90	30
	0718	NA	20.69	8.30	7.97	92.9	2.0	390	10	200	120	77	30
	0801	NA	21.56	9.37	7.99	106.4	2.0	354	5	200	105	66	30
	0829	NA	19.86	6.21	7.94	67.0	2.0	392	5	200	120	72	30
	0912	NA	17.38	11.41	7.52	118.7	2.0	378	5	200	108	74	30
	Mean	635	20.1	9.2	7.9	96.3	2	388	6	200	116	75.8	30
1.60	0705	629	20.90	9.20	8.08	NA	2.0	434	5	200	128	91	30
	0718	NA	21.61	7.65	7.98	87.8	2.0	426	5	200	116	77	30
	0801	NA	23.13	8.03	8.05	93.9	2.0	362	5	200	107	65	30
	0829	NA	20.66	7.63	8.06	85.2	2.0	495	5	200	120	73	30
	0912	NA	18.19	9.90	7.53	106.1	2.0	396	5	200	111	76	30
	Mean	629	20.9	8.5	7.9	93.3	2	423	5	200	116	76.4	30

Appendix Table C.1.13. Results of water column metals sampling conducted in the Little Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Tributaries

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
						SPRING FORK (EWH)							
15.90	0705	10	404	204	38	16	40	2	11	1060	13	0.2	2
	0718	10	259	1220	24	29	40	5	9	503	15	0.2	2
	0801	10	327	391	29	18	40	3	10	724	10	0.2	2
	0829	10	367	223	37	46	40	3	16	1260	10	0.2	2
	0913	10	411	160	38	82	40	2	13	1940	10	0.2	2
	Mean	10	354	440	33.2	38.2	40	3	11.8	1097	11.6	0.2	2
13.40	0705	No Sample											
	0718	10	200	1500	20	37	40	8	8	1460	15	0.2	2
	0801	10	327	377	31	31	40	3	10	1980	10	0.2	2
	0829	10	386	272	41	42	40	3	16	8190	10	0.2	2.2
	0913	10	430	237	42	91	40	3	19	9390	15	0.2	2
	Mean	10	336	597	33.5	50.3	40	4.25	13.3	5255	12.5	0.2	2.05
7.80	0705	10	384	206	38	16	40	2	12	6580	10	0.2	2
	0718	10	287	1700	29	41	40	3	11	3420	23	0.2	2
	0801	10	336	468	33	33	40	3	10	3400	12	0.2	2
	0829	10	367	211	40	52	40	4	15	8650	10	0.2	3
	0913	10	386	158	41	102	40	4	17	7410	10	0.2	2.9
	Mean	10	352	549	36.2	48.8	40	3.2	13	5892	13	0.2	2.38
0.80	0705	10	394	325	41	22	40	2	12	5840	10	0.2	2
	0718	10	323	383	36	49	40	2	14	4870	10	0.2	2
	0801	10	273	1360	28	57	40	4	8	3420	12	0.2	2.9
	0829	10	347	400	40	46	40	4	28	6250	10	0.2	3.8
	0913	10	399	216	43	40	40	4	27	7230	10	0.2	3.5

Little Darby Creek Tributaries

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Mean	10	347	537	37.6	42.8	40	3.2	17.8	5522	10.4	0.2	2.84
BALES DITCH (Undesignated)													
0.40 U	0705	10	415	153	42	10	40	2	8	8120	10	0.2	2
	0718	10	342	239	37	26	40	3	10	12000	11	0.2	3.1
	0801	10	370	197	36	20	40	3	7	6300	10	0.2	3.3
	0829	10	330	350	36	36	40	4	8	8970	10	0.2	5.2
	0913	10	343	1150	42	82	40	4	12	9470	10	0.2	6
	Mean	10	360	418	38.6	34.8	40	3.2	9	8972	10.2	0.2	3.92
BARRON CREEK (EWH)													
0.20	0705	10	440	1020	45	52	40	2	10	5170	12	0.2	2.9
	0718	10	404	445	43	36	40	2	12	7740	14	0.2	3.6
	0801	10	440	2230	48	147	40	4	14	7590	14	0.2	8.3
	0829	10	427	734	48	70	40	2	17	8020	10	0.2	10.4
	0913	10	445	668	48	57	40	2	13	8270	13	0.2	7.8
	Mean	10	431	1019	46.4	72.4	40	2.4	13.2	7358	12.6	0.2	6.6
HOWARD RUN (EWH)													
0.60	0705	10	424	235	43	13	40	2	10	7150	10	0.2	2
	0718	10	372	291	37	19	40	2	9	9100	18	0.2	2
	0801	10	393	394	42	27	40	3	10	9710	27	0.2	3.1
	0829	10	404	626	43	49	40	3	13	10700	16	0.2	4.1
	0912	10	383	615	39	30	40	3	12	6480	10	0.2	3.1
	Mean	10	395	432	40.8	27.6	40	2.6	10.8	8628	16.2	0.2	2.86
LAKE RUN (EWH)													
0.90	0705	10	350	507	34	32	40	2	8	2270	10	0.2	2.3
	0718	10	324	668	32	41	40	2	7	2890	10	0.2	2.8
	0801	10	348	871	36	81	40	2	9	5850	10	0.2	5.3
	0829	10	351	668	38	77	40	2	9	7800	10	0.2	4.7
	0913	10	372	658	37	97	40	2	8	10200	10	0.2	5
	Mean	10	349	674	35.4	65.6	40	2	8.2	5802	10	0.2	4.02
JUMPING RUN (EWH)													

Little Darby Creek Tributaries

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
0.30	0705	10	408	249	39	10	40	2	7	762	10	0.2	2
	0718	10	371	256	35	10	40	2	6	560	12	0.2	2
	0801	10	395	295	39	22	40	2	7	622	10	0.2	2
	0829	10	400	416	42	35	40	2	7	790	10	0.2	2.5
	0913	10	422	366	40	35	40	3	10	808	10	0.2	2.7
	Mean	10	399	316	39	22.4	40	2.2	7.4	708	10.4	0.2	2.24
CLOVER RUN (EWH)													
0.60	0705	10	421	362	41	24	40	3	8	1780	10	0.2	2
	0718	10	356	412	35	23	40	4	6	1670	14	0.2	2
	0801	10	404	274	41	31	40	4	8	1990	10	0.2	2.3
	0829	10	418	357	44	38	40	3	8	2300	10	0.2	2
	0913	10	440	259	42	33	40	3	8	2480	10	0.2	2
	Mean	10	408	333	40.6	29.8	40	3.4	7.6	2044	10.8	0.2	2.06
TREACLE CREEK (EWH)													
11.80	0705	10	357	320	37	19	40	2	7	1770	10	0.2	2
	0718	10	309	479	32	39	40	2	6	2390	15	0.2	2
	0801	10	337	587	37	82	40	5	6	2650	20	0.2	3.6
	0829	10	335	463	37	67	40	4	6	3190	14	0.2	3.7
	0912	10	351	415	35	36	40	3	9	2010	10	0.2	2.2
	Mean	10	338	453	35.6	48.6	40	3.2	6.8	2402	13.8	0.2	2.7
8.30	0705	10	385	236	39	18	40	2	11	4650	10	0.2	2
	0718	10	370	670	37	33	40	2	11	4770	10	0.2	2.0
	0801	10	361	212	38	24	40	3	12	5280	10	0.2	2
	0829	10	373	180	39	22	40	2	13	5730	10	0.2	2
	0912	10	423	139	39	16	40	3	10	5000	10	0.28	2
	Mean	10	382	287	38.4	22.6	40	2.4	11.4	5086	10	0.22	2
6.00	0705	10	389	582	40	77	40	2	12	4710	10	0.2	2
	0718	10	349	971	35	134	40	2	11	4520	15	0.2	2
	0801	10	363	1280	39	164	40	3	12	5030	27	0.2	2
	0829	10	360	263	39	29	40	3	13	5230	10	0.2	2

Little Darby Creek Tributaries

RM	Date	Cu	Hard	Fe	Mg	Mn	Ni	K	Na	Sr	Zn	Hg	As
	mmdd	µg/l	mg/l	µg/l	mg/l	µg/l	µg/l	mg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	0912	10	396	101	38	12	40	3	10	4990	10	0.2	2
	Mean	10	371	639	38.2	83.2	40	2.6	11.6	4896	14.4	0.2	2
0.80	0705	10	397	782	40	50	40	2	10	6240	11	0.2	2
	0718	10	346	1540	36	92	40	2	9	5790	16	0.2	2.1
	0801	10	384	1400	41	87	40	2	13	7700	10	0.2	2.7
	0829	10	363	1380	39	89	40	3	11	8250	11	0.2	3.6
	0912	10	325	817	34	44	40	4	11	6600	10	0.2	2
	Mean	10	363	1184	38	72.4	40	2.6	10.8	6916	11.6	0.2	2.48
						PROCTOR RUN (EWH)							
4.90	0705	10	369	432	38	34	40	2	16	18500	10	0.2	3
	0718	10	283	402	33	40	40	2	16	33800	10	0.2	4.1
	0801	10	269	1090	32	61	40	3	9	6970	14	0.2	2.9
	0829	10	306	699	36	63	40	2	16	21200	10	0.2	4.1
	0912	10	272	603	31	43	40	3	9	5840	10	0.2	2.3
	Mean	10	300	645	34	48.2	40	2.4	13.2	17262	10.8	0.2	3.28
3.10	0705	10	385	232	39	16	40	2	9	9030	12	0.2	2
	0718	10	340	223	36	18	40	2	9	12100	21	0.2	2
	0801	10	305	240	34	21	40	3	10	10600	10	0.2	2.4
	0829	10	340	144	39	23	40	3	13	14000	10	0.2	2.3
	0912	10	329	128	35	11	40	3	10	8350	10	0.2	2.2
	Mean	10	340	193	36.6	17.8	40	2.6	10.2	10816	12.6	0.2	2.18
1.60	0705	10	392	180	40	12	40	2	8	8550	10	0.2	2
	0718	10	340	190	36	17	40	2	9	10400	16	0.2	2
	0801	10	310	202	36	17	40	3	10	11100	10	0.2	2
	0829	10	343	225	39	24	40	2	11	14400	10	0.2	2.1
	0912	10	334	160	35	15	40	3	10	8130	10	0.2	2.4
	Mean	10	344	191	37.2	17	40	2.4	9.6	10516	11.2	0.2	2.1

Appendix Table C.1.14. Results of selected metals, selected field parameters and bacteriological sampling conducted in Little Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Tributaries

RM	Date	Cd	Pb	Se	E coli	Fecal	Fecal	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
					SPRING FORK (EWH)					
15.90	0705	0.2	2	2	470	627	460	292	29.9	14
	0718	0.2	2	2	6300	5000	20000	215	26.3	21
	0801	0.39	2	2	410	350	2600	250	25.2	31
	0829	0.2	2	2	250	160	940	307	35.9	11
	0913	0.2	2	2	NA	NA	NA	301	30.2	17
	Mean	0.238	2	2	1857.5	1534.25	6000	273	29.5	18.8
13.40	0705	No sample								
	0718	0.2	2	2	6000	5700	32000	167	23.7	18
	0801	0.2	2	2	260	400	1260	260	24.2	22
	0829	0.2	2	2	250	190	920	301	27.5	10
	0913	0.2	2	2	40	50	420	297	15.6	10
	Mean	0.2	2	2	1637.5	1585	8650	256.25	22.8	15
7.80	0705	0.2	2	2	680	791	1170	280	26.8	14
	0718	0.2	2	2	58000	5000	20000	234	26.6	10
	0801	0.2	2	2	600	600	1170	261	25.3	22
	0829	0.2	2	2	40	180	680	300	25.1	10
	0913	0.2	2	2	130	50	900	279	25.3	23
	Mean	0.2	2	2	11890	1324.2	4784	270.8	25.8	15.8
0.80	0705	0.2	2	2	280	550	180	286	28.8	10
	0718	0.2	2	2	2900	3800	740	285	30.3	10
	0801	0.2	2	2	2900	2000	420	221	22.4	11
	0829	0.2	2	2	3000	3700	280	275	45.3	10
	0913	0.2	2	2	3100	1700	410	308	41.5	10
	Mean	0.2	2	2	2436	2350	406	275	33.7	10.2

Little Darby Creek Tributaries

RM	Date mmdd	Cd µg/l	Pb µg/l	Se µg/l	E coli #/100 ml	Fecal #/100 ml	Fecal #/100 ml	Alkalinity mg/l	Cl mg/l	COD mg/l
BALES DITCH (Undesignated)										
0.40 U	0705	0.2	2	2	120	160	170	290	28.7	14
	0718	0.2	2	2	280	300	360	288	26.9	10
	0801	0.2	2	2	150	120	240	270	22.7	22
	0829	0.2	2	2	120	150	130	268	21.4	11
	0913	0.2	2	2	160	210	90	271	27	14
	Mean	0.2	2	2	166	188	198	277.4	25.3	14.2
BARRON CREEK (EWH)										
0.20	0705	0.2	2	2	10500	20000	1400	307	26.6	17
	0718	0.2	2	2	12200	16000	5200	327	28	10
	0801	0.2	2	2	14100	22000	3700	314	30.4	28
	0829	0.2	2	2	80000	60000	8300	315	27	103
	0913	0.2	2	2	4000	12200	1300	320	21	10
	Mean	0.2	2	2	24160	26040	3980	316.6	26.6	33.6
HOWARD RUN (EWH)										
0.60	0705	0.2	2	2	490	590	1440	295	25.2	17
	0718	0.2	2	2	982	1050	3600	298	24.8	10
	0801	0.2	2	2	2500	1130	3200	282	24.3	10
	0829	0.2	2	2	710	745	3000	275	26.9	10
	0912	0.2	2	2	400	773	770	278	29.4	10
	Mean	0.2	2	2	1016.4	857.6	2402	285.6	26.1	11.4
LAKE RUN (EWH)										
0.90	0705	0.2	2	2	680	636	2200	292	19.1	11
	0718	0.2	2	2	2800	3200	4700	284	15.3	10
	0801	0.2	2	2	530	390	1190	275	15.3	10
	0829	0.2	2	2	100	80	2000	310	10.9	10
	0913	0.2	2	2	410	430	920	303	8.2	10
	Mean	0.2	2	2	904	947.2	2202	292.8	13.8	10.2
JUMPING RUN (EWH)										
0.30	0705	0.2	2	2	1130	1430	2700	290	21.4	10
	0718	0.2	2	2	1200	1100	5300	301	20	10

Little Darby Creek Tributaries

RM	Date	Cd	Pb	Se	E coli	Fecal	Fecal	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0801	0.2	2	2.4	1100	1040	8100	285	22.4	10
	0829	0.2	2	2	3800	5200	6700	303	21.5	10
	0913	0.2	2	2	891	900	3900	296	27.8	10
	Mean	0.2	2	2.08	1624.2	1934	5340	295	22.6	10
CLOVER RUN (EWH)										
0.60	0705	0.2	2	2	745	846	865	305	24.2	10
	0718	0.2	2	2	4250	5480	5600	299	21.3	13
	0801	0.2	2	2	740	390	1440	311	23.6	10
	0829	0.2	2	2	340	390	1800	290	21.1	10
	0913	0.2	2	2	460	170	1160	326	21.5	10
	Mean	0.2	2	2	1307	1455.2	2173	306.2	22.3	10.6
TREACLE CREEK (EWH)										
11.80	0705	0.2	2	2	320	320	780	280	21.9	14
	0718	0.2	2	2	740	745	1060	287	18.4	10
	0801	0.2	2	2	1010	636	2300	267	20.8	10
	0829	0.2	2	2	490	590	760	285	18.2	10
	0912	0.2	2	2	330	400	560	282	22.5	10
	Mean	0.2	2	2	578	538.2	1092	280.2	20.4	10.8
8.30	0705	0.2	2	2	480	530	540	292	24.9	17
	0718	0.2	2	2	818	736	980	297	23.6	10
	0801	0.2	2	2	420	220	1130	270	26.6	10
	0829	0.2	2	2	20	65	80	283	25	10
	0912	0.2	2	2	240	260	400	281	22.1	10
	Mean	0.2	2	2	395.6	362.2	626	284.6	24.4	11.4
6.00	0705	0.2	2	2	891	1130	1000	284	25.6	17
	0718	0.2	2	2	2300	1800	2700	285	25.4	10
	0801	0.2	2	2	225	1850	32500	267	24.3	11
	0829	0.2	2	2	460	545	1110	284	25	10
	0912	0.2	2	2	190	240	690	265	21.3	10
	Mean	0.2	2	2	813.2	1113	7600	277	24.3	11.6
0.80	0705	0.2	2	2	400	945	630	284	23.9	58

Little Darby Creek Tributaries										
RM	Date	Cd	Pb	Se	E coli	Fecal	Fecal	Alkalinity	Cl	COD
	mmdd	µg/l	µg/l	µg/l	#/100 ml	#/100 ml	#/100 ml	mg/l	mg/l	mg/l
	0718	0.2	2	2	10500	10460	14100	273	21.8	10
	0801	0.2	2	2	210	2000	785	279	23.7	10
	0829	0.2	2	2	2300	1230	655	280	22.4	10
	0912	0.2	2	2	670	827	960	238	20.7	10
	Mean	0.2	2	2	2816	3092.4	3426	270.8	22.5	19.6
PROCTOR RUN (EWH)										
4.90	0705	0.2	2	2	2600	3300	4000	301	25.7	11
	0718	0.2	2	2	9730	11100	25000	315	9	10
	0801	0.2	2	2	2400	1160	3100	218	16.3	11
	0829	0.2	2	2	60	30	410	287	13.8	10
	0912	0.2	2	2	3900	3600	540	223	16.2	10
	Mean	0.2	2	2	3738	3838	6610	268.8	16.2	10.4
3.10	0705	0.2	2	2	150	260	440	287	16.4	14
	0718	0.2	2	2	570	600	1230	300	15.2	10
	0801	0.2	2	2	120	160	310	245	17.1	11
	0829	0.2	2	2	43000	40000	980	283	17.7	10
	0912	0.2	2	2	40	130	120	260	17.2	10
	Mean	0.2	2	2	8776	8230	616	275	16.7	11
1.60	0705	0.2	2	2	260	380	490	286	17.5	11
	0718	0.2	2	2	500	550	850	285	17.2	10
	0801	0.2	2	2	100	80	510	241	17.8	10
	0829	0.2	2	2	70	130	690	273	17.3	10
	0912	0.2	2	2	40	70	10	256	18.4	10
	Mean	0.2	2	2	194	242	510	268.2	17.6	10.2

Appendix Table C.1.15. Results of water column nutrient sampling conducted in Little Darby Creek Tributaries during June-September, 2001. Underlined values indicate concentrations below the method detection limit. NA means not analyzed. CG indicates confluent growth for microbiological results, a subscript b indicates the parameter was detected in the field blank. Warmwater Habitat (WWH) sites are noted with the river mile in plain print, Exceptional Warmwater Habitat (EWH) sites are printed in **boldface**, undesignated streams are noted with a U, and Modified Warmwater Habitat (MWH) sites are underlined. An E and italic print in the river mile indicates an effluent sample.

Little Darby Creek Tributaries							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
				SPRING FORK (EWH)			
15.90	0705	0.02	0.05	3.91	51.6	0.42	0.05
	0718	0.025	0.05	3.76	33	1.06	0.154
	0801	0.02	0.05	1.77	38	0.72	0.05
	0829	0.02	0.05	0.63	40.5	0.43	0.05
	0913	0.041	0.05	1.81	40.3	0.44	0.05
	Mean	0.0252	0.05	2.376	40.68	0.614	0.0708
13.40	0705			No sample			
	0718	0.044	0.05	2.99	27.4	1.00	0.175
	0801	0.02	0.05	1.86	44.3	0.68	0.05
	0829	0.02	0.05	0.36	62.5	0.39	0.05
	0913	0.02	0.05	0.23	98.3	0.35	0.05
	Mean	0.026	0.05	1.36	58.125	0.605	0.08125
7.80	0705	0.02	0.05	5.06	55	0.51	0.05
	0718	0.038	0.05	1.80	47	0.47	0.074
	0801	0.02	0.05	2.15	43.4	0.71	0.05
	0829	0.02	0.05	0.24	66	0.53	0.05
	0913	0.02	0.05	0.10	61.8	0.54	0.05
	Mean	0.0236	0.05	1.87	54.64	0.552	0.0548
0.80	0705	0.025	0.05	5.34	51.1	0.40	0.05
	0718	0.035	0.07	1.72	48.8	0.57	0.10
	0801	0.048	0.063	2.88	32.8	0.72	0.072
	0829	0.023	0.095	1.10	49.4	0.64	0.129
	0913	0.025	0.05	2.29	56.4	0.70	0.174
	Mean	0.0312	0.0656	2.666	47.7	0.606	0.105

Little Darby Creek Tributaries							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BALES DITCH (Undesignated)							
0.40 U	0705	0.035	0.05	8.28	53.6	0.59	0.05
	0718	0.02	0.05	0.85	60.2	0.57	0.062
	0801	0.035	0.05	3.04	42.6	0.62	0.05
	0829	0.02	0.05	0.18	42.7	0.76	0.075
	0913	0.02	0.05	0.10	37.4	0.62	0.05
	Mean	0.026	0.05	2.49	47.3	0.632	0.0574
BARRON CREEK (EWH)							
0.20	0705	0.043	0.064	4.56	76.5	0.73	0.055
	0718	0.031	0.061	0.78	85.8	0.52	0.05
	0801	0.025	0..156	0.18	86.9	0.70	0.112
	0829	0.02	0.077	0.10	81.8	0.91	0.155
	0913	0.02	0.05	0.10	77.1	0.58	0.053
	Mean	0.0278	0.0504	1.144	81.62	0.688	0.085
HOWARD RUN (EWH)							
0.60	0705	0.026	0.05	4.76	72	0.27	0.05
	0718	0.02	0.05	2.16	74.5	0.37	0.05
	0801	0.02	0.05	0.90	70.9	0.41	0.05
	0829	0.02	0.052	0.26	80.6	0.31	0.052
	0912	0.02	0.05	0.53	63.3	0.61	0.05
	Mean	0.0212	0.0504	1.722	72.26	0.394	0.0504
LAKE RUN (EWH)							
0.90	0705	0.021	0.05	2.12	50.1	0.51	0.05
	0718	0.021	0.073	1.04	47.4	0.41	0.05
	0801	0.02	0.067	0.39	43.4	0.40	0.05
	0829	0.02	0.083	0.13	46	0.43	0.05
	0913	0.02	0.097	0.10	43.4	0.35	0.05
	Mean	0.0204	0.074	0.756	46.06	0.42	0.05
JUMPING RUN (EWH)							
0.30	0705	0.02	0.05	3.81	58.2	0.33	0.05
	0718	0.02	0.05	2.66	57.2	0.23	0.05

Little Darby Creek Tributaries							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0801	0.02	0.05	1.95	58	0.36	0.05
	0829	0.02	0.05	0.65	59	0.33	0.05
	0913	0.02	0.05	0.34	62.7	0.44	0.05
	Mean	0.02	0.05	1.882	59.02	0.338	0.05
CLOVER RUN (EWH)							
0.60	0705	0.02	0.05	1.86	58.4	0.38	0.069
	0718	0.02	0.05	1.46	55	0.42	0.08
	0801	0.02	0.05	0.97	56.1	0.25	0.05
	0829	0.02	0.05	0.68	62.3	0.35	0.05
	0913	0.02	0.05	0.33	58.4	0.35	0.054
	Mean	0.02	0.05	1.06	58.04	0.35	0.0606
TREACLE CREEK (EWH)							
11.80	0705	0.028	0.05	3.42	36.3	0.39	0.05
	0718	0.026	0.057	1.04	35.1	0.48	0.05
	0801	0.153	0.757	0.94	34.1	1.86	0.078
	0829	0.073	0.304	0.62	34.1	0.88	0.079
	0912	0.02	0.05	1.10	35.5	0.44	0.056
	Mean	0.06	0.2436	1.424	35.02	0.81	0.0626
8.30	0705	0.02	0.05	3.12	59.1	0.45	0.05
	0718	0.02	0.05	2.07	56.9	0.33	0.05
	0801	0.02	0.05	1.29	59.8	0.45	0.05
	0829	0.02	0.05	1.05	59.6	0.24	0.05
	0912	0.02	0.05	2.58	81.2	0.36	0.521
	Mean	0.02	0.05	2.022	63.32	0.366	0.1442
6.00	0705	0.02	0.05	3.73	57.7	0.43	0.05
	0718	0.02	0.05	1.87	58.7	0.37	0.054
	0801	0.02	0.05	1.25	56.4	0.21	0.052
	0829	0.02	0.05	0.62	57.4	0.34	0.05
	0912	0.02	0.05	2.86	72.7	0.60	0.05
	Mean	0.02	0.05	2.066	60.58	0.39	0.0512
0.80	0705	0.027	0.05	5.64	64.4	0.58	0.05

Little Darby Creek Tributaries							
RM	Date	NO_2-N	NH_3-N	NO_2+NO_3-N	SO_4	TKN	P
	mmdd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0718	0.031	0.10	1.74	62.7	0.46	0.063
	0801	0.024	0.104	1.58	69	0.48	0.069
	0829	0.02	0.133	0.45	63.3	0.40	0.06
	0912	0.02	0.05	1.11	52.4	0.68	0.093
	Mean	0.0244	0.0874	2.104	62.36	0.52	0.067
PROCTOR RUN (EWH)							
4.90	0705	0.02	0.05	1.55	44.2	0.44	0.05
	0718	0.02	0.071	0.51	40.8	0.27	0.053
	0801	0.02	0.05	0.18	35.1	0.51	0.05
	0829	0.02	0.099	0.32	37.9	0.39	0.05
	0912	0.02	0.05	0.22	35.8	0.39	0.111
	Mean	0.02	0.064	0.556	38.76	0.4	0.0628
3.10	0705	0.02	0.05	4.54	53.7	0.38	0.05
	0718	0.025	0.05	2.88	50.7	0.44	0.05
	0801	0.02	0.05	1.03	44.2	0.62	0.05
	0829	0.02	0.05	0.85	46.6	0.32	0.05
	0912	0.02	0.05	0.97	45.8	0.49	0.05
	Mean	0.021	0.05	2.054	48.2	0.45	0.05
1.60	0705	0.022	0.05	3.94	64.2	0.30	0.05
	0718	0.02	0.05	2.11	64.6	0.44	0.05
	0801	0.02	0.05	0.84	53.1	0.46	0.05
	0829	0.02	0.05	0.49	61.1	0.42	0.05
	0912	0.02	0.05	1.02	51.9	0.53	0.05
	Mean	0.0204	0.05	1.68	58.98	0.43	0.05

Appendix C.2 Physical Habitat

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Key QHEI Components

			WWH Attributes											MWH Attributes																		
														High Influence					*Moderate Influence*													
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	**Total HIL MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total MIL MWH Attributes**	**(MWH HIL+1)/(WWH+1) Ratio**	**(MWH MIL+1)/(WWH+1) Ratio**
(02-200) Big Darby Creek																																		
Year: 2002																																		
66.0	74.5	4.35	■	■		■	■	■	■	■	■	■	9						0		•								•	•		3	0.10	0.40
26.1	94.5	7.87	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
15.7	88.5	3.94	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
10.4	85.0	4.15	■	■		■	■	■	■	■	■	■	9						0										•	•		2	0.10	0.30
8.4	69.5	4.74	■	■		■	■	■	■		■		7						0	•	•								•	•		4	0.13	0.63
Year: 2001																																		
82.5	68.0	43.48	■	■		■	■	■		■	■	■	8						0	•				•				•	•	•		5	0.11	0.67
80.8	61.0	19.61	■	■		■	■	■			■		6		♦				1	•	•		•	•				•	•	•		7	0.29	1.29
79.2	64.5	12.20	■	■		■	■	■	■		■		7						0	•				•					•	•		4	0.13	0.63
78.4	63.5	12.50	■	■				■			■		4			♦			1	•				•				•	•	•		5	0.40	1.40
76.6	73.5	6.94	■	■		■	■	■	■		■		7						0				•						•	•		3	0.13	0.50
69.5	70.5	5.92	■	■		■	■	■			■		6						0	•	•				•			•	•	•		6	0.14	1.00
63.8	80.5	8.93	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
62.5	83.5	3.80	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
54.2	83.5	4.76	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
53.9	93.0	4.76	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
52.0	81.0	5.21		■		■	■	■	■	■	■	■	8						0	•												1	0.11	0.22
49.5	76.0	4.69	■	■		■	■	■	■		■	■	8						0				•	•					•	•		4	0.11	0.56
42.0	81.5	7.40	■	■		■	■	■		■	■	■	8						0									•		•		2	0.11	0.33
38.9	82.5	3.97	■	■		■	■	■	■		■		7						0		•								•	•		3	0.13	0.50
34.1	93.5	4.48	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
29.1	86.0	4.52	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
23.8	87.5	6.71	■	■		■	■	■	■	■	■	■	9						0											•		1	0.10	0.20
22.8	84.5	4.10	■	■		■	■	■	■	■	■	■	9						0											•		1	0.10	0.20
18.7	85.0	4.74	■	■		■	■	■	■	■	■	■	9						0											•		1	0.10	0.20
13.4	85.5	4.37	■	■		■	■	■	■	■	■	■	9						0											•		1	0.10	0.20
3.1	82.0	2.86	■	■		■	■	■	■	■	■	■	9						0										•	•		2	0.10	0.30
0.3	71.5	12.20	■	■		■	■	■	■	■	■		8						0		•								•	•		3	0.11	0.44
(02-201) Georges Creek																																		
Year: 2001																																		
0.9	61.0	58.82	■	■		■	■	■		■	■		7						0		•							•	•	•		4	0.13	0.63

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Key QHEI Components

			WWH Attributes											MWH Attributes																							
														High Influence					*Moderate Influence*																		
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	≤ 1 Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max Depth > 40 cm	Low/Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	≤ 1/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (MD, HW)	**Total HI MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total MI MWH Attributes**	**(MWH HI+1)/(WWH+1) Ratio**	**(MWH MI+1)/(WWH+1) Ratio**
(02-202) Greenbrier Creek																																					
Year: 2001																																					
2.7	57.0	34.48	■	■			■	■		■	■		6						0				●	●				●		●		●	5	0.14	0.86
1.3	74.5	17.86	■	■		■	■	■		■	■	■	8						0				●	●				●		●			4	0.11	0.56
(02-203) Springwater Run																																					
Year: 2001																																					
0.8	48.5	50.00		■		■	■	■					4			♦	♦	♦	3	●	●			●				●		●	●		6	0.80	2.00
(02-204) Hellbranch Run																																					
Year: 2001																																					
10.3	39.5	3.37									■		1		♦		♦		2	●	●			●	●			●		●		●	7	1.50	5.00
7.4	51.0	7.52		■						■	■		3				♦		1	●	●			●	●			●			●		6	0.50	2.00
5.8	65.5	7.30	■	■						■	■	■	5				♦		1		●			●	●			●			●		5	0.33	1.17
3.7	83.5	16.67	■	■		■	■	■	■	■	■	■	9						0														0	0.10	0.10
1.0	84.5	11.36	■	■		■	■	■	■	■	■	■	9						0							●							1	0.10	0.20
0.5	83.5	11.36	■	■		■	■	■	■	■	■	■	9						0														0	0.10	0.10
(02-206) Sugar Run																																					
Year: 2001																																					
7.5	31.0	7.52		■									1		♦		♦	♦	♦	4	●	●			●				●		●		●	6	2.50	5.50
7.0	29.5	7.52											0	♦	♦		♦	♦	♦	5		●			●		●		●		●		●	6	6.00	*.**
5.4	38.5	5.21									■		1	♦	♦		♦	♦		4		●			●				●		●		●	5	2.50	5.00
0.5	65.5	7.69		■		■	■	■	■		■		6						0	●	●									●	●		4	0.14	0.71
(02-207) Robinson Run																																					
Year: 2001																																					
2.1	64.0	9.35	■	■			■	■		■	■	■	7				♦		1	●			●	●				●					4	0.25	0.75
0.7	70.0	15.87	■	■		■	■	■		■	■	■	8				♦		1	●				●				●		●	●		5	0.22	0.78
(02-209) Buck Run																																					
Year: 2001																																					
10.4	40.0	5.99		■									1	♦			♦	♦	♦	4	●	●		●	●				●		●		●	7	2.50	6.00
7.8	55.5	6.58	■	■		■	■	■			■		6				♦		1					●				●		●	●		4	0.29	0.86
0.1	70.5	6.71	■	■			■	■		■	■	■	7						0		●			●				●		●			4	0.13	0.63
(02-210) Little Darby Creek																																					
Year: 2002																																					
41.2	70.0	43.47	■	■		■	■	■	■		■		7						0		●							●		●	●		4	0.13	0.63

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Key QHEI Components

			WWH Attributes												MWH Attributes																							
															High Influence					*Moderate Influence*																		
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	≤ 1 Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**		Channelized or No Recovery	≤ 1/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (MD, HW)	**Total HI, MWH Attributes**		Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle		**Total MI, MWH Attributes**	**(MWH HI+1)/(WWH+1) Ratio**	**(MWH MI+1)/(WWH+1) Ratio**
(02-210) Little Darby Creek																																						
Year: 2002																																						
26.6	58.0	2.17	■	■		■	■	■	■		■		7							0			•								•	•			3	0.13	0.50
23.1	55.5	2.02		■				■			■		3			♦				1		•	•		•	•			•		•	•			7	0.50	2.25
20.5	64.5	3.18		■		■		■	■	■	■	■	7							0		•	•		•	•					•	•			6	0.13	0.88
Year: 2001																																						
41.2	80.5	43.47	■	■		■	■	■	■	■	■	■	9							0															0	0.10	0.10
39.6	69.5	13.33	■	■		■	■	■	■		■		7					♦		1		•	•		•				•		•	•			6	0.25	1.00
38.8	82.0	12.99	■	■		■	■	■	■	■	■	■	9							0			•		•				•		•				4	0.10	0.50
34.7	82.5	4.72	■	■	■	■	■	■	■	■	■	■	10							0															0	0.09	0.09
29.5	66.5	2.67	■	■		■		■	■	■	■	■	8							0		•	•				•					•			4	0.11	0.56
24.5	62.5	2.02		■			■	■	■		■		5							0		•	•		•	•			•		•	•			7	0.17	1.33
15.3	95.5	2.69	■	■	■	■	■	■	■	■	■	■	10							0															0	0.09	0.09
6.5	95.5	8.47	■	■		■	■	■	■	■	■	■	9							0															0	0.10	0.10
4.1	99.0	5.59	■	■	■	■	■	■	■	■	■	■	10							0															0	0.09	0.09
0.7	63.5	7.30	■	■					■		■		4					♦		1					•	•					•	•			4	0.40	1.20
0.2	77.5	9.90		■		■		■	■	■	■		6							0		•	•		•	•					•	•			6	0.14	1.00
0.2	77.5	9.90		■	■	■	■	■	■	■	■	■	9							0		•			•	•			•		•				5	0.10	0.60
(02-211) Spring Fork																																						
Year: 2002																																						
10.1	69.0	3.73	■	■		■	■	■	■		■		7							0			•								•	•			3	0.13	0.50
3.3	67.5	8.30		■		■	■	■			■		5							0		•	•		•				•		•	•		•	6	0.17	1.17
Year: 2001																																						
15.8	60.5	17.24	■	■				■		■	■	■	6					♦		1		•			•				•						3	0.29	0.71
13.7	62.5	12.99		■		■	■	■		■	■	■	7					♦		1		•	•		•				•		•	•			6	0.25	1.00
13.4	53.0	12.99	■	■					■	■	■		5					♦	♦	2			•		•								•		3	0.50	1.00
7.8	54.5	3.33		■			■	■			■		4					♦	♦	2		•	•		•				•		•	•			6	0.60	1.80
(02-212) Barron Creek																																						
Year: 2001																																						
2.1	44.5	5.26		■						■	■		3					♦	♦	2		•			•				•		•	•			5	0.75	2.00
(02-213) Treacle Creek																																						
Year: 2001																																						
11.8	67.5	15.63	■	■			■	■		■	■	■	7					♦		1			•		•				•		•	•			5	0.25	0.88

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Key QHEI Components

WWH Attributes: No Channelization or Recovered; Boulder/Cobble/Gravel Substrates; ≤ 1 Fine Substrates; Good/Excellent Substrates; Moderate/High Sinuosity; Extensive/Moderate Cover; Fast Current; Eddies; Low-Normal Overall Embeddedness; Max Depth > 40 cm; Low-Normal Riffle Embeddedness; Total WWH Attributes

MWH Attributes — *High Influence*: Channelized or No Recovery; ≤ 1 Muck Substrates; No Sinuosity; Sparse/No Cover; Max Depth < 40 cm (MD, HW); Total HL MWH Attributes

MWH Attributes — *Moderate Influence*: Recovering Channel; Heavy/Moderate Silt Cover; Sand Substrates (Boat); Hardpan Substrate Origin; Fair/Poor Development; Low Sinuosity; Only 1-2 Cover Types; Intermittent and Poor Pools; No Fast Current; High/Mod. Overall Embeddedness; High/Mod. Riffle Embeddedness; No Riffle; Total ML MWH Attributes; (MWH HL+1)/(WWH+1) Ratio; (MWH ML+1)/(WWH+1) Ratio

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes	Total WWH Attributes	High Influence	Total HL MWH Attributes	Moderate Influence	Total ML MWH Attributes	(MWH HL+1)/(WWH+1) Ratio	(MWH ML+1)/(WWH+1) Ratio
(02-222) Spain Creek										
Year: 2001										
5.7	66.0	22.22	■ ■ ■ ■ ■ ■ ■ ■	8		0	• • •	3	0.11	0.44
3.7	72.0	21.74	■ ■ ■ ■ ■ ■ ■ ■ ■	9		0	•	1	0.10	0.20
0.1	76.0	11.36	■ ■ ■ ■ ■ ■ ■ ■	8		0	• •	2	0.11	0.33
(02-223) Flat Branch										
Year: 2001										
3.2	25.5	9.09		0	♦ ♦ ♦ ♦ ♦	5	• • • • •	6	6.00	*.**
0.8	36.5	4.93	■	1	♦ ♦ ♦	3	• • • • • •	7	2.00	5.50
(02-245) Clover Groff Ditch										
Year: 2001										
4.7	22.0	3.39		0	♦ ♦ ♦ ♦ ♦	5	• • • • •	5	6.00	*.**
0.8	61.5	9.90	■ ■ ■ ■ ■ ■ ■ ■	8	♦	1	• • • •	4	0.22	0.67
(02-251) Little Darby Creek (B. Darby headwaters)										
Year: 2002										
3.5	32.0	31.25	■ ■ ■	3	♦ ♦ ♦ ♦	4	• • • •	4	1.25	2.25
Year: 2001										
3.5	71.5	31.25	■ ■ ■ ■ ■ ■ ■ ■ ■	9		0		0	0.10	0.10
0.4	68.0	26.32	■ ■ ■ ■ ■ ■ ■	8		0	•	1	0.11	0.22
(02-259) Hamilton Ditch										
Year: 2001										
3.4	21.0	4.44		0	♦ ♦ ♦ ♦ ♦	5	• • • • •	5	6.00	*.**
0.5	36.5	7.41		0	♦ ♦ ♦ ♦ ♦	5	• • • • • •	6	6.00	*.**
(02-270) Trib. to Big Darby Creek (RM 20.20)										
Year: 2001										
0.8	77.5	25.64	■ ■ ■ ■ ■ ■ ■ ■	8		0	• • •	3	0.11	0.44
(02-272) Fitzgerald Ditch										
Year: 2001										
0.5	56.5	33.33	■ ■ ■ ■	4	♦ ♦	2	• • • • • •	6	0.60	1.80
(02-298) Gay Run										
Year: 2001										
2.2	66.5	55.56	■ ■ ■ ■ ■ ■ ■	7		0	• •	2	0.13	0.38
(02-352) Trib. to Big Darby Creek (RM 23.77)										
Year: 2001										

Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

			WWH Attributes										MWH Attributes																							
													High Influence					*Moderate Influence*																		
Key QHEI Components			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	≤ 1 Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max Depth > 40 cm	Low/Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	≤ 1/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (MD, HM)	**Total HI MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total MI MWH Attributes**	**(MWH HI+1)/(WWH+1) Ratio**	**(MWH MI+1)/(WWH+1) Ratio**
River Mile	**QHEI**	**Gradient (ft/mile)**																																		
(02-363) Wamp Ditch																																				
Year: 2001																																				
0.1	45.5	12.50	■							■		■	3	♦			♦	♦	♦	4	●				●				●	●	●		5	1.25	2.50
(02-365) Trib. to Flat Branch (RM 1.50)																																				
Year: 2001																																				
0.1	36.5	4.42									■		1		♦		♦	♦		3	●	●			●				●	●	●		6	2.00	5.00
(02-366) Trib. to Big Darby Creek (RM 18.41)																																				
Year: 2002																																				
0.1	52.5	27.78									■	■	2				♦	♦	♦	3	●	●			●				●	●	●		6	1.33	3.33

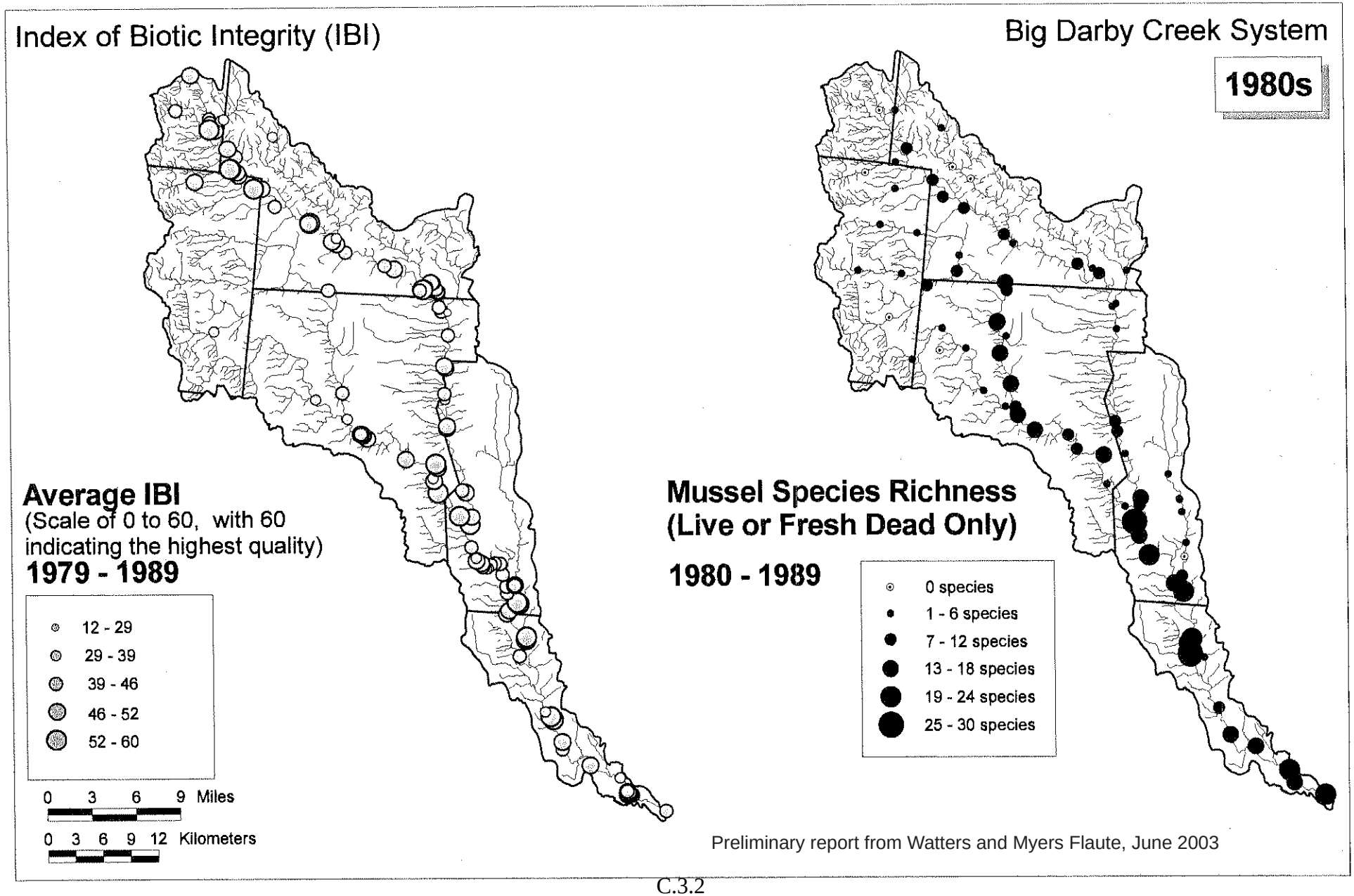
Qualitative Habitat Evaluation Index (QHEI) for sites in the Big Darby Creek basin.

Key QHEI Components

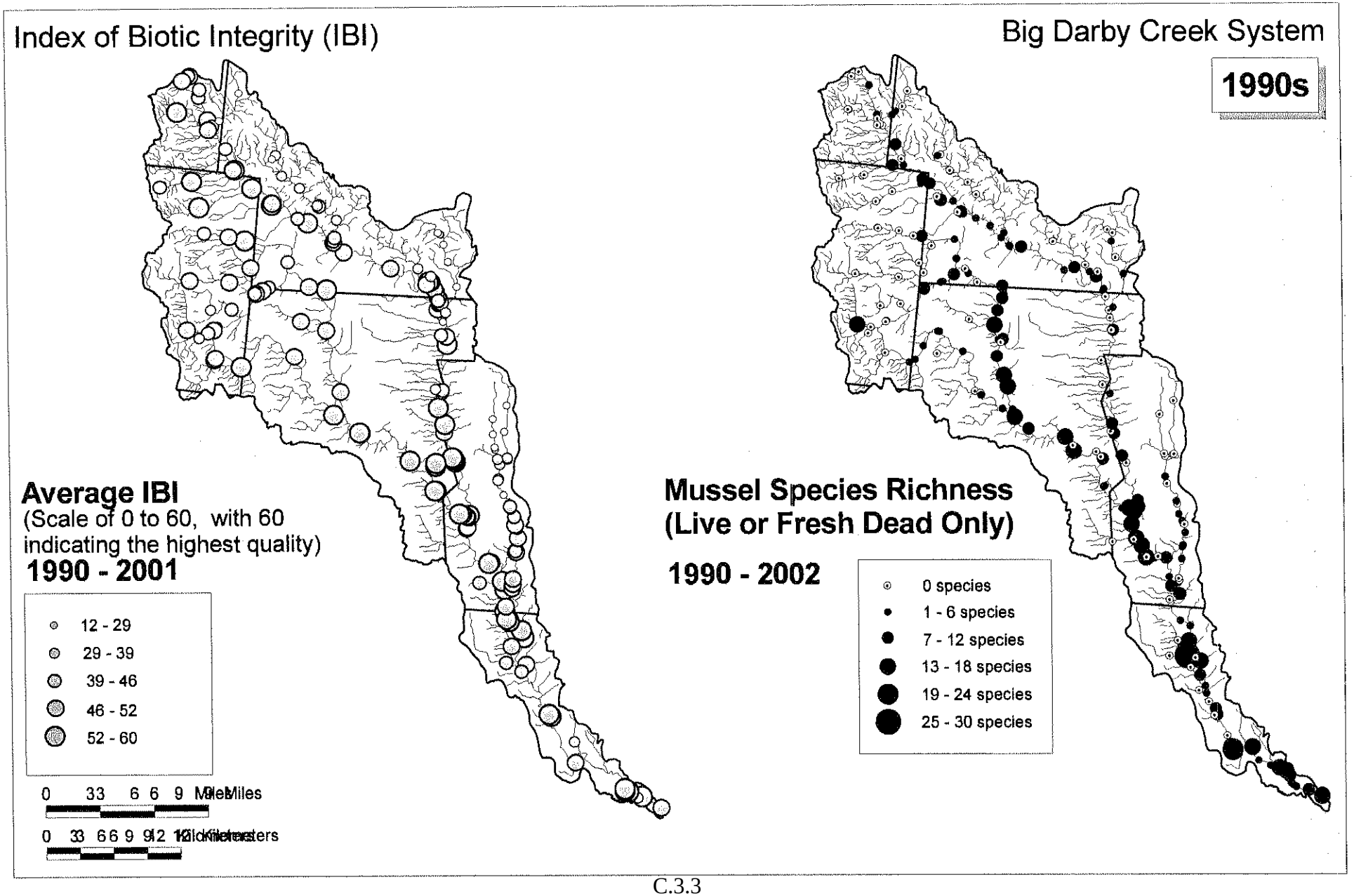
			WWH Attributes											MWH Attributes																							
														High Influence					*Moderate Influence*																		
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	≤ 1 Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	≤ 1/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (MD, HW)	**Total H.I. MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**	**(MWH H.I.+1)/(WWH+1) Ratio**	**(MWH M.I.+1)/(WWH+1) Ratio**
(02-352) Trib. to Big Darby Creek (RM 23.77)																																					
Year: 2001																																					
0.1	61.5	111.1	■	■		■	■	■		■			6				♦		♦	2				●			●				●	3	0.43	0.86
(02-353) Smith Ditch																																					
Year: 2001																																					
2.1	77.5	40.00	■	■		■	■	■			■		6							0								●		●	●	3	0.14	0.57
0.3	73.0	35.71	■	■		■	■	■		■	■		7							0								●			●	2	0.13	0.38
(02-354) Trib. to Smith Ditch																																					
Year: 2001																																					
0.2	67.0	76.92	■	■		■	■	■		■	■	■	8					♦		1		●						●		●		3	0.22	0.56
(02-355) Ballenger-Jones Ditch																																					
Year: 2001																																					
0.4	69.0	15.15	■	■		■	■	■	■		■		7							0		●								●	●	3	0.13	0.50
(02-356) Worthington Ditch																																					
Year: 2001																																					
0.2	46.5	20.83		■							■		2	♦			♦	♦		3		●		●		●		●		●	●	6	1.33	3.33
(02-357) Sweeny Run																																					
Year: 2001																																					
0.1	58.0	31.25		■			■	■	■		■		5				♦	♦		2	●	●		●						●	●	5	0.50	1.33
(02-358) Trib. to Sugar Run (RM 7.39)																																					
Year: 2001																																					
0.1	27.0	3.73											0	♦	♦		♦	♦	♦	5	●	●		●				●		●		●	6	6.00	*.**
(02-360) Trib. to Big Darby Creek (RM 69.40)																																					
Year: 2002																																					
0.3	30.5	17.86											0	♦	♦		♦	♦	♦	5		●		●				●		●	●	●	6	6.00	*.**
Year: 2001																																					
0.3	33.5	17.86											0		♦		♦	♦	♦	4	●	●		●				●		●	●		6	5.00	*.**
(02-361) Trib. to Big Darby Creek (RM 74.91)																																					
Year: 2001																																					
0.2	62.5	13.51	■	■		■	■	■	■		■		7							0		●		●						●	●		4	0.13	0.63
(02-362) Bales Ditch																																					
Year: 2001																																					
0.4	70.0	17.86	■	■		■	■	■		■	■	■	8							0		●			●			●					3	0.11	0.44

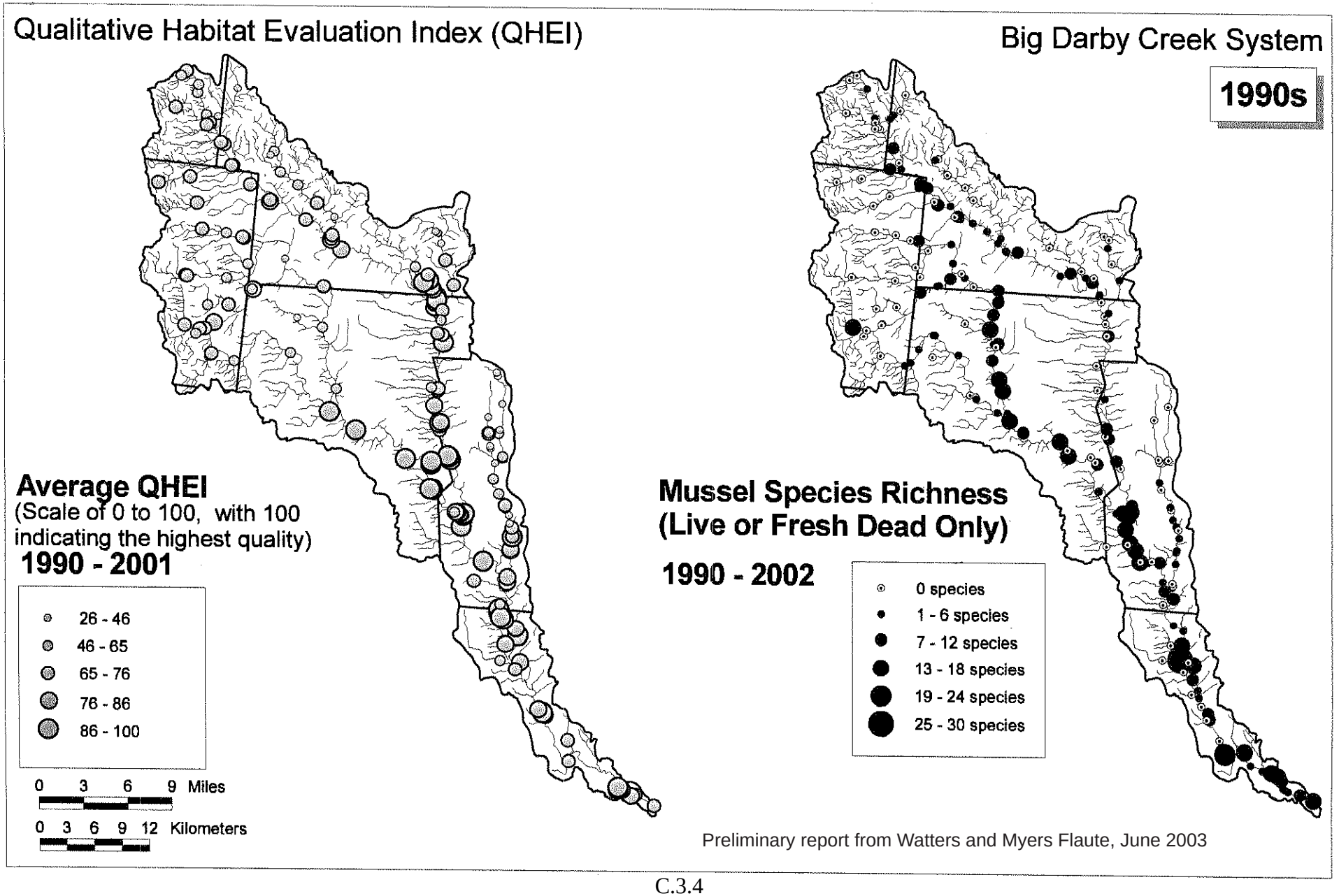
Appendix C.3 Mussel Species Richness Maps

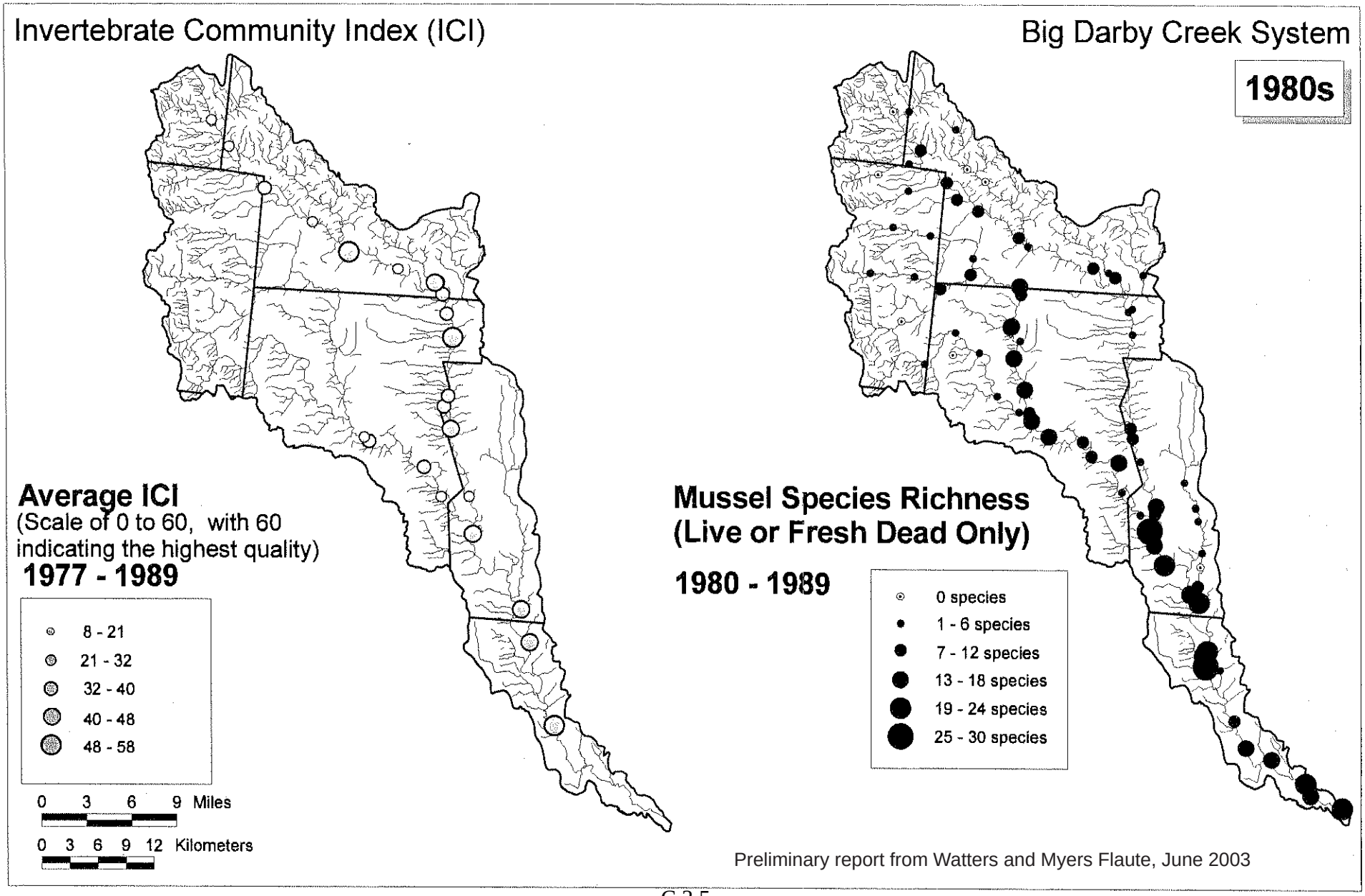
A Selection of various
Mussel Species Richness Maps as related to
certain Physical, Chemical, or Biological Parameters
and some
Individual Mussel Species Distribution Maps
from
the preliminary report of:
Trends in freshwater Mussel Populations in the
Big Darby Creek: A GIS Approach.
by
G.T. Watters and C.J. Myers Flaute, June 2003

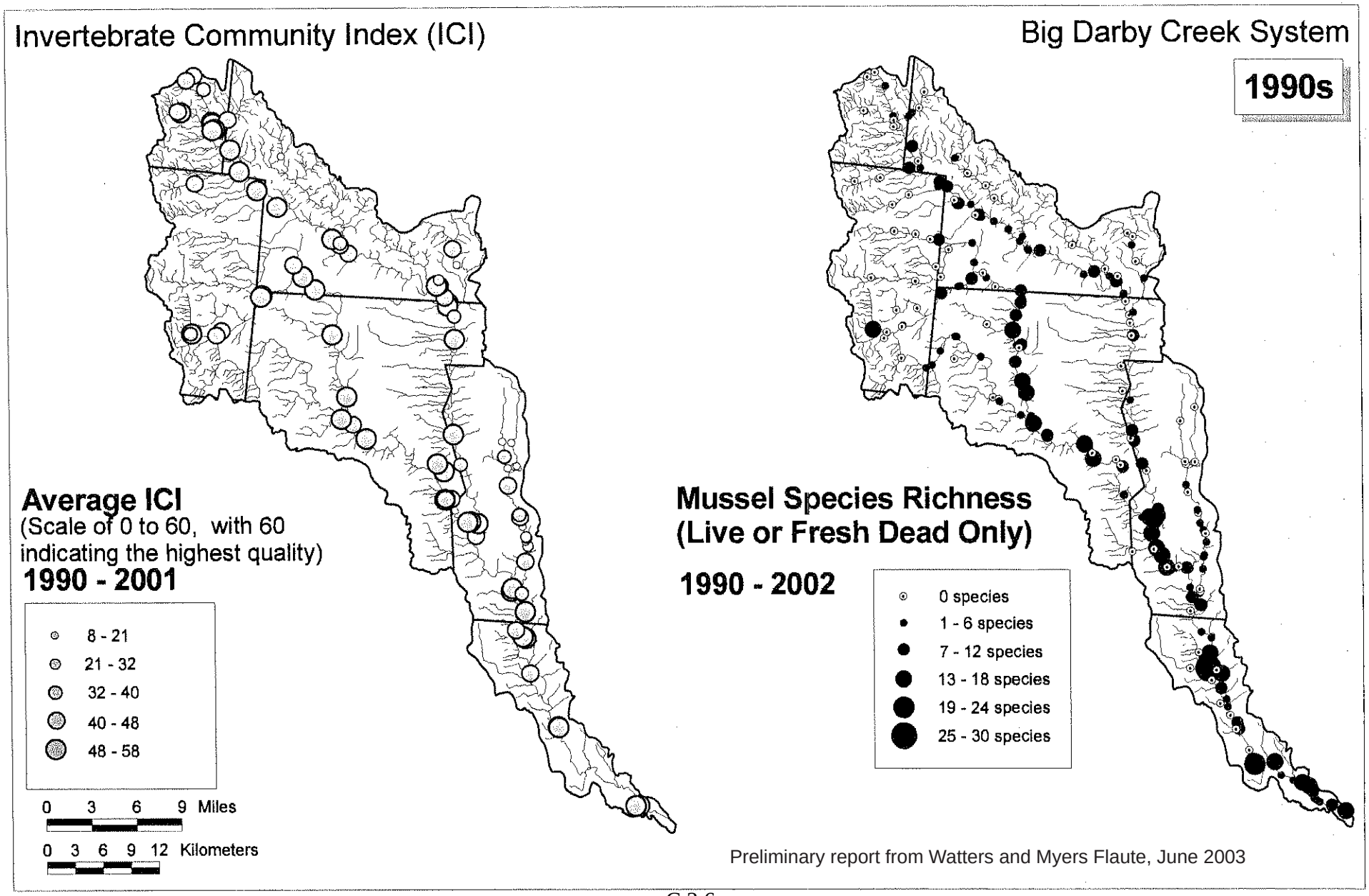


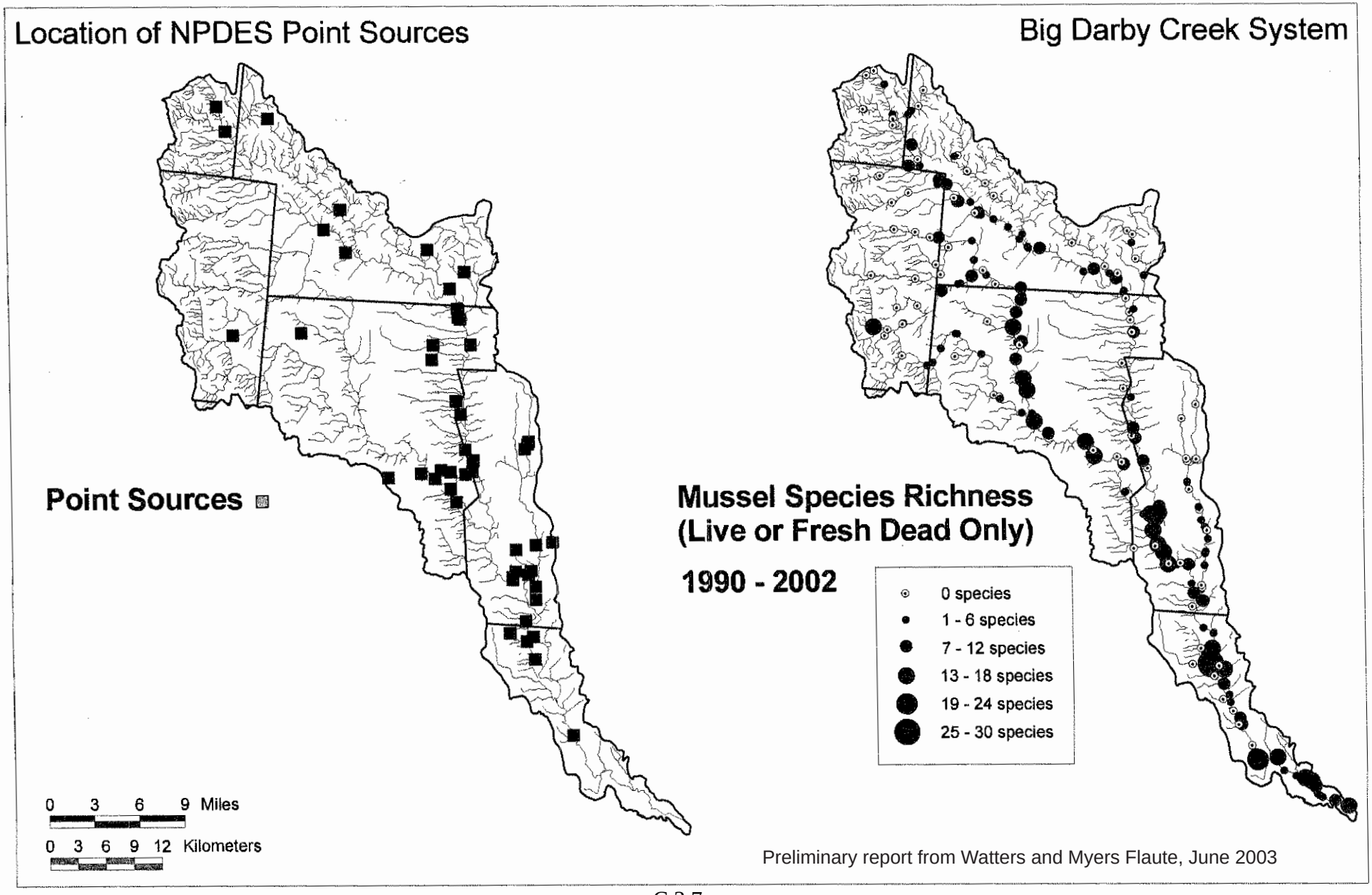
Preliminary report from Watters and Myers Flaute, June 2003


Index of Biotic Integrity (IBI)
Average IBI
(Scale of 0 to 60, with 60 indicating the highest quality)
1990 - 2001
12 - 29
29 - 39
39 - 46
46 - 52
52 - 60
Big Darby Creek System
1990s
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species


Qualitative Habitat Evaluation Index (QHEI)
Big Darby Creek System
1990s
Average QHEI
(Scale of 0 to 100, with 100 indicating the highest quality)
1990 - 2001
26 - 46
46 - 65
65 - 76
76 - 86
86 - 100
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


Invertebrate Community Index (ICI)
Big Darby Creek System
1980s
Average ICI
(Scale of 0 to 60, with 60 indicating the highest quality)
1977 - 1989
8 - 21
21 - 32
32 - 40
40 - 48
48 - 58
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1980 - 1989
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


Invertebrate Community Index (ICI)
Big Darby Creek System
1990s
Average ICI
(Scale of 0 to 60, with 60 indicating the highest quality)
1990 - 2001
8 - 21
21 - 32
32 - 40
40 - 48
48 - 58
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003



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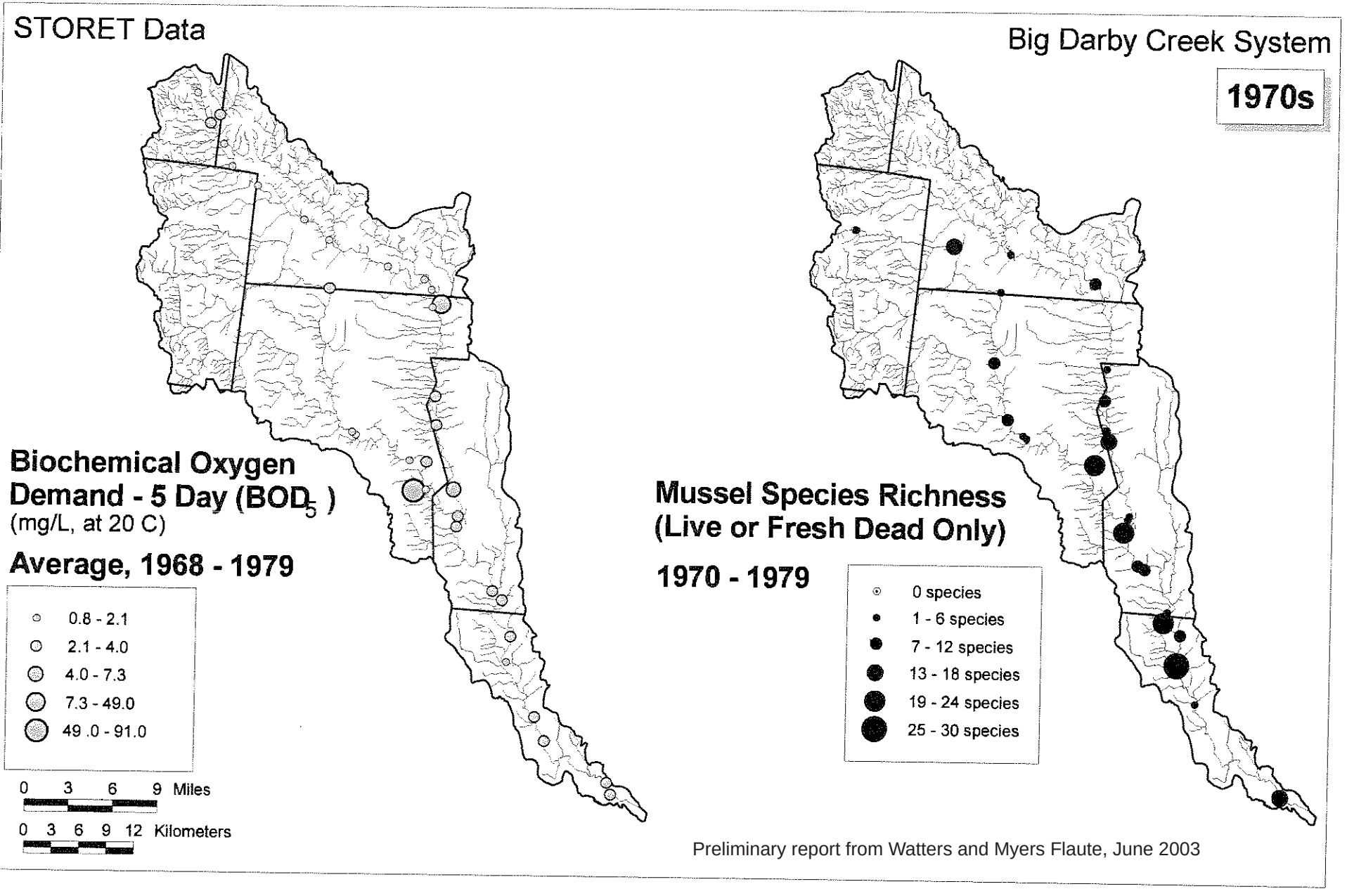
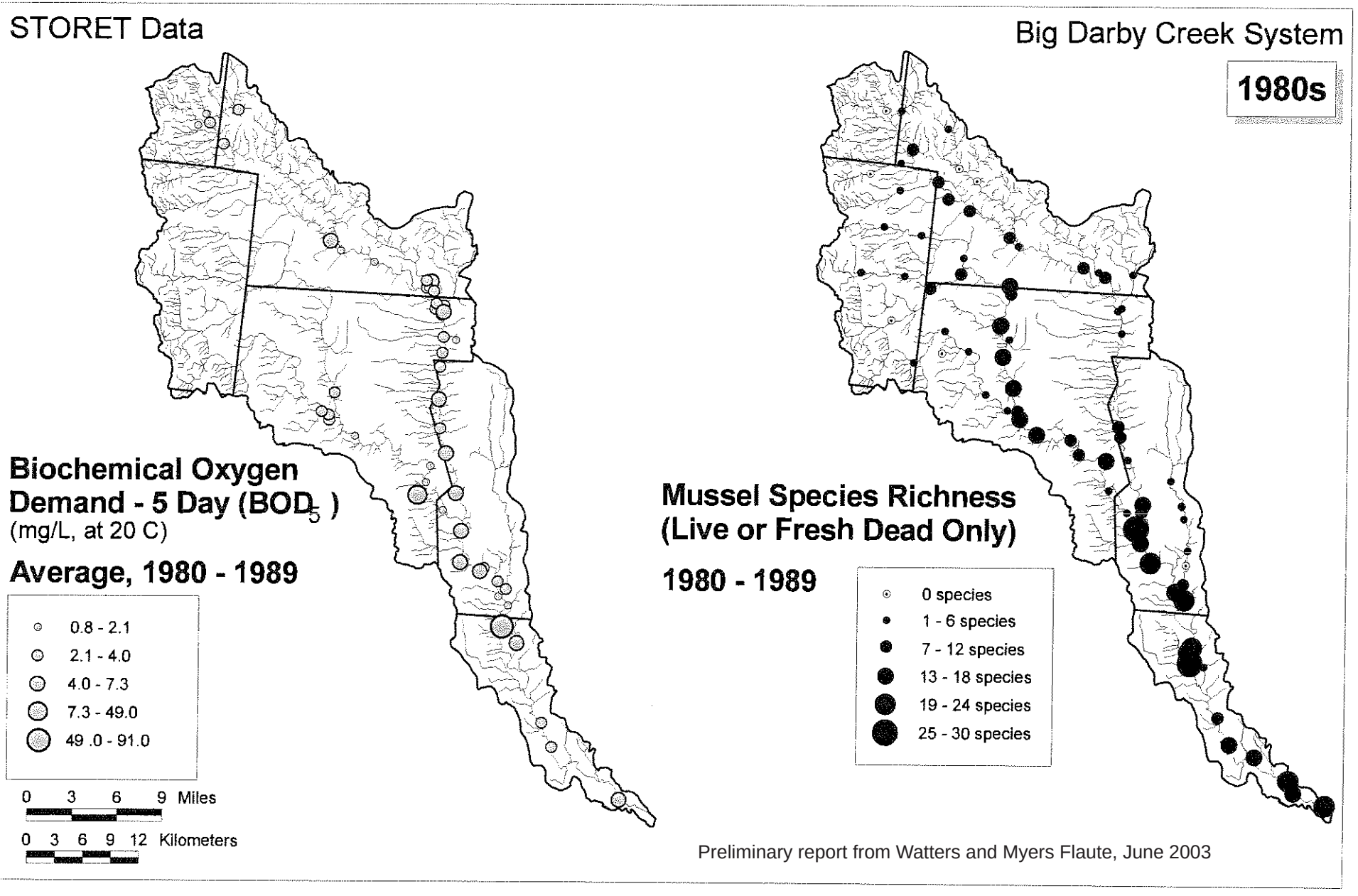
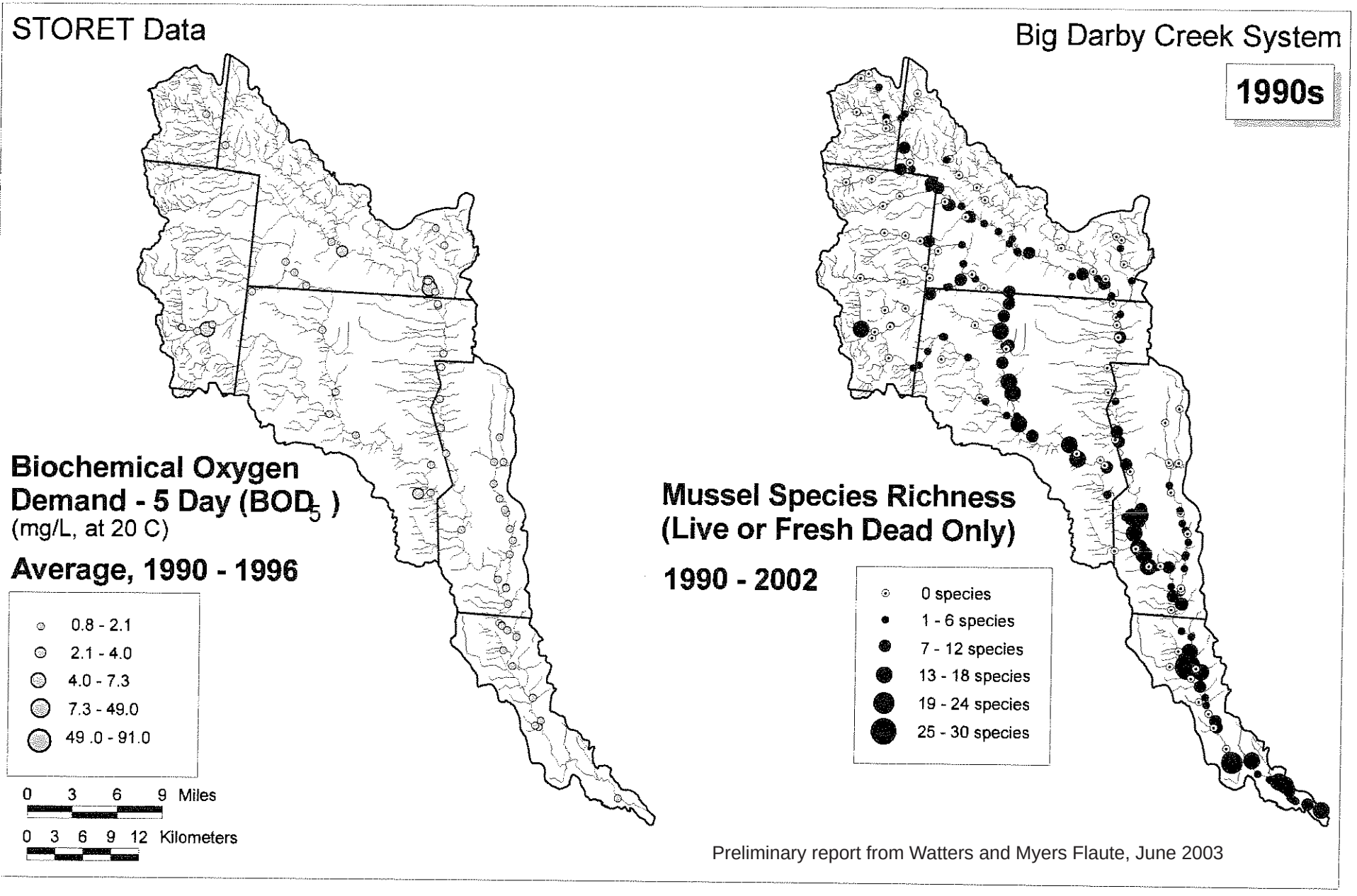
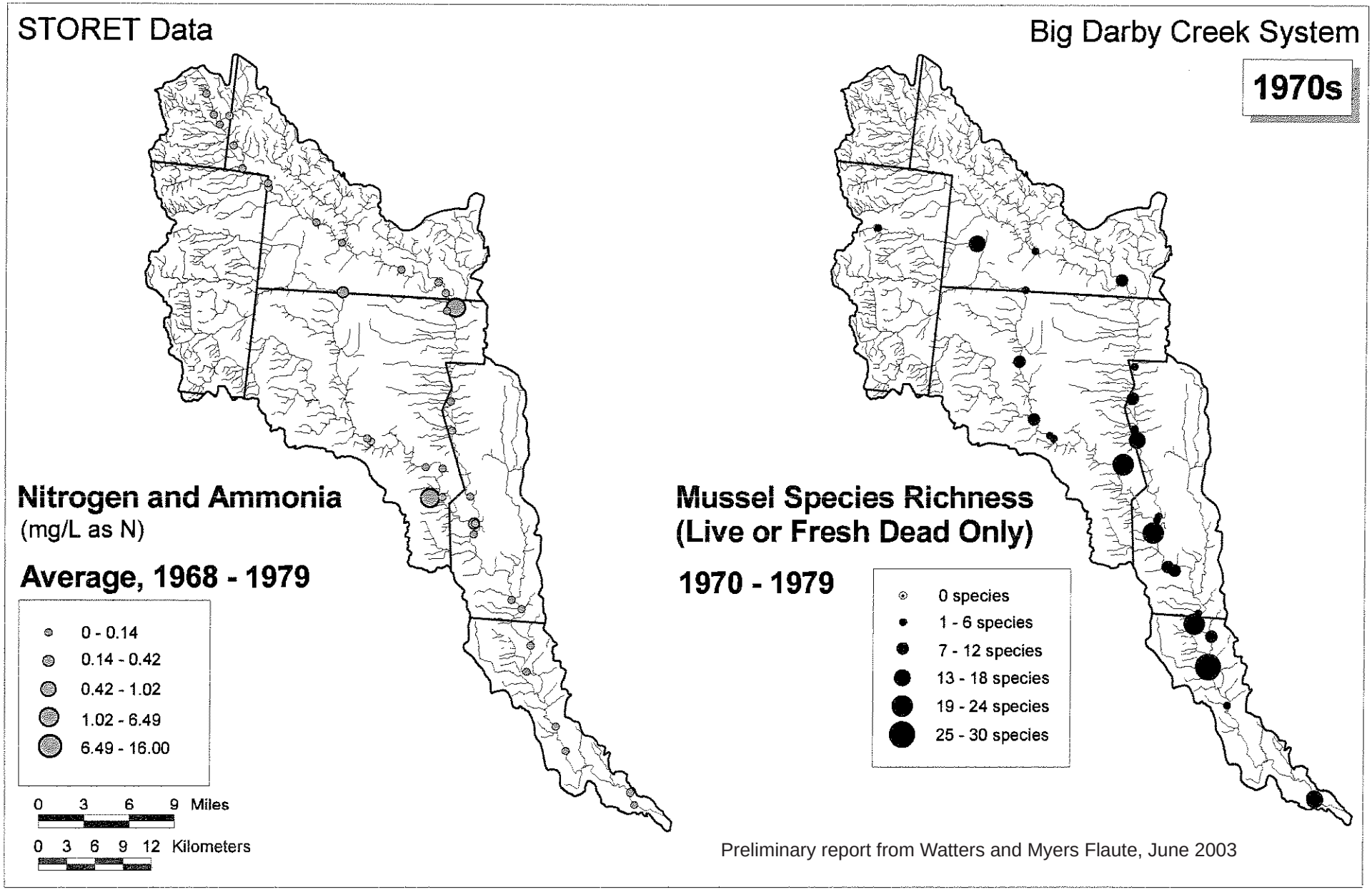
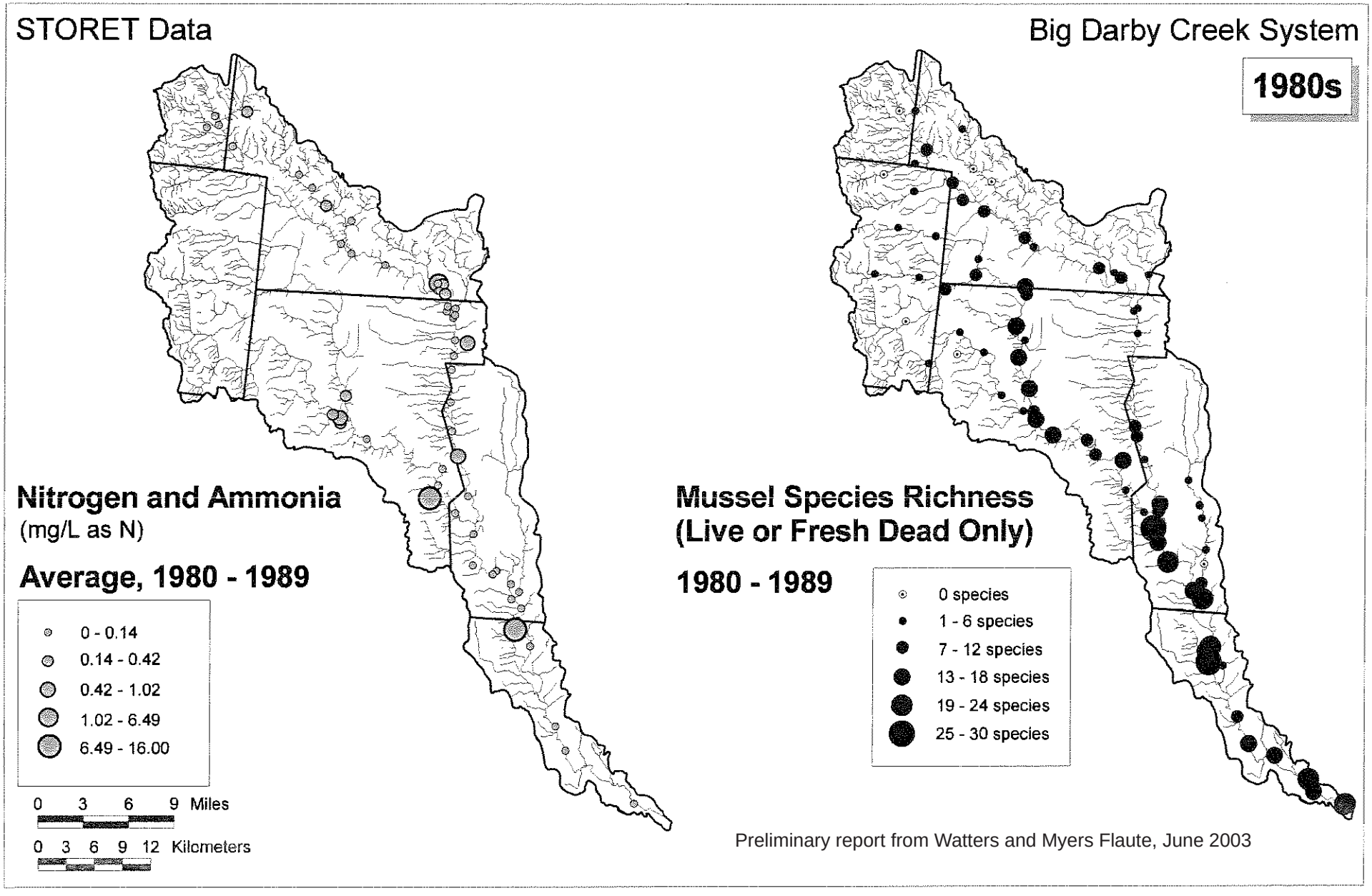
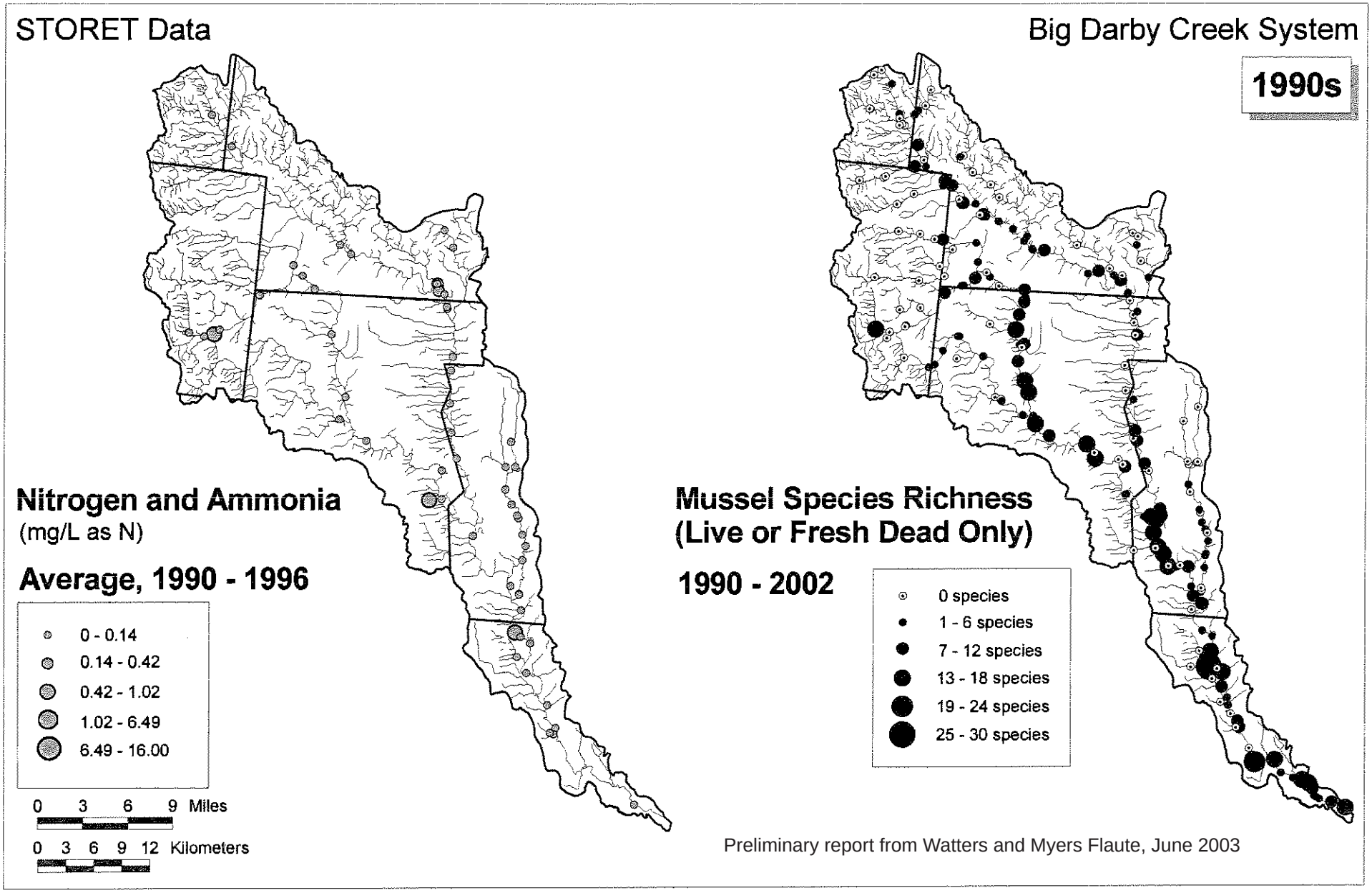

STORET Data
Big Darby Creek System
1970s
Biochemical Oxygen Demand - 5 Day (BOD_5)
(mg/L, at 20 C)
Average, 1968 - 1979
0.8 - 2.1
2.1 - 4.0
4.0 - 7.3
7.3 - 49.0
49 .0 - 91.0
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003

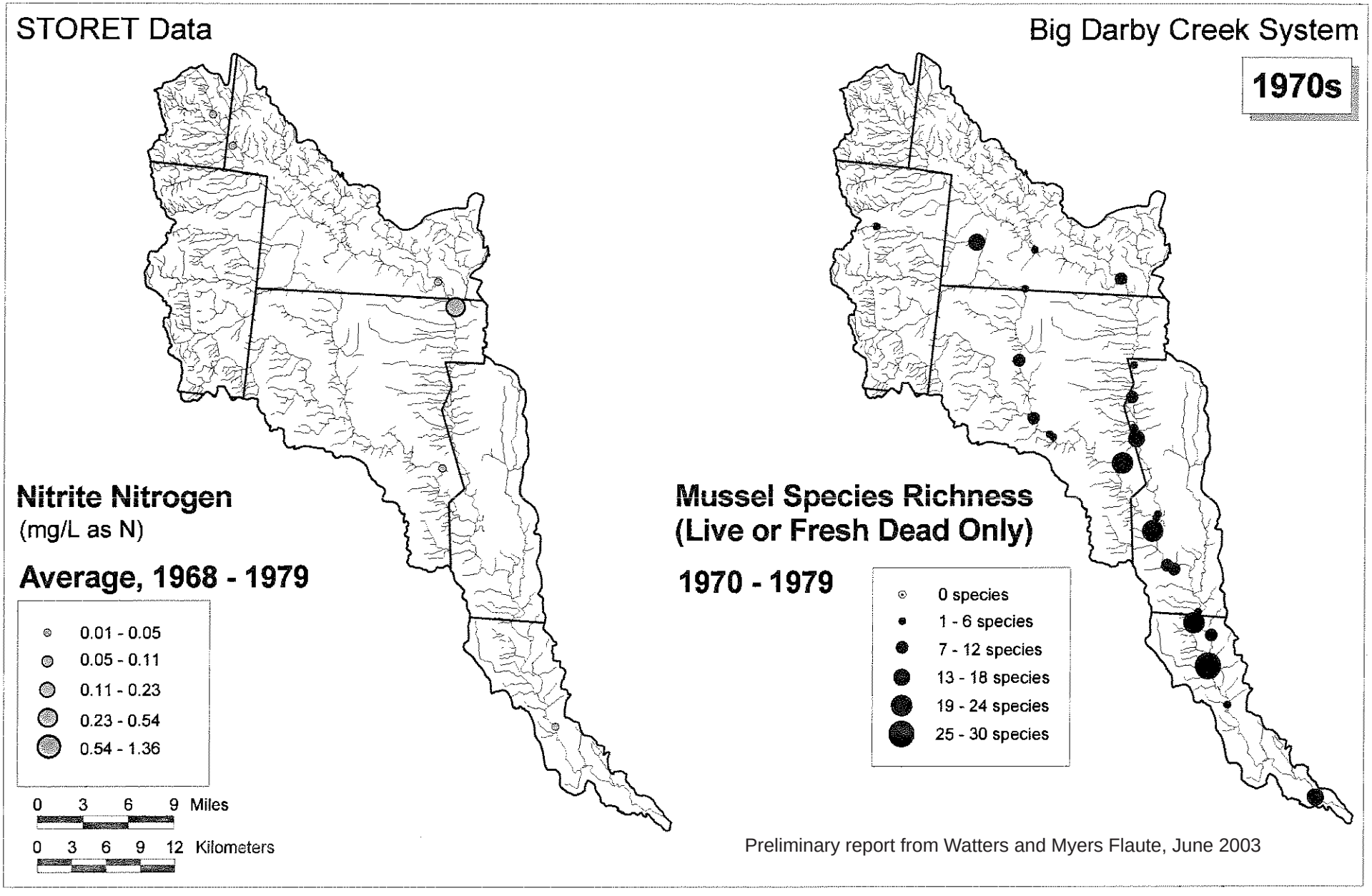

STORET Data
Big Darby Creek System
1980s
Biochemical Oxygen Demand - 5 Day (BOD_5)
(mg/L, at 20 C)
Average, 1980 - 1989
0.8 - 2.1
2.1 - 4.0
4.0 - 7.3
7.3 - 49.0
49 .0 - 91.0
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1980 - 1989
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003

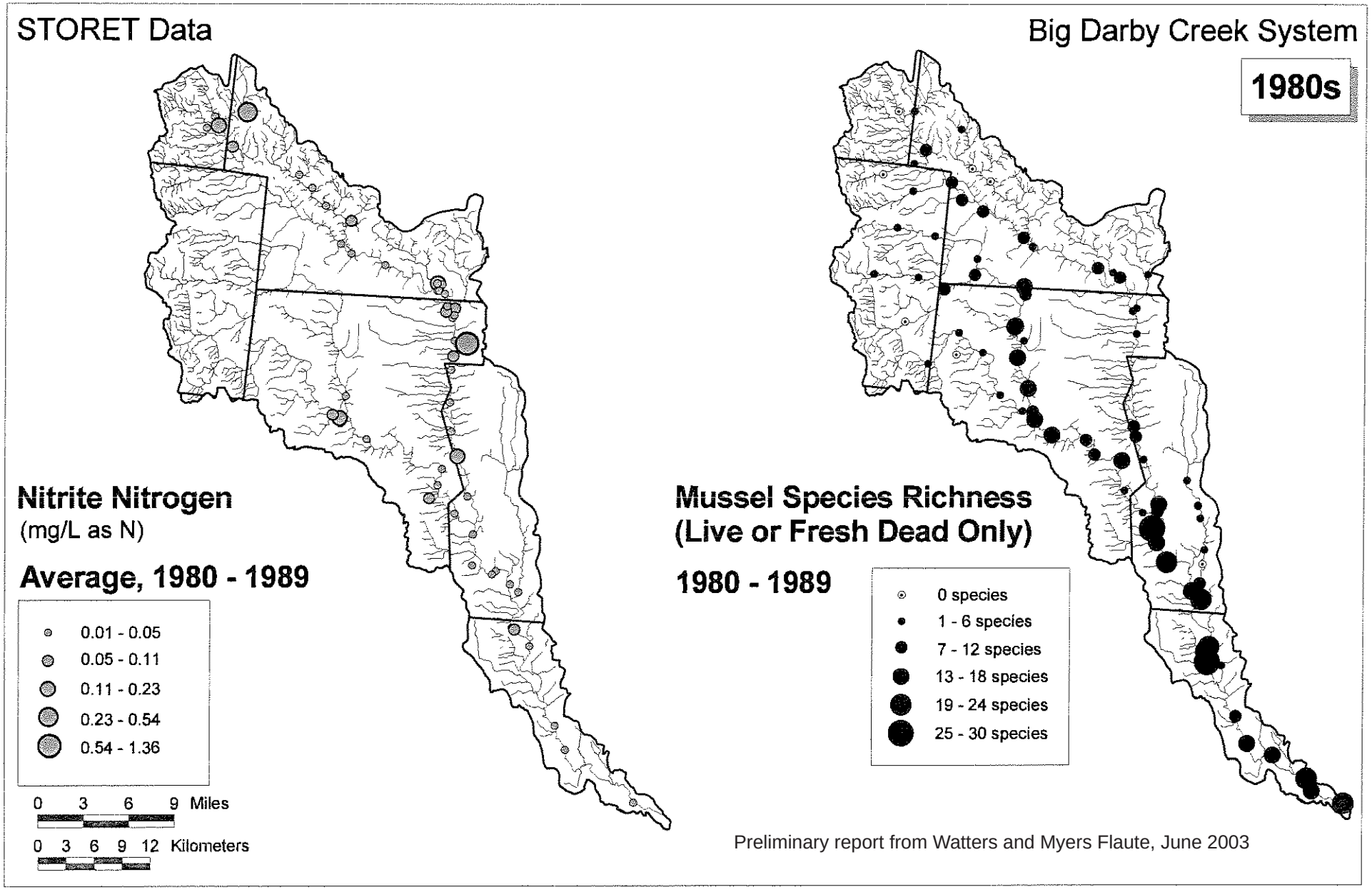

STORET Data
Big Darby Creek System
1990s
Biochemical Oxygen Demand - 5 Day (BOD_5)
(mg/L, at 20 C)
Average, 1990 - 1996
0.8 - 2.1
2.1 - 4.0
4.0 - 7.3
7.3 - 49.0
49 .0 - 91.0
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1970s
Nitrogen and Ammonia
(mg/L as N)
Average, 1968 - 1979
0 - 0.14
0.14 - 0.42
0.42 - 1.02
1.02 - 6.49
6.49 - 16.00
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1980s
Nitrogen and Ammonia
(mg/L as N)
Average, 1980 - 1989
0 - 0.14
0.14 - 0.42
0.42 - 1.02
1.02 - 6.49
6.49 - 16.00
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1980 - 1989
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1990s
Nitrogen and Ammonia
(mg/L as N)
Average, 1990 - 1996
0 - 0.14
0.14 - 0.42
0.42 - 1.02
1.02 - 6.49
6.49 - 16.00
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1970s
Nitrite Nitrogen
(mg/L as N)
Average, 1968 - 1979
0.01 - 0.05
0.05 - 0.11
0.11 - 0.23
0.23 - 0.54
0.54 - 1.36
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1980s
Nitrite Nitrogen
(mg/L as N)
Average, 1980 - 1989
0.01 - 0.05
0.05 - 0.11
0.11 - 0.23
0.23 - 0.54
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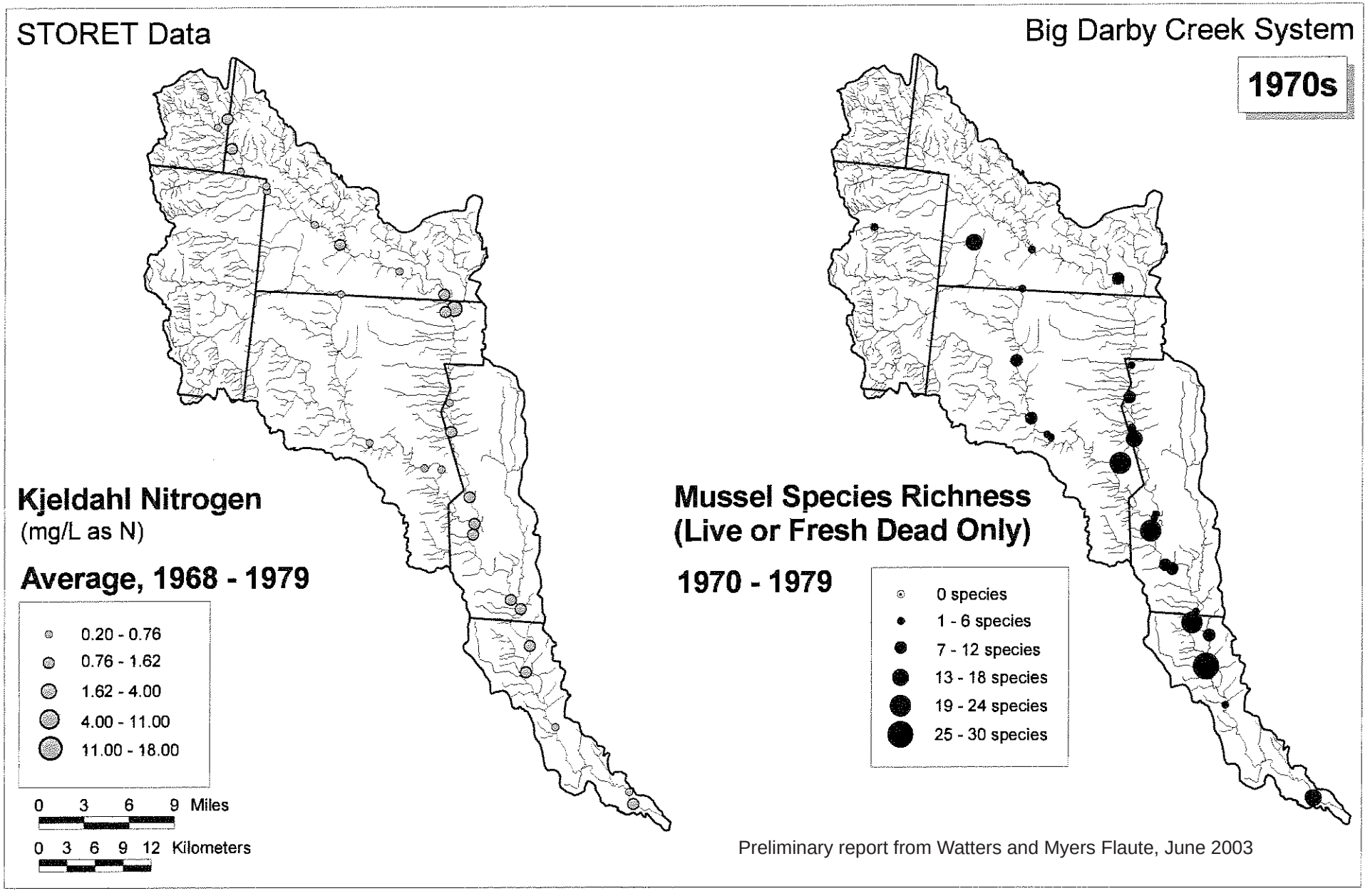
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1970s
Kjeldahl Nitrogen
(mg/L as N)
Average, 1968 - 1979
0.20 - 0.76
0.76 - 1.62
1.62 - 4.00
4.00 - 11.00
11.00 - 18.00
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
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19 - 24 species
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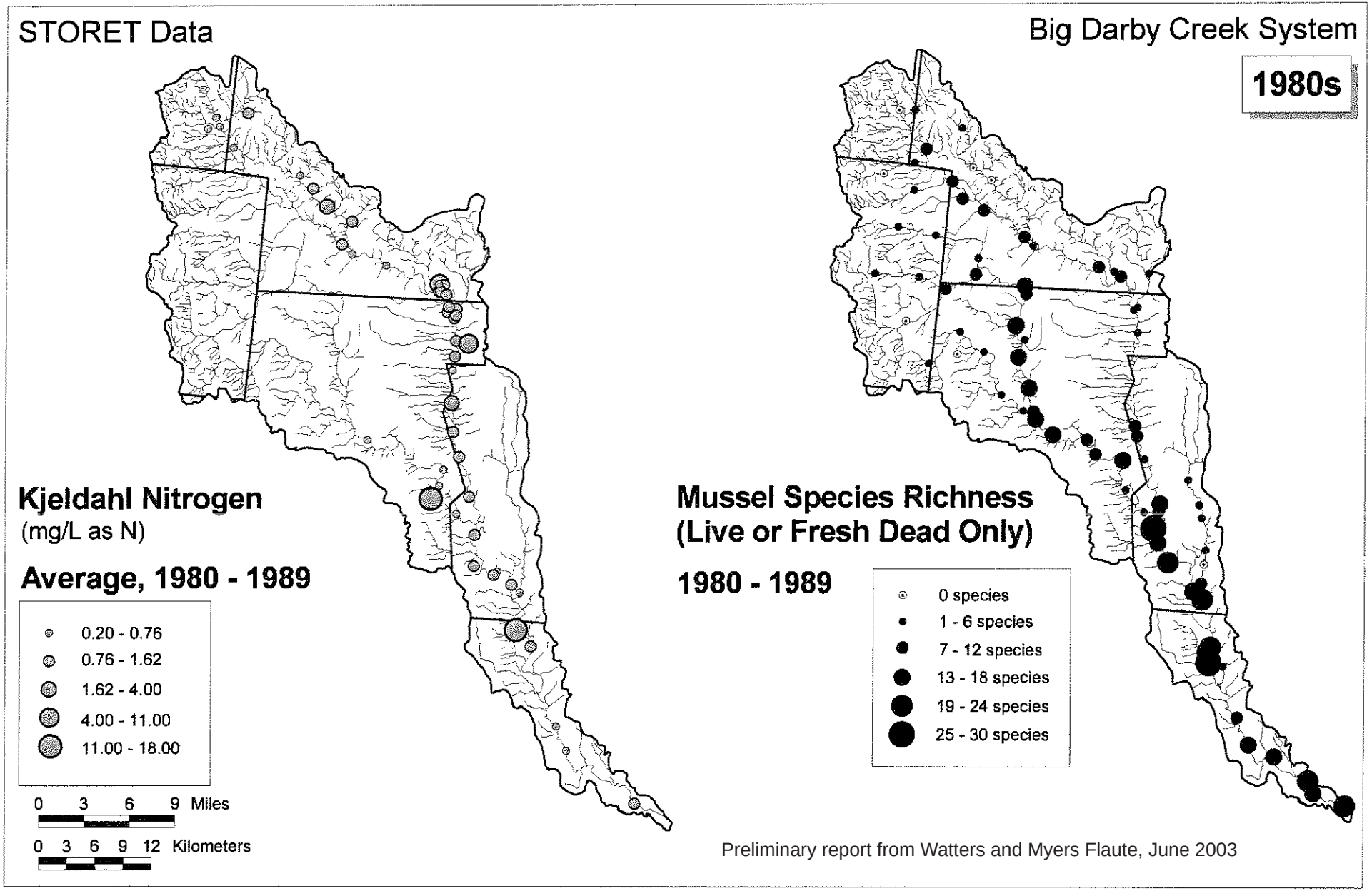
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
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(mg/L as N)
Average, 1980 - 1989
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0.76 - 1.62
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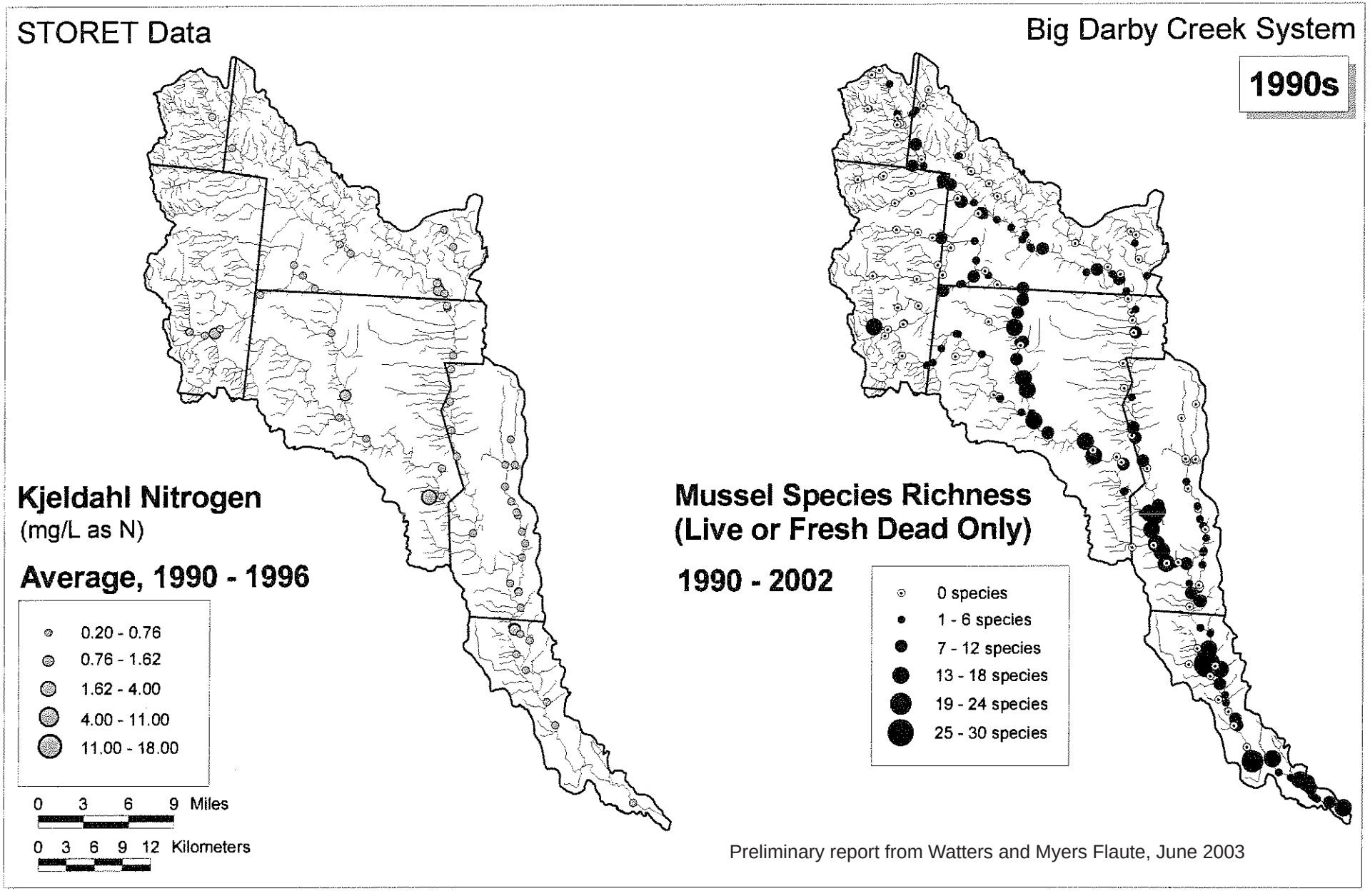
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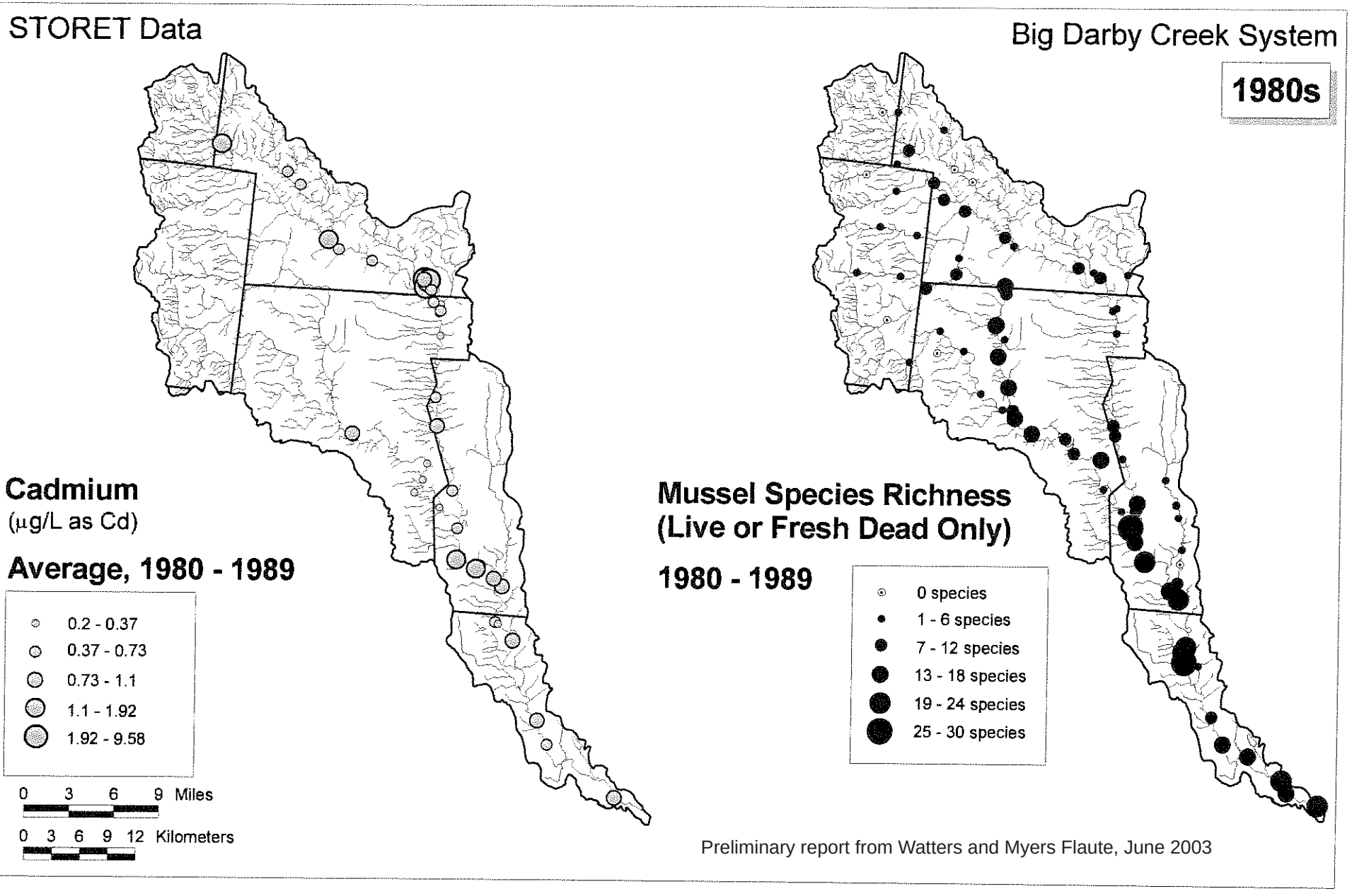
STORET Data
Big Darby Creek System
1980s
Cadmium
(µg/L as Cd)
Average, 1980 - 1989
0.2 - 0.37
0.37 - 0.73
0.73 - 1.1
1.1 - 1.92
1.92 - 9.58
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
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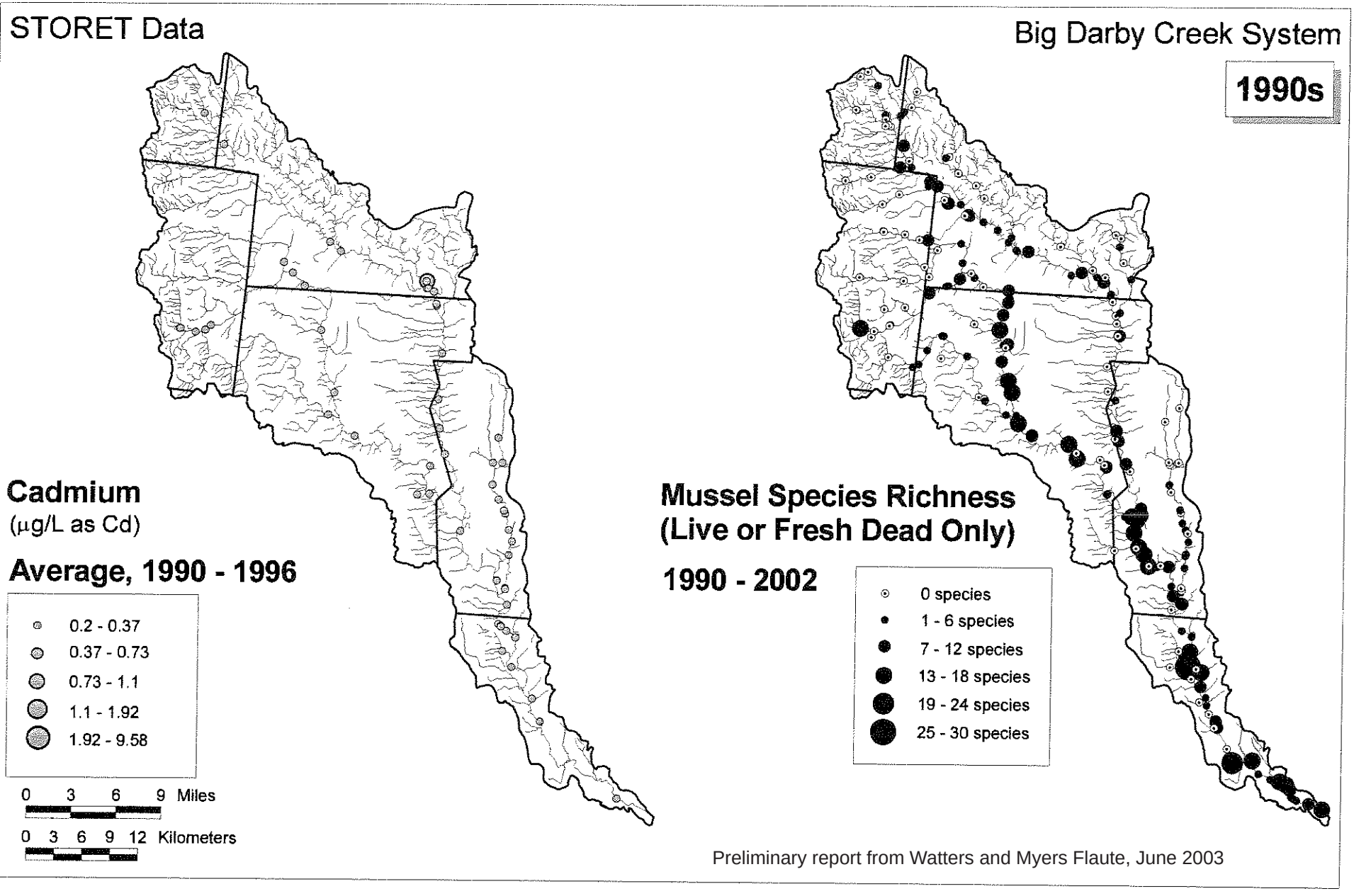
Preliminary report from Watters and Myers Flaute, June 2003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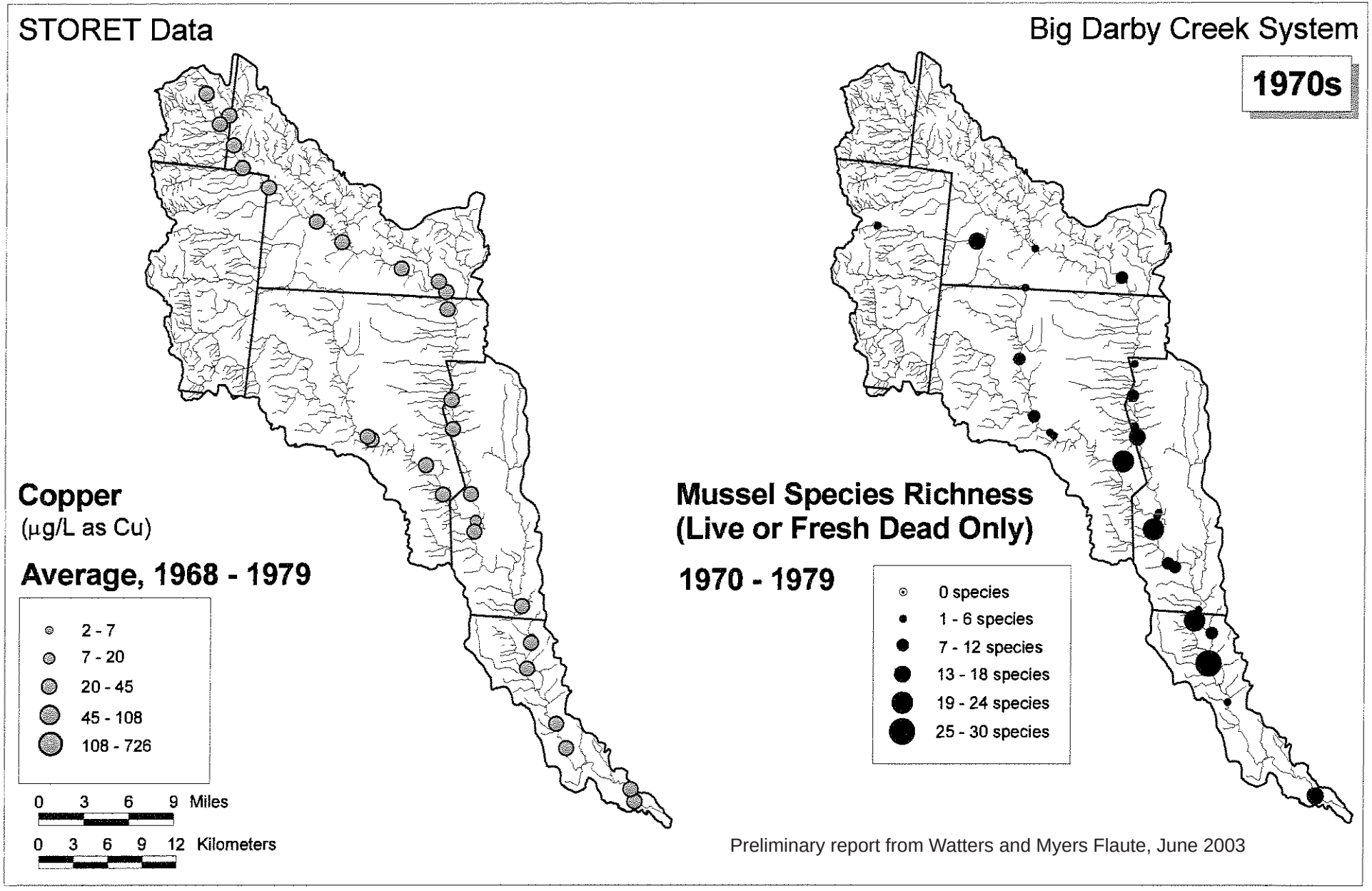
STORET Data
Big Darby Creek System
1970s
Copper
(µg/L as Cu)
Average, 1968 - 1979
2 - 7
7 - 20
20 - 45
45 - 108
108 - 726
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
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1970 - 1979
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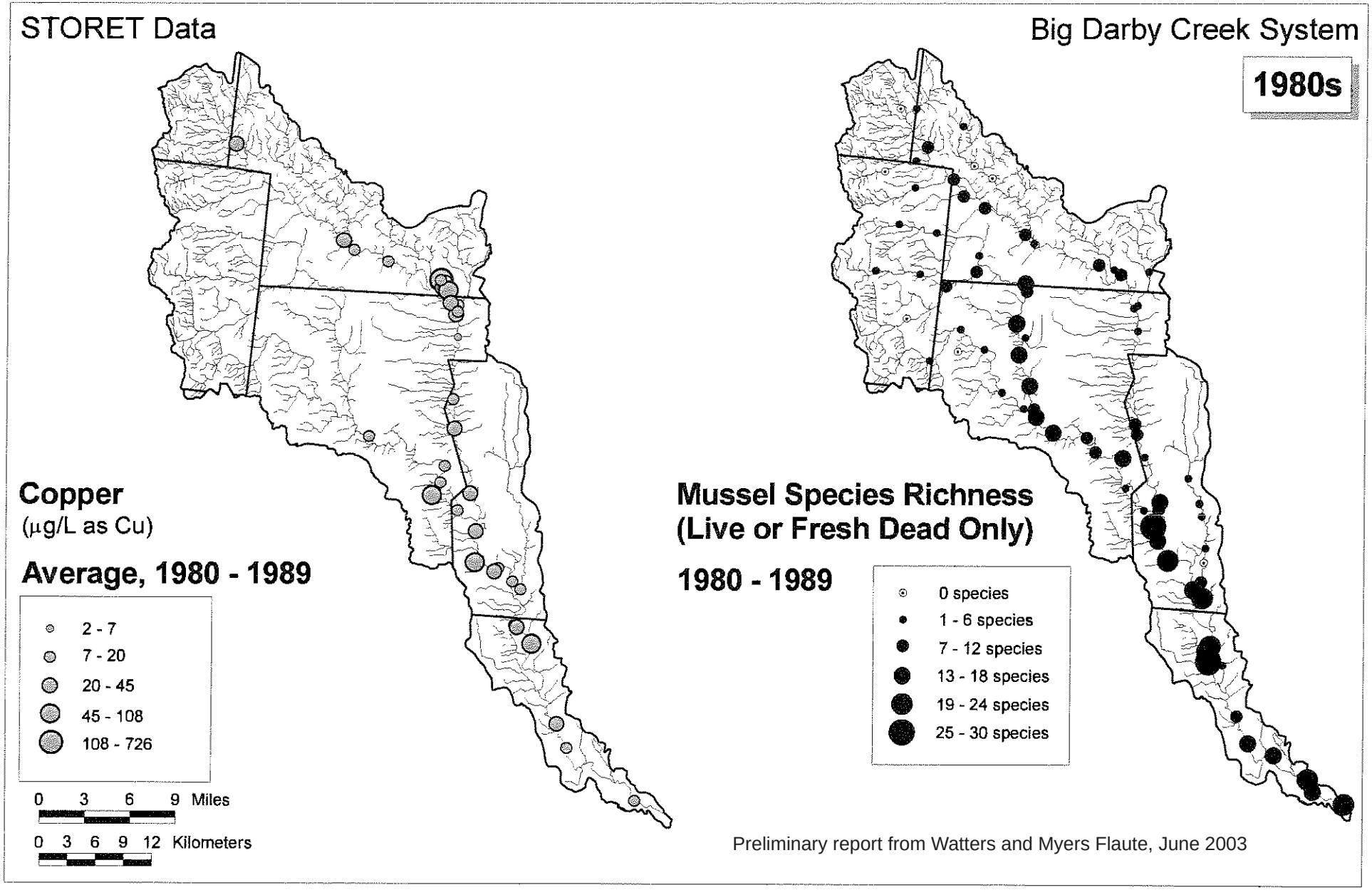
Preliminary report from Watters and Myers Flaute, June 2003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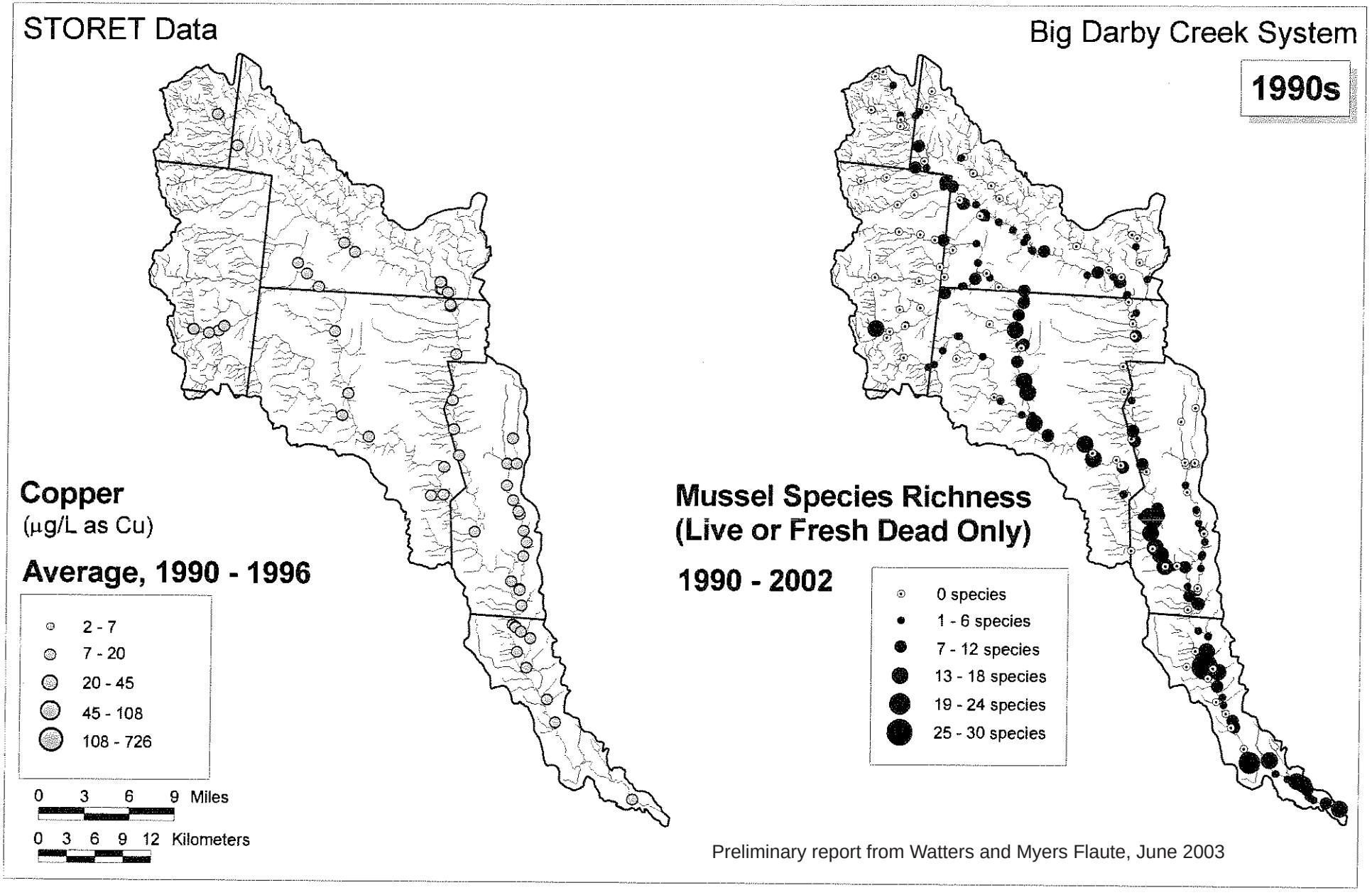
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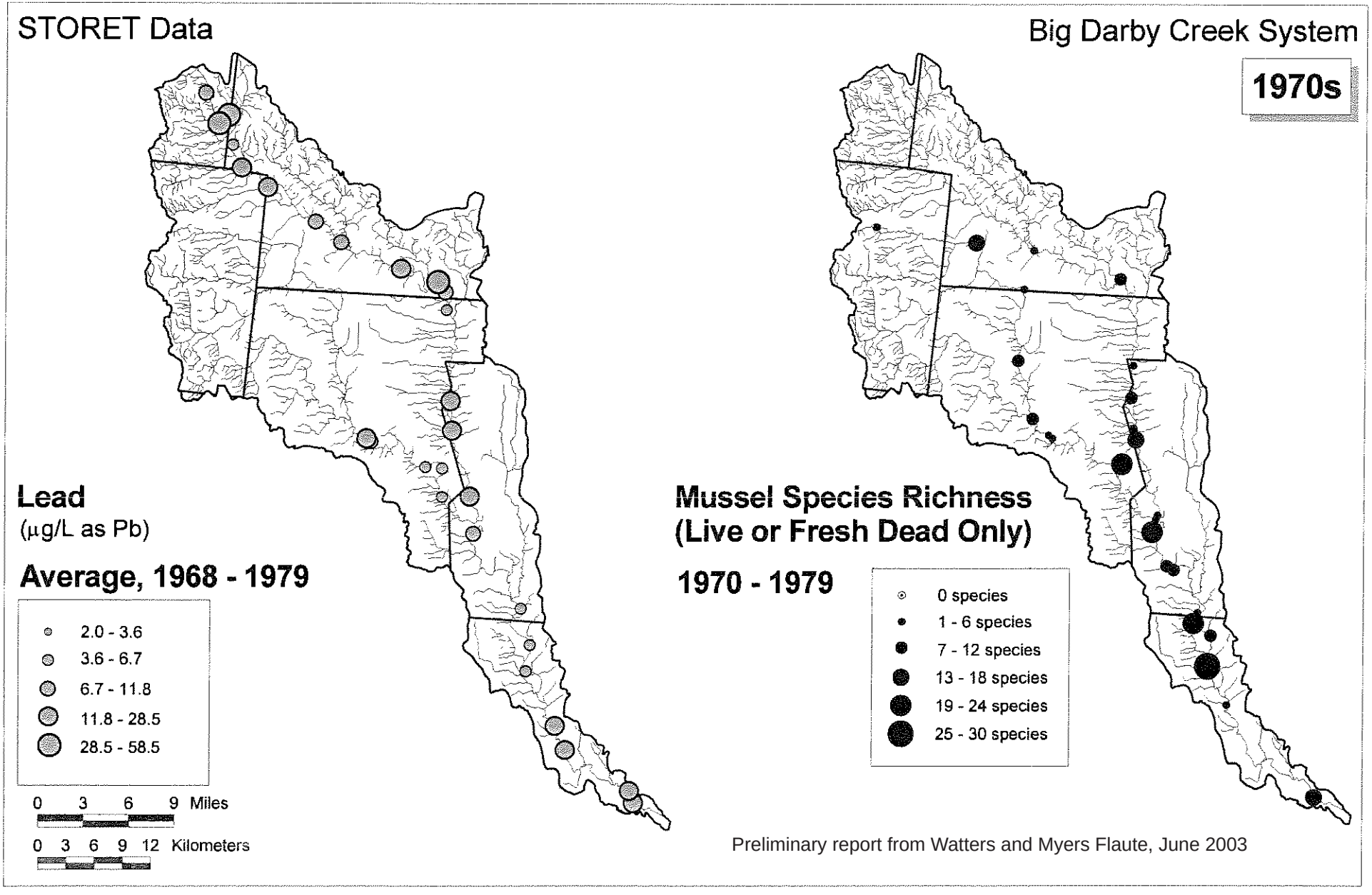
STORET Data
Big Darby Creek System
1970s
Lead
(µg/L as Pb)
Average, 1968 - 1979
2.0 - 3.6
3.6 - 6.7
6.7 - 11.8
11.8 - 28.5
28.5 - 58.5
0 3 6 9 Miles
0 3 6 9 12 Kilometers
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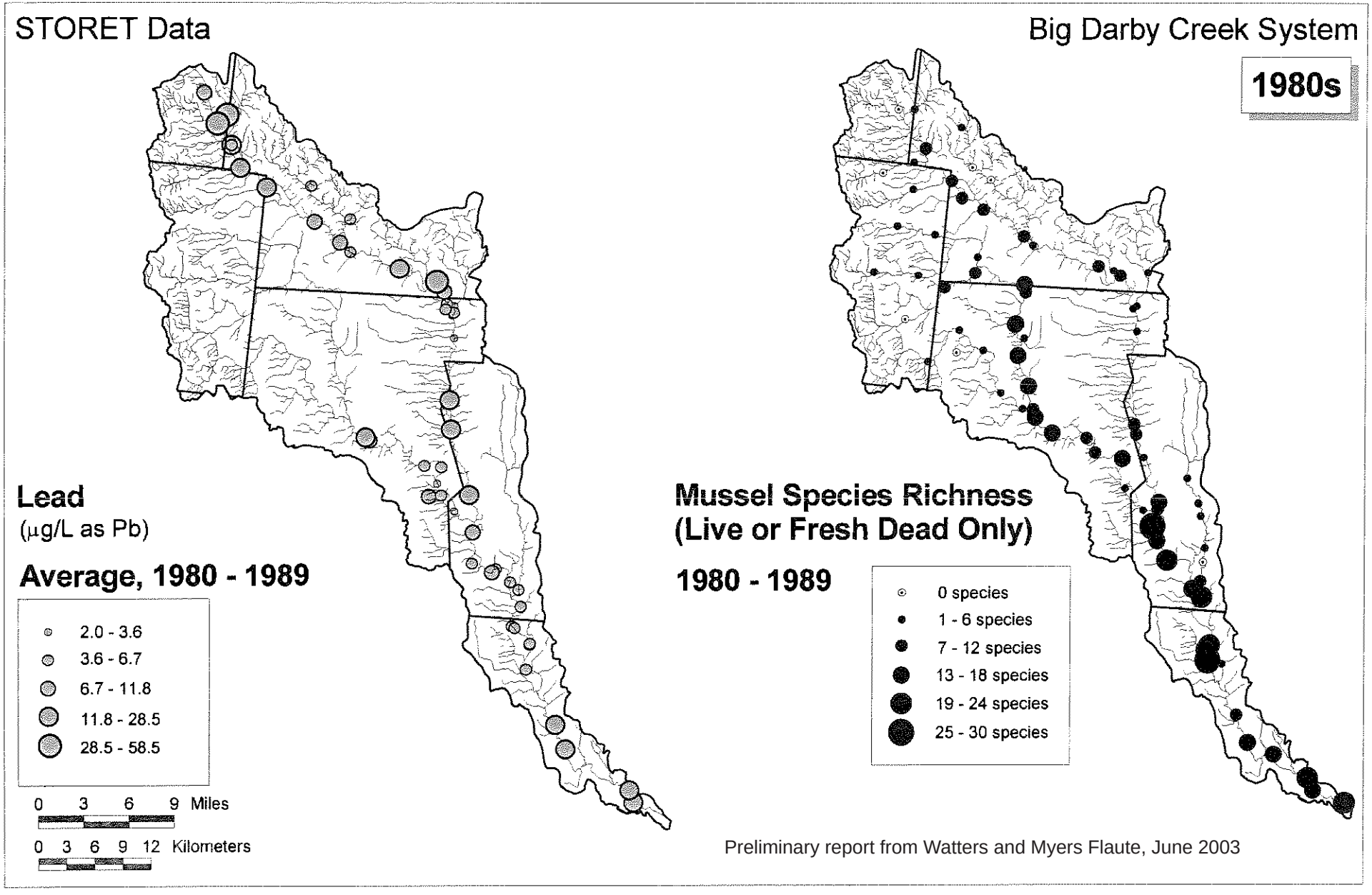
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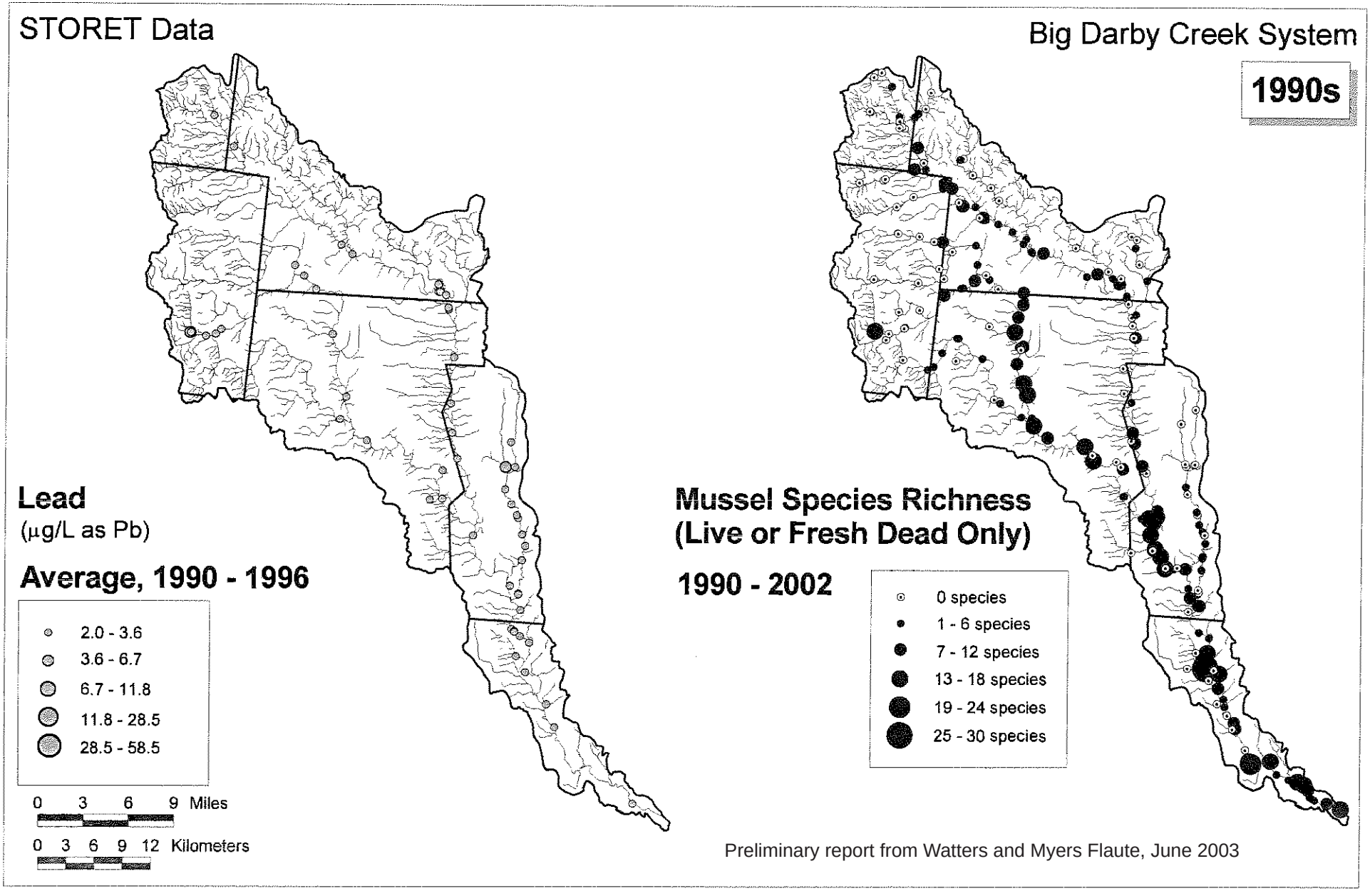
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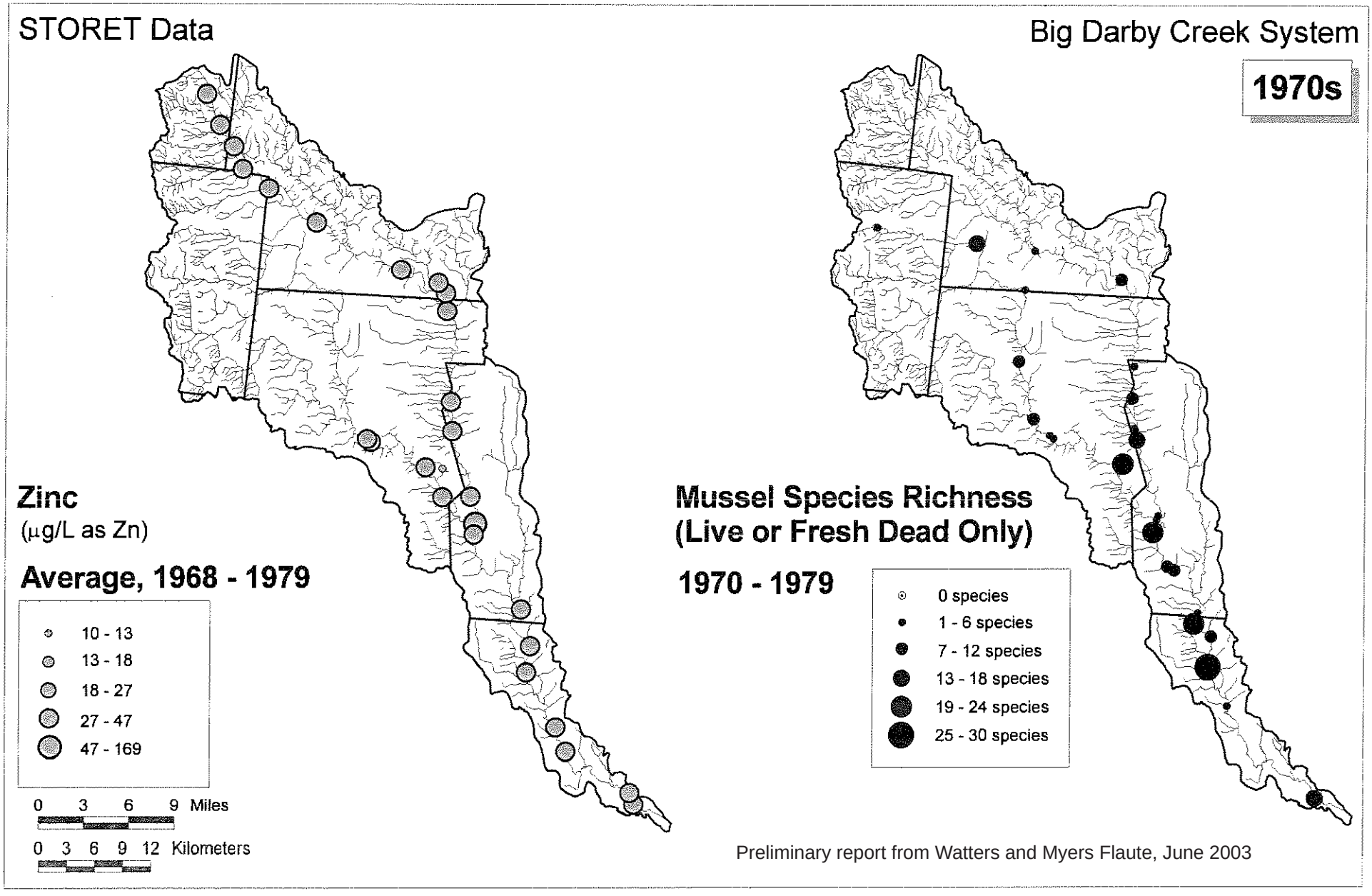
STORET Data
Big Darby Creek System
1970s
Zinc
(µg/L as Zn)
Average, 1968 - 1979
10 - 13
13 - 18
18 - 27
27 - 47
47 - 169
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
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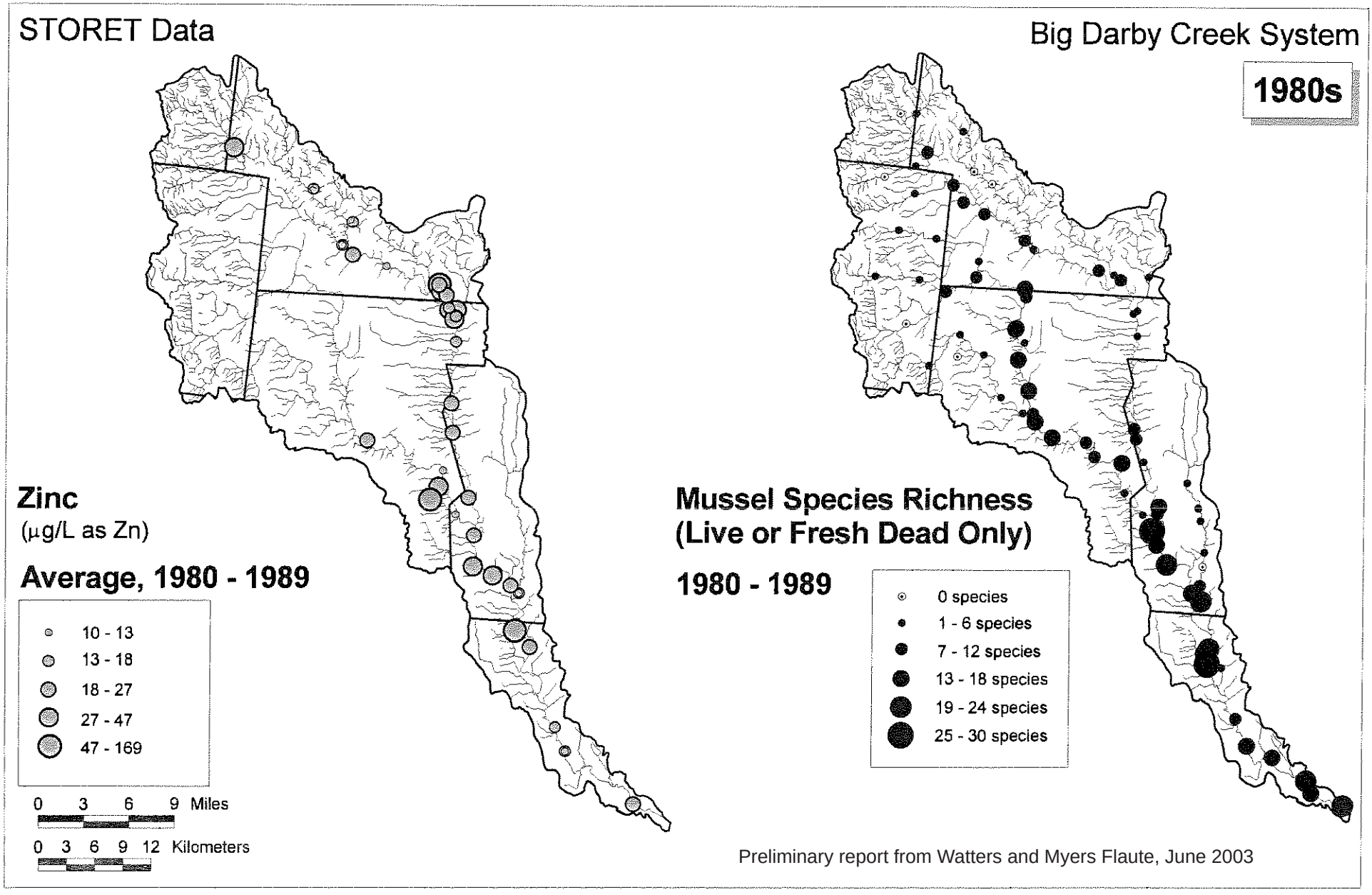
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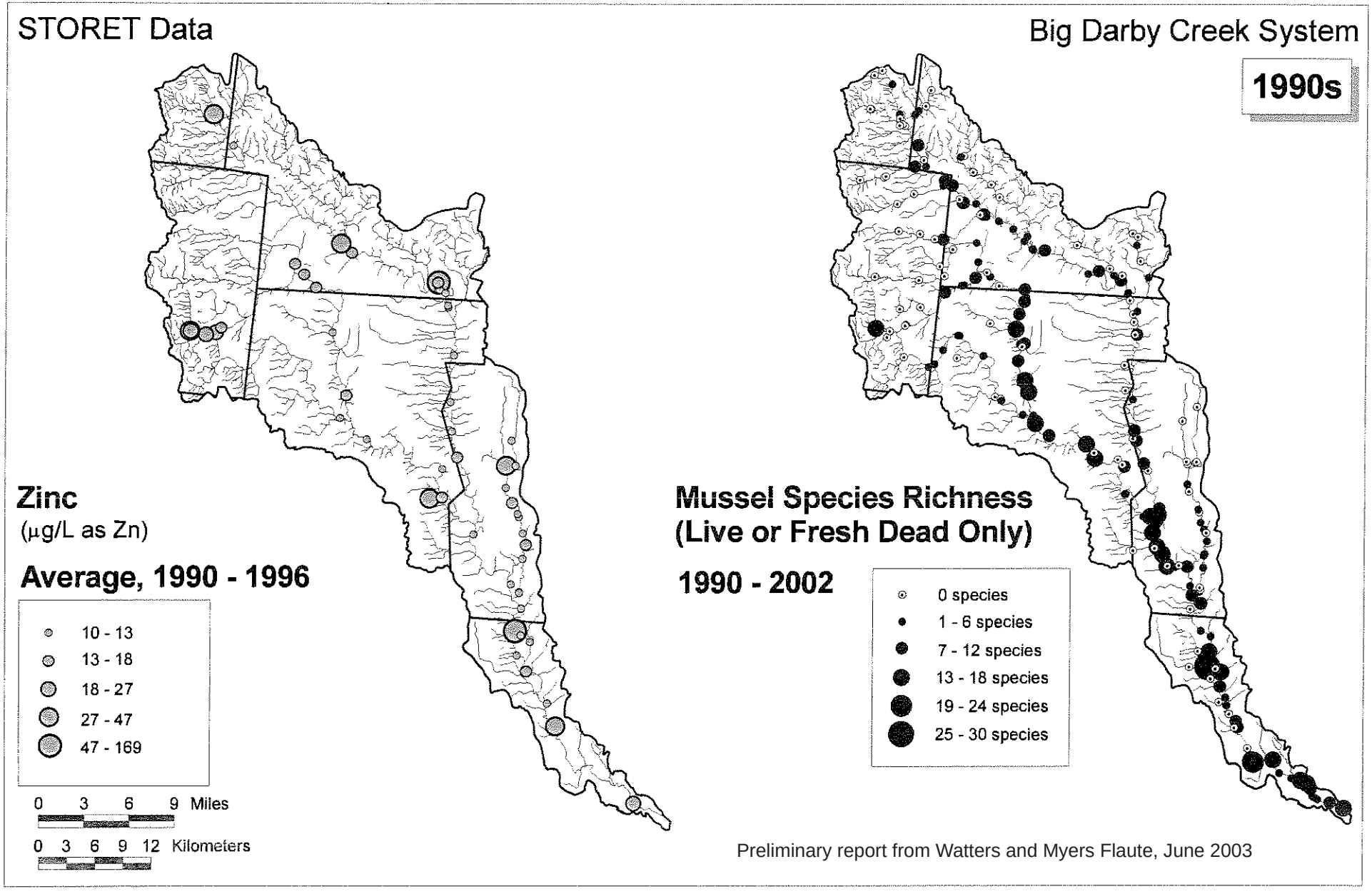
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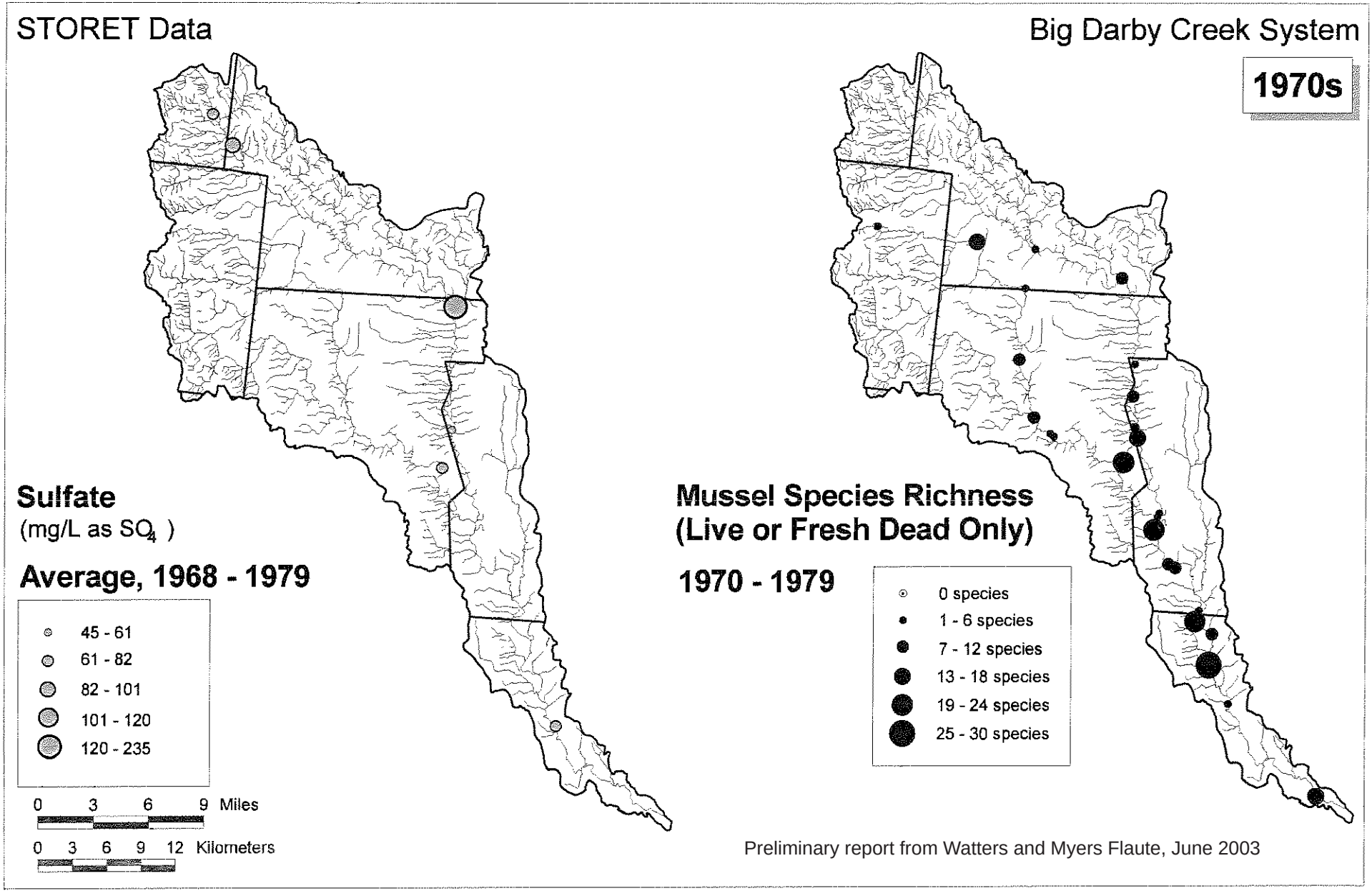
STORET Data
Big Darby Creek System
1970s
Sulfate
(mg/L as SO_4)
Average, 1968 - 1979
45 - 61
61 - 82
82 - 101
101 - 120
120 - 235
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
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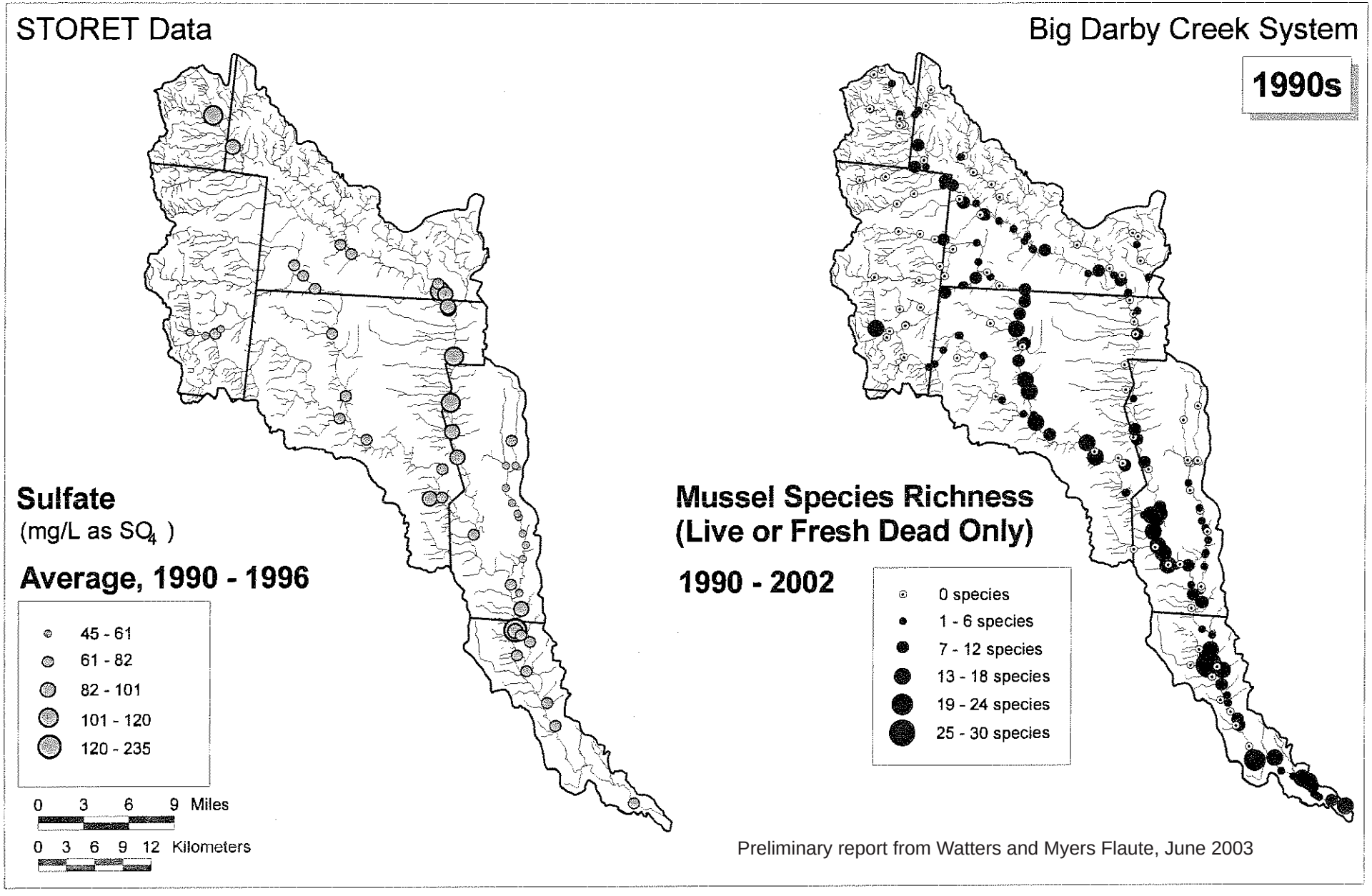
Preliminary report from Watters and Myers Flaute, June 2003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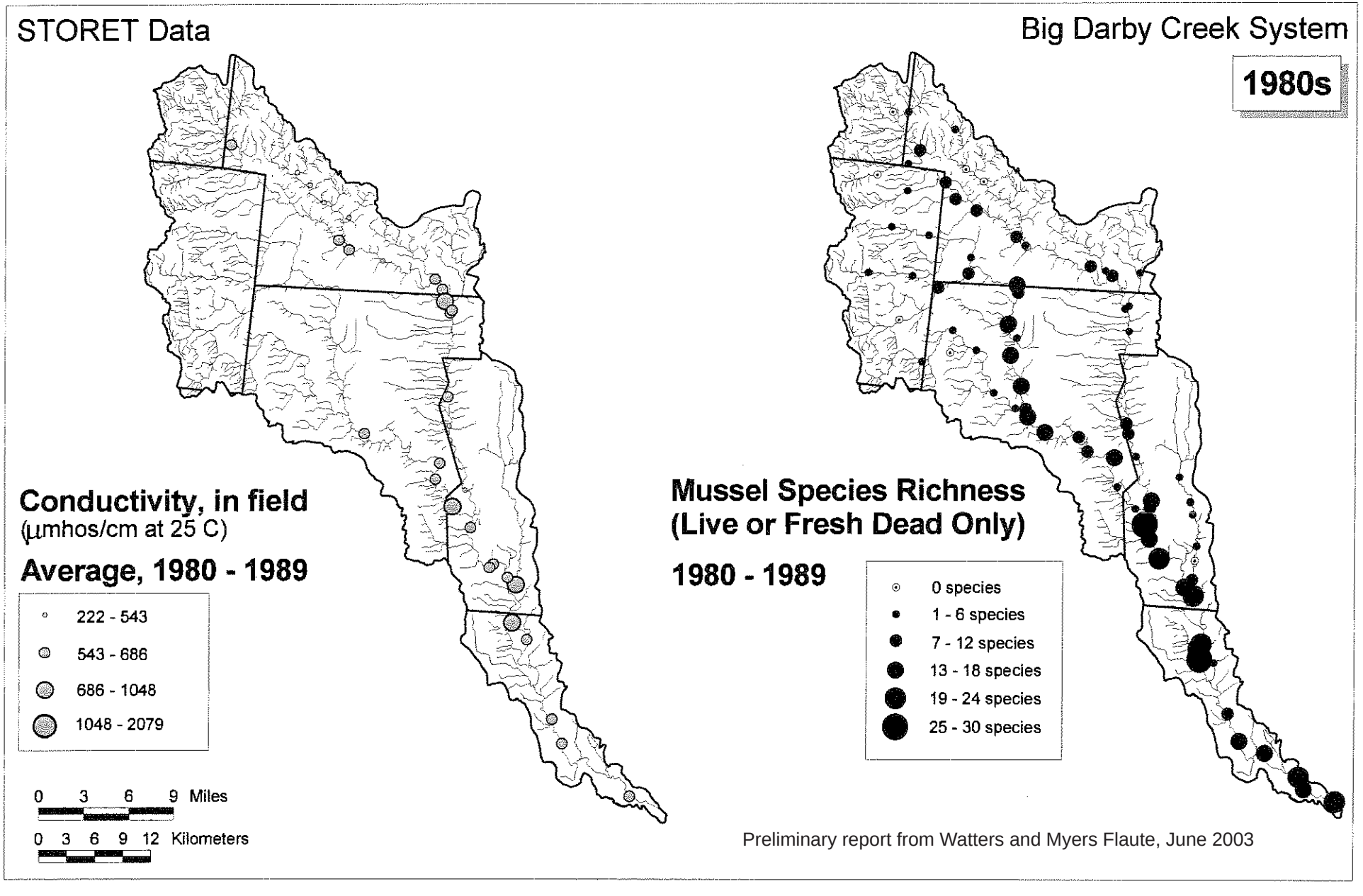
STORET Data
Big Darby Creek System
1980s
Conductivity, in field
(µmhos/cm at 25 C)
Average, 1980 - 1989
222 - 543
543 - 686
686 - 1048
1048 - 2079
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
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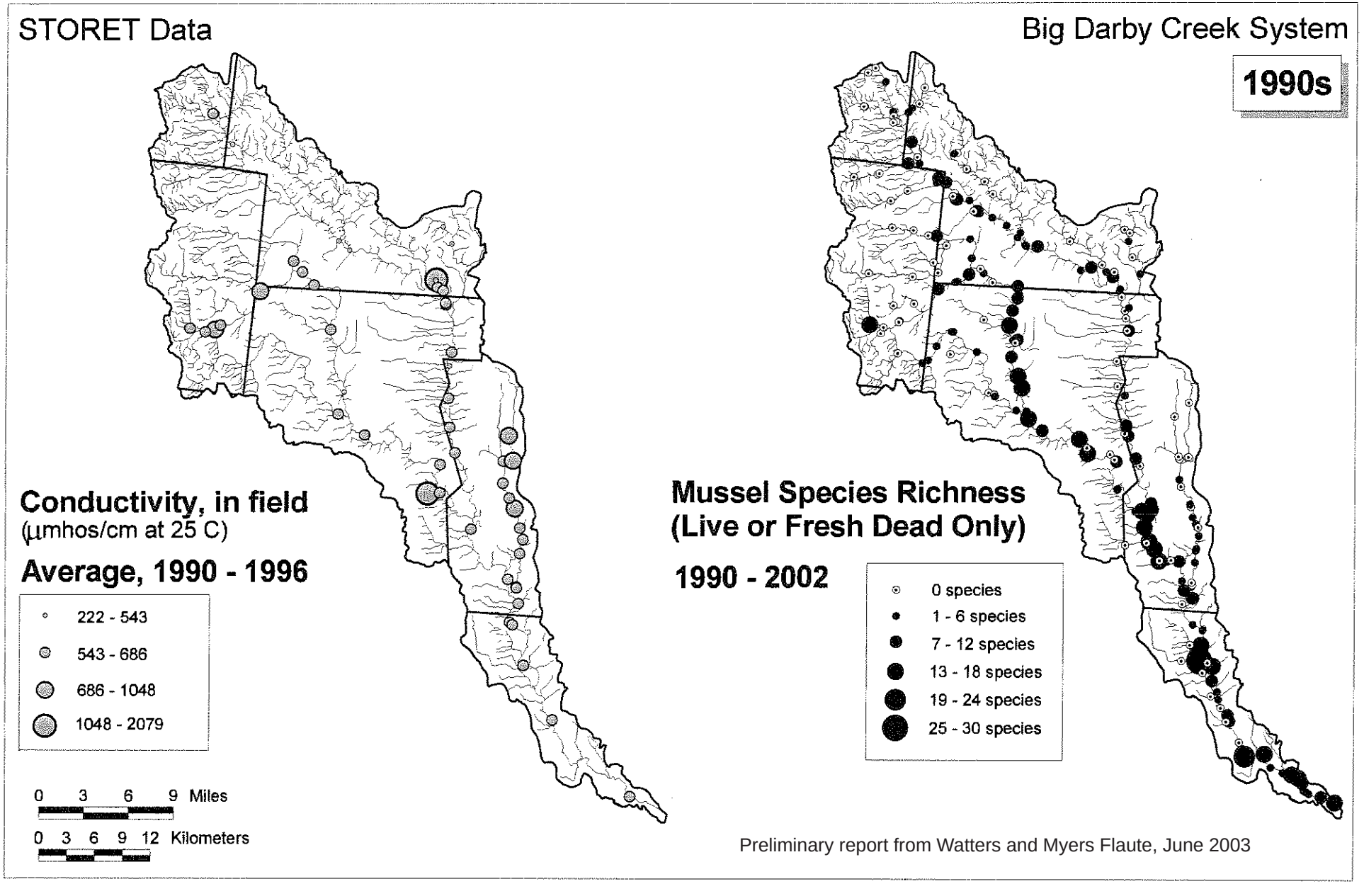
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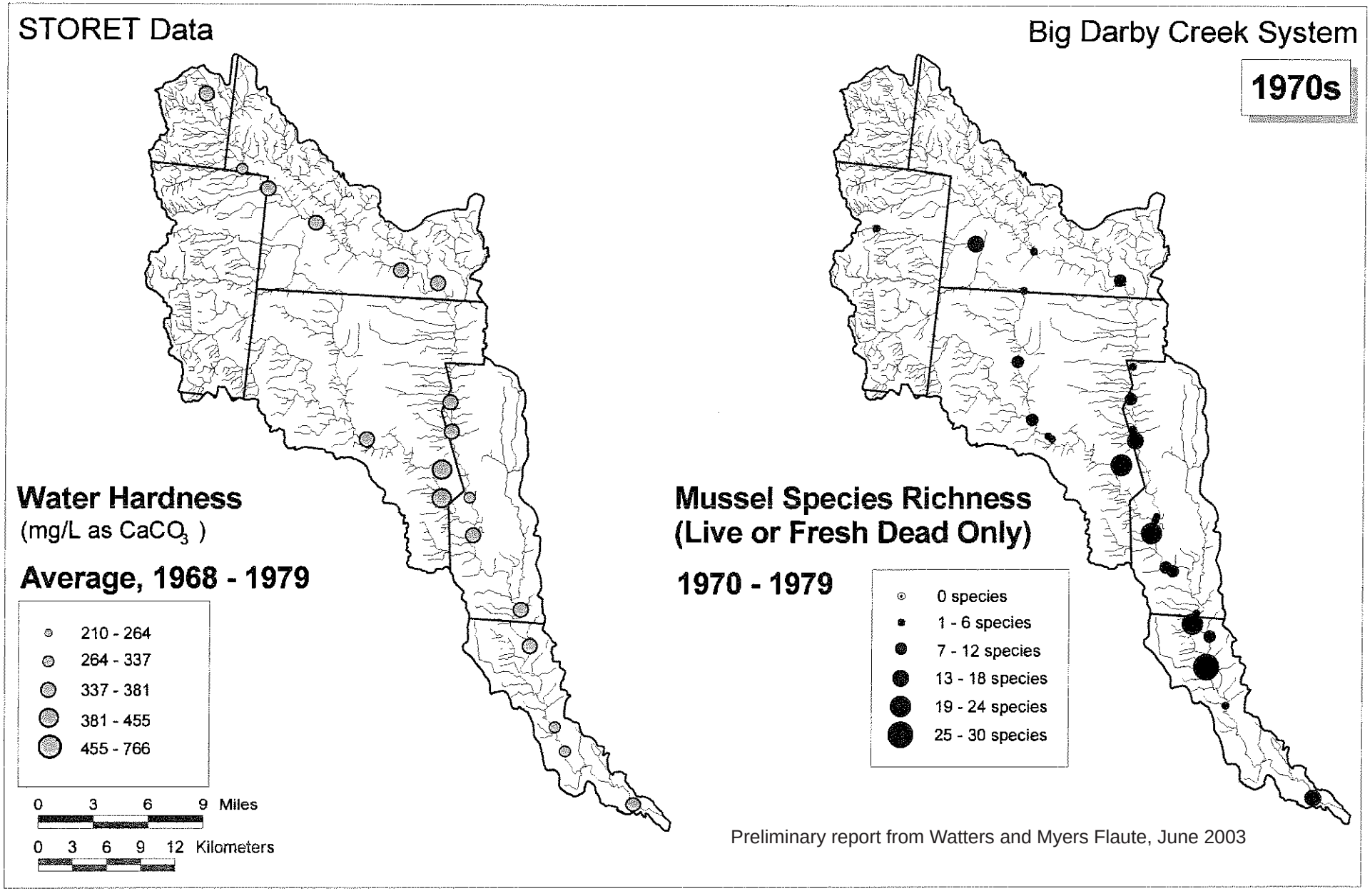
STORET Data
Big Darby Creek System
1970s
Water Hardness
(mg/L as CaCO3)
Average, 1968 - 1979
210 - 264
264 - 337
337 - 381
381 - 455
455 - 766
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
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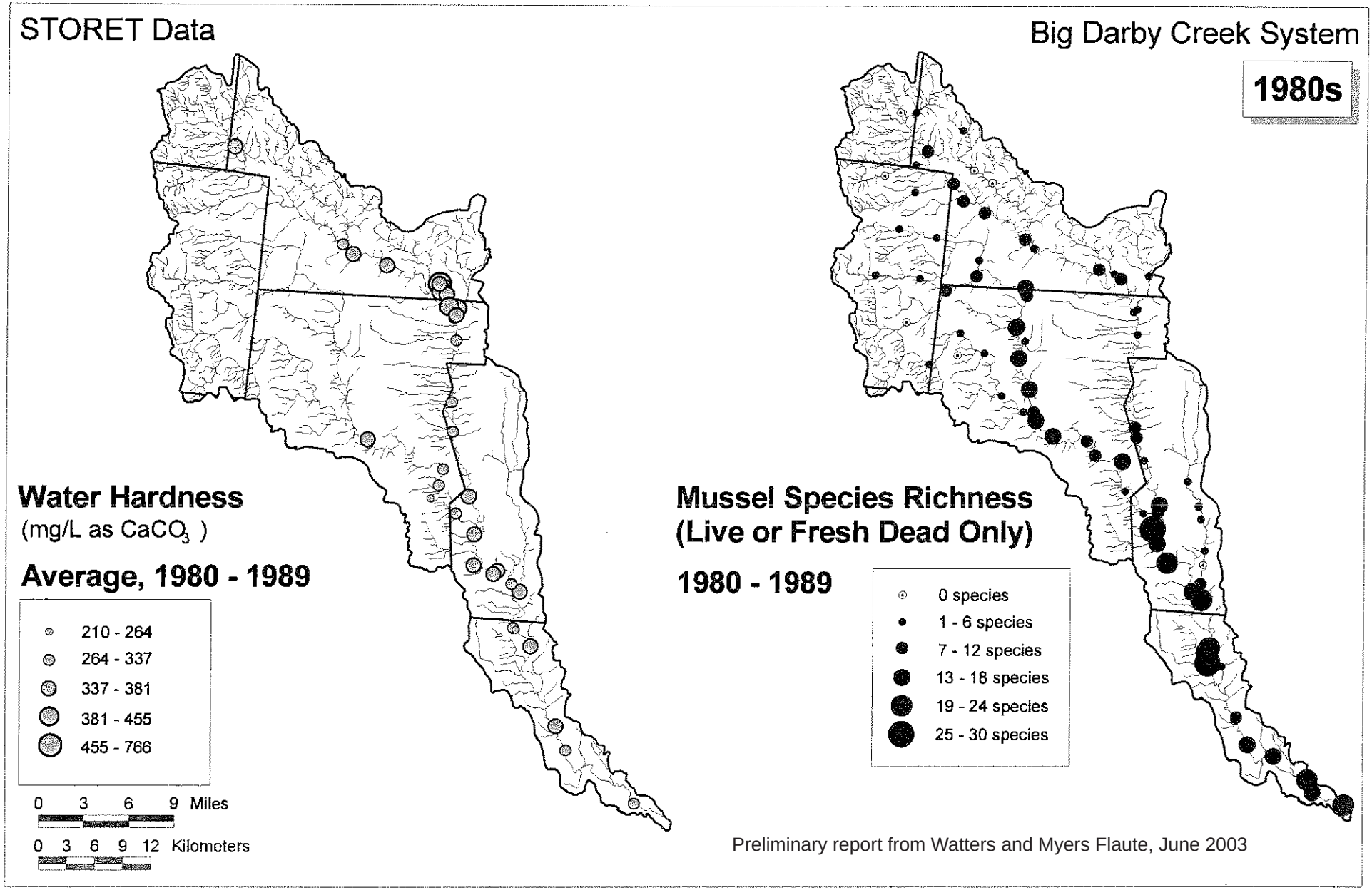
Preliminary report from Watters and Myers Flaute, June 2003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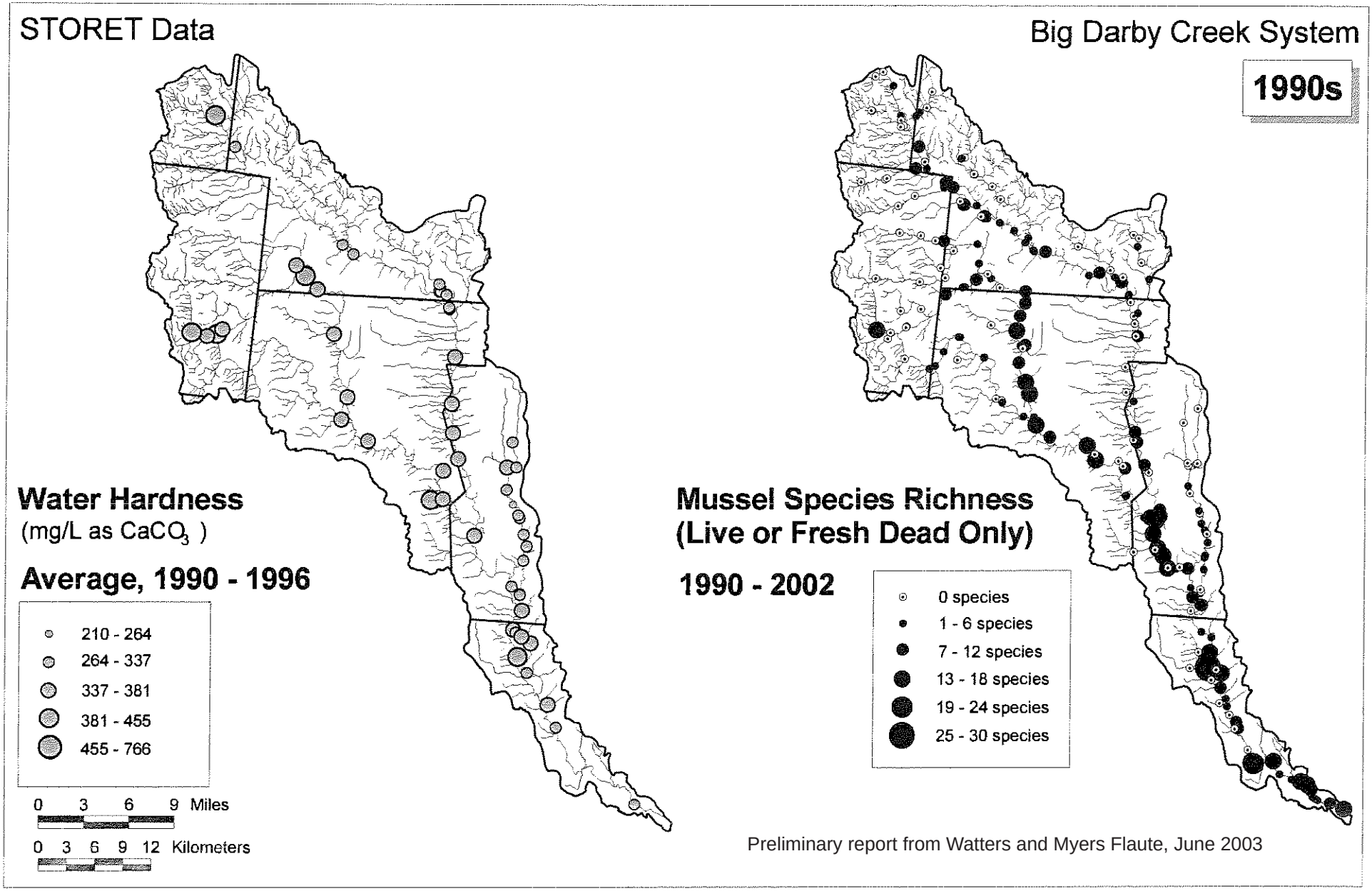
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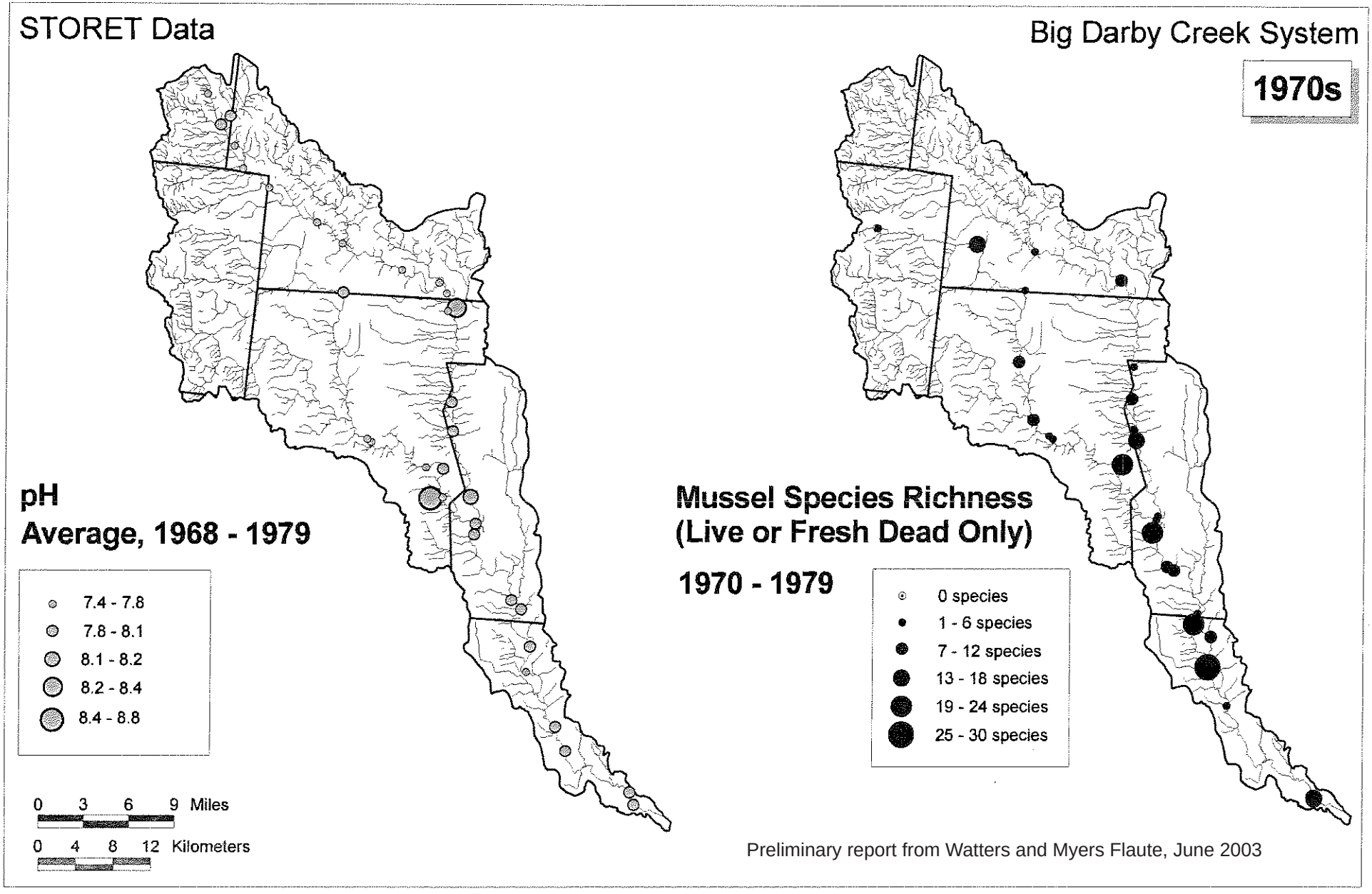
STORET Data
Big Darby Creek System
1970s
pH
Average, 1968 - 1979
7.4 - 7.8
7.8 - 8.1
8.1 - 8.2
8.2 - 8.4
8.4 - 8.8
0 3 6 9 Miles
0 4 8 12 Kilometers
Mussel Species Richness
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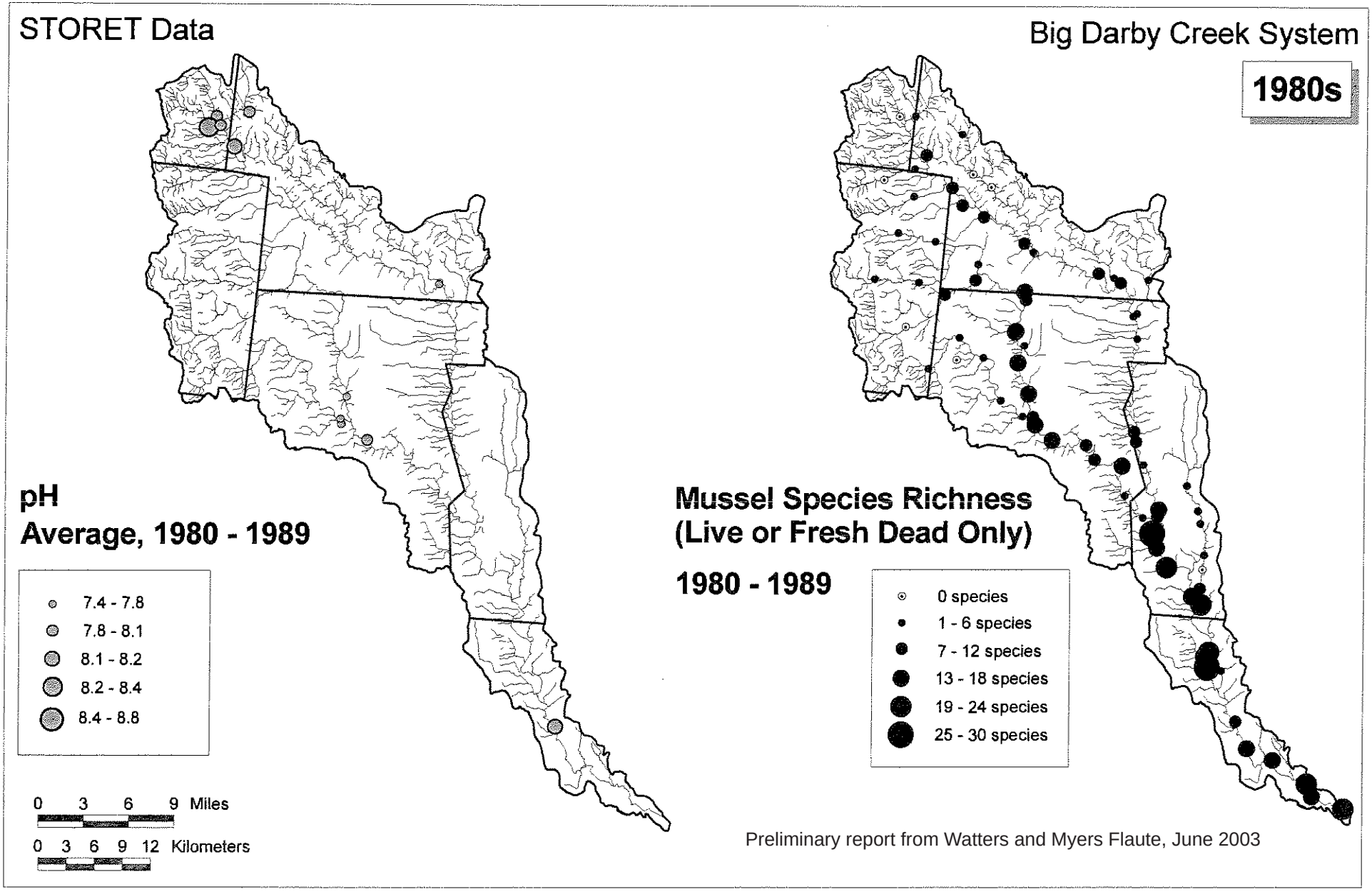
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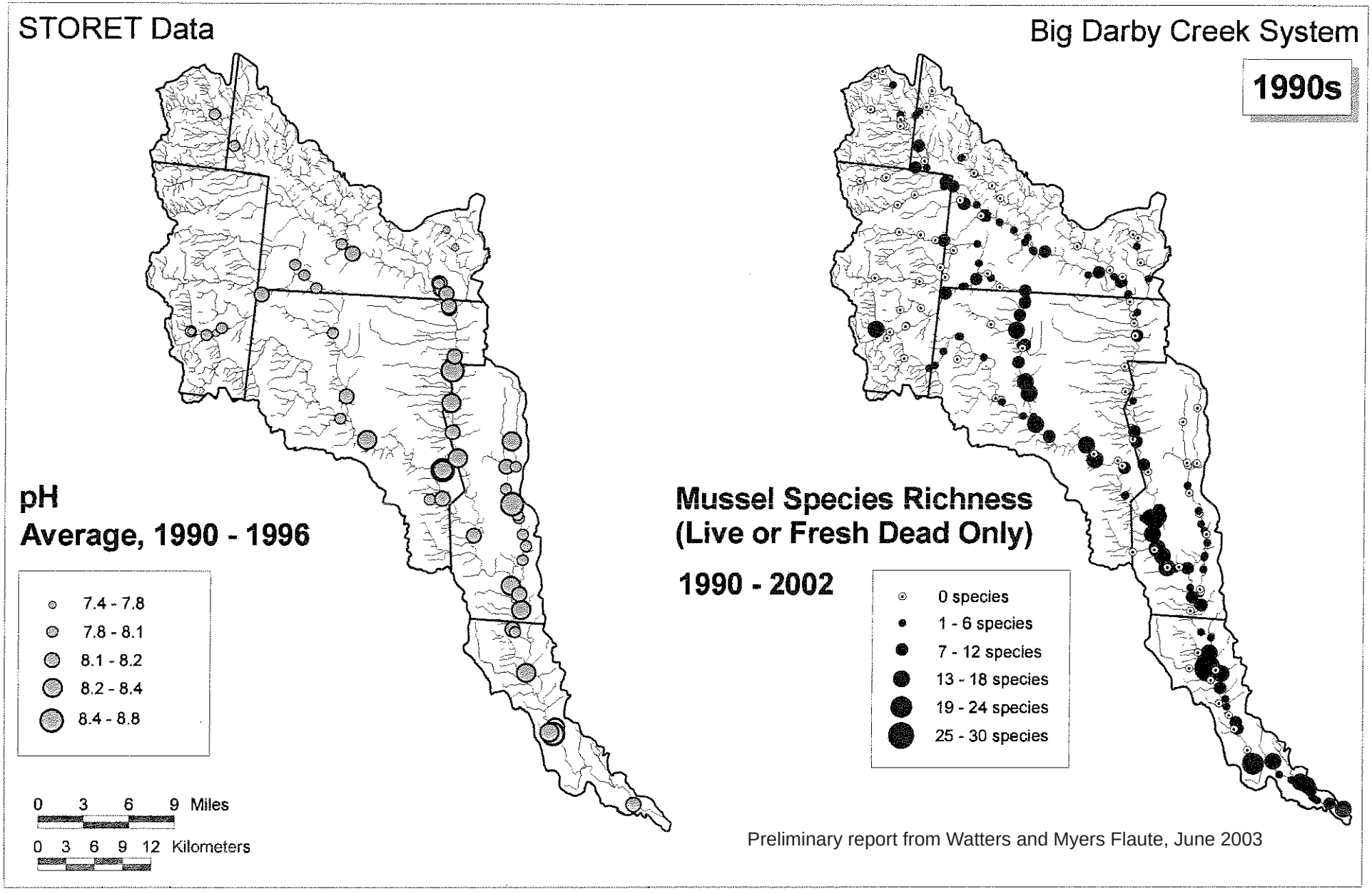
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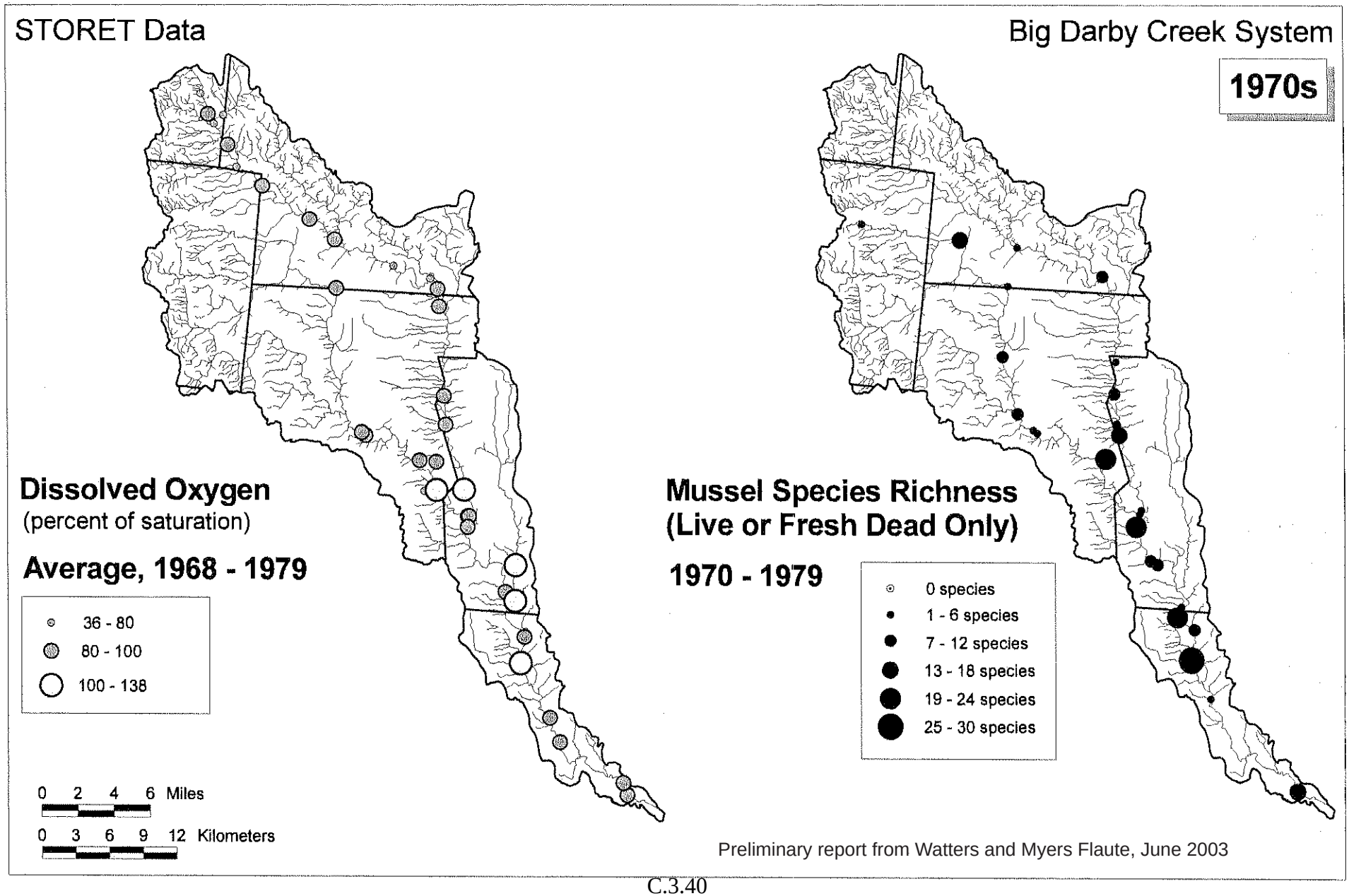
STORET Data
Big Darby Creek System
1970s
Dissolved Oxygen
(percent of saturation)
Average, 1968 - 1979
36 - 80
80 - 100
100 - 138
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
1 - 6 species
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0 2 4 6 Miles
0 3 6 9 12 Kilometers
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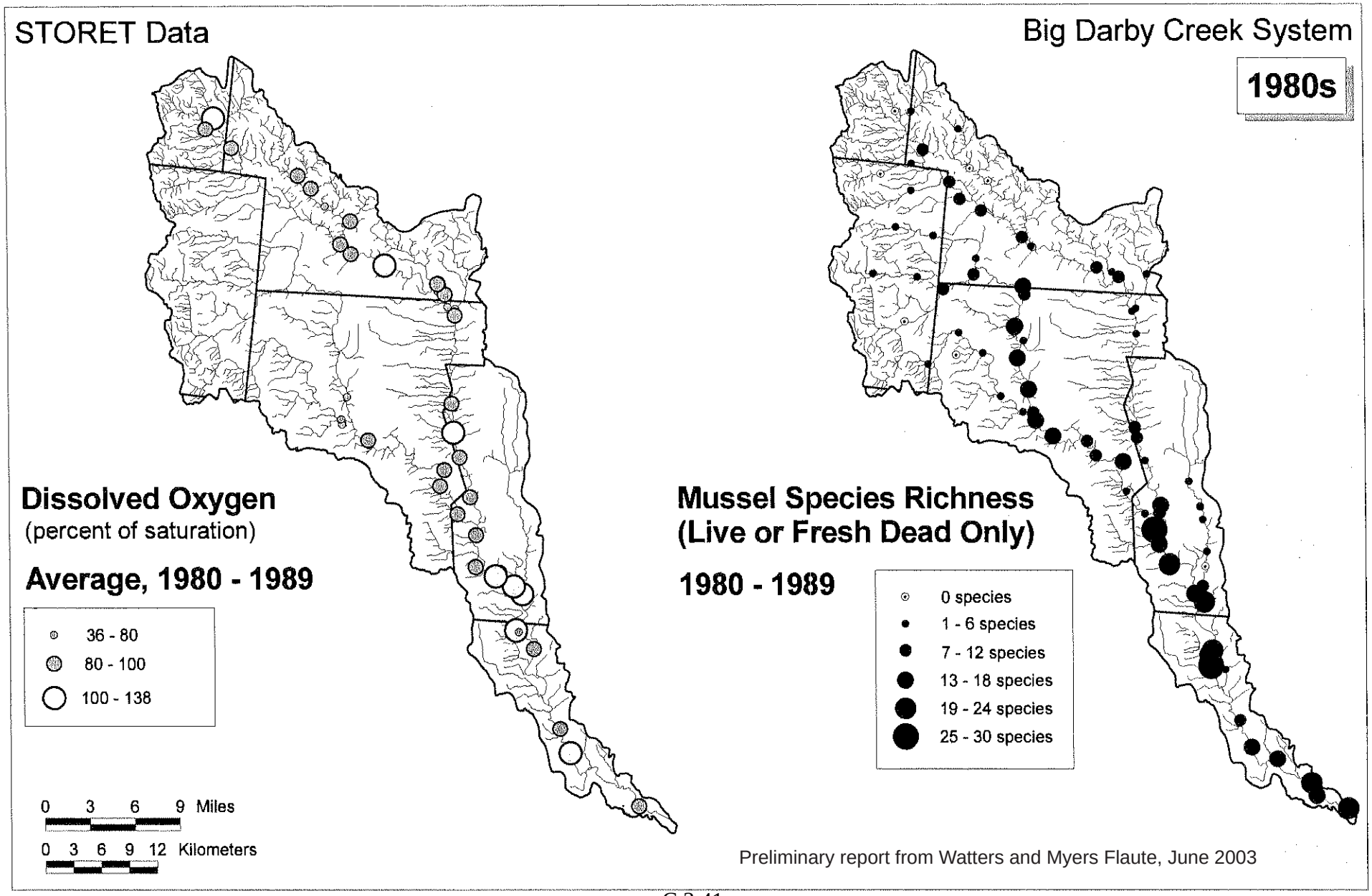
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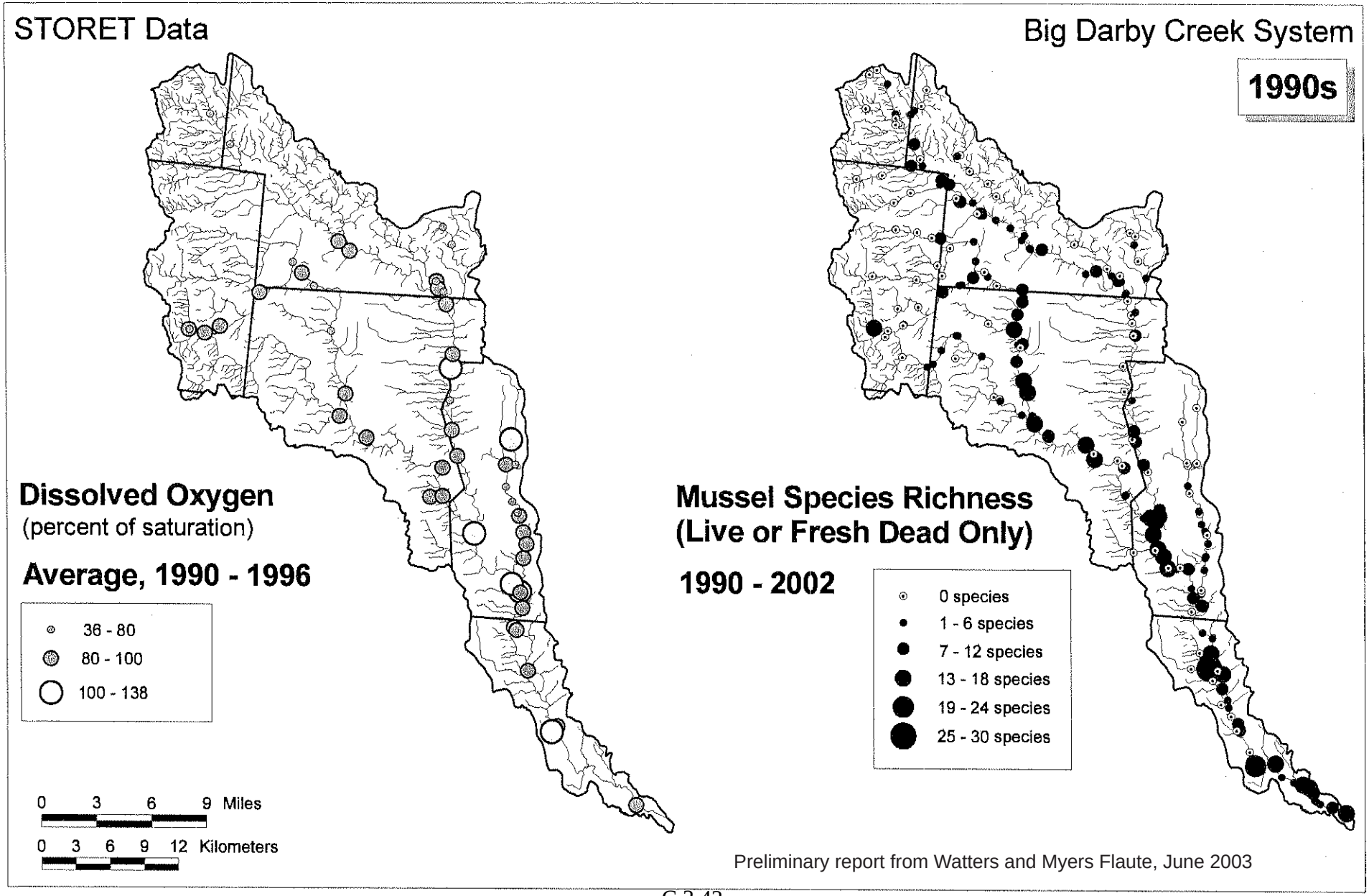
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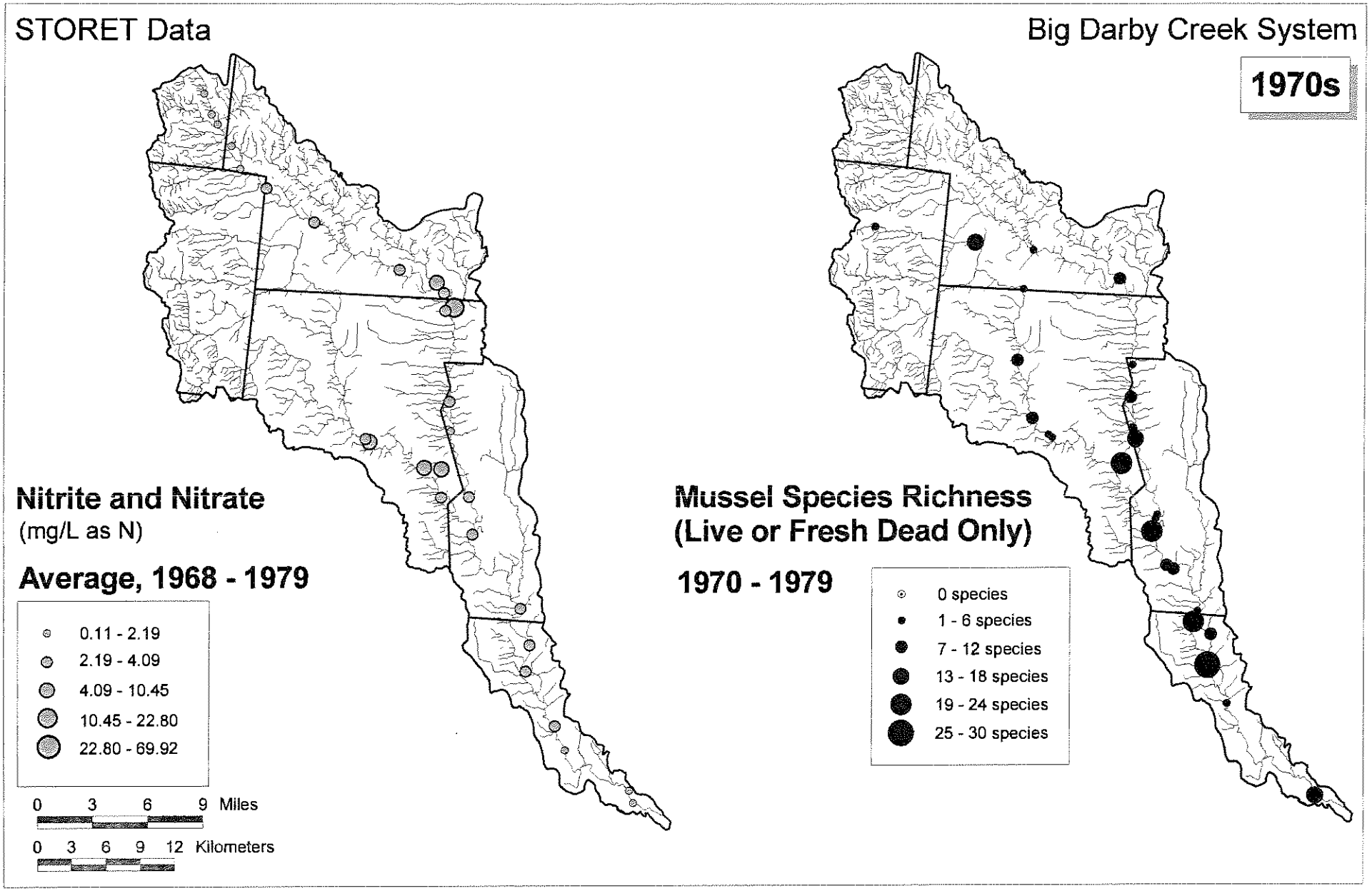
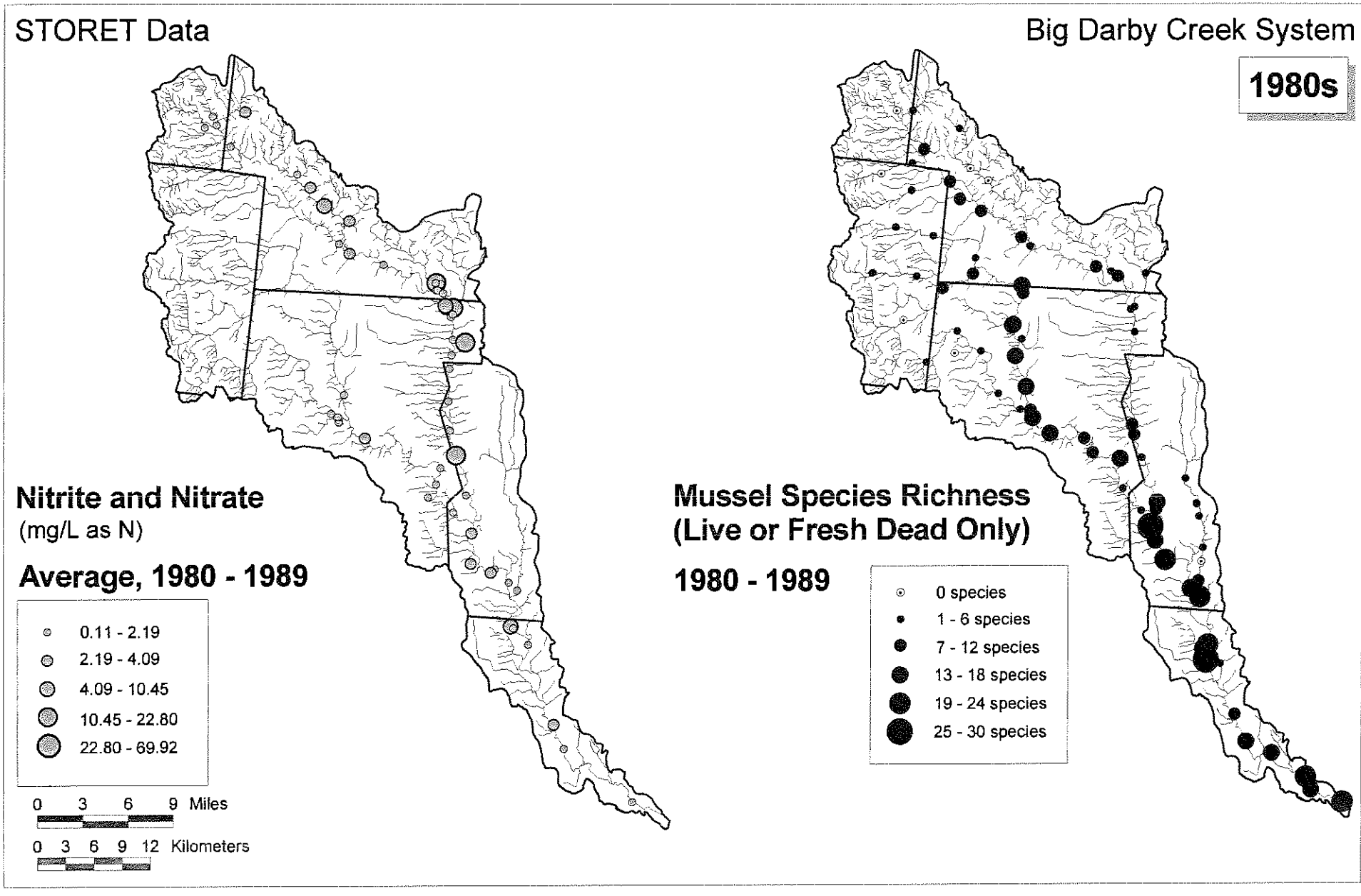
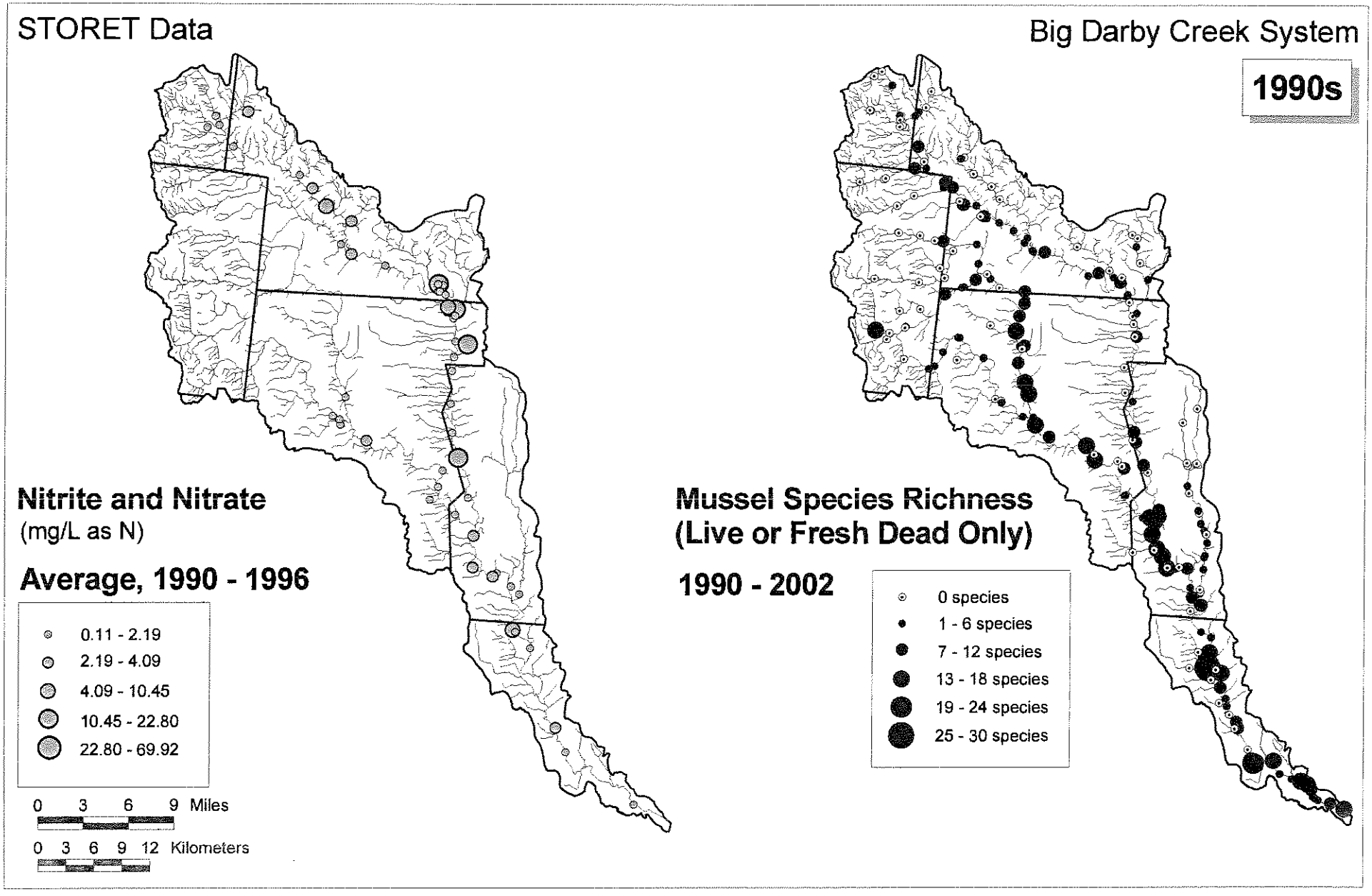
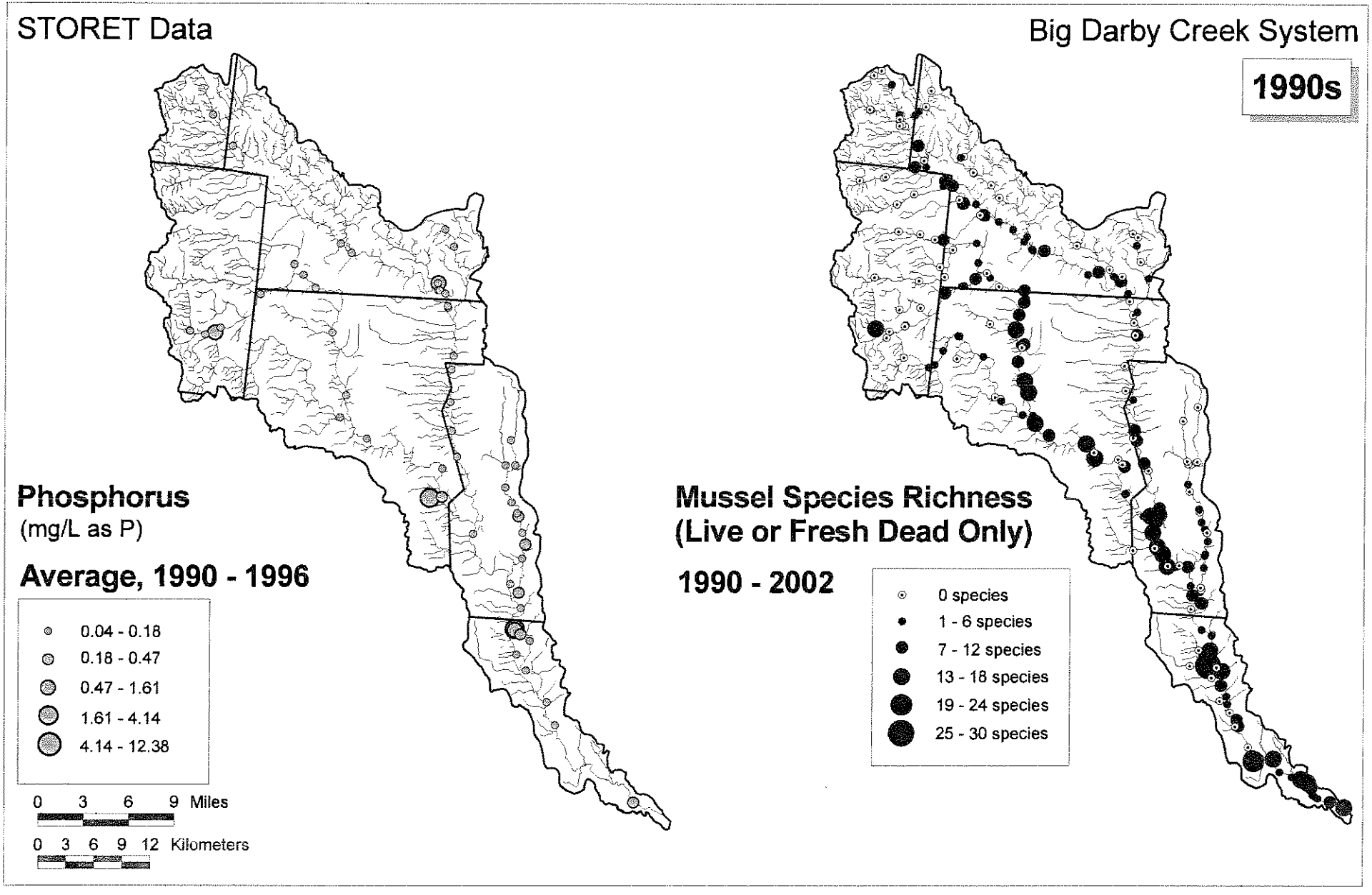
0 3 6 9 12 Kilometers
Preliminary report from Watters and Myers Flaute, June 2003


STORET Data
Big Darby Creek System
1970s
Nitrite and Nitrate
(mg/L as N)
Average, 1968 - 1979
0.11 - 2.19
2.19 - 4.09
4.09 - 10.45
10.45 - 22.80
22.80 - 69.92
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1970 - 1979
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species

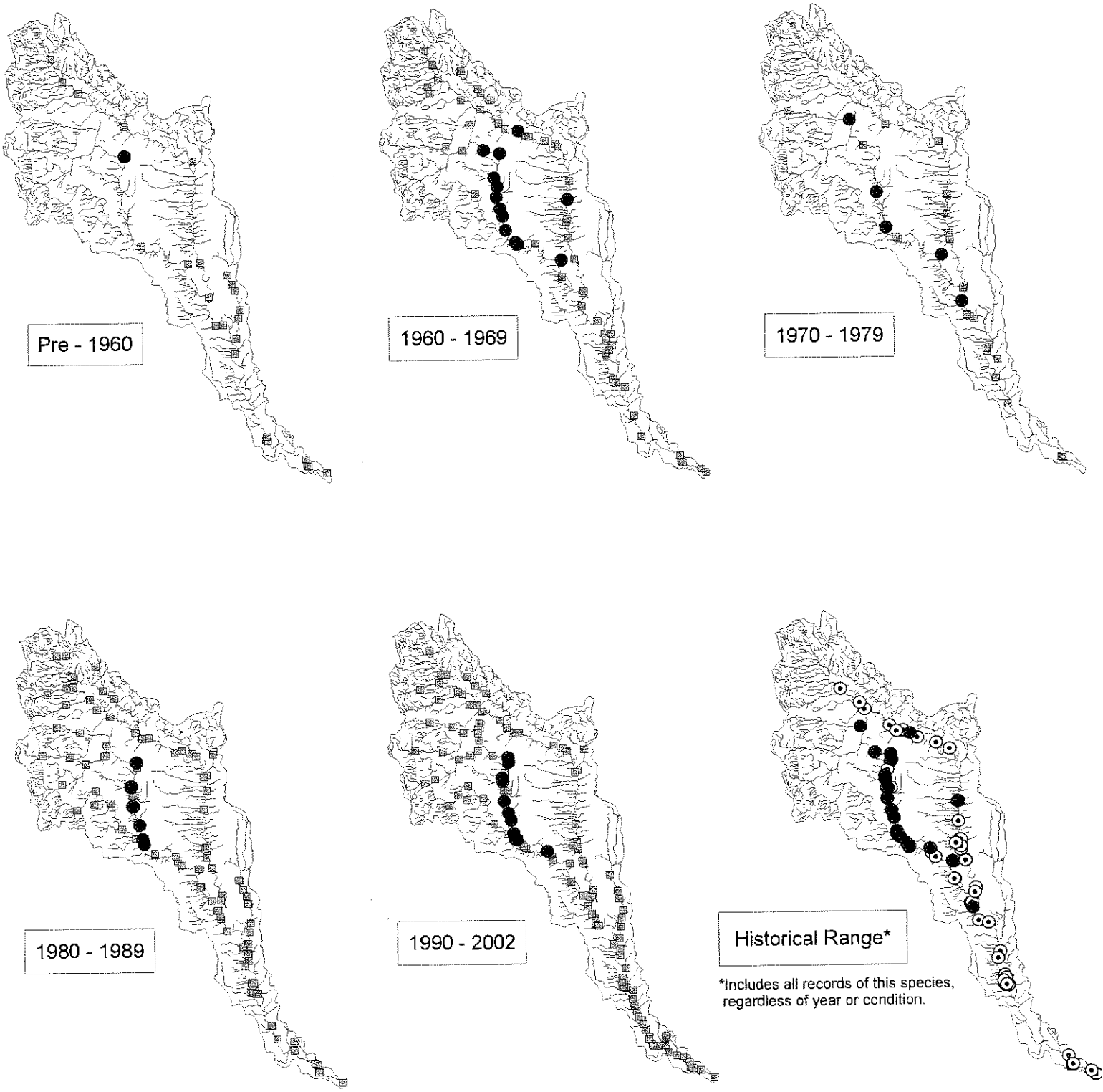

STORET Data
Big Darby Creek System
1980s
Nitrite and Nitrate
(mg/L as N)
Average, 1980 - 1989
0.11 - 2.19
2.19 - 4.09
4.09 - 10.45
10.45 - 22.80
22.80 - 69.92
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1980 - 1989
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species


STORET Data
Big Darby Creek System
1990s
Nitrite and Nitrate
(mg/L as N)
Average, 1990 - 1996
0.11 - 2.19
2.19 - 4.09
4.09 - 10.45
10.45 - 22.80
22.80 - 69.92
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species


STORET Data
Big Darby Creek System
1990s
Phosphorus
(mg/L as P)
Average, 1990 - 1996
0.04 - 0.18
0.18 - 0.47
0.47 - 1.61
1.61 - 4.14
4.14 - 12.38
0 3 6 9 Miles
0 3 6 9 12 Kilometers
Mussel Species Richness
(Live or Fresh Dead Only)
1990 - 2002
0 species
1 - 6 species
7 - 12 species
13 - 18 species
19 - 24 species
25 - 30 species

Clubshell

Pleurobema clava (Lamarck, 1819).



0 4 8 12 16 20 Miles

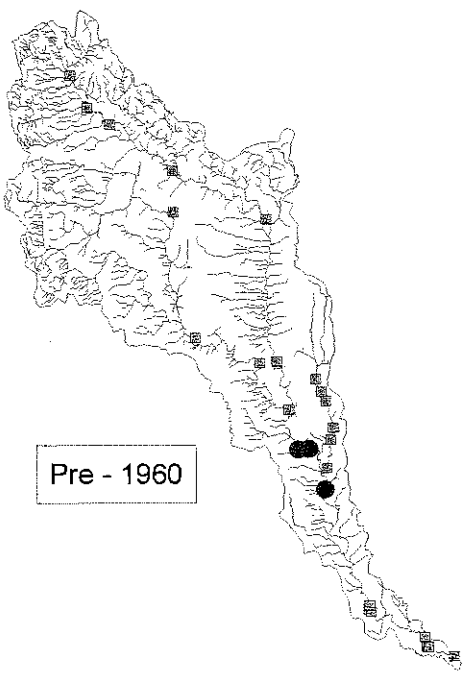
0 5 10 15 20 25 Kilometers

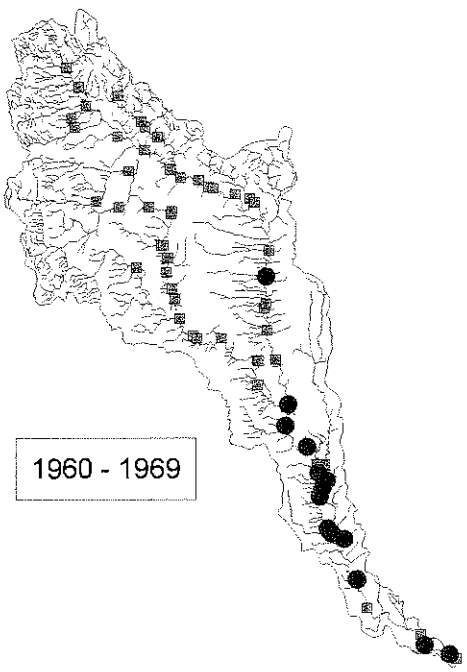
- ● Alive or fresh dead
- ⊙ Weathered or subfossil only (noted only for Historical Range)
- ▩ Location surveyed, but this species not found

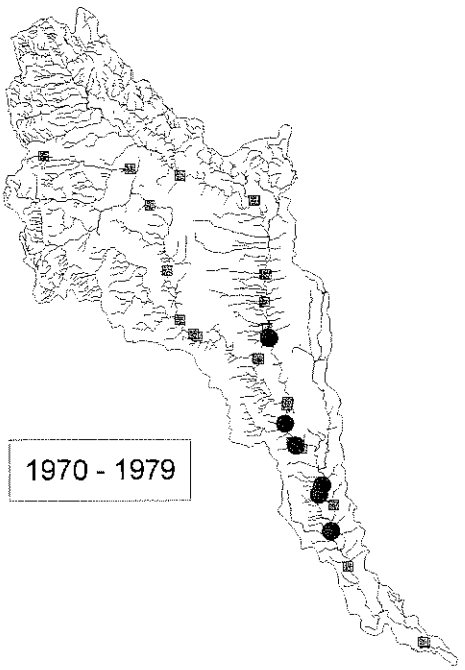
Northern riffleshell

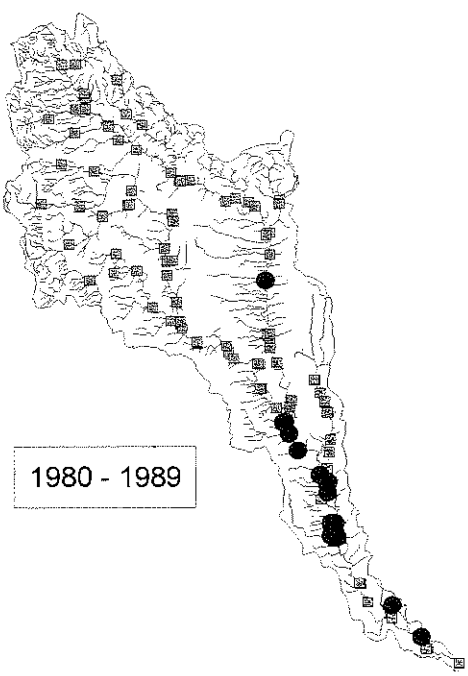
Big Darby Creek System

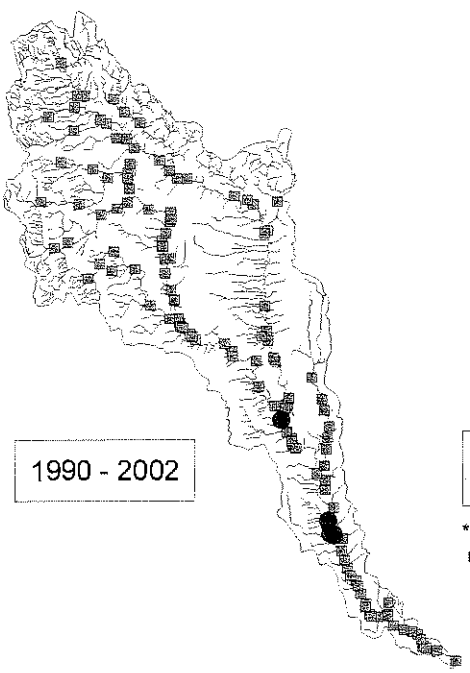
Epioblasma rangiana(Lea, 1838).

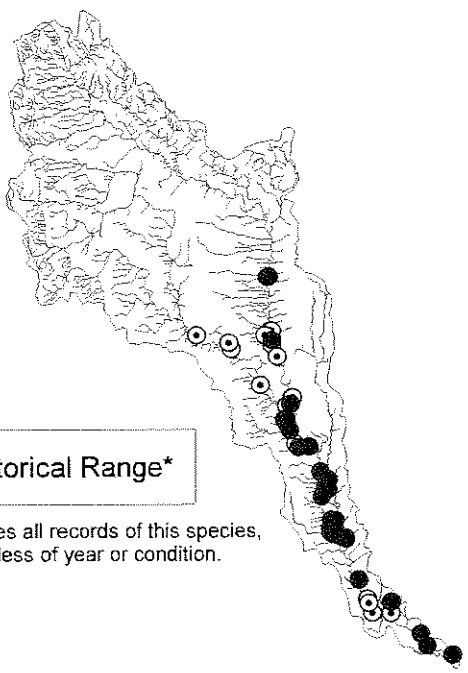












0 4 8 12 16 20 Miles

0 5 10 15 20 25 Kilometers

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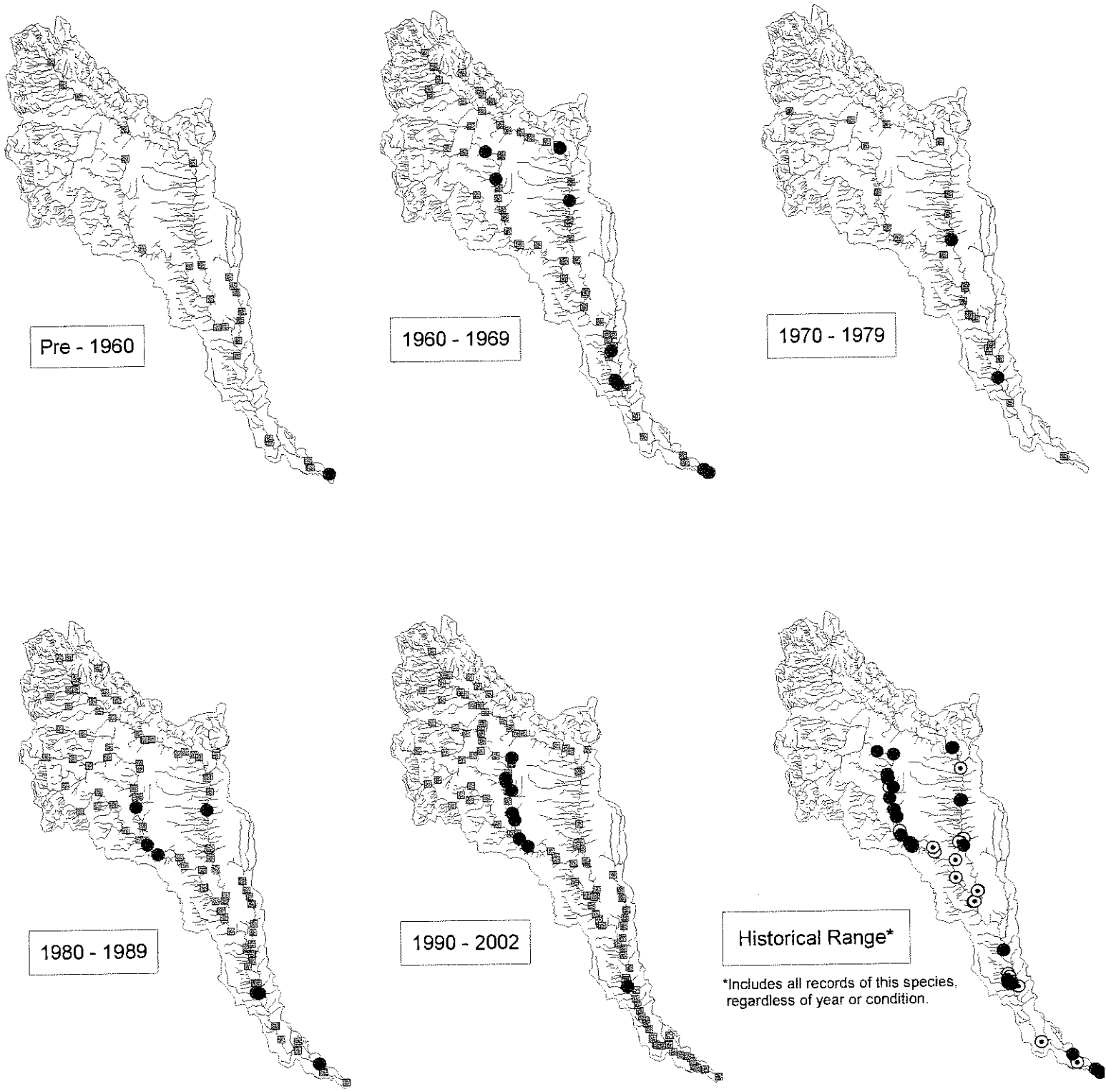
Rabbitsfoot

Quadrula cylindrica (Say, 1817).



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0 5 10 15 20 25 Kilometers

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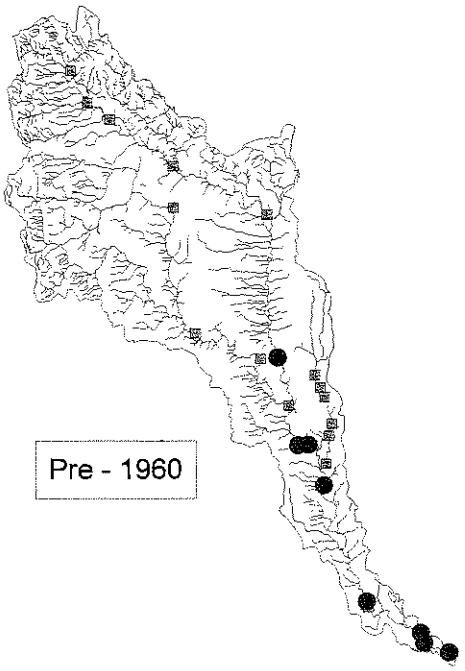
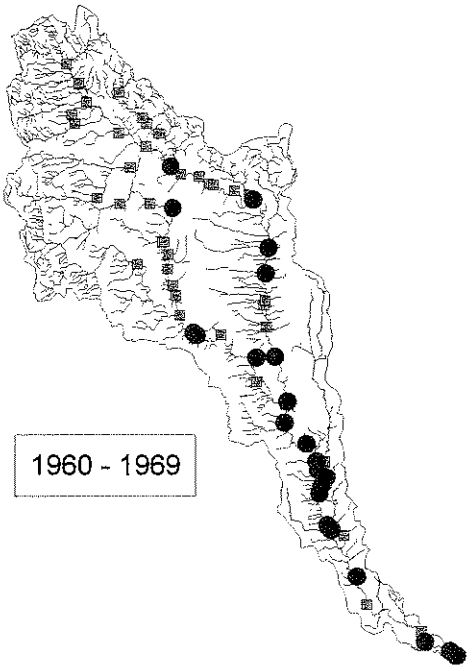
- ▨ Location surveyed, but this species not found

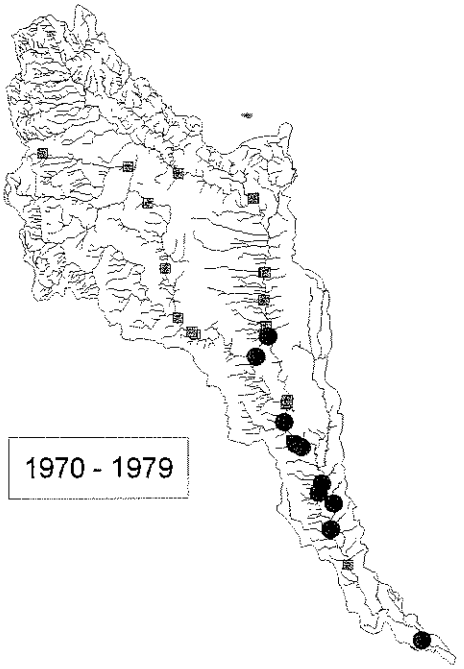
Snuffbox

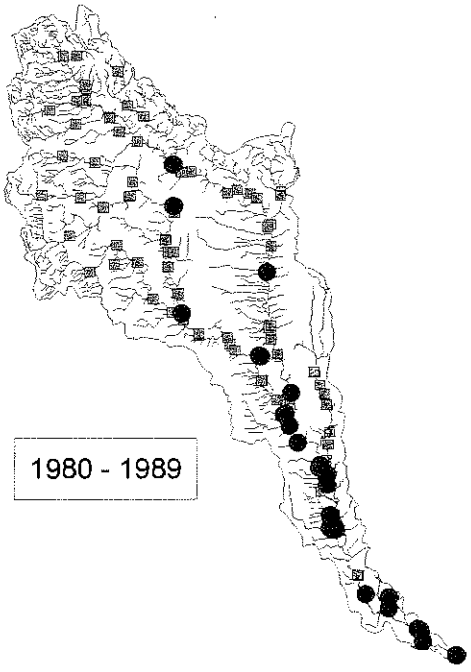
Big Darby Creek System

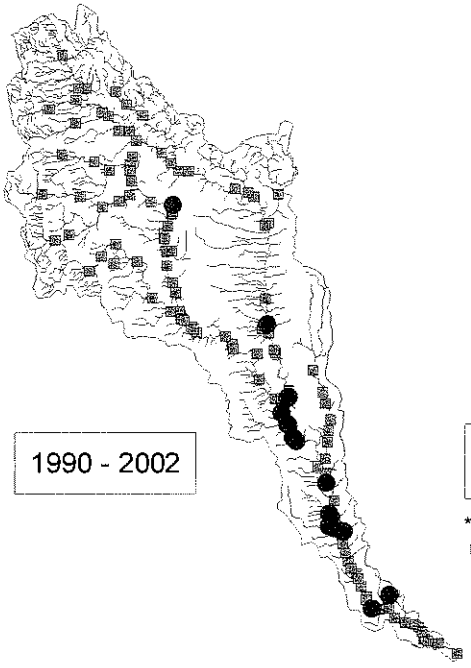
Epioblasma triquetra (Rafinesque, 1820).

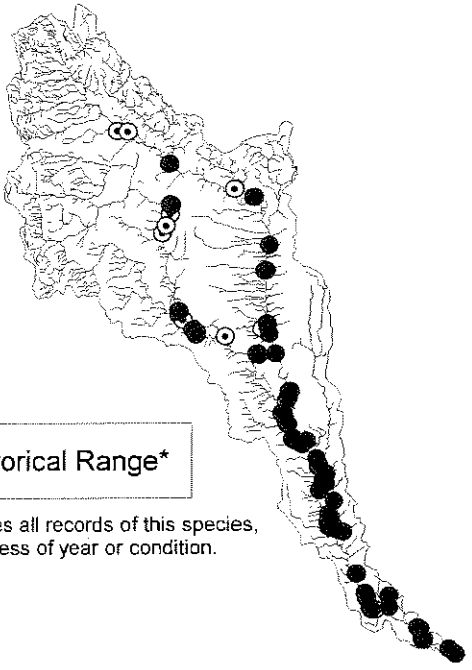












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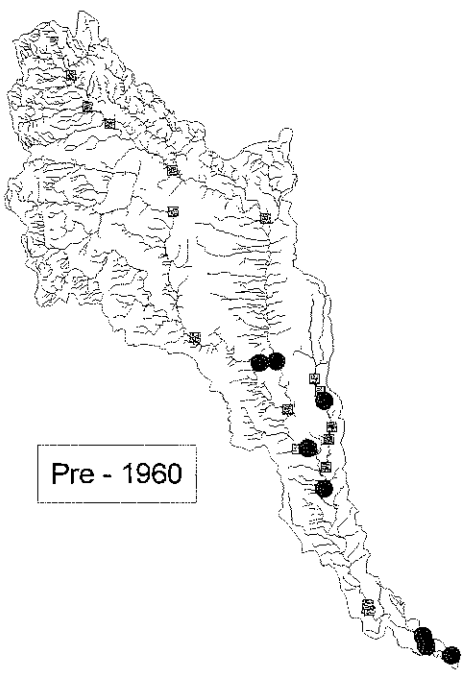
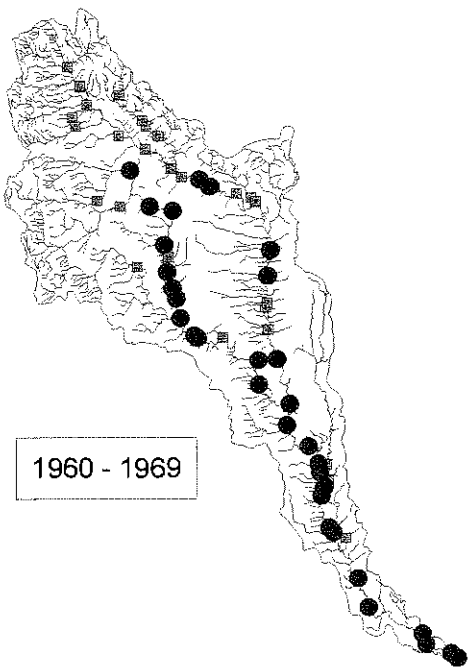
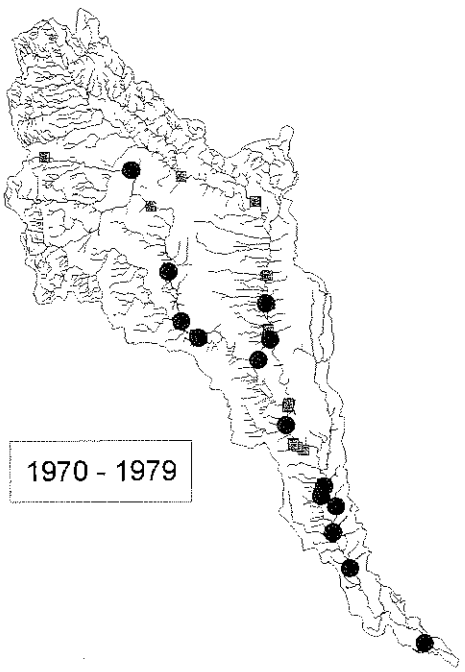
Wavy-rayed lampmussel

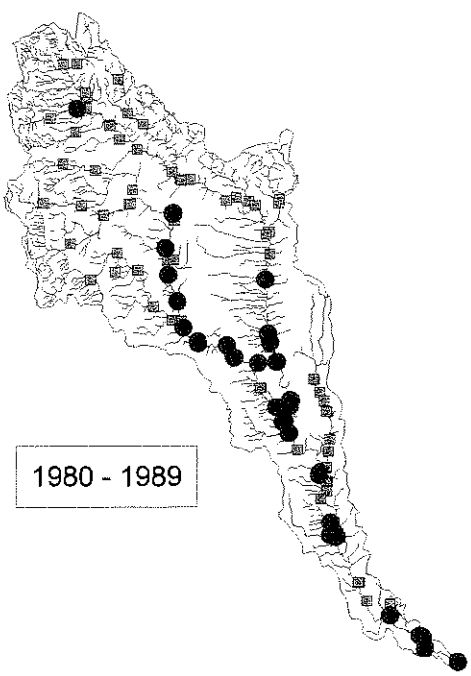
Big Darby Creek System

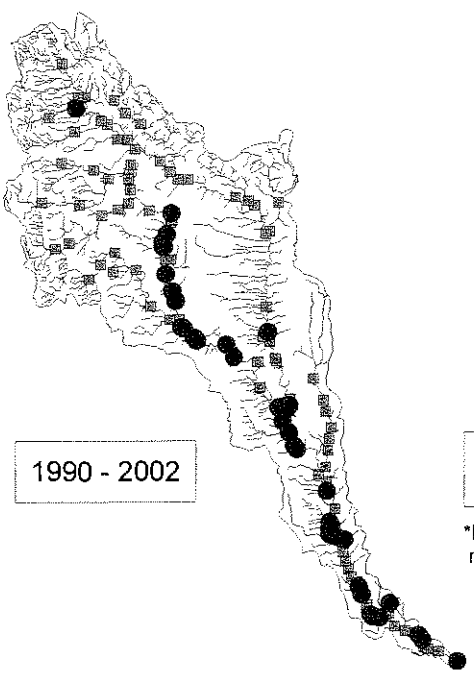
Lampsilis fasciola Rafinesque, 1820.

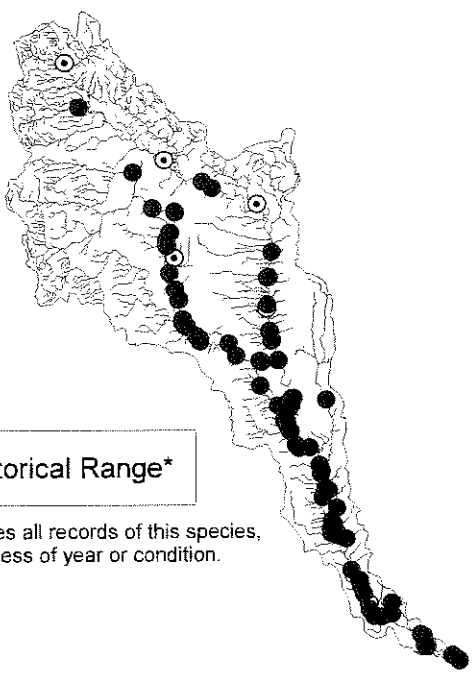












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