U.S. Environmental Protection Agency Region 7

Blackbird Creek
Adair County, Missouri

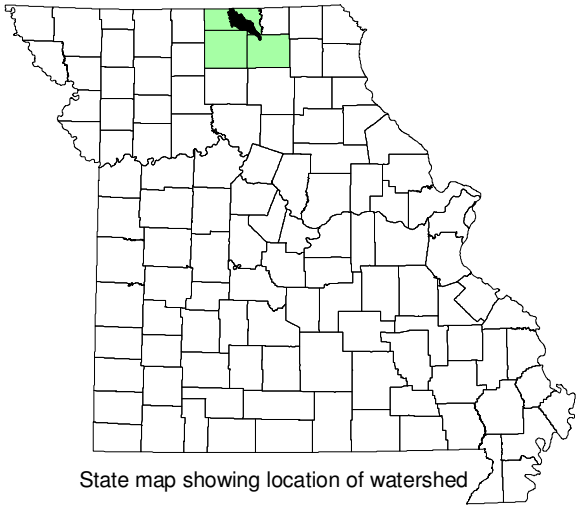
Total Maximum Daily Load

June, 2006

Approved by:

_____/s/_____ ___06/27/2006_
Betty J. Berry Date
Acting Director
Water, Wetlands, and Pesticides Division

Total Maximum Daily Load (TMDL)
For Blackbird Creek
Pollutant: Sediment


State map showing location of watershed

Name: Blackbird Creek

Location: In northwest Adair County and southeast Putnam County, Missouri

Hydrologic Unit Code (HUC): 10280201-130003

Water Body Identifications (WBID): 653

Missouri Stream Classification: 6.0 miles Class P[1]
4.5 miles Class C

Beneficial Uses[2]:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health associated with Fish Consumption
- Whole Body Contact Recreation (Swimming)

Impairment: Stream Habitat Degradation

Size of Impaired Segment: 10.5 miles

Location of Impaired Segment: From (upstream) Section 2, T64N, R17W to (downstream) its mouth at the Chariton River in NW ¼, Section 10, T63N, R16W

Pollutant Source: Agricultural Nonpoint Sources

Pollutant: Sediment

TMDL Priority Ranking: Medium

1. Introduction

This Blackbird Creek Total Maximum Daily Load (TMDL) for Sediment is being established in accordance with Section 303(d) of the Clean Water Act, because the State of Missouri determined on the 1998 and 2002 303(d) lists of impaired waters that the water quality

[1] Class P are streams that maintain permanent flow even in drought periods. Class C streams may cease to flow in dry periods but maintain permanent pools that support aquatic life. See Missouri Water Quality Standards (WQS) 10 Code of State Regulations 20-7.031(1)(F). The WQS can be found at the following uniform resource locator (URL): www.dnr.mo.gov/env/wpp/rules/index.html#Chap7

[2] For Beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H)

standards (WQS) for Blackbird Creek were exceeded due to sediment. The Missouri Department of Natural Resources (MDNR) Water Protection Program developed and public noticed documentation that Blackbird Creek is meeting WQS using the same data and analysis that is used in this TMDL. To meet the milestones of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001, EPA is establishing this TMDL. EPA public noticed this document from May 23, 2006, to June 23, 2006, and no comments were received.

The purpose of a TMDL is to determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. The TMDL also establishes the pollutant load allocation necessary to meet the WQS established for each waterbody based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumption and data inadequacies.

2. Background and Water Quality Problems

Blackbird Creek is a small northeastern Missouri tributary of the Chariton River. The stream begins at the confluence of North and South Blackbird Creeks in southeastern Putnam County, about 15 miles southeast of Unionville, Missouri. Blackbird Creek then flows southeast for about ten miles and empties into the Chariton River northeast of Novinger, Missouri. The total watershed is about 150 square miles.

All waters of the State, as per Missouri WQS, must provide suitable conditions for aquatic life. The conditions include both the physical habitat and the quality of the water. TMDLs are not written to address habitat, but are written to correct water quality conditions.

The quality and quantity of habitat for aquatic life have been affected generally in Missouri. A combination of natural geology and land use in the prairie portions of the State (where Blackbird Creek is located) is believed to have incurred these habitat alterations. Excessive rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, channelization causing loss of stream length and loss of stream channel heterogeneity, changes in basin hydrology increasing flood flows and prolonged low flow conditions all are impacting habitat. Loss of tree cover in riparian zones may have caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat has been demonstrated by the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the State where they once lived. However, as mentioned above, habitat loss is not an appropriate TMDL target to correct the water quality conditions. Other water quality measures must be assessed.

EPA placed Blackbird Creek on the Missouri 303(d) list for sedimentation. This was primarily based on best professional judgment because little sediment data exists to directly document sediment impacts to the stream. General fisheries data and the effect of sediment on

fish were the initial data used to consider Blackbird Creek for 303(d) listing. For this TMDL, sediment targets were derived using generalized information from the ecological drainage unit. (EDU).

Since the 303(d) listing, MDNR has developed a sediment protocol to determine if sediment is actually the pollutant in the streams listed and to arrive at a standard way to measure sediment. The first step of that protocol is a biological assessment to see if the biological community is actually impaired. In the case of Blackbird Creek, the study[3] measured habitat quality, water quality, and macroinvertebrate (like larval mayflies and crayfish) communities. It found that those three measures are similar among Blackbird Creek stream segments and are similar between Blackbird Creek and biocriteria reference (high quality) streams within the same Ecological Drainage Unit (see map in Appendix A). Therefore, the stream is considered not impaired (see data in Appendix B). For more details, refer to the study itself (footnote 3).

3. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

Beneficial Uses:

The designated uses of Blackbird Creek, WBID 653:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health associated with Fish Consumption
- Whole Body Contact Recreation (Swimming)

The stream classifications and designated uses may be found at 10 CSR20-7.031(1)(C) and (F) and Table H.

Use that is impaired:

Protection of Warm Water Aquatic Life

Anti-degradation Policy:

Missouri's WQS include the U.S. Environmental Protection Agency's (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

[3] Biological Assessment and Habitat Study, Blackbird Creek, Adair and Putnam Counties, 2003-2004. Department of Natural Resources, Environmental Services Program

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria:

The impairment of this waterbody is based on exceedence of the general, or narrative, criteria contained in Missouri's WQS, 10 CSR 20-7.031(3)(A), (C) and (G).

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.
(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

4. Calculation of Load Capacity

Load capacity (LC) is defined as the maximum pollutant load that a waterbody can assimilate and still attain WQS. This total load is then divided among a Wasteload Allocation (WLA) for point sources, a Load Allocation (LA) for nonpoint sources and a Margin of Safety (MOS). Since the biological assessment showed that Blackbird Creek is unimpaired, the sediment is set at no increase in the current sediment loading; no net reduction in the current condition is required. The paucity of specific instream data does not allow for the generation of a site-specific TMDL curve and a generalized ecological drainage unit evaluation was therefore used. Thus, the LC, LA and WLA for the TMDL are zero percentage net reduction, as shown in the Figure 1 below:

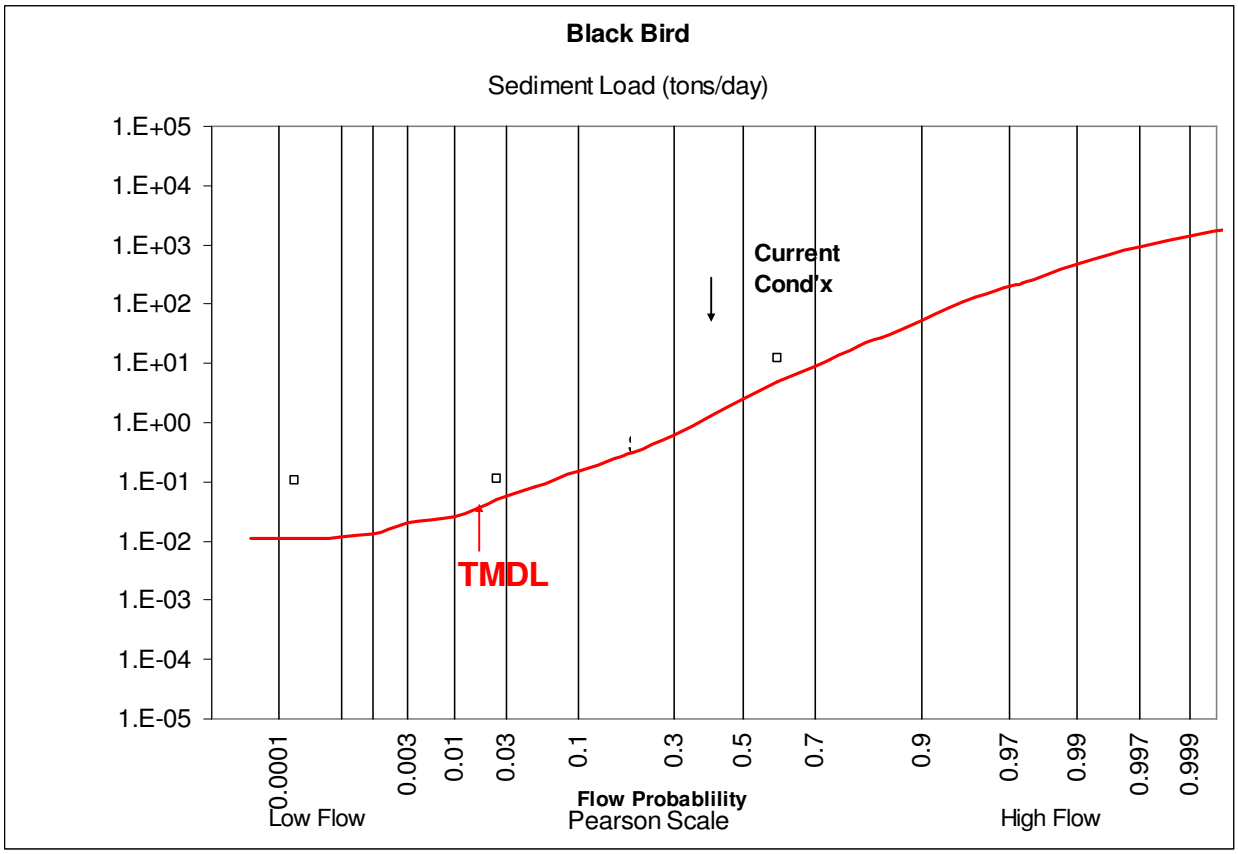


Figure 1 -- TMDL curve over the range of flows.

For a full description of the Development of Suspended Sediment Targets using Reference Load Duration Curves, please refer to Appendix C.

5. Load Allocation (Nonpoint Source Loads)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. In the Biological Assessment and Habitat Study, included as Appendix D, the impairment to warm water aquatic life from stream habitat degradation due to sediment was not found and Blackbird Creek supported a macroinvertebrate community similar to reference streams analyzed. Since the data show that Blackbird Creek is unimpaired, no net reduction in the current condition is required. The LA is zero percentage net reduction in sediment load and the TMDL curve is set at an estimated of those conditions over the range of flows.[4]

[4] Refer to Appendix D: Biological Assessment and Habitat Study, Blackbird Creek, Adair and Putnam Counties, 2003-2004. Department of Natural Resources, Environmental Services Program

6. Waste Load Allocation (Point Source Loads)

WLA is the allowable amount of the pollutant that can be assigned to point sources. There are no major point sources of pollution in the Blackbird Creek watershed. The town of Unionville has two small municipal wastewater treatment facilities that discharge treated effluent to tributaries of North and South Blackbird Creeks. In addition, stormwater runoff from Unionville also discharges to the streams. Because these discharges are small and are located at the upstream end of the watershed, they likely do not substantially impact Blackbird Creek within the study area. Since the data show that Blackbird Creek is meeting WQS, no net reduction in the current condition is required. The WLA is zero percentage net reduction in sediment load.

7. Margin of Safety

A Margin of Safety (MOS) is usually added to a TMDL, if a TMDL is necessary, to account for the uncertainties inherent in the calculations and data gathering. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit – Reserve a numeric portion of the loading capacity as a separate term in the TMDL.

(2) Implicit – Incorporate the MOS as part of the critical conditions for the waste load allocation and the load allocation calculations by making conservative assumptions in the analysis.

The MOS in this case is implicit because WQS are being met with the present load.

8. Seasonal Variation

Data used in this TMDL, was generated by MDNR's Environmental Services Program (ESP). Invertebrate sampling was collected for two seasons, Fall 2003 and Spring 2004. Invertebrate scores of 16 or greater are judged to indicate unimpaired streams and scores less than 16 are judged to be impaired. The samples were collected at 3 sites in Fall 2003, and 2 sites in Spring 2004, as shown in the table 7.1. All samples were 16 or greater, thus the stream is judged to be unimpaired and meeting the Protection of Warm Water Aquatic Life use during both seasons.

Table 7.1. Blackbird Creek Invertebrate Data

Aquatic Invertebrate Scores		
Location	**Fall 2003**	**Spring 2004**
Site 1	16	--
Site 2	16	18
Site 3	20	20

9. Report on MDNR Monitoring Plans for Blackbird Creek

The Missouri Department of Natural Resources has scheduled low flow studies for North and South Blackbird Creeks in 2006 and 2007. There is annual ambient monitoring on North Blackbird Creek at Highway 136 in Putnam County.

10. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). EPA is providing public notice of this TMDL for Blackbird Creek on the EPA, Region 7, TMDL website: http://www.epa.gov/region07/water/tmdl.htm. The response to comments and final TMDL will be available at: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

This water quality limited segment of Blackbird Creek in Adair County, Missouri, is included on the approved 1998 and 2002 303(d) lists for Missouri. The Missouri Department of Natural Resources' Water Protection Program developed and public noticed documentation that this segment of Blackbird Creek is "Meeting Water Quality Standards" using much of the same data and analysis that is used in this TMDL. This TMDL is being produced by EPA to meet the requirements of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001. EPA is developing this TMDL in cooperation with the State of Missouri, and EPA is establishing this TMDL at this time to fulfill the *American Canoe* consent decree obligations. Missouri may submit and EPA may approve another TMDL for this water at a later time.

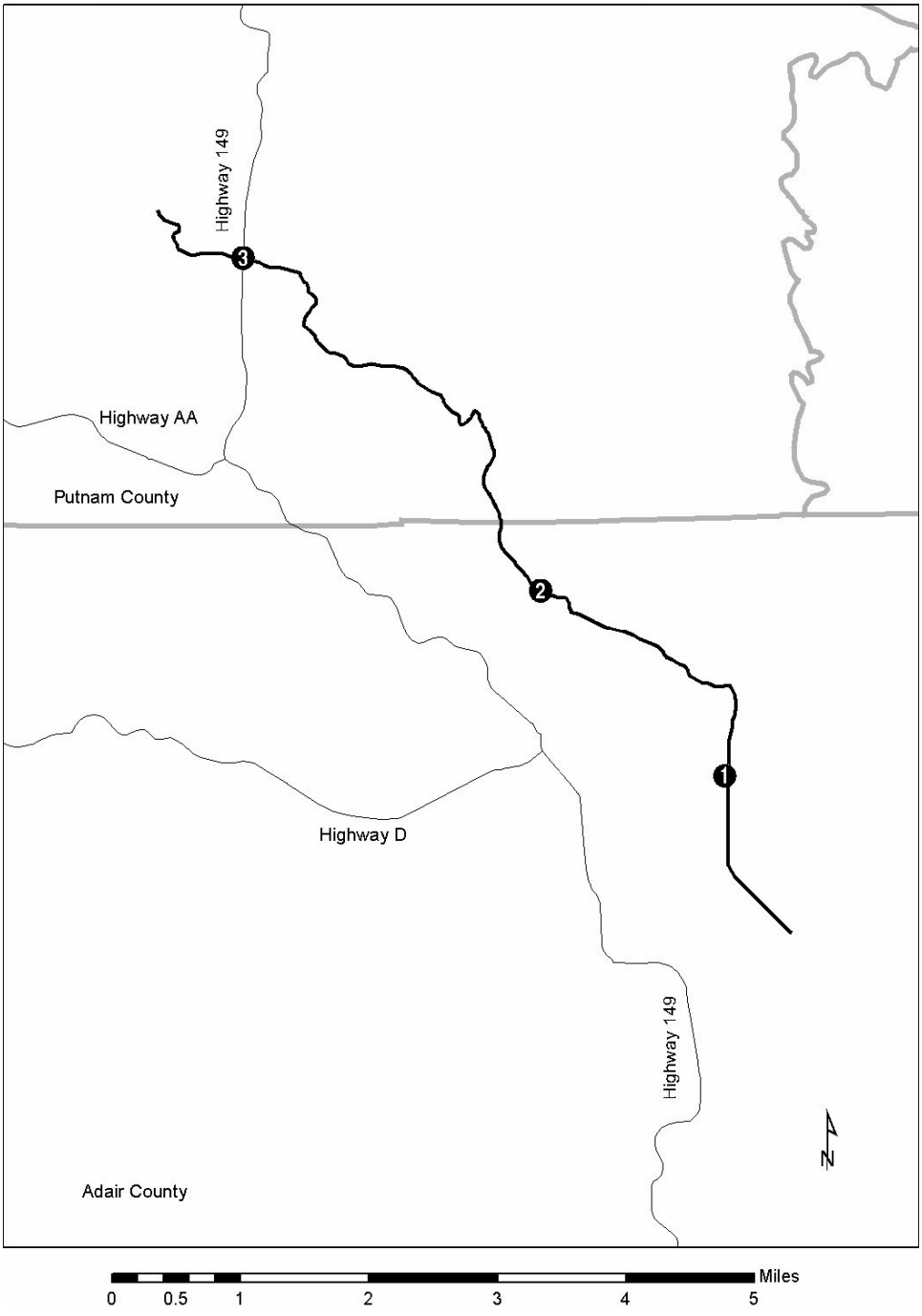
When MDNR's public noticed this waterbody as meeting WQS, the public notice period was from January 13, 2006, to February 12, 2006. As part of the public notice process, MDNR maintained an email mailing list of interested persons to provide notification of issues relating to the Blackbird Creek TMDL. Groups that received the public notice announcement included the Missouri Clean Water Commission, the Water Quality Coordinating Committee, Stream Team Volunteers in the county (47), and the legislators representing Adair County (2). No comments were received to the MDNR public notice. The same groups received notice of this TMDL and were invited to provide comment from May 23, 2006, to June 23, 2006. EPA received no comments and this TMDL was made final June 27, 2006. An electronic version of this final TMDL can be found at: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

11. Appendices

Appendices:
Appendix A – Map of Blackbird Creek, impaired segment and sampling sites
Appendix B – Data for Blackbird Creek
Appendix C – Development of Suspended Sediment Targets using Reference Load Duration Curves
Appendix D – Biological Assessment and Habitat Study, Blackbird Creek, Adair and Putnam Counties, 2003-2004.
Appendix E – Total Maximum Daily Load Information Sheet for Blackbird Creek

Appendix A

Figure 1: Blackbird Creek Sample Stations



Site Index

1- Upstream of Sand Creek Bottom Road in Adair County; 1.4 miles upstream from the Chariton River

2- Upstream of Grapevine Road; about 2.4 miles upstream from #1

3- Upstream of Highway 149; about 4.4 miles upstream from #2 in Putnam County.

Appendix B

Blackbird Creek Invertebrate Data

Aquatic Invertebrate Scores		
Location	**Fall 2003**	**Spring 2004**
Site 1	16	--
Site 2	16	18
Site 3	20	20

Note: Invertebrate scores of 16 or greater are judged to indicate unimpaired streams. Scores less than 16 are judged to be impaired. For ESP invertebrate sampling: where there are seven or fewer samples, if 75 percent or more of the samples indicate an unimpaired stream, the stream will be judged to be unimpaired (Missouri 2004 Listing Methodology Document). All samples above were 16 or greater, thus the stream is judged to be unimpaired.

Blackbird Creek Water Chemistry Data

Site	Site Name	Year	Mo	Day	Flow	C	DO	PH	SC	KJN	NH3N	NO3N	TP	Cl
1	Blackbird Cr. @ Sand Creek Bottom Rd	2003	10	1	0.7	9	11.4	8.4	382	0.47	0.01499	0.00499	0.05	14
2	Blackbird Cr. @ Grapevine Rd.	2003	10	2	0.38	8.5	8.9	7.7	405	0.59	0.01499	0.00499	0.08	14
2	Blackbird Cr. @ Grapevine Rd.	2004	4	7	28.6	15	10.8	7.8	410	0.53	0.01499	0.11	0.1	15
3	Blackbird Cr. @ Hwy 149	2003	10	2	0.42	14	12.1	8.5	410	0.52	0.01499	0.00499	0.05	15
3	Blackbird Cr. @ Hwy 149	2004	4	7	31.6	13	10.8	7.6	430	0.48	0.01499	0.11	0.09	15
Water Quality Standard						**32**	**5**	**6.5-9**			**2.0***			**230**

- The ammonia standard is water temperature and pH dependent. The 2.0 mg/L estimated standard is based on typical summer water

Appendix C

Development of Suspended Sediment Targets using Reference Load Duration Curves

Overview

This procedure is used where a lotic system is placed on the 303(d) impaired waterbody list for sediment and the designated use being addressed is aquatic life. In cases where suspended solids data for the impaired stream is not available a reference approach is used. The target for suspended solids is the 25th percentile calculated from all data available within the ecological drainage unit (EDU) in which the waterbody is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for suspended solids within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75th percentile of reference lakes or the 25th percentile of all lakes in the region is targeted in the TMDL. For most cases available suspended sediment data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL load duration curve.

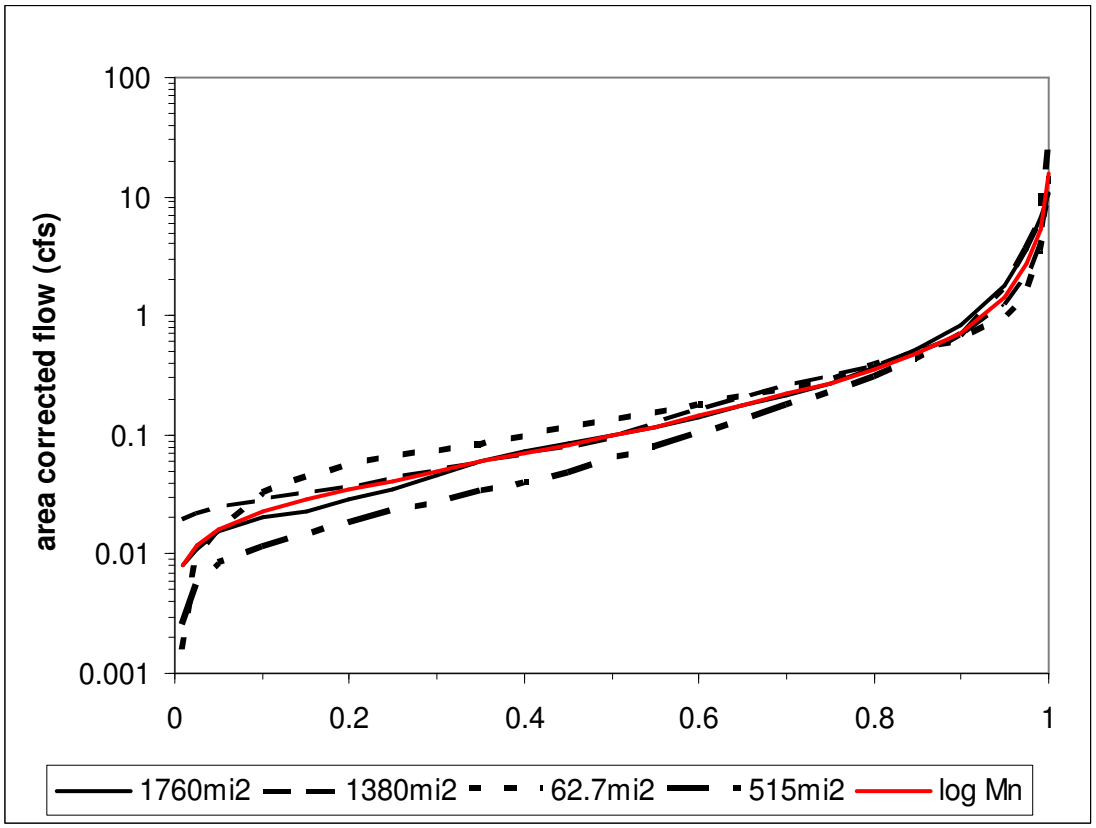
Methodology

The first step in this procedure is to locate available suspended solids data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and suspended solids concentration are needed in order to match the measured data to the synthetic EDU flow record.

Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the suspended solids record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

The following examples show the application of the approach to one Missouri EDU.

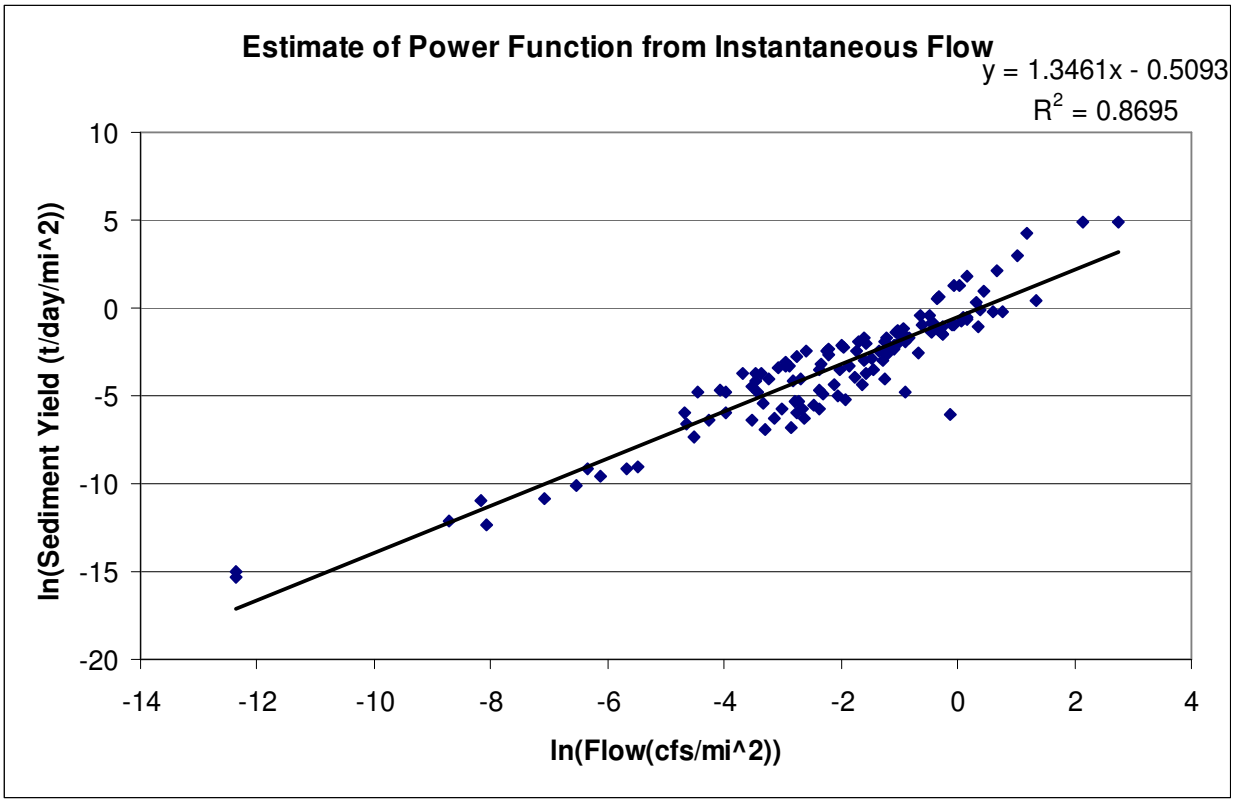
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The results of this analyses is displayed in the following figure and table:



Gage	gage	area (mi^2)	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate sediment-discharge relationships for the EDU, these are log transformed data for the yield (tons/mi^2/day) and the instantaneous flow (cfs/mi^2.) The following graph shows the EDU relationship:



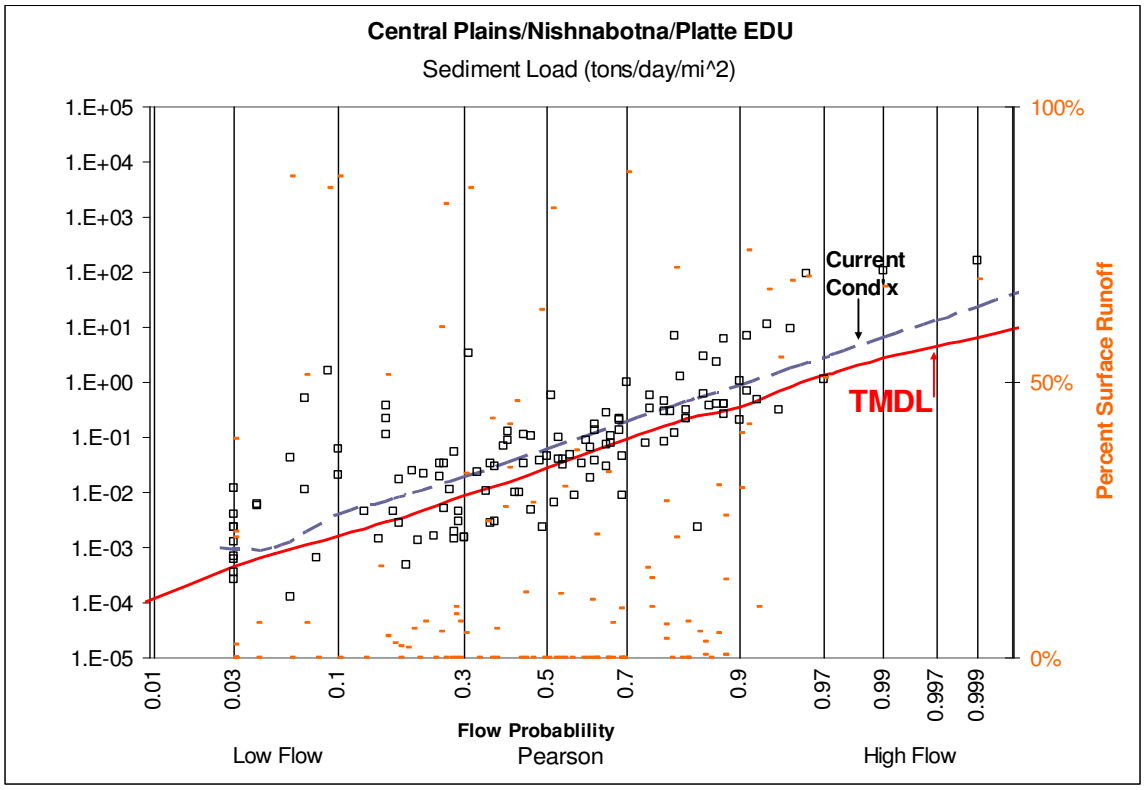
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r^2	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25%ile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z_{75} statistic times the standard error of (y). The resulting TMDL Equation is the following:

*Sediment yield (t/day/mi^2)=exp(1.34608498 * ln (flow) - 1.36627)*

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area.

For more information contact:
Environmental Protection Agency, Region 7
Water, Wetlands, and Pesticides Division
Total Maximum Daily Load Program
901 North 5th Street
Kansas City, Kansas 66101
Website: http://www.epa.gov/region07/water/tmdl.htm

Appendix D
Biological Assessment and Habitat Study

Biological Assessment and Habitat Study

Blackbird Creek
Adair and Putnam Counties

2003-2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program
Water Pollution Branch

Prepared by:

Missouri Department of Natural Resources
Air and Land Protection Division
Environmental Services Program
Water Quality Monitoring Section

Blackbird TMDL
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Appendix B **Macroinvertebrate Bench Sheets for Blackbird Creek and Spring Creek Stations, Fall 2003-Spring 2004**

1.0 Introduction

At the request of the Missouri Department of Natural Resources **(MDNR)** Water Protection Program **(WPP)**, the Environmental Services Program **(ESP)** Water Quality Monitoring Section **(WQMS)** conducted a macroinvertebrate bioassessment and habitat study of Blackbird Creek in Adair and Putnam Counties in north central Missouri.

A 10.5-mile section of Blackbird Creek (virtually the entire stream length) is listed as a 303(d) stream for sediment pollution from agriculture non-point sources by the WPP in the Total Maximum Daily Load (TMDL) listing of 2002. The 303(d) list does not include habitat loss as an impact. However, portions of Blackbird Creek have poor habitat due to poor riparian zones, steep banks, and channelization. On August 29,2003 a study plan was submitted to the WPP (Appendix A).

1.1 Purpose

The purpose of the study was to determine if the Blackbird Creek macroinvertebrate community was impaired and, if so, determine possible causes.

1.2 Objectives

1) Define the habitat characteristics of Blackbird Creek.

2) Define the water quality characteristics of Blackbird Creek.

3) Determine if the macroinvertebrate community and water quality of Blackbird Creek are impaired by factors related to habitat loss.

1.3 Tasks

1) Conduct a habitat assessment of Blackbird Creek.

2) Conduct a water quality assessment of Blackbird Creek.

3) Conduct a bioassessment of the macroinvertebrate community of Blackbird Creek.

1.4 Null Hypotheses

- Habitat quality, water quality, and macroinvertebrate assemblages are similar among Blackbird Creek stream segments.

- Habitat quality, water quality, and macroinvertebrate assemblages are similar between Blackbird Creek and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit **(EDU)**.

2.0 Study Area

Blackbird Creek is a small fourth order northeastern Missouri tributary of the Chariton River. The stream begins at the confluence of North and South Blackbird Creeks in southeastern Putnam County, about 15 miles southeast of Unionville, Missouri. Blackbird Creek flows southeast from

the confluence of its tributaries for about ten miles and empties into the Chariton River northeast of Novinger, Missouri. Total watershed including tributaries is approximately 150 square miles. Blackbird Creek is considered a permanently flowing class "P" stream by the Missouri Water Quality Standards (MDNR 2000). Beneficial use designations are "Livestock and Wildlife Watering **(LWW)**, Protection of Warm Water Aquatic Life and Human Health-Fish Consumption **(AQL)**, and Whole Body Contact Recreation **(WBC)**.

2.1 Water Quality Concerns

There are no major point sources of pollution in the Blackbird Creek watershed. Non-point source impacts from farming and agricultural industry are of much greater concern.

The town of Unionville has two small municipal wastewater treatment facilities that discharge treated effluent to tributaries of North and South Blackbird Creeks. In addition, stormwater runoff from Unionville also discharges to the streams. Because these discharges are small and are located at the upstream end of the watershed, they likely do not substantially impact Blackbird Creek within the study area.

Agriculture is a major industry within northern Missouri and the Chariton River basin, including row crops, pasturing of cattle, and concentrated animal feeding operations (**CAFO**). There is potential discharge and ground water infiltration to North Blackbird Creek from Premium Standard Farms, Whitetail facility, a Class 1A hog CAFO that includes lagoons and land application of wastewater within the watershed.

Erosion of cropland is a major cause of silt and sand sediment deposition in northern Missouri streams. In addition, row crops are often planted to the edge of stream banks that have been denuded of riparian vegetation, causing steep, shadeless, unstable banks, high summer water temperatures, and loss of stream habitat. Pastured cattle often have access to streams and contribute organic and bacterial loading, destruction of stream banks, and increased turbidity and siltation. Many of the larger northern Missouri streams have various degrees of channelization to provide more area in the river bottoms for cropland. Channelization causes a loss of channel structure and subsequent deterioration and destruction of stream habitats.

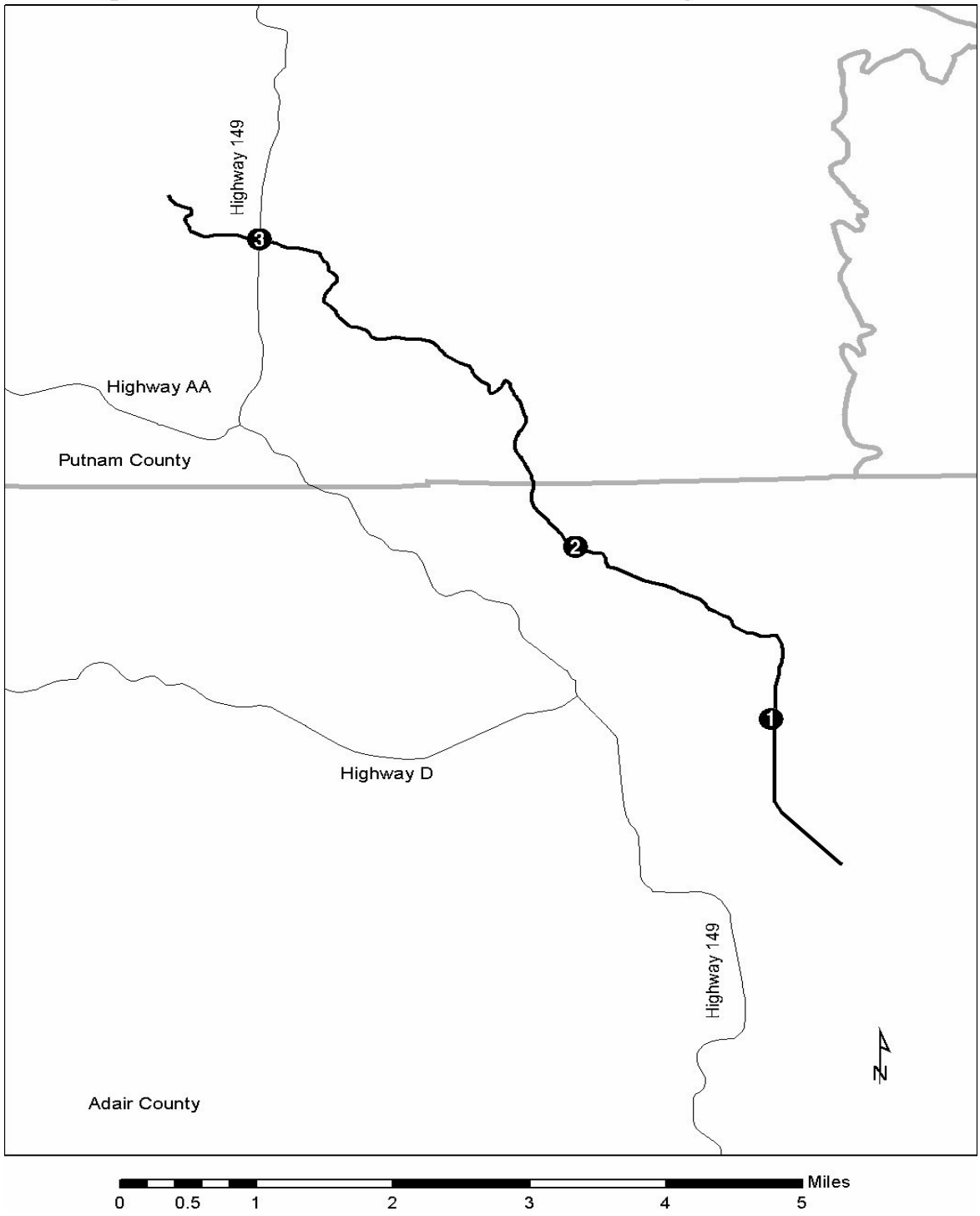
2.2 Blackbird Creek Site Descriptions

Three stations were chosen along the approximately 10.5 mile length of Blackbird Creek. During the low-flow fall sampling period, Blackbird Creek was shallow, sand-bottomed, nearly clear, and had a trickling flow. See Figure 1 for a map of Blackbird Creek study locations.

Blackbird Creek Station #1: (SE 1/4 sec. 28, T. 64 N., R. 16 W.) was located at the lower end of the study reach, upstream from Sand Creek Bottom Road crossing in Adair County. This station was 1.4 miles upstream from the Chariton River and appeared to be a channelized reach within the diked Chariton River flood plain. At low flow the stream was less than 0.5 feet deep and had a wetted width of about 15 feet and a discharge of 0.7 cubic feet per second (cfs). There were

remains of two small beaver dams at the middle and lower end of the reach. Small fish and *Progomphus* dragonfly larvae were common. Geographic coordinates for this station are Latitude 40° 18' 51.2", Longitude -92° 41' 44.6".

Figure 1: Blackbird Creek Sample Stations



Blackbird Creek Station #2: (NE 1/4 sec. 19, T. 64 N., R. 16 W.) was located approximately 2.4 miles upstream from station #1,upstream from Grapevine Road crossing in Adair County and within the western edge of the Chariton River floodplain. An extensive beaver pond was the dominant feature of this station. A beaver dam about 50 feet wide and 2.5 feet high was located about 100 yards upstream from the road crossing. The pool formed by the dam was approximately 650 feet long, 40 feet wide, about one foot deep, and moderately turbid. Substrate was mostly sand, both within and upstream from the beaver pond. Macroinvertebrate habitat was judged to be poor because of the sand bottom, lack of root-mat, and limited amount of woody debris. Stream flow below the beaver dam measured 0.4 cfs in the fall of 2003. Geographic coordinates for station #2 are Latitude 40° 20' 5.6", Longitude -92° 43' 23.7".

Blackbird Creek Station #3: (SE 1/4 sec. 2, T. 64 N., R. 17 W.) was located upstream from Missouri State Highway 149 crossing, approximately 4.4 miles upstream from station #2 in Putnam County. This location was above the Chariton River floodplain. Blackbird Creek at this station was basically a shallow, sand-bottomed narrow meander within a wide lower bank. During the fall sampling period, discharge at this station was 0.4 cfs. Aquatic habitat was very limited; there was no woody debris, very limited root-mat, and no pools. There was considerable filamentous algae in several places that was several feet long. Small fish, mostly minnows, were very abundant. Geographic coordinates for this station are Latitude 40° 22' 20.2", Longitude -92° 46' 02.1".

2.3 Biocriteria Reference Stations

Spring Creek Station #1: (NE 1/4 sec. 25, T. 63 N., R. 17 W.) was located in Adair County off Highway O, north of Novinger, Missouri. This station is a Biocriteria Reference Location within the EDU and served as a macroinvertebrate control station for this study. Geographic coordinates for this station are Latitude 40° 14' 22.5", Longitude -92° 44' 43.7".

West Locust Creek Station #1: (NE 1/4 sec. 11, T. 61 N., R. 21 W.) was located in Sullivan County southwest of Milan, Missouri. This station was just downstream from a Biocriteria Reference Location within the EDU. This station will be designated as part of an expanded reference section of West Locust Creek in the near future. Habitat assessment data collected from this station was used as a control comparison to Blackbird Creek. Geographic coordinates for this station are Latitude 40° 06' 8.5", Longitude -93° 13' 1.7".

3.0 Methods

Steve Humphrey, Cecilia Campbell, and other staff of the MDNR, ESP conducted this study. Sampling of Blackbird Creek was conducted during the fall of 2003 and spring of 2004. Spring Creek was sampled once, during the spring of 2004. Fall sampling was conducted October 1 and 2, 2003, and consisted of macroinvertebrate sampling, water quality sampling, habitat assessments, and quantitative channel measurements of width (at the top of the lower bank), wetted width, and mean water depth at three stations on Blackbird Creek. Spring sampling was conducted April 2 and 7, 2004, and consisted of macroinvertebrate and water quality sampling at

two stations on Blackbird Creek and one station on Spring Creek. Habitat assessment data from West Locust Creek was collected September 30, 2004.

3.1 Habitat

Blackbird Creek was placed on the federal 303(d) list for stream habitat degradation due to excessive sedimentation. Little sediment data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment on fish were the initial data used to consider Blackbird Creek for 303(d) listing. Sedimentation is one of many instream habitat problems associated with land use. Although instream habitat can be directly measured, the causes of the degradation can range from local scale sources to watershed scale sources. We collected habitat measures at the watershed scale, the reach scale, and the habitat scale to better allow us to evaluate the causes of poor habitat conditions.

3.1.1 Land Use

The land use conditions were summarized from land cover Geographic Information System (GIS) files. These land cover files were provided by the Missouri Resource Assessment Partnership (MoRAP) and derived from 1991-1993 LANDSAT data.

3.1.2 Habitat Assessment and Riparian Zone Condition

A standardized assessment procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure (SHAPP) (MDNR 2003a). The habitat assessment was conducted on Blackbird Creek during the October 2003 sample season.

The riparian zone condition was visually observed and qualitatively described as very poor, poor, good, and mixed. A very poor riparian zone condition is characterized by mostly or entirely row crops and/or grassland up to the stream bank and no or very little trees or shrubs. Poor riparian zone condition is characterized by row crops and/or grassland planted close to the stream bank, but with a thin zone of trees less than 20 feet wide remaining in the riparian zone. Fair to good riparian zone condition is characterized by a riparian zone of 20 to 60 feet wide in front of row crops and/or grassland. Very good riparian zone condition is characterized by little influence from row crops, abundant forest coverage, and a riparian zone greater than 60 feet wide. A mixed riparian zone is characterized by having one side of the stream rated differently than the other (e.g. very poor and good).

3.1.3 Sinuosity

Sinuosity was used as a rough indicator of the amount of channelization that has taken place. Sinuosity was measured from 7.5-minute series topographic maps of the area and is represented as a ratio of the straight line distance between two points on the stream to the actual stream segment length of stream between the two points. Measurement points were approximately two miles apart, with the sampling reach at the center.

3.1.4 Stream Width and Depth Measurements

Lack of instream habitat is typical of Northern Missouri streams that are wide and shallow. Wider, shallower streams tend to have less ability to develop pools and retain woody debris (Haithcoat et al. 2003). At each sampling station a series of 10 bank to bank transects were established. Each transect was equally spaced within the sampling reach, which was 20x the average width. Measurements taken at each transect included lower bank width (see SHAPP for a definition of Lower Bank), wetted width, and water depth at ¼, ½, and ¾ of the distance across the wetted width. In order to document critical habitat conditions, measurements were collected during the fall low flow period.

3.2 Physicochemical Water Parameters

Physical and chemical water samples were collected from all stations during each season. Parameters collected were nitrate+nitrite-nitrogen, ammonia-nitrogen, Total Kjeldahl nitrogen, chloride, turbidity, temperature, conductivity, dissolved oxygen, pH, and discharge. WQMS personnel analyzed temperature, conductivity, dissolved oxygen, pH, and discharge in the field and turbidity in the biology laboratory. All other parameters were delivered to the ESP, Chemical Analyses Section for analyses. All samples were collected according to the standard operating procedure MDNR-FSS-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2002a) and were recorded on a MDNR chain-of-custody (MDNR 2001).

3.3 Biological Assessment

The biological assessment was conducted according to the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**)(MDNR 2003b). All stations were sampled in October 2003 and April 2004. Three standard habitats of glide/pool streams (e.g. woody debris substrate, depositional substrate in non-flowing water, and root-mat substrate) were sampled at all locations, except station #3 during the fall sampling. Woody debris was lacking at this station; therefore sampling was limited to depositional and root-mat substrates.

Macroinvertebrate data were evaluated by comparison to Biological Criteria for Perennial/ Wadeable Streams of Missouri (MDNR 2002b with an updated Appendix B) within the Plains/Grand/Chariton Ecological Drainage Unit (**EDU**). An EDU is an ecological area in which the aquatic biological communities and stream habitat can be expected to be similar.

Macroinvertebrate scores were analyzed each season using two methods. The first analysis was a metric evaluation, per the SMSBPP, versus BIOREF score ranges. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The four-core metrics of the MSCI are: Taxa Richness (**TR**); Ephemeroptera, Plecoptera, and Trichoptera Taxa Richness (**EPPT**); Biotic Index (**BI**); and the Shannon Diversity Index (**SDI**). An MSCI score of 16-20 is considered full biological sustainability, 10-14 is partial biological sustainability, and 4-8 is non-biological sustainability. Table 1 provides scoring criteria for the fall index period and Table 2 for the spring index period.

The second analysis of the biological data was an evaluation of the dominant macroinvertebrate families (**DMF**) using percent composition of predominant macroinvertebrate taxa.

Table 1

Biological Criteria for Glide/Pool-Fall Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 25	25 - 50	> 50
EPTT	< 4	4 - 9	> 9
BI	> 8.61	8.61 – 7.21	< 7.21
SDI	< 1.34	1.34 – 2.68	> 2.68

Table 2
Biological Criteria for Glide/Pool-Spring Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 25	25 - 50	> 50
EPTT	< 4	4 – 8	> 8
BI	> 8.62	8.62 – 7.25	< 7.25
SDI	< 1.27	1.27– 2.53	> 2.53

4.0 Results and Analyses

4.1 Land Use

According to MoRAP land cover files, the watershed of Blackbird Creek is comprised mostly of grassland (~62%), deciduous forest (~23%), and row crops (~14%) (Table 3). On site observations indicated this was accurate for stations #2 and #3. However, the furthest downstream site, station #1, was within the Chariton River floodplain and was almost entirely utilized for row crops. Even though most of the watershed upstream from station #1 is grassland,

the row cropping at the local scale at station #1 likely impacted this station more than broader scale or watershed grassland use upstream.

Table 3 also provides two scales of land use comparisons based on 14-digit hydrologic units provided by MoRAP. A broad scale comparison is provided by comparing Blackbird Creek land use with the Plains/Grand/Chariton EDU. A watershed comparison is provided by comparing Blackbird Creek land use with three BIOREF streams in the EDU. Blackbird Creek land use compared to the EDU land use shows less row cropping and more grassland and forest cover in the Blackbird Creek watershed than in the EDU. This indicates that Blackbird Creek may be less impacted by row cropping, with the probable exception of station #1, than are most streams in the EDU.

In comparison to the BIOREF streams, Blackbird Creek row cropping land use is similar to the three BIOREF streams. Grassland use in the Blackbird Creek watershed is somewhat less than in the Locust Creek and West Locust Creek watersheds, but much higher than in the Spring Creek watershed. Forest cover of the Blackbird Creek catchment is greater than in the Locust Creek and West Locust Creek watersheds, but much less than in the Spring Creek watershed. Based on these similarities and differences in land cover, Blackbird Creek stream quality is comparable to West Locust and Locust Creeks, but it is probably more impacted by agricultural use than Spring Creek.

Table 3
Land Use

Watershed	% Urban	% Row Crops	% Grassland	% Forest
Plains Grand/Chariton EDU	0.2	30.3	53	15.2
Blackbird Creek Stations1, 2, & 3	0.3	13.9	62.4	22.9
BIOREF Locust Creek	0	8.5	75.5	15.7
BIOREF Spring Creek	0.4	9.7	45.6	43.9
BIOREF West Locust Creek	0	16.4	71.7	11.6

4.2 Habitat Assessment

Two comparisons were made to assess the quality of Blackbird Creek habitat. First, in order to determine the percentage of similarity, the Blackbird Creek habitat scores were compared to the habitat score from the West Locust Creek BIOREF station. Macroinvertebrate habitat assessment at this station was conducted in the fall of 2004 and thus was seasonably comparable to fall 2003 conditions at the Blackbird Creek stations. According to SHAPP, a study stream that scores 75 percent of reference stream conditions is considered to have habitat that fully supports

a similar biological community. Secondly, comparisons were made among the three Blackbird Creek stations.

Habitat assessment scores of all Blackbird Creek stations were comparable to the West Locust Creek BIOREF station score (Table 4). Percent similarity ranged from 78 percent at Blackbird Creek station #3 to 87 percent at Blackbird Creek station #1.

Blackbird Creek stations had comparable habitats. The lowest score of 77 at Blackbird Creek #3 was 90 percent of the highest score of 85 at Blackbird Creek #1. The three Blackbird Creek stations should therefore support a similar biological community.

Table 4
Blackbird Creek and Spring Creek Habitat Assessment Scores

Station	Habitat Assessment Score	Percent of BIOREF
Blackbird Creek #1	85	87
Blackbird Creek #2	81	83
Blackbird Creek #3	77	78
West Locust Creek #1 (BIOREF)*	98	

*Habitat assessment conducted in September 2004

4.3 Sinuosity and Riparian Zone Condition

Table 5 lists station reach characteristics for each Blackbird Creek station and the West Locust Creek BIOREF. Points were chosen along Blackbird Creek approximately two miles apart, incorporating each sampling station in the center of the reach, and along a 1.6 mile length of the West Locust Creek #1 BIOREF that encompassed the sampled reach of this stream. Sinuosity ratios near 1 are considered potentially channelized. The sinuosity of Blackbird Creek was 1.00 at stations #1 and #2, and 0.80 at station #3. Stations #1 and #2 are therefore very likely channelized.

The riparian zone condition of Blackbird Creek was good at station #1, poor at station #2, and a mix of very good and poor at station #3. The riparian zone of the West Locust Creek BIOREF was ranked as very good.

Table 5
Blackbird Creek and Spring Creek Station Reach Characteristics

Station	*Sinuosity (miles/mile)	Likely to be Channelized	Riparian Zone Condition

Blackbird Creek #1	1.00	Yes	Good
Blackbird Creek #2	1.00	Yes	Poor
Blackbird Creek #3	0.80	No	Mixed**
West Locust Creek #1 (BIOREF)	0.62	No	Very Good

* Higher number equates to less sinuosity.
** Left descending bank rated very good; right descending bank rated poor.

4.4 Stream Width and Depth Measurements

Transect measurements for average channel width (= lower bank width), average wetted width, and average stream depth for Blackbird Creek and the Plains/Grand/Chariton EDU BIOREF stations are presented in Table 6. The BIOREF data represent an average of nine channel measurements at eight BIOREF stations within the EDU. Also provided in Table 6 are two columns of ratios: channel width to wetted width and wetted width to depth. The ratios allow the standardization of channel measurements for longitudinal comparisons along a stream. For example, channel width normally widens as one proceeds downstream. Wetted width and depth do not necessarily increase as one proceeds downstream. By incorporating ratios of channel width to wetted width and wetted width to depth, channel widths and depths can be compared along a stream reach.

The average channel width of Blackbird Creek was, with the exception of three transects designated as station #2a, similar to the average BIOREF mean channel width of 42.5 feet. Channel width of the stream unexpectedly decreased instead of increased from upstream to downstream. Station #3, the furthest upstream station, had a mean channel width of 48.4 feet. The mean of all ten transects at station #2 (from channel measurement form) was 44.4 feet, and the average channel width at station #1 was 39.3 feet. A possible reason for this anomaly was that the downstream stations, especially station #1, were likely channelized and the stream channel was perhaps more confined at stations #1 and #2 than at the unchannelized station #3.

The average wetted width and average depth of Blackbird Creek was, with the exception of the beaver pond segment station #2b, much narrower and shallower than the BIOREF averages. For example, stations #1 and #3 had wetted widths between 10 and 11 feet and station #2a wetted width was about 16 feet, while the BIOREF mean was 26.5 feet. Similarly, these three Blackbird Creek stations averaged only about 0.3 feet deep compared to the BIOREF average of 1.0 feet.

The ratios of channel width to wetted width and wetted width to depth of Blackbird Creek were also greater than the BIOREF ratios. The channel width to wetted width ratio of Blackbird Creek was 3.2 to 4.6, or from two to three times greater than the average value of 1.6 for the EDU BIOREF, again excepting the ponded segment. A higher number indicates a smaller stream width in a larger high water channel. The wetted width to depth ratio of stations #1, #2a,

and #3 ranged from 34.7 to 53.5, whereas the BIOREF streams had a value for this ratio of 26.5. A higher number indicates a tendency towards a shallower stream.

Table 6
Blackbird Creek and Plains/Grand/Chariton BIOREF
Stream Width and Depth Summary

Station	Average Channel Width (ft)	Average Wetted Width (ft)	Average Depth (ft)	Channel Width/ Wetted Width	Wetted Width/ Depth
Blackbird Creek #1	39.3	10.7	0.2	3.7	53.5
Blackbird Creek #2a*	53.7	16.3	0.4	3.3	40.8
Blackbird Creek #2b**	40.4	38.1	0.9	1.1	34.6
Blackbird Creek #3	48.4	10.4	0.3	4.6	34.7
Plains/Grand/Chariton BIOREF	42.5	26.5	1.0	1.6	26.5

* Data is from two transects upstream from beaver pond and one transect downstream from beaver pond.

** Data is from seven transects within beaver pond.

4.5 Physicochemical Results

Tables seven and eight provide physicochemical results of surface water grab samples collected from Blackbird Creek during fall 2003 and spring 2004. Spring Creek BIOREF data from spring 2004 are also given. All analyzed and measured parameters from all stations each sampling period had values that were within expected ranges for minimally impacted and unpolluted streams within the Plains/Grand/Chariton Ecoregion.

Fall 2003 water quality data were similar among the three Blackbird Creek stations. Levels of ammonia-nitrogen and nitrate + nitrite-nitrogen were below detection limits. Total Kjeldahl nitrogen ranged from 0.47 mg/L to 0.59 mg/L among the three stations (Table 7). Total phosphorus was also low at each station and the maximum value was 0.08 mg/L at Blackbird Creek #2.

Physicochemical results for spring 2004 among Blackbird Creek stations #3 and #2 and Spring Creek BIOREF were similar. All nutrient parameters at the two test stations had fairly low values. Ammonia-nitrogen was below detection limits and nitrate + nitrite-nitrogen was 0.11 mg/L at each Blackbird Creek station. Total Kjeldahl nitrogen and total phosphorus levels were not excessive (Table 8). Spring Creek BIOREF nutrient levels for ammonia-nitrogen were below detection limits. The remaining Spring Creek nutrient parameters all had low values, including a total phosphorus concentration of 0.06 mg/L.

Table 7
Physicochemical Results for Blackbird Creek, October 2003
Units mg/L unless otherwise noted

Variable-Station	Blackbird Creek #1	Blackbird Creek #2	Blackbird Creek #3
Sample Number	0337312	0337313	0337314
pH (Units)	8.4	7.7	8.50
Temperature (C°)	9.0	8.5	14.0
Conductivity (uS)	382	405	410
Dissolved O_2	11.4	8.9	12.1
Discharge (cfs)	0.7	0.38	0.42
Turbidity (NTUs)	5.11	19.5	4.36
Ammonia-N	<0.03	<0.03	<0.03
Nitrate/Nitrite-N	<0.01	<0.01	<0.01
TKN	0.47	0.59	0.52
Chloride	14.1	14.3	14.8
Total Phosphorus	0.05	0.08	0.05

Table 8
Physicochemical Results for Blackbird Creek and Spring Creek BIOREF, April 2004
Units mg/L unless otherwise noted

Variable-Station	Spring Creek BIOREF	Blackbird Creek #2	Blackbird Creek #3

Sample Number	0411715	0411721	0411720
pH (Units)	7.7	7.8	7.6
Temperature (C°)	14.0	15.0	13.0
Conductivity (uS)	460	410	430
Dissolved O_2	10.4	10.8	10.8
Discharge (cfs)	24.9	28.6	31.6
Turbidity (NTUs)	23.0	21.7	15.7
Ammonia-N	<0.03	<0.03	<0.03
Nitrate/Nitrite-N	0.22	0.11	0.11
TKN	0.32	0.53	0.48
Chloride	6.09	14.6	14.9
Total Phosphorus	0.06	0.10	0.09

Seasonal differences in physicochemical results at Blackbird Creek were mostly limited to higher stream discharge in the spring. Fall discharge values were less than one cubic foot per second (cfs) at each station. Spring stream flow measured 31.6 cfs and 28.6 cfs, respectively, at Blackbird Creek stations #3 and #2. Spring 2004 nitrate + nitrite-nitrogen nutrient levels were slightly higher than fall 2003 values. In the fall, levels of this parameter were below detection limits, while in the spring, 0.11 mg/L of nitrate + nitrite-nitrogen was measured at Blackbird Creek stations #3 and #2.

4.6 Biological Assessment

As outlined in the methods, macroinvertebrate data were evaluated by two methods. The first analysis was metric evaluation using the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). The second analysis of the biological data was an evaluation of dominant macroinvertebrate family (DMF) composition.

4.6.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure

The Blackbird Creek metric results and MSCI scores for fall 2003 and spring 2004 are presented in Tables 9 and 10, respectively. The MSCI scores were calculated by scoring station metrics against the appropriate criteria in Table 1 or Table 2.

Table 9

Biocriteria Metric Scores, Macroinvertebrate Stream Condition Index Scores, and Sustainability for Blackbird Creek, October 2003

Sampling Station	Blackbird Creek #1	Blackbird Creek #2	Blackbird Creek #3
Sample Number	0318749	0318750	0318751
Taxa Richness	59	59	64
EPT Taxa	8	12	12
Biotic Index	7.08	7.45	6.73
Shannon Index	2.36	2.03	2.91
MSCI Score	16	16	20
Sustainability	Full	Full	Full

Full biological sustainability was achieved at each Blackbird Creek station in October 2003. MSCI scores were 16 at stations #1 and #2, and 20 at station #3. However, an MSCI score of 16 is the minimum number for a rating of full sustainability. Therefore, station #3 likely has a more balanced and diverse macroinvertebrate community than stations #1 and #2. At station #3, each of the four metrics scored the maximum of five to give a total of 20. Station #1 scored only 16 because there were only eight EPT taxa and the Shannon Index was 2.36. These values decreased the score of these metrics to three, while Taxa Richness and Biotic Index metrics each scored five, thus giving a total MSCI score of 16. Similarly, station #2 Biotic Index and Shannon Index values each scored three to bring the total MSCI score down to 16.

Full sustainability also characterized the April 2004 samples from the Spring Creek BIOREF station and Blackbird Creek stations #2 and #3 (Table 10). Blackbird Creek station #1 could not be sampled in the spring of 2004 and Spring Creek was not sampled in the fall of 2003. MSCI scores were 20 at Spring Creek and 18 and 20, respectively, at Blackbird Creek stations #2 and #3. An unexpectedly low number of EPT taxa at Blackbird Creek station #2 resulted in a score of three for this metric and a total MSCI score of 18 for this station. Blackbird Creek station #3 scored very well and exceeded the BIOREF station values for EPT taxa and Shannon Index and the Biotic Index value was less than the BIOREF value. (The Biotic Index score is an inverted score; i.e., the lower the value the higher the score.)

Table 10
Biocriteria Metric Scores, Macroinvertebrate Stream Condition Index Scores, and Sustainability for Blackbird Creek and Spring Creek BIOREF, April 2004

Sampling Station	Spring Creek #1	Blackbird Cr. #2	Blackbird Cr. #3

Sample Number	0418686	0418692	0418691
Taxa Richness	68	54	65
EPT Taxa	11	6	15
Biotic Index	7.20	7.00	6.63
Shannon Index	2.54	2.81	2.75
MSCI Score	20	18	20
Sustainability	Full	Full	Full

4.6.2 Dominant Macroinvertebrate Families

Dominant macroinvertebrate taxa collected from Blackbird Creek during fall 2003 and spring 2004 are presented in Tables 11 and 12. Spring Creek BIOREF station data are also presented in Table 12. Table 12 does not include Blackbird Creek #1 because this station could not be accessed in spring 2004.

Fifty-nine total taxa were identified at Blackbird Creek stations #1 and #2 and 64 taxa were found in station #3 samples collected in October 2003. The number of EPT taxa this sampling period was eight at station #1 and 12 at stations #2 and #3. Mayflies comprised most of the EPT taxa. Caddisflies comprised from one to three taxa per station and stoneflies were not collected in the fall.

April 2004 macroinvertebrate samples yielded 64 total taxa at the Spring Creek BIOREF station, 54 taxa at station #2, and 63 taxa at station #3. EPT taxa comprised 11 taxa at the BIOREF station. An unusually low number of only six EPT taxa were collected from Blackbird Creek station #2. Fifteen EPT taxa were found in station #3 samples. Caddisflies represented from one to four taxa per station and stoneflies accounted for two EPT taxa at each station.

Ephemeroptera (mayflies) and Diptera (true flies) collectively comprised 70 percent or more of the total numbers of organisms at each station each sampling period. Chironomidae (midge flies) was the dominant Diptera family and Caenidae (square gilled mayflies) made up most of the Ephemeroptera abundance. Chironomidae was composed of a fairly diverse assemblage of 18 or more taxa at each station. Caenidae was made up almost exclusively of a single species, *Caenis latipennis* (Appendix C).

In the fall 2003 samples, Chironomidae and Caenidae collectively comprised from 62 to 87 percent of the number of organisms (Table 11). At station #3, the mayfly families Leptophlebiidae (pronggill mayflies) and Baetidae (small minnow mayflies), although collected in much smaller numbers than Chironomidae and Caenidae, were among the five most abundant

macroinvertebrate families at this station. Percent occurrence of these mayflies at station #3 was eight percent Leptophlebiidae and four percent Baetidae. Coenagrionidae (damselflies), Hydrophilidae (water scavenger beetles), and Physidae (pouch snails) constituted most of the remaining organisms at station #3. At Blackbird Creek stations #1 and #2, baetid mayflies accounted for four percent and two percent of the organisms, respectively. All remaining families of organisms made up two percent or less of the total macroinvertebrates at these stations.

Table 11
Blackbird Creek Macroinvertebrate Composition and Percent Dominant Macroinvertebrate Families (DMF) per Station, October 2003

Variable	Station 1	Station 2	Station 3
Sample Number	03-18749	03-18750	03-18751
Total Taxa	59	59	64
Number EPT Taxa	8	12	12
% DMF; below			
Chironomidae	57	34	34
Caenidae	30	52	28
Leptophlebiidae	<1	1	8
Baetidae	4	2	4
Coenagrionidae	<1	1	4
Hydrophilidae	<1	<1	4
Physidae	1	2	2
Leptoceridae	2	1	<1

Macroinvertebrate families Caenidae and Chironomidae, as noted above, were also the dominant families collected from Spring Creek and Blackbird Creek in the spring of 2004. From 70 to 75 percent of the organisms were composed of these families (Table12). At the Spring Creek BIOREF station, the remaining dominant families were Perlidae (common stoneflies), Enchytraeidae and Tubificidae (worms), and Corixidae (water boatmen). At Blackbird Creek #2, Corixidae was the third most abundant family, followed by Simuliidae (black flies), Perlidae, Echytraeidae, and Leptophlebiidae. Blackbird Creek #3 dominant families were similar to

Blackbird Creek #2, except that Simuliidae was the third most abundant family, followed by Perlidae, Ceratopogonidae (biting midges), and Enchytraeidae.

Table 12
Blackbird Creek and Spring Creek BIOREF Macroinvertebrate Composition and Percent Dominant Macroinvertebrate Families (DMF) per Station, April 2004

Variable	BIOREF	Station 2	Station 3
Sample Number	04-18686	04-18692	04-18691
Total Taxa	68	54	63
Number EPT Taxa	11	6	15
% DMF; below			
Caenidae	45	24	24
Chironomidae	29	46	51
Perlidae	4	2	3
Enchytraeidae	3	2	2
Tubificidae	2	<1	1
Simuliidae	<1	6	5
Ceratopogonidae	<1	<1	2
Corixidae	2	8	<1
Leptphlebiidae	<1	2	1

5.0 Discussion

5.1 Land Use

Land use data showed that the Blackbird Creek watershed had considerably less row cropping and somewhat more grassland and forest cover than the average percentages of these parameters for the Plains/Grand/Chariton EDU. Blackbird Creek land use was also comparable to three nearby BIOREF catchments. This indicates that the Blackbird Creek watershed could be expected to have good stream quality.

5.2 Habitat Assessment

Blackbird Creek macroinvertebrate habitat, as scored by SHAPP, was comparable to a nearby BIOREF stream. The three stations on Blackbird Creek had similar macroinvertebrate habitats.

This indicates that the macroinvertebrate habitat of Blackbird Creek was not impaired and should support a macroinvertebrate community similar to reference streams within the EDU.

5.3 Sinuosity and Riparian Zone Condition

Although the overall SHAPP of Blackbird Creek indicated a macroinvertebrate habitat comparable to reference stream conditions, two components of SHAPP, sinuosity and riparian zone condition, indicated some potential stream impairment. Sinuosity measurements and observations of Blackbird Creek stations #1 and #2 found the stream channel to be nearly straight and likely to have been historically channelized. Channelized stream reaches generally are less desirable macroinvertebrate habitat because of poor habitat diversity, steeper stream gradients that cause eroded substrates and higher turbidities, and often, lack of shading that causes higher water temperatures. The riparian zone condition of station #2 was determined to be poor and station #3 riparian zone was found to be poor along the right descending bank. In spite of these findings, overall stream habitat quality of Blackbird Creek was adequate to support a fairly diverse macroinvertebrate community.

5.4 Stream Width and Depth Measurements

Stream width and depth measurements of Blackbird Creek found greater channel width to wetted width ratios and larger wetted width to depth ratios, with the exception of a beaver pond segment, than the average values of these parameters for the EDU BIOREF streams. Excepting the ponded segment, the channel width to wetted width ratio was between two and three times greater than the average BIOREF value. The wetted width to depth ratio of these Blackbird Creek stations was 1.3 to 1.6 times greater than the BIOREF averages.

The channel width to wetted width and wetted width to depth ratios of Blackbird Creek were typical of several TMDL listed streams within the Plains/Grand/Chariton EDU. In 2004, ESP WQMS personnel collected 36 sets of channel measurements from six listed streams within the EDU, including Blackbird Creek. The average channel width to wetted width ratio was 2.4 and the mean wetted width to depth ratio was 42.5. Blackbird Creek was therefore somewhat wider and shallower than the average listed stream value, but considerably wider and shallower than the BIOREF streams.

5.5 Physicochemical Data

The water quality of Blackbird Creek was very good and comparable to BIOREF values. There were no exceedances of Missouri water quality standards during either sampling event. Nutrient concentrations of surface water grab samples were generally low and several measurements were below detection limits. Highest nitrate/nitrite-nitrogen values were 0.11 in spring 2004. This was half the value analyzed from the Spring Creek BIOREF sample. Total phosphorus was not excessive. Highest concentration of this nutrient was also in the spring and measured 0.10 mg/L.

5.6 Biological Data

5.6.1 Sustainability

All Blackbird Creek stations achieved a full sustainability MSCI score. However, in the fall of 2003, stations #1 and #2 each scored 16, which is the minimum score needed to receive full biological sustainability. Station #1 EPT taxa and the Shannon Index each scored 3 instead of 5, and at station #2 the Biotic Index and Shannon Index also scored 3 instead of 5. At station #1 only eight EPT taxa were found and ten or more were needed to score 5. Of the eight EPT taxa, five were represented by three or fewer individuals (Appendix C). At station #2, six of twelve EPT taxa were represented by three or fewer organisms and at station #3, seven of twelve EPT taxa were made up of less than four individuals. Numerous non-EPT taxa were also rare at each of these stations. Therefore, it is likely that the lower number of EPT taxa at station #1 was because many taxa, including EPT taxa, were present in very low numbers and by chance, may not have been collected or were not subsampled in the laboratory.

The fall score of three for the Shannon Index at Blackbird Creek stations #1 and #2 probably resulted from a large proportion of a few taxa within certain habitats at these stations. The chironomids *Cricotopus/Orthocladius, Dicrotendipes,* and *Tanytarsus* and the mayfly, *Caenis latipennis*, were found in large numbers at station #1 and *Dicrotendipes* and *C. latipennis* made up a large portion of the station #2 collection (Appendix C). For example, the four taxa comprised 75 percent of station #1 organisms and 77 percent of station #2 individuals. In contrast, these four taxa comprised only 47 percent of the station #3 composite. The dominance of these taxa at stations #1 and #2 likely lowered the Shannon Index at these stations.

The Biotic Index score of 3 at station #2 in the fall was also likely because of the dominance of the composite by *Dicrotendipes* and *C. latipennis*. *Dicrotendipes* has a fairly high tolerance value of 7.9 and the tolerance value of *C. latipennis* is 7.6. These two taxa collectively made up 68 percent of station #2 organisms and likely lowered the Biotic Index to a score of 3.

Blackbird Creek stations #2 and #3 attained full sustainability in April 2004. As noted above, station #1 was not sampled in the spring because the landowner refused access to the site from his property. At station #2 the MSCI score was 18 instead of 20 because only three mayfly taxa and a total of six EPT taxa were found in samples from this station. The reason for the low number of mayfly taxa is unknown. High spring flows may have impacted this station more than station #3 or the Spring Creek BIOREF. Field notes taken during macroinvertebrate sampling stated that macroinvertebrate habitat was very poor at this station.

5.6.2 BIOREF Metric Comparisons

Table 13 gives a comparison of average MSCI metric values between Blackbird Creek and the Plains/Grand/Chariton EDU BIOREF streams.

Blackbird Creek total taxa richness averaged 61 total taxa in the fall 2003 samples. Average EPT taxa richness among the three stations this sampling period was 11. The average Biotic Index for the three stations was 7.1 and the Shannon Index mean was 2.43. Spring 2004 macroinvertebrate samples from the two Blackbird Creek stations averaged 58 total taxa and 10 EPT taxa. The spring Biotic Index averaged 6.8 and the mean Shannon Index for this period was 2.78.

A query of the ESP Aquatic Invertebrate Database was conducted in February 2005. The query was for the average number of total taxa, EPT taxa, Biotic Index, and Shannon Index values from all glide/pool BIOREF samples within the Plains/Grand/Chariton EDU. For the fall season, the mean number of total taxa was 56, EPT taxa averaged 11, the Biotic Index average was 6.8, and the mean Shannon Index value was 2.86. Spring samples averaged 59 total taxa, 10 EPT taxa, a Biotic Index of 7.1, and the mean Shannon Index was 2.67.

Blackbird Creek total taxa richness, EPT taxa richness, and Biotic Index values were very similar to the average EDU BIOREF values during both sampling seasons. Mean total taxa richness at Blackbird Creek in fall 2003 samples was slightly higher than the EDU BIOREF mean values. Spring 2004 average total taxa richness of 58 was only one less than the BIOREF average of 59. EPT taxa richness values of Blackbird Creek were identical to the BIOREF averages each season.

The average Biotic Index value of Blackbird Creek was slightly higher than the BIOREF average in the fall and slightly lower than the BIOREF mean in the spring, and by the same amount. The fall average Shannon Index at Blackbird Creek was somewhat lower than the BIOREF value, while the spring mean Shannon Index at Blackbird Creek was slightly higher than the BIOREF value. Based on these similarities of metric values, Blackbird Creek is not impaired and has a macroinvertebrate fauna comparable to glide/pool BIOREF streams within the Plains/Grand/Chariton EDU.

Table 13
MSCI Metric Comparisons between Blackbird Creek and Plains/Grand/Chariton EDU Glide/Pool BIOREF Streams

MSCI Metric	Blackbird Creek Fall	P/G/C BIOREF Fall	Blackbird Creek Spring	P/G/C BIOREF Spring
Total Taxa	61	56	58	59
EPT Taxa	11	11	10	10
Biotic Index	7.1	6.8	6.8	7.1
Shannon Index	2.43	2.86	2.78	2.67

6.0 Conclusions

The introduction of this report stated two null hypotheses: 1) Habitat quality, water quality, and macroinvertebrate communities are similar among Blackbird Creek stream segments; and 2) Habitat quality, water quality, and macroinvertebrate communities are similar between Blackbird Creek and biocriteria reference (BIOREF) streams within the Plains/Grand/Chariton Ecological Drainage Unit.

Null hypothesis #1 is accepted. Habitat, water quality, and macroinvertebrate assemblages were similar among Blackbird Creek stations.

Null hypothesis #2 is also accepted. Habitat, water quality, and macroinvertebrate communities of Blackbird Creek were similar to BIOREF streams within the Plains/Grand/Chariton EDU.

7.0 Recommendations

1) Propose the entire listed portion of Blackbird Creek for de-listing from the 303(d) list.

2) Conduct bioassessments of extensively channelized streams and row cropped watersheds to further evaluate the relationships between biological health, stream channel, and catchment characteristics.

8.0 Literature Cited

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Missouri Department of Natural Resources. 2003b. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. Missouri Department of Natural Resources, Air and Land Protection Division, Environmental Services Program, Water Quality Monitoring Section, Jefferson City, Missouri. 24 pp.

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Appendix A

Missouri Department of Natural Resources Bioassessment Study Plan
Blackbird Creek, Putnam and Adair Counties

Missouri Department of Natural Resources

Blackbird Creek Bioassessment Study Plan
Putnam & Adair Counties

August 29, 2003

Objective

This study will characterize the aquatic macroinvertebrate community and habitat in Blackbird Creek to determine whether the stream is impaired from habitat degradation and warrants continued 303(d) listing. Our specific objectives are to determine: 1) whether there are aquatic life impairments in the stream relative to biocriteria reference streams; 2) if biological impairment is present, determine if it is related to channelized segments or segments with little riparian and heavy concentration of row crops relative to more natural segments on biocriteria reference streams; and 3) if biological impairment is present, determine if it is related to channelized segments or segments with little riparian and heavy concentration of row crops relative to unchannelized segments and segments with better riparian and lesser amount of row crop on Blackbird Creek.

Null Hypotheses

1) Macroinvertebrate assemblages and habitat will not substantially differ between Blackbird Creek and biocriteria reference streams within the Plains-Grand/Chariton Ecological Drainage Unit (EDU).

2) Macroinvertebrate assemblages and habitat will not differ between Blackbird Creek stream segments.

Background

Blackbird Creek, in Putnam and Adair counties is listed as a 303(d) stream in the Total Maximum Daily Load (TMDL) listing of 1998 by the Water Pollution Control Program (WPCP). A 10.5-mile section of stream is listed for sediment impairment from agricultural non-point sources. The assessment of the listed reach of Blackbird Creed will be conducted in the fall of 2003 and spring of 2004.

Study Design

General:

Three Blackbird Creek stations will be surveyed. The approximate locations are as follows: Station #1 (SE ¼ S28, T64N, R16W) upstream from the Sand Creek Bottom Road crossing, Adair Co; Station #2 (NE ¼ S19, T64N, R16W) upstream from the Grapevine Road crossing, Adair Co; and Station #3 (SE ¼ S2, T64N, R17W) upstream from the Hwy 149 crossing, Putnam Co.

Each station will consist of a length approximately 20 times the average stream width, and will contain at least two pool/glide sequences, as outlined in the Missouri Department on Natural Resources (MDNR), Environmental Services Program (ESP), Stream Habitat Assessment Project Procedure (SHAPP) (MDNR 2003a). In order to assess variability among sampling stations, stream discharge, habitat assessment and water chemistry will be determined during macroinvertebrate surveys. Sampling will be conducted during the fall of 2003 (September 15 through October 15) and spring of 2004 (March 15 through April 15).

Biological Sampling Methods: Macroinvertebrates will be sampled per the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP) (MDNR 2003b). Blackbird Creek will be considered a glide/pool predominant streams; therefore samples will be collected from depositional (non-flowing water over depositional habitat), large woody debris, and root-mat habitats. Macroinvertebrate samples will be composites of six subsamples within non-flow and rootmat habitats and 12 subsamples within large woody debris habitat.

Habitat Sampling Methods:
1) Stream discharge will be measured at each sampling location using a Marsh-McBirney flow meter.
2) Stream habitat assessments will also be conducted within each study area following the guidelines of SHAPP.
3) GIS analyses will be used to quantify the sinuosity, riparian, and row crop characteristics of the study segment.
4) Quantitative channel measurements of width (at the top of the lower bank), wetted width, and mean water depth will be collected at Blackbird Creek.
5) Pool volumes behind beaver dams will also be estimated to provide information of this increasingly common phenomenon.

Water Quality Sampling Methods: Water samples from all sampled stations will be analyzed at the ESP laboratory for ammonia, nitrogen as NO_2 +NO_3, total Kjeldahl nitrogen, total phosphorus, chloride and turbidity. Field measurements will include pH, conductivity, temperature and dissolved oxygen.

Laboratory Methods: All samples of macroinvertebrates will be processed and identified as per MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification (MDNR 2001). Turbidity samples will be analyzed at the MDNR biological laboratory

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214, Quality Control Procedures for Data

Processing (MDNR 2003c). Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each reach. Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T) may be employed to discern differences in taxa between stations.

Macroinvertebrate data will be analyzed in two specific ways. First, a stratified comparison between habitat degraded (i.e. channelized vs. non-channelized; high density row crop/little riparian vs. low-density row crop/intact riparian) and habitat intact reaches on Blackbird Creek will be performed. Secondly, the data from the Blackbird Creek sites will be compared to numeric biological criteria from reference streams within the same EDU & watershed size classification (MDNR 2002).

As interpretive information for biological data the habitat scores and landscape scale characteristics will be ranked against the macroinvertebrate Stream Condition Index scores.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Attachments

Map of all sampling stations in this study.

Literature Cited:

Missouri Department of Natural Resources. 2003a. Stream Habitat Assessment Project Procedure. MDNR-FSS-032. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 40 pp.

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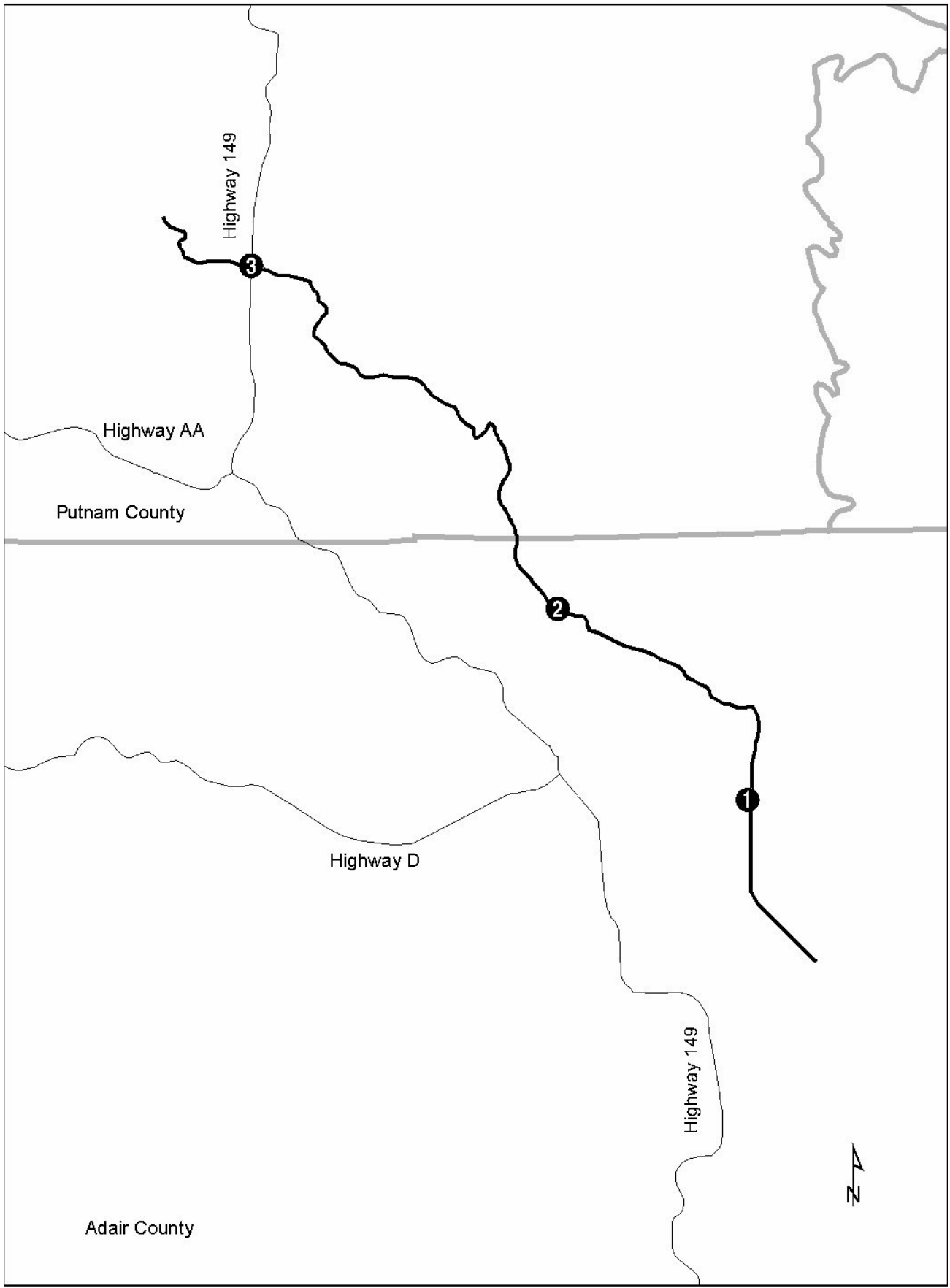
Figure 1: Blackbird Creek Sample Stations



Appendix B

Macroinvertebrate Bench Sheets for Blackbird Creek and Spring Creek
Fall 2003-Spring 2004

Key: NF = Non-flow habitat (i.e. pools), SG = Snag habitat (i.e. woody debris), RM = Root-mat habitat, -99 = Large/Rare presence

Aquid Invertebrate Database Bench Sheet Report
Blackbird Ck [0318749], Station #1, Sample Date: 10/1/2003 12:15:00 PM

ORDER: TAXA	CS	NF	SG	RM
COLEOPTERA				
Berosus		2	2	1
Dubiraphia		4	2	1
Helichus lithophilus		3	6	6
Hydroporus			3	2
Scirtes				2
Tropisternus				-99
DECAPODA				
Orconectes		1	1	-99
DIPTERA				
Ablabesmyia		6		
Ceratopogoninae		5		2
Chironomus		1	1	
Chrysops		1		
Cladotanytarsus		20	1	
Cricotopus bicinctus				10
Cricotopus/Orthocladius		2	167	2
Cryptochironomus		3		
Dicrotendipes		6	237	
Glyptotendipes		2	18	1
Labrundinia		2		6
Nanocladius		2		
Ormosia		2		3
Paracladopelma		6		
Parakiefferiella			1	
Paratanytarsus		1		2
Paratendipes		3		
Pericoma				1
Polypedilum convictum grp				1
Polypedilum halterale grp		3		1
Polypedilum illinoense grp		3	2	8
Polypedilum scalaenum grp		1		
Rheotanytarsus			2	8
Simulium				1
Stempellinella		6	2	10
Stratiomys				1
Tanytarsus		41	59	15
Thienemanniella			1	1
Thienemannimyia grp.		1	1	

ORDER: TAXA	CS	NF	SG	RM
Tipulidae				1
Tribelos		1		
EPHEMEROPTERA				
Brachycercus		1		1
Caenis latipennis		127	55	172
Leptophlebiidae		2		1
Paracloeodes		1	1	41
Stenacron			2	
Tricorythodes		1		
HEMIPTERA				
Belostoma				-99
Hebrus				1
Mesovelia				1
LIMNOPHILA				
Physella		1	2	13
ODONATA				
Argia			4	
Boyeria		-99		
Enallagma		1	1	
Gomphus		-99		
Libellula				1
Macromia		-99		
Progomphus obscurus		1		1
TRICHOPTERA				
Cheumatopsyche				1
Nectopsyche		3	1	14
TUBIFICIDA				
Tubificidae		1		
VENEROIDEA				
Sphaerium		1		

Aquid Invertebrate Database Bench Sheet Report
Blackbird Ck [0318750], Station #2, Sample Date: 10/2/2003 10:00:00 AM

ORDER: TAXA	CS	NF	SG	RM
N/A				
Gordiidae				1
"HYDRACARINA"				
Acarina		2	1	
AMPHIPODA				
Hyalella azteca			1	
COLEOPTERA				
Berosus		3	1	
Dubiraphia		4		3
Helichus lithophilus				1
Hydroporus		1	1	1
DIPTERA				
Ablabesmyia		3		1
Chironomus		2		
Cladotanytarsus		2	3	
Cricotopus bicinctus		1	2	4
Cricotopus/Orthocladius			30	
Cryptochironomus		1		
Dicrotendipes		1	138	10
Endochironomus				1
Forcipomyiinae			1	
Glyptotendipes		2	19	2
Labrundinia		1		
Larsia		1		
Nanocladius		2	1	2
Ormosia				2
Paracladopelma		2		
Paratanytarsus		3		3
Paratendipes		2		3
Pilaria				1
Polypedilum halterale grp		1		
Polypedilum illinoense grp		3	1	15
Stempellinella		1		
Tanytarsus		21	19	12
Tipula				1
Tribelos		1	2	
EPHEMEROPTERA				
Caenis hilaris				1
Caenis latipennis		244	64	176

ORDER: TAXA	CS	NF	SG	RM
Callibaetis		2		1
Heptageniidae			1	
Hexagenia limbata		3		
Leptophlebiidae			1	9
Paracloeodes		4	3	7
Procloeon		5		2
Stenacron		3		1
HEMIPTERA				
Corixidae		3		
LIMNOPHILA				
Fossaria				1
Physella		8		9
LUMBRICINA				
Lumbricidae		1		
ODONATA				
Argia		2		5
Enallagma				1
Gomphus		1		
Hetaerina			-99	
Ischnura		1		
Libellula		1	1	
Macromia			-99	
Progomphus obscurus		4		
TRICHOPTERA				
Nectopsyche		4		4
Oecetis		1	1	
Oxyethira		1		
TUBIFICIDA				
Aulodrilus		1		
Enchytraeidae		1		
Tubificidae		1		
VENEROIDEA				
Sphaerium		1		2

Aquid Invertebrate Database Bench Sheet Report
Blackbird Ck [0318751], Station #3, Sample Date: 10/2/2003 1:45:00 PM

ORDER: TAXA	CS	NF	SG	RM
N/A				
Chordodidae		1		1
AMPHIPODA				
Hyalella azteca		3		1
COLEOPTERA				
Agabus		1		
Berosus		9		10
Dubiraphia		10		8
Helichus lithophilus		2		12
Hydroporus		3		3
Paracymus		1		
Scirtes		2		
Tropisternus		-99		-99
DECAPODA				
Orconectes immunis				1
DIPTERA				
Ablabesmyia		1		1
Anopheles				3
Ceratopogoninae				11
Chironomus		3		
Cladotanytarsus				1
Corynoneura				1
Cricotopus bicinctus		2		1
Cricotopus/Orthocladius		3		3
Cryptochironomus		1		
Cryptotendipes		1		
Dicrotendipes		31		7
Glyptotendipes				1
Labrundinia		1		3
Nanocladius		1		4
Ormosia		1		
Paracladopelma		3		
Paratendipes		36		
Polypedilum halterale grp		4		
Polypedilum illinoense grp		3		2
Procladius		3		1
Pseudochironomus				1
Stempellinella		6		
Tanypus		1		

ORDER: TAXA	CS	NF	SG	RM
Tanytarsus		52		15
Zavreliella		1		
EPHEMEROPTERA				
Caenis latipennis		66		92
Caenis punctata				1
Centroptilum				1
Heptageniidae				2
Hexagenia limbata		1		
Labiobaetis		1		5
Leptophlebiidae		21		27
Paracloeodes				12
Procloeon		3		1
Stenacron				1
Tricorythodes				1
HEMIPTERA				
Belostoma		-99		-99
Pelocoris				1
Ranatra fusca		-99		
LIMNOPHILA				
Fossaria				1
Physella		4		7
LUMBRICINA				
Lumbricidae				1
ODONATA				
Argia		1		9
Boyeria				-99
Erythemis				1
Gomphus				-99
Ischnura		9		2
Libellula		1		
Macromia		1		
TRICHOPTERA				
Nectopsyche				2
TUBIFICIDA				
Tubificidae				7
VENEROIDEA				
Pisidium				7
Sphaerium		-99		1

Aquid Invertebrate Database Bench Sheet Report
Blackbird Ck [0418691], Station #3, Sample Date: 4/7/2004 9:30:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		1		
AMPHIPODA				
Hyalella azteca		1		5
COLEOPTERA				
Berosus		1		
Chaetarthria				1
Dubiraphia		1		3
Haliplus			1	
Helichus lithophilus				5
Hydroporus		2		3
Paracymus		1		
Peltodytes		2		
Scirtes				1
DECAPODA				
Orconectes virilis				-99
DIPTERA				
Ablabesmyia		1		
Ceratopogoninae		15		3
Cladotanytarsus		71		
Cricotopus bicinctus			12	7
Cricotopus/Orthocladius		21	85	41
Cryptochironomus		1		
Dicrotendipes		3	8	3
Glyptotendipes		1	1	
Hydrobaenus		21	15	17
Labrundinia			1	
Nanocladius		1		1
Paracladopelma		2		
Paratanytarsus		8	3	7
Pericoma				2
Polypedilum halterale grp		2		
Polypedilum illinoense grp		4	1	2
Simulium			14	26
Stenochironomus			1	
Stratiomys				2
Tabanus		1		
Tanytarsus		10	8	11
Thienemannimyia grp.				5

ORDER: TAXA	CS	NF	SG	RM
Tipula				-99
Zavrelimyia		1		
EPHEMEROPTERA				
Acentrella				2
Caenis latipennis		74	9	90
Centroptilum				2
Hexagenia limbata		1		
Leptophlebia		2		4
Paraleptophlebia		1		3
Stenacron			2	4
Stenonema femoratum		1		1
Stenonema terminatum		2		
HEMIPTERA				
Belostoma				-99
Trichocorixa		2		
LIMNOPHILA				
Fossaria		1		3
LUMBRICINA				
Lumbricidae		1		
ODONATA				
Boyeria				1
Gomphus				1
Ischnura		1		
Libellula		1		
Progomphus obscurus		7		
PLECOPTERA				
Amphinemura				1
Perlesta		1	2	21
TRICHOPTERA				
Cheumatopsyche				1
Ironoquia				-99
Ptilostomis				-99
Triaenodes				1
TUBIFICIDA				
Enchytraeidae		5		12
Limnodrilus hoffmeisteri		3		
Tubificidae		2		
VENEROIDEA				
Pisidium		1		
Sphaerium		1		

Aquid Invertebrate Database Bench Sheet Report
Blackbird Ck [0418692], Station #2, Sample Date: 4/7/2004 11:45:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		3		
AMPHIPODA				
Crangonyx				-99
Hyalella azteca		2		3
COLEOPTERA				
Berosus			2	
Dubiraphia		2	1	2
Helichus lithophilus				5
Hydroporus		1		1
Macronychus glabratus				1
Peltodytes		5		2
Scirtes				1
DECAPODA				
Orconectes immunis				-99
DIPTERA				
Ablabesmyia		2		8
Ceratopogoninae		3		1
Cladotanytarsus		7	1	
Cricotopus bicinctus		10	24	17
Cricotopus/Orthocladius		17	55	38
Dicrotendipes		2	28	
Endochironomus				1
Eukiefferiella			2	
Glyptotendipes		3		
Hydrobaenus		25	9	23
Labrundinia		1		3
Nanocladius				4
Ormosia		1	1	
Paraphaenocladius		3		
Paratanytarsus		4	2	11
Paratendipes		5		
Phaenopsectra		1		
Polypedilum convictum grp			2	1
Polypedilum illinoense grp		4	5	4
Simulium		1	28	18
Tabanus		1		
Tanytarsus		9	10	6
Thienemannimyia grp.				5

ORDER: TAXA	CS	NF	SG	RM
Tipula		-99		
Zavrelimyia				1
EPHEMEROPTERA				
Caenis latipennis		77	7	103
Heptagenia			1	
Leptophlebia		3	3	12
HEMIPTERA				
Belostoma		1		-99
Trichocorixa		62		
LUMBRICINA				
Lumbricidae				1
ODONATA				
Argia				1
Enallagma				1
Gomphus				2
Libellula		1		1
Macromia		1		-99
Plathemis				1
Progomphus obscurus		9	1	1
PLECOPTERA				
Amphinemura		1		4
Perlesta		1	4	11
TRICHOPTERA				
Ironoquia				2
TUBIFICIDA				
Enchytraeidae		5	1	9
Tubificidae		1		

Aquid Invertebrate Database Bench Sheet Report
Spring Ck A [0418686], Station #1, Sample Date: 4/2/2004 12:30:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		2		
AMPHIPODA				
Hyalella azteca		1		13
COLEOPTERA				
Agabus				1
Dubiraphia		1		
Helichus lithophilus		2		2
Hydroporus		3		
Paracymus		1		1
Peltodytes		4		
Stenelmis		1		
Tropisternus				1
DECAPODA				
Orconectes virilis				1
Palaemonetes kadiakensis				-99
DIPTERA				
Ablabesmyia		2		1
Ceratopogoninae		3		1
Chaoborus		1		
Cladopelma		1		
Cladotanytarsus		13	2	
Cnephia				1
Corynoneura		1		
Cricotopus bicinctus		3	5	6
Cricotopus/Orthocladius		2	35	27
Cryptochironomus		1		
Dicrotendipes		5	16	2
Diptera			5	1
Glyptotendipes		1	3	2
Gonomyia		1	1	
Hydrobaenus		3	11	16
Larsia				1
Nanocladius				1
Ormosia		12		1
Paralauterborniella		1		
Paraphaenocladius		2		3
Paratanytarsus			2	3
Pericoma		6		3

ORDER: TAXA	CS	NF	SG	RM
Phaenopsectra		1		
Polypedilum halterale grp		2		
Polypedilum illinoense grp		1		
Polypedilum scalaenum grp		1		
Psychoda		1		
Rheotanytarsus			1	
Silvius		1		
Stictochironomus		1		1
Stratiomys		1		
Tanytarsus		12	6	6
Thienemannimyia grp.			1	2
Zavrelimyia				1
EPHEMEROPTERA				
Acentrella			1	
Caenis latipennis		124	35	163
Centroptilum		1		3
Heptagenia			1	
Hexagenia limbata		1		
Leptophlebia				2
Stenonema femoratum		1		1
HEMIPTERA				
Corixidae		14		
ODONATA				
Boyeria				1
Enallagma				3
Libellula		2		-99
Macromia		1		
Progomphus obscurus		5		
PLECOPTERA				
Amphinemura				1
Perlidae			10	19
TRICHOPTERA				
Nectopsyche				1
Ptilostomis				-99
TUBIFICIDA				
Aulodrilus		4		
Enchytraeidae		10	4	7
Limnodrilus hoffmeisteri		1		1
Tubificidae		5		6
VENEROIDEA				
Sphaeriidae		7		

Appendix E

Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

For Streams with Aquatic Habitat Loss that are Listed for Sediment

Waterbody Segment at a Glance:

Location: Streams in Northern and West Central Missouri and in the Mississippi Embayment of Southeast Missouri and the Missouri and Mississippi Rivers.

Impairment: In 1998 the Department of Natural Resources listed 38 streams with habitat impairment due to agricultural nonpoint source problems. Twelve of them were delisted because new data showed they were higher quality reference streams, not impaired by sediment. One of them was retained on the list for "unknown" pollutants. The other 25 of them appear on the 2002 US EPA 303(d) list for Missouri as being impaired by "sediment".

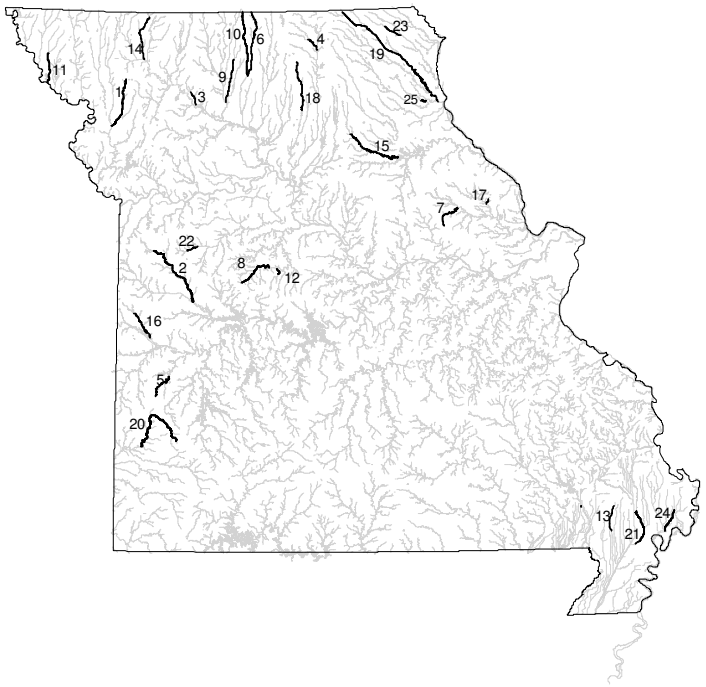
Description of the Problem

All of these waters, as per Missouri Water Quality Standards, must provide a suitable home for aquatic life. A combination of natural geology and land use in the prairie portions of the state and the Mississippi Embayment is believed to have reduced the amount and impaired the quality of aquatic habitat. The major problems are excessive rates of sediment deposition due to streambank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived.

The department proposed changing the listing of "sediment" to "habitat loss." This change was proposed because sediment is often an important, but certainly not the only, pollutant or condition causing degradation of aquatic habitat in these streams. With this proposed change, other problems such as channelization, alteration of streambanks and riparian zones, and alteration of normal flow regimes would be included as conditions contributing to impairment. The US Environmental Protection Agency denied this change because habitat loss is "pollution", not a specific "pollutant" that can be measured and calculated. This is necessary because a TMDL (Total Maximum Daily Load) is a numeric calculation.

The department is developing a sediment protocol to determine if sediment is actually the pollutant in these streams and a standard way to measure sediment.

Missouri Streams with Loss of Habitat due to Agricultural Non-Point Source Pollution



#	Waterbody	County (lower section)	Miles affected		#	Waterbody	County (lower section)	Miles affected
1	3rd Fork Platte River	Buchanan	31.5		14	M. Fork Grand River	Gentry	25
2	Big Creek	Henry	49		15	M. Fork Salt River	Monroe	49
3	Big Muddy Creek	Daviess	8		16	Miami Creek	Bates	18
4	Blackbird Creek	Adair	10.5		17	Mill Creek	Lincoln	4
5	Clear Creek	Vernon	18		18	Mussel Fork	Macon	29
6	E. Fork Medicine Cr.	Grundy	36		19	N. Fabius River	Marion	82
7	Elkhorn Creek	Montgomery	19		20	N. Fork Spring River	Jasper	51.5
8	Flat Creek	Pettis	20		21	Old Channel Little R.	New Madrid	20
9	Honey Creek	Livingston	23		22	S. Fork Blackwater R.	Johnson	5
10	Little Medicine Creek	Grundy	40		23	S. Wyaconda River	Clark	9
11	Little Tarkio Creek	Holt	17.5		24	Spillway Ditch	New Madrid	13.5
12	Lake Creek	Pettis	5		25	Troublesome Creek	Marion	3.5
13	Lateral #2 Main Ditch	Stoddard	11.5					

For more information call or write:

Missouri Department of Natural Resources
Water Protection Program
P.O. Box 176, Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 751-1300 office or (573) 751-9396 fax
Program Home Page: www.dnr.state.mo.us/deq/wpcp