Missouri Department of Natural Resources

Biological Assessment Report

2nd Nicholson Creek
Barton County

March 27, 2001

Prepared for:

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

Prepared by:

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

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1.0 Introduction

At the request of the Water Pollution Control Program (WPCP), the Environmental Services Program (ESP) Water Quality Monitoring Section (WQMS) conducted a biological assessment of 2nd Nicholson Creek, north of Mindenmines in the Prairie State Park area. 2nd Nicholson Creek was added to the 303(d) list of impaired waters in 1998 due to a suspected elevation in sulfate levels. Much of the watershed supplying this creek consists of abandoned mine land (AML) that was formerly strip mined for coal.

Little Drywood Creek, an adjoining drainage free of AML influence which is located northwest of Lamar, was selected as a control site to compare with 2nd Nicholson. This comparison was to determine whether a biological impairment exists in a system with elevated sulfate levels. Sampling at 2nd Nicholson and Little Drywood creeks was conducted on March 27 and April 2, 2001, respectively, to provide data to the WPCP for use in evaluating and comparing the biological integrity of the two streams. Dave Michaelson, Cecilia Campbell, and others of the Environmental Services Program, Air and Land Protection Division conducted the sampling.

On March 22, 2001 a study plan was submitted to the WPCP (Appendix A). Because standard statistical methods were proposed in the study plan, a null hypothesis of no difference between macroinvertebrate communities of a high sulfate stream and a control was stated. Six contiguous stations were sampled at each study site.

2.0 Study Area

2nd Nicholson Creek originates west of Prairie State Park near the Kansas-Missouri state line and flows northeast through an upper watershed dominated by grasslands (see Table 1) with extensive areas of abandoned mine land. The stream reach assessed is class "P" with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption."

Little Drywood Creek originates northwest of Lamar and flows north through a watershed dominated by grasslands (see Table 1). The stream reach assessed is class "C" with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption." This stream was chosen as a control in the study due to several factors: its close proximity to the study stream within the same Ecological Drainage Unit (EDU); a watershed of comparable size; and a lack of observable AML within the watershed. Very few if any streams in the vicinity of 2nd Nicholson Creek met these criteria. A lower segment of Little Drywood Creek is designated as a reference stream for the development of biological criteria.

2nd Nicholson and Little Drywood creeks are located within the Plains/Osage EDU. An EDU is a region in which biological communities and habitat conditions can be expected to be similar. Please see Appendix A for maps of the EDUs and the 14 digit Hydrologic Units (HU), #10290104030020 and #10290104060001, that contain the sampling reaches

for 2nd Nicholson and Little Drywood creeks, respectively. See Table 1 for a comparison of land use for the 14 digit HU. Land cover data were derived from the Thematic Mapper satellite data from 1991-1993, and interpreted by the Missouri Resource Assessment Partnership (MoRAP).

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest	Swamp
EDU	0.2	23.0	54.9	17.9	0.3
2nd Nicholson HU	0.1	18.4	56.3	22.3	0.0
L. Drywood HU	0.0	19.1	60.9	18.8	0.0

3.0 Site Descriptions

2nd Nicholson Creek Stations #1 through #6 (NW ¼, sec. 17, T. 32 N., R. 33 W. & NE ¼, sec. 18, T. 32 N., R. 33 W.) were located both upstream and downstream from Barton County Road NW 160th Lane. The most downstream station was located within the Prairie State Park boundaries. Average stream width was 18.3 feet; the total length of stream sampled was approximately 2196 feet. Geographic coordinates at the downstream terminus of Station #1 are Lat. 37.53436°, Long. –94.58577°. Discharge was measured at 8.12 cubic feet/second (cfs). Geographic coordinates at the upstream terminus of Station #6 are Lat. 37.53335°, Long. –94.59048°. Discharge was measured at 5.62 cfs. The watershed at the most downstream segment was approximately 13.5 mi^2 .

ESP personnel returning to study the site in April 2001 observed long strands of filamentous algae covering various substrates in the stream (Randy J. Sarver, MDNR-ESP, personal comments) This is the only stream out of six streams sampled at the same time of year in which excessive algae was noted.

Little Drywood Stations #3 through #8 (SE ¼, sec. 28, T. 33 N., R. 31 W.) were located downstream of Barton County Road NW 20th Lane. Average stream width was 28 feet; the total length of stream sampled was approximately 3360 feet. Geographic coordinates at the downstream terminus of Station #3 are Lat. 37.57727°, Long. –94.33743°. Discharge was measured at 1.41 cfs. Geographic coordinates at the upstream terminus of Station #8 are Lat. 37.57781°, Long. –94.33104°. Discharge was measured at 1.89 cfs. The watershed at the most downstream segment was approximately 9 mi^2 .

4.0 Methods

4.1 Macroinvertebrate Collection

A single standard habitat (non-flowing water with depositional substrate) was sampled at each of the stations as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. Other habitats available during the spring sample season (coarse substrate, large woody debris, and rootmat) were not sampled due to their potential ephemeral nature at these sites. It was decided that only the depositional areas (i.e., pools) were likely to have been hydrated during the previous months and that sampling this habitat would provide the best assessment of the macroinvertebrate community. A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure.

4.2 Discharge Measurements

Stream velocity was measured using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113 (Flow Measurement in Open Channels).

4.3 Macroinvertebrate Analysis

A standardized sample analysis procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. One deviation was made to the metrics that are calculated in the Project Procedure. The Biotic Index was not calculated because it is a general indicator of organic pollution and the study was specific to sulfate.

4.4 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure.

4.5 Stream Habitat Assessment

A standardized assessment analysis procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure.

4.6 Statistical Methods

Macroinvertebrate biological indices (Total Richness, EPT Index, and Shannon Diversity Index) and Habitat Assessment scores were compared among sites using a t-test at the $\alpha = 0.05$ level. Because the t-test is a parametric method, each data set was tested for normality before proceeding. All statistical interpretations were conducted using

SigmaStat® (version 2.03, Jandel Scientific, San Rafael, California) software. An *a priori* p-value of <0.05 was selected to determine statistically significant differences among data sets.

5.0 Observations

Stream stage at 2nd Nicholson Creek appeared to be at base flow, with all available habitat types submerged by flowing water. There was no evidence of recent high water events. Although situated in the Prairie/Osage EDU, the stream exhibited characteristics consistent with a riffle/pool regime.

At the commencement of sampling activities at Little Drywood, stream stage appeared to be at base flow. There was no evidence of recent high water events prior to sampling; however, immediately after sampling was finished heavy rains fell which resulted in flash flood conditions later in the afternoon.

6.0 Data Results

6.1 Water Chemistry

The results of three sulfate samples collected in 1997 and 1998 were provided by the WPCP. All water quality samples were collected approximately 1.5 river miles downstream of the study site, downstream of the confluence of 2nd Nicholson and Middle Drywood creeks (the latter watershed drains the center portion of Prairie State Park and a parcel of AML upgradient of the park). Of those samples, one exhibited sulfate concentrations in excess of 1000 mg/L, the upper limit for state water quality standards. The mean concentration of samples was 762 mg/L, ranging from 448-1080 mg/L.

A single water quality sample collected on April 2, 2001 from the Little Drywood study site had a sulfate concentration of 90 mg/L. Additional past water quality samples collected from Little Drywood were a considerable distance downstream and were not considered for this report.

6.2 Habitat Assessment

Habitat assessment scores (see Table 2) were recorded for each sample reach at both sites following macroinvertebrate collection according to methods described in the Stream Habitat Assessment Project Procedure. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of the reference site. The mean habitat score of 2nd Nicholson Creek was 102% of the mean habitat score of Little Drywood Creek.

Additionally, a two-tailed t-test used to compare habitat assessment scores between sites showed that the mean habitat score of 121.67 (of a possible 200) for six reaches sampled on 2nd Nicholson Creek was not significantly higher than the Little Drywood mean score of 119.17 ($p = 0.656$).

Although neither comparison is meant to provide an absolute distinction between sites, it does provide a method for determining whether substantial differences exist between a study site and its reference. In this study, both the project procedure and the statistical analysis lead to the conclusion that the study site should support a comparable biological community.

Table 2
Habitat Scores

Stream	Station #1	Station #2	Station #3	Station #4	Station #5	Station #6	Mean
2nd Nicholson	143	125	124	115	105	118	121.67
Little Drywood	122	115	113	122	122	121	119.17

6.3 Biological Assessment

Macroinvertebrate metrics, with the exception of the EPT Taxa, were higher at 2nd Nicholson Creek (see Table 3). There was no statistically significant difference in the EPT Taxa Index among sites ($p = 0.614$). For the EPT Taxa the null hypothesis of no difference would be accepted.

The 2nd Nicholson Creek mean Taxa Richness of 37.67 was significantly higher than the mean of 21.00 at Little Drywood Creek ($p < 0.001$). The mean Shannon Diversity Index of 2.548 at 2nd Nicholson was also significantly higher than the mean of 1.085 at Little Drywood ($p < 0.001$). For Taxa Richness and the Shannon Diversity Index the null hypothesis would be rejected. Although Taxa Richness and the Shannon Diversity Index are significantly different at 2nd Nicholson and Little Drywood creeks, the difference could have been in either a positive or negative direction for the study stream as compared to the control. In this case the study stream is elevated in diversity over the control stream.

Table 3
Macroinvertebrate Metrics

Stream/metric	Station #1	Station #2	Station #3	Station #4	Station #5	Station #6	Mean
2nd Nicholson Taxa Richness	39	37	40	32	43	35	37.7
Little Drywood Taxa Richness	17	10	24	22	24	29	21
2nd Nicholson EPT Taxa	2	4	4	2	3	2	2.8
Little Drywood EPT Taxa	1	1	3	3	3	4	2.5
2nd Nicholson Shannon Index	2.56	2.60	2.74	2.38	2.63	2.38	2.55
Little Drywood Shannon Index	0.63	0.62	1.36	0.77	1.1	2.03	1.09

Chironomidae taxa made up the majority of the total count at both sites, comprising an average of 78% of individuals in samples and 46% of Taxa Richness at 2nd Nicholson. At Little Drywood, Chironomidae taxa made up 87% of individuals and 42% of Taxa Richness.

The highest number of taxa found at a single sample station was 43 at 2nd Nicholson Creek; at Little Drywood, the highest number of taxa was 29. As is common in prairie streams, few EPT taxa were found. No more than 8 species of EPT taxa were found at either location and generally very few individuals of each taxon were present in samples.

7.0 Discussion

Although sulfate concentrations in 2nd Nicholson Creek water samples were higher than the control site, it did not appear to have impaired the macroinvertebrate community during spring 2001. Taxa Richness and the Shannon Diversity Index both favored 2nd Nicholson over Little Drywood by showing a significant increase in diversity. Due to the relatively low abundance of EPT taxa, no significant difference among sites could be observed with that metric.

It is possible that 2nd Nicholson's relatively higher taxa richness could be attributed in part to increased discharge compared to Little Drywood. The 2nd Nicholson watershed was slightly larger (13.5 mi^2) than the Little Drywood watershed (9 mi^2), but its average discharge rate was considerably higher (6.87 cfs versus 1.65 cfs). Because this area of the state has very little ground water influence, a possible explanation for the considerable difference in discharge between slightly different size watersheds is the

potential input from strip pit ponds in the upper parts of the 2nd Nicholson watershed. Increased flows may play a role in the difference in diversity if it is assumed that higher flows result in more available habitat, niches, and thus species.

In summary, the habitat was comparable between 2nd Nicholson Creek and Little Drywood Creek study segments. In addition, the macroinvertebrate community from the permanent pools in the 303(d) listed stream were at least as diverse as the control stream as measured by three of the four metrics used for biological criteria in Missouri streams.

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Appendix A

Proposed Bioassessment Study Plan
2nd Nicholson Creek
March 22, 2001

Missouri Department of Natural Resources
Proposed Bioassessment Study Plan
West Tebo Creek, Mulberry Creek, and 2nd Nicholson Creek
March 22, 2001

Objective

Compare macroinvertebrate communities between 303(d) streams listed for sulfate and non-sulfate impaired control streams.

Hypothesis

Null = No difference between macroinvertebrate communities of high sulfate streams and controls.

Background

All high sulfate streams have relatively small watersheds and are considered either temporary or intermittent. Because of this situation any biological assessment must be accomplished when the streams are well hydrated. The time period that coincides with established MDNR macroinvertebrate bioassessments is mid-March through mid-April. All streams will be sampled only one year, one season, unless environmental conditions dictate further sampling.

Study Design

General: Although over eight years of work has been invested in biological criteria development in wadeable and perennial streams by MDNR, the streams in question are in a different classification and require adapting standard procedures. Ecoregional reference streams for this size class are not currently available, thus a paired watershed approach is proposed. Considerable caution was taken in selecting controls that are of comparable size and uninfluenced by coal mining. West Tebo Creek (watershed area 19 sq. mi.) is paired with East Fork of Honey Creek (watershed area 17 sq. mi.); Mulberry Creek (watershed area 33 sq. mi) with upper Miami Creek (watershed area 47 sq. mi); and 2nd Nicholson Creek (watershed area 14 sq. mi) with Little Drywood Creek (watershed area 10 sq. mi.).

Sampling units will be at the reach scale. Each stream will be sampled in six reaches. Each reach will be determined as twenty average stream widths, which is consistent with the MDNR Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Stream reaches will be selected within one segment of stream in which conditions can be expected to be approximately the same. To account for potential influences that would affect some segments but not all segments, discharge, water chemistry, and habitat measures will be taken during sampling.

Biological Sampling Methods: The MDNR (SMSBPP) will be modified to fit the smaller stream size of this study. Only one of the three standard habitats normally collected in larger streams will be sampled. This habitat, non-flowing water over depositional substrate, will standardize samples between reaches. Each reach sample will be a composite of six, approximately 1 square meter, sub-samples from various pools within the reach. The advantage of taking a composite sample in small intermittent streams that dry to varying degrees is the ability to minimize the problems associated with the past hydration of each individual pool.

Physical and Habitat Sampling Methods: The MDNR Stream Habitat Assessment Project Procedure (SHAPP) will be utilized at all locations. The habitat score will, in part, allow a measure of the variability of factors that might influence macroinvertebrate communities between reaches. Discharge will also be measured at the most upstream and most downstream locations. Because no major tributaries are to be present between the most upstream and downstream reaches, flow conditions and water quality are expected to be similar between all reaches.

Chemical Sampling Methods: All streams will be sampled for sulfate, conductivity, chloride, pH, and dissolved oxygen on a quarterly basis to establish the background and range of conditions. Control streams are expected to have sulfate levels well below state standards.

Laboratory Methods: Macroinvertebrates collected at all sampling locations will be processed and identified as stated in the MDNR (SMSBPP) and the MDNR Standard Operating Procedure MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification.

Data Recording and Analysis: Data recording will be done in a Microsoft Access database according to the MDNR Standard Operating Procedure MDNR-WQMS-214, Quality Control Procedures for Data Processing. Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP. One of these, the Biotic Index, is designed to respond to organic enrichment and will not be utilized in this study. The remaining metrics of Total Taxa (TT), Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT), and the Shannon Index (SI) will be calculated for each reach. The six reach samples for each stream will be used for mean comparison analysis (unpaired t-test) if data is normally distributed or Mann-Whitney Rank Sum Test if data cannot fit the normality distribution. The probability level for concluding a significant difference will be $p<0.05$. Analysis will be done on a paired watershed approach and, since all sites are within the same ecological region, the possibility exists of attempting to pool all control data if variability allows. This possibility would also allow for analyses consistent with biological criteria as developed for wadeable/perennial streams.

Data Reporting: Results of the study will be written in report format.

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

Attachments

Standard Operating Procedures

Taxonomic Levels for Macroinvertebrate Identification (MDNR-FSS-209)
Quality Control Procedures for Data Processing (MDNR-WQMS-214)

Project Procedures

Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure
Stream Habitat Assessment Project Procedure

Appendix B

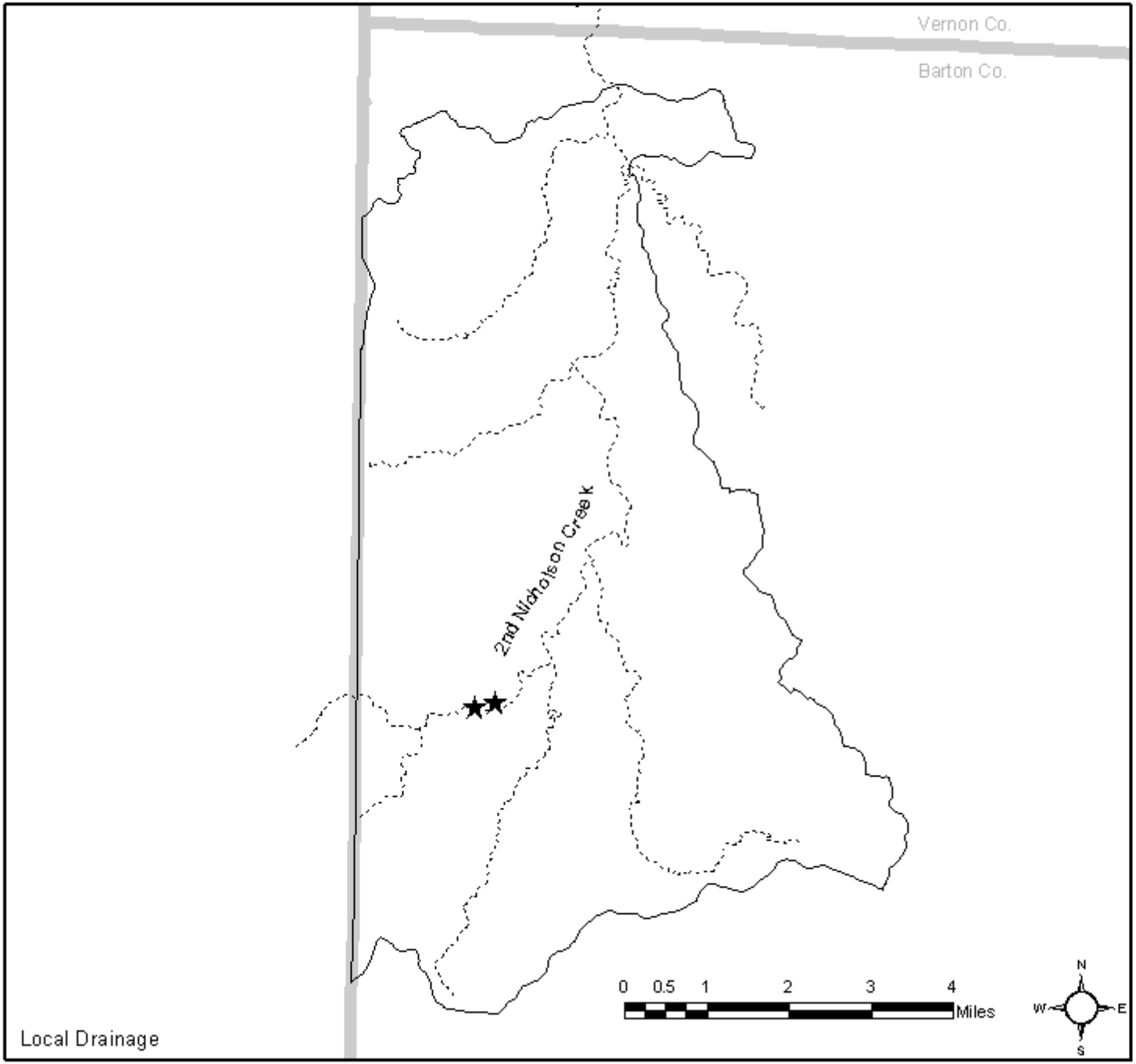
Maps

2nd Nicholson
Prairie/Osage EDU

&

Little Drywood Creek
Prairie/Osage EDU

2nd Nicholson Creek Study Site



Local Drainage

★ Sample Reach Boundaries

14-digit hydrologic unit

County Boundaries

Streams

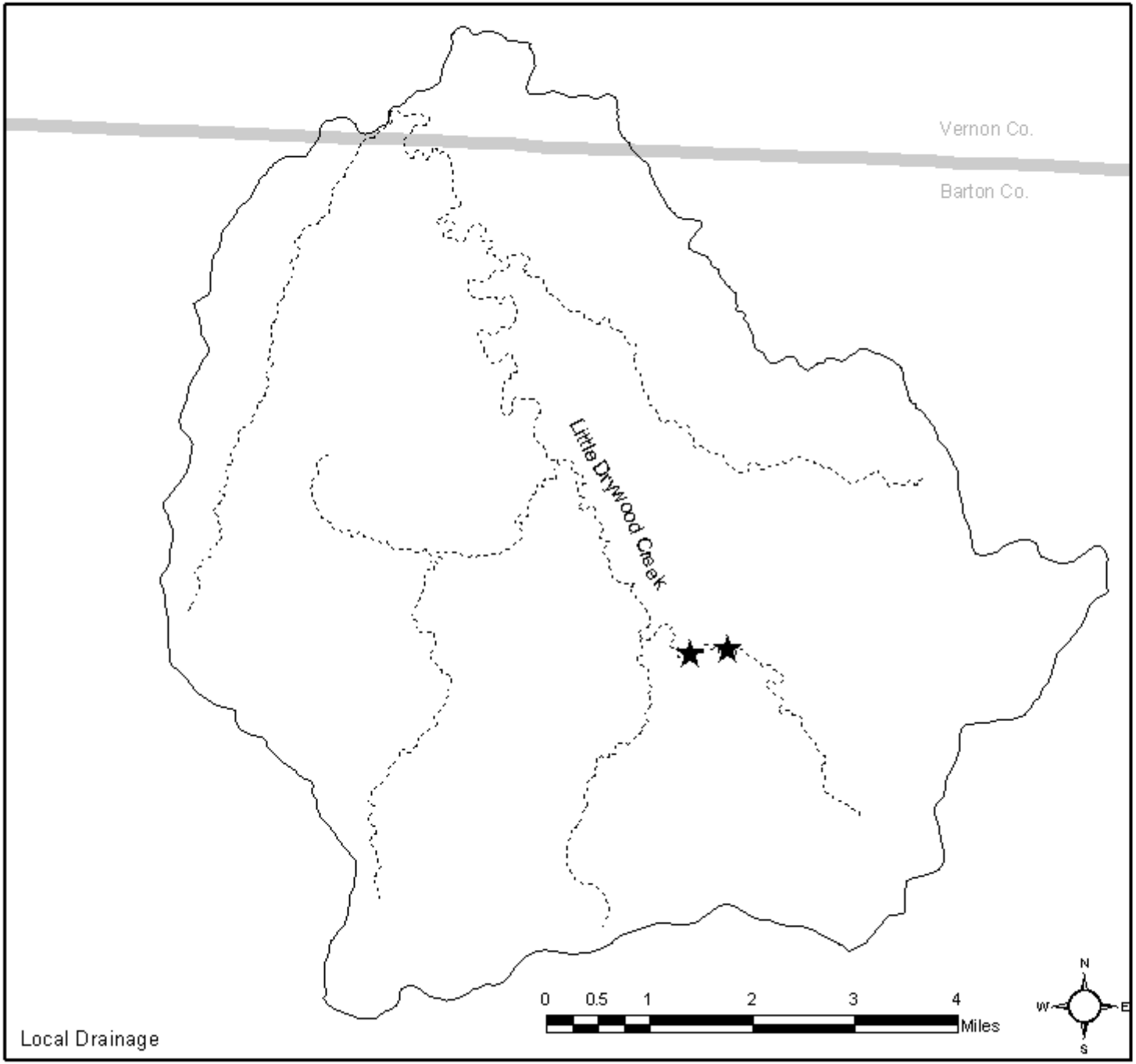
Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map above. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map above. This area is a portion of the local watershed. Missouri is split into over 1500 such units.

Ecological Drainage Unit

Little Drywood Creek Study Site



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Ecological Drainage Unit