



Aquatic Invertebrate Monitoring at Tallgrass Prairie National Preserve, 2009-2015

A vast North American prairie once covered over 160 million hectares, but over 95% of this resource has been destroyed by human encroachment making it one of the most endangered biomes on the continent (Samson and Knopf 1994). Tallgrass Prairie National Preserve (TAPR) was the first National Park Service area established specifically for the preservation, protection, and interpretation of a large tract of remaining tallgrass prairie ecosystem. Prairie streams were critical components of the Great Plains ecosystems, but many were permanently lost or impaired due to development and agricultural activities. Many of the remaining prairie fragments are not sufficiently large enough to support proper ecological functioning of their resident streams. Prairie streams continue to face anthropogenic threats and understanding their ecology has become critically important. Streams and their watersheds at TAPR are largely protected, but they remain vulnerable to human disturbance (Fig. 1). Periodic monitoring of their biological communities will help detect disturbances and their associated impacts.



Figure 1. Fox Creek at Tallgrass Prairie National Preserve.

Methods:

For details on methods used for invertebrate monitoring and analysis see Bowles et al. (2008).

- From a single reach at each of Fox Creek and Palmer Creek, three successive riffles were sampled with three benthic invertebrate samples collected at each riffle, resulting in nine samples per reach.
- A Surber stream bottom sampler (500 μm mesh, 0.09 m^2) was used to collect the samples.
- Samples were sorted in the laboratory following a subsampling routine described in Bowles et al. (2008).
- Taxa were identified to the lowest practical taxonomic level (usually genus) and counted.
- Metrics calculated for each sample included taxa richness, Shannon diversity index, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, EPT ratio (EPT density/(EPT density+Chironomidae density), taxa evenness (where 0=minimum evenness, 1=maximum evenness), and Hilsenhoff biotic index (HBI).
- High values are preferred for all metrics, except for HBI, where smaller values are the desired response. An increase in HBI values over time is undesired, because that would reflect an increase in tolerance to disturbance for that community.

The Heartland Inventory and Monitoring Network (HTLN) began monitoring water quality and invertebrate community structure in Palmer and Fox creeks at TAPR in September 2009 according to the HTLN small streams monitoring protocol (Bowles et al. 2008). Aquatic invertebrates are an important tool for understanding and detecting changes in lotic ecosystem integrity, and they can be used to reflect cumulative impacts that cannot otherwise be detected through traditional water quality monitoring. They are sensitive to a wide variety of impacts that potentially may occur in the watershed, such as changes in chemical constituents, hydrological alterations, sedimentation and bank erosion, land use, and other changes in the watershed.

The monitoring objectives of this study are: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics, and 2) relate the invertebrate community to overall water quality through quantification of metrics related to taxa richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat conditions. Cribbs and Bowles (2012) summarized the data collected during the initial 2009 sampling event, and Bowles et al. (2016) summarized data through 2015. This report summarizes baseline aquatic invertebrate and associated habitat and water quality monitoring data collected from 2009 through 2015.

- Water quality and habitat data were collected in conjunction with invertebrate samples (see Bowles et al. 2008, Cribbs and Bowles 2012), but those data are not shown here. Please refer to Bowles et al. (2016) for methodology and the summarized habitat data.

Summary of Findings:

Fox Creek

Mean taxa richness ranged from 13.44 to 19.44 (Fig. 2). Mean EPT richness across years for Fox Creek ranged from 3.33 to 8.89. Conversely, mean % EPT abundance across years for Fox Creek ranged from 23% to 68%, indicating this stream ranged from non-supporting to fully supporting of biological life (Fig. 3). Based on Kansas Department of Health and Environment (KDHE) standards (KDHE 2016a, Poulton et al. 2007), EPT richness was partially supporting in 2015, but not supporting in the other years.

The dominant taxa in most samples were Chironomidae (Diptera, TV=6), the caddisflies (Trichoptera) *Cheumatopsyche* and *Chimarra* (TV=6.6 and 2.8, respectively), and the mayfly (Ephemeroptera) family Baetidae (TV=4). The dominant EPT taxa were *Cheumatopsyche*, and the mayflies Baetidae, *Caenis* (TV=7.6), *Leptoplebia* (TV=6.4), and *Stenacron* (TV=7.1), all of which are tolerant of some disturbance. Stoneflies (Plecoptera, Perlidae, TV≤1) were present but generally poorly represented numerically. The EPT ratio for Fox Creek across years ranged from 0.47 to 0.77, indicating that the dipteran family Chironomidae largely did not dominate a substantial portion of the benthic community among samples.

HBI was moderate for all years and generally around 5 or 6, which indicates water quality is good to fair. Shannon's index among years ranged from 1.94 to 2.05. For biological data, values of Shannon's index range generally from 1.5 (low species richness and evenness) to 3.5 (high species richness and evenness). Taxa evenness ranged from 0.68 to 0.75, with 1.0 representing maximum evenness.

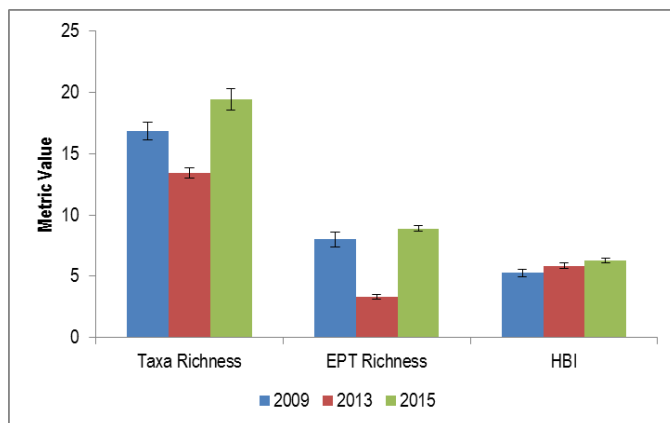


Figure 1. Means and standard errors (n=3) for richness metrics and HBI at Fox Creek, Tallgrass National Preserve.

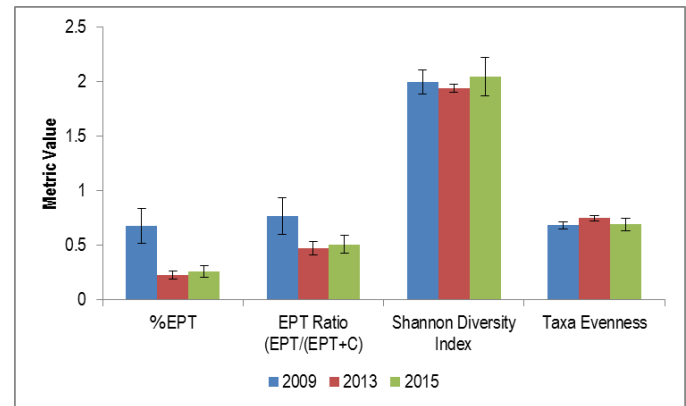


Figure 2. Means and standard errors (n=3) for diversity metrics at Fox Creek, Tallgrass National Preserve.

Palmer Creek

Invertebrate metrics for Palmer Creek exhibited a broad range of responses, which do not allow any conclusions to be drawn from this data at this time. Mean taxa richness across sampling years ranged from 12.78 to 15.89 (Fig. 4). Mean EPT richness ranged from 2.44 to 6.11, which would be classified as non-supporting under KDHE criteria. Mean % EPT abundance ranged from 4% to 52%, which largely did not support biological criteria established by KDHE (Fig. 5). EPT ratio ranged from 0.05 to 0.73. HBI ranged from 5.20 to 5.99, which indicates good to fair water quality.

The dominant taxa in most samples were Chironomidae, Baetidae, the riffle beetle *Stenelmis* (Coleoptera, TV=5.4), and *Cheumatopsyche*. Dominant EPT taxa included the mayflies Baetidae and *Stenonema* (TV=3.4), caddisflies *Cheumatopsyche*, *Helicopsyche* (TV=0), *Chimarra* and *Hydroptila* (TV=6.2) and Baetidae (TV=4). Similar to Fox Creek, stoneflies were present but at low densities. Shannon's index among samples ranged from 0.92 to 2.04, which indicates low to mid-diversity. Taxa evenness ranged from 0.36 to 0.74, also a low to mid value range. Several sensitive taxa were collected including the caddisflies *Rhyacophila* (Rhyacophilidae) and *Helicopsyche* (Helicopsychidae), and *Chimarra* (Trichoptera: Philopotamidae); all had tolerance values less than 3.

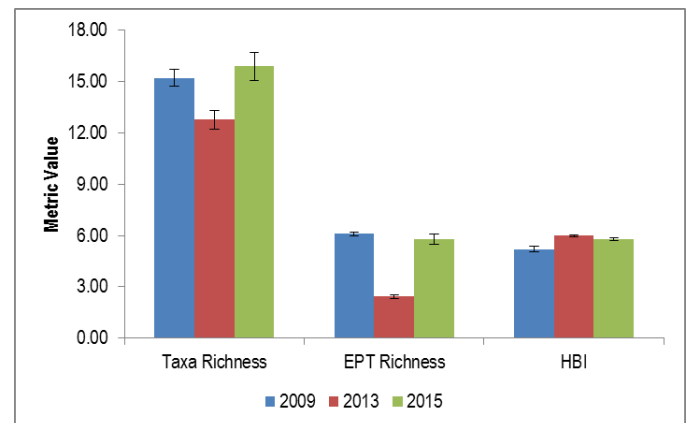


Figure 3. Means and standard errors (n=3) for richness metrics and HBI at Palmer Creek, Tallgrass National Preserve.

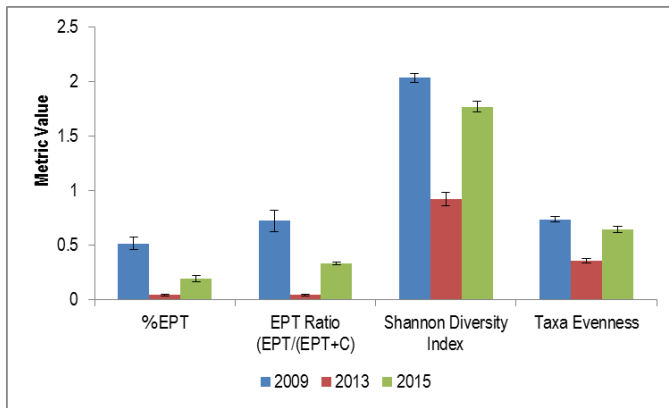


Figure 4. Means and standard errors (n=3) for diversity metrics at Palmer Creek, Tallgrass National Preserve.

All metrics varied considerably among sampling years although there was overlap among years for some. This suggests that the natural range of variation in these prairie streams is quite broad. Factors potentially influencing the results presented here are that Palmer Creek receives substantial baseflow from small springs in its basin whereas Fox Creek does not. Additionally, the 2009 sampling event occurred during a drought in which each stream was barely flowing. In contrast, the 2013 sampling event was unseasonably cold, including snowfall, and stream flows were higher than measured for the other two years. It is likely these conditions may have influenced aquatic invertebrate community structure at those times. Previous surveys of Fox Creek and Palmer Creek indicated these streams did not meet aquatic life criteria, and the state of Kansas lists both Fox and Palmer creeks on the 303(d) list for impaired streams (KDHE 2016b). Our data show similar results. However, the occurrence of rare and environmentally sensitive species, including stoneflies (Plecoptera) in both streams suggests that they are not impaired. The majority of the Palmer Creek watershed within TAPR is characterized as prairie, and it is subject to minimal anthropogenic disturbance. In comparison, numerous anthropogenic stressors occur in Fox Creek's watershed upstream of TAPR. The intermittent nature of prairie streams, including those in this study, may also serve as seasonal stressors, which could cause them to appear impaired. This notion is substantiated in that water quality collected in this study met the Kansas aquatic life criteria (KDHE 2016a) for prairie streams. Additionally, several intolerant taxa were represented in samples from Fox Creek and Palmer Creek, including Plecoptera. The invertebrate metrics presented in this report are generally comparable to those observed for other regional streams. Although the available data are inconclusive, continued monitoring of invertebrate communities will provide important water quality information to TAPR resource managers regarding the health of Fox Creek and Palmer Creek's respective watersheds.

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Citations:

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