Original Research Paper

Benthic Macro-Invertebrate Survey in Little Beaver Creek, Kaw Lake Watershed

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Abstract: The Kaw Nation Environmental Department, as part of the water quality monitoring parameters in its non-point source pollution project conducted a benthic macro-inventebrat sampling and taxonomic classification as a stream bioassessment of Little Beaver and Bear Creeks. Little Beaver Creek is located in the tall grass prairie of Kay County, Oklahoma. It is one of the tributary creeks that enter Kaw Lake in the HUC 110060001. The macro-invertebrate samples were collected from three sites within Little Beaver Creek. The samples were collected in a net using a kick disturbance method referenced in U.S. EPA Rapid Bioassessment Protocol. A total of 10 orders and 46 taxa were identified. Taxa richness, EPT taxa richness, EPT abundance, Hilsenhoff Biotic Index and Shannon Weaver Diversity Index were calculated. It is the objective of this study to identify the chemical, physical and biological integrity of the water quality of the creeks and determine streams health as per the Clean Water Act stipulations. Based on the U.S. Environmental Protection Rapid Bioassessment protocol, the macro-invertebrate communities could be used as a tool to identify water quality and impaired streams as a result of non-point source pollution.

Keywords: Benthic Macro-Invertebrates, Water Quality, Macro-invertebrate, Stream BioAssessment

Introduction

The Kaw Nation is a federally recognized Native American tribe located in north central Kay County, OK. The Kaw Nation Environmental Department (KNED) as part of its water quality program collects macro-invertebrate sample from at least two creeks each year as a measure of the water quality parameters. Macro-invertebrates are indicative of the overall health of stream systems due to the tendency of the species to remain stationary within an area and their ability to respond quickly to stream conditions (Kenney *et al.*, 2009). In 2009, KNED staff sampled Little Beaver Creek twice and Bear Creek once. These samples may tell KNED about the environmental health of the creeks.

The Clean Water Act stipulates that the chemical, physical and biological integrity waters are of high value. Most monitoring activities focused on chemical monitoring that alone has not lead to clean water in healthy streams (Karr and Chu, 1997). When biological integrity of a stream is considered as a criteria, the composition, diversity and functional organization of the habitat increases (Karr and Dudley, 1981; Karr *et al.*, 1986). Macro-invertebrates studies can provide insight to the human impact upon streams and provides data where and when to protect streams from human influence. These studies may help us categorize the environmental health of the two creeks.

It is the objective of this study to describe the seasonal and spatial diversity of benthic macro-invertebrates in Little Beaver Creek.

Materials and Methods

Benthic invertebrate samples were collected as stream bioassessment from Little Beaver (star shape) and Bear Creeks (dot shape) in Kay County, Oklahoma as shown in Fig. 1. The study area, Little Beaver Creek, is located in the tall grass prairie region of Kay County, Oklahoma. It flows southerly entering Arkansas River at 12 miles. The site is within 11060001 Hydrological Unit Code.

(a)

(b)

(c)

(d)

(e)

(f)

Fig. 1. (a) Kaw Lake Watershed; (b) Stirring up water before macro-invertebrate; (c) Kicking up sand before macro-invertebrate; (d) Picking macro-invertebrates out of net; (e) Sorting at KNED Lab; (f) Sorting at KNED Lab

Kaw Nation Environmental Department staff collected two macro-invertebrate sample sites using a macro-invertebrate net and a kick disturbance method as detailed in the USEPA's Rapid Bio-assessment Protocols (Barbour *et al.*, 1999).

The samples were collected from riffle sections of the creek. Before macro-invertebrate sampling, the water and sand in stirred up or kicked, so more macro-invertebrates will be captured in the net (Fig. 1b and 1c).

Macro-invertebrates were then picked out of the net and placed in 99% Isopropyl alcohol to euthanize and preserve them (Fig. 1d).

The samples were transported back to KNED's lab where they were sorted and identified to family level. Sorting at the KNED Lab was done using a white macro tray with a square inch divider (Fig. 1e and 1f).

The sorted samples were then sent to the Ecotoxicology and Water Quality Research Laboratory at Oklahoma State University in Stillwater, OK. This laboratory further identified the macro-invertebrate samples to the genus and species level and reported to KNED. The Index of Biotic Integrity (IBI) was calculated using a five metric Family Level Scoring Criteria. KNED also took water quality samples from the creek sites at the same time when the macro-invertebrates samples were taken. Water samples are taken regularly as part of KNED's, Section 106 water quality monitoring program. Physical parameters, such as pH, DO and Temperature, were measured using YSI 6600 probes. Chemical analyses of N, P, SO_4 and other parameters were done in the KNED laboratory. Further

chemical analyses were done at Accurate Laboratory, an EPA certified lab in Stillwater, OK.

Results

The results generated by the OSU Laboratory were used to generate Table 1 and Fig. 2a-b. The OSU data and the Procedures in the Stream Keeper's Field Guide were used to calculate the Family Biotic Index (FBI), EPT/Midge Ratio, Taxa Richness, EPT Taxa Richness, EPT Abundance, Hilsenhoff Biotic Index (HBI), EPT/EPT + Chrionomids, Contribution of Dominant Taxon and the Shannon-Weaver Diversity (Murdoch *et al.*, 1996).

Abundance and richness of assemblages or communities are simple measures and are often used in assessments; species-poor systems are generally assumed to have degraded water quality (Norris and Georges, 1993). Certain taxa such as stoneflies (Plecoptera), are known to be more sensitive to pollutants (DeWalt *et al.*, 2005) and their presence is often considered an indicator of a healthy stream. Groupings of sensitive taxa such as the presence of EPT, which measures the proportion of individuals in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) are also used as an indicator of a healthy stream (Barbour *et al.*, 1999).

Water Quality

The physical and chemical parameters of the water were recorded at the same time as the macro-invertebrate samples. Those results are shown here in Table 2 and 3.

Table 1. Macro-invertebrate calculations

	Little beaver creek 6/09/2010	Bear creek 6/09/2010
Total Taxa/rep	10.00	4.000
Total Taxa/site		4.000
#EPT*	5.00	1.000
%EPT	68.10	1.600
Abundance	116.00	62.000
Diversity	1.77	0.479
Average Diversity (Standard Deviation)		0.480
Family Biotic Index	2.78	6.000
EPT/Midge Ratio	1.25	1.000
Shannon-Weaver Index	1.80	0.480
Hilsenhoff Biotic Index	2.10	125.400
5 Metric Family Level IBI	32.00	22.000

Table 2. Physical parameters (06/09/2010)

	Little beaver	Bear creek	Unit of measurement
Temperature	23.40	24.14	deg C
Specific conductance	423.00	275.00	µS/cm
Dissolved oxygen	13.64	12.77	mg/l
pH	8.04	8.13	
Turbidity	15.30	59.00	NTU
Chlorophyll α	3.70	12.10	µg/l

Table 3. Chemical parameters (06/09/2010)

|	Little beaver creek	Bear creek	Unit of measurement
Alkalinity, bicarbonate	221	152	mg/l
Alkalinity, carbonate	BPQL	BPQL	mg/l
Chloride	1.88	2.97	mg/l
Chlorophyll a	2.7	6.4	mg/m^3
Fecal Coliform	310	360	cfu/100 mL
Escherichia coli	387	248	MPN/100 mL
Enterococcus	150	113	MPN/100 mL
Phosphorus as P	BPQL	0.11	mg/l
Ammonia	BPQL	BPQL	mg/l
Nitrite	BPQL	BPQL	mg/l
Nitrate	0.6	0.52	mg/l
Kjeldahl nitrogen	BPQL	BPQL	mg/l
Aluminum	1.16	2.47	mg/l
Arsenic	BPQL	BPQL	mg/l
Barium	0.126	0.101	mg/l
Beryllium	BPQL	BPQL	mg/l
Cadmium	BPQL	BPQL	mg/l
Calcium	74.5	48.9	mg/l
Chromium	BPQL	BPQL	mg/l
Cobalt	BPQL	BPQL	mg/l
Copper	BPQL	BPQL	mg/l
Iron	0.88	1.74	mg/l
Magnesium	6.4	5.72	mg/l
Manganese	0.039	0.073	mg/l
Mercury	BPQL	BPQL	mg/l
Nickel	BPQL	BPQL	mg/l
Potassium	2.18	3.52	mg/l
Selenium	BPQL	BPQL	mg/l
Sodium	5	7.87	mg/l
Zinc	0.005	0.005	mg/l
Triazine mixture, unspecified	BPQL	BPQL	ug/l
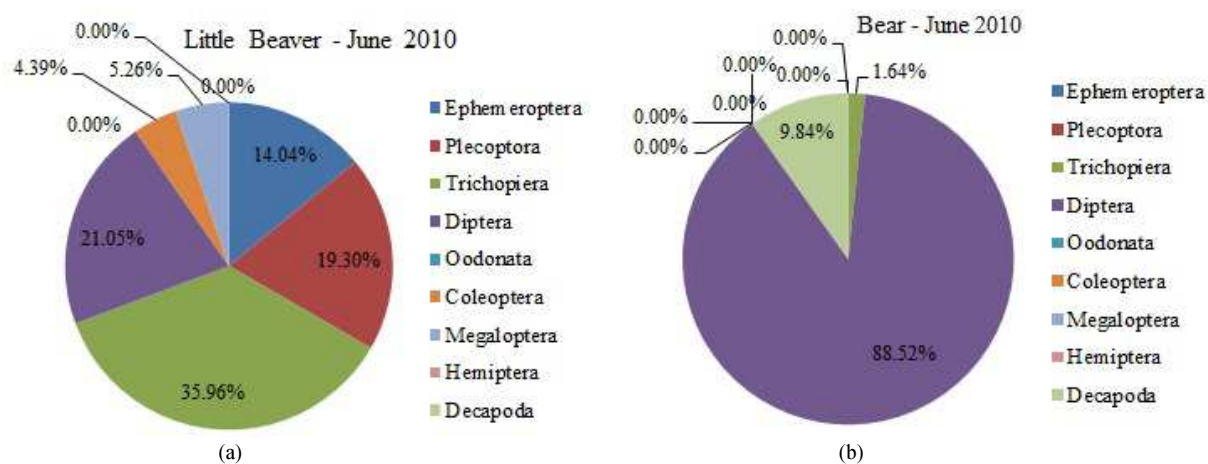
Fig. 2. (a) Little beaver Creek Class percentages; (b) Bear class percentages

Discussion

Ten different invertebrate taxa were identified from Little Beaver Creek while only 4 different taxa were identified from Bear Creek. Trichoptera (Cheumatopsyche) were the most abundant genus on macro-invertebrate in Little Beaver Creek in June, 2010.

At Bear Creek Diptera (Chironomidae) were most abundant. All the indexes above show Little Beaver Creek is of better quality than Bear Creek in terms of water quality and species diversity. In Table 1, the average macro-invertebrate diversity, Ephemeroptera, Plecoptera and Trichoptera (EPT) and total abundance were higher at Little Beaver Creek than Bear Creek.

Table 4. Evolution of water quality using the family biotic index (Hilsenhoff, 1988)

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

Table 1 data reflects the condition of Bear Creek being poorer than Little Beaver Creek. The FBI indicated that Bear Creek is in fairly poor condition and Little Beaver Creek was in good condition in June according to the classification described below by Hilsenhoff (1988) in Table 4.

Non-point source pollution is the major source of impairment for both Little Beaver Creek and Bear Creek. However, there is less buffer zone present along Bear Creek. Bear Creek is also much more influenced by Kaw Lake's water level. The lake backs up all the way up to Bear Creek several times per year. At dry times Bear Creek dries fast to the point of having no flow. The combination of both of these conditions greatly reduces the amount of permanent habitat available for macro-invertebrates.

Conclusion

The water quality data that was collected at the time of macro-invertebrate sampling showed over all good water quality. Turbidity of the sites matched up to that of the biotic indexes calculated from the macro-invertebrate data. Bear Creek had the highest turbidity and the lowest biotic index both indicating poor environmental health due to runoff coming to the creeks from various farm lands within the watershed called non-point source pollution.

Bear Creek was lower in bacteria than Little Beaver Creek due to the volume of lake water that serves to dilute concentrations. Human activities such as cattle ranching and the building of the Kaw Dam have affected Bear Creek. A decrease in the abundance of individual species or genera could be attributed to riparian deforestation. A decrease in the riparian vegetation would contributed to an increase in nutrients or litter inputs, altered water temperature, decreased bed stability and increase in sedimentation making Bear Creek more impaired than Little Beaver Creek.

The hypothesis that Little Beaver Creek is in better environmental health than Bear Creek was verified by this macro-invertebrate sampling and that Bear Creek is more impaired than Little Beaver Creek due to the non-point source pollution.

In general, macro-invertebrate can be used as biological indicators to determine whether a stream has good or bad water quality. The abundance and species richness determines stream health. The higher percentage of Ephemeroptera, Plecoptera and Trichoptera (EPT) in a stream like Little Beaver Creek exhibits better water quality.

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