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Abstract

The purpose of this study was to determine whether the effluent of the Ash Flat Wastewater Treatment Plant changes the water quality or aquatic macroinvertebrate community structure of North Big Creek. Weekly water samples were analyzed for pH, N, P, COD, TSS and fecal coliform bacteria from 17 June to 19 August 1992. Aquatic macroinvertebrates were collected biweekly using a Turtox Indestructible™ Dip Net, and density indices were calculated. Station 1, above the effluent, was a spring habitat. Fecal coliform, N, P, TSS and COD values were higher at this station, while the aquatic macroinvertebrate community was relatively simple. The effluent impact upon Station 2 was most obvious from the persistent presence of foam and filamentous algae. Moderating water temperature and enhanced nutrient supply has resulted in a more complex aquatic macroinvertebrate community with a lower numerical standing crop.

Introduction

To our knowledge, no studies have been made on the aquatic macroinvertebrates of North Big Creek. The purpose of this study was to determine if the effluent of the Ash Flat Wastewater Treatment Plant changes the water quality or aquatic macroinvertebrate community structure of this stream. The treatment plant, an extended aeration type, was installed in 1986, with a flow capacity of 350,000 l per day.

North Big Creek arises in northwest Sharp and southeast Fulton Counties. If flows southeasterly through Ash Flat to its confluence with the Strawberry River about 3.2 km north of Poughkeepsie, or approximately 1.6 km west of the St. Hwy 58 bridge. Its drainage lies completely within the Salem Plateau of the Ozark Mountains Physiographic Province.

Within the study area, North Big Creek is a third order stream. It is spring fed as is evidenced by the extensive growth of water cress, particularly at the upper end of the study area. The stream has a substrate of rock, sand, gravel, silt and organic mud. Its banks are at times steep, and either lined with rock outcroppings or eroded. Frequently, vegetation grows to the water's edge. Vegetation along the banks includes grasses, oak, willow, elm, hickory, sycamore, sweetgum, birch, cottonwood and hackberry. Climax vegetation is oak-hickory hardwood forest. The soil type is Gepp-Doniphan. It is well drained, gently sloping to steep, deep, very cherty and cherty soils. The Gepp series consists of deep, well drained, moderately permeable soils on hilltops and hillsides. The soils are formed in clayey residuum and in places in colluvium over cherty limestone bedrock. Slope ranges from 3 to 40%. Doniphan soils are on adjacent side slopes and broad ridgetops. These have a clayey control section, and base saturation is less than 35% (Soil Conservation Service, 1984a, 1984b).

Materials and Methods

Sample collections were made on North Big Creek between 17 June and 19 August 1992. The upstream collection site (Station 1), about 1 km above the effluent, was in the southern part of Ash Flat just east of the U.S. Hwy 167 bridge (SE1/4NE1/4 S15, T18N, R6W). The downstream collection site (Station 2), about 2 km below the Ash Flat Wastewater Treatment Plant (NW1/4SW1/4 S14, T18N, R6W), was east of Ash Flat just north of the St Hwy 354 bridge (SW1/4SW1/4 S12, T18N, R6W). Water samples were taken weekly (approximately) at each station for ten weeks. Each sample was analyzed for pH, nitrogen and phosphate using a Hach test kit (Water Analysis Handbook, 1982). Fecal coliform, chemical oxygen demand (COD), and total suspended solids (TSS) were analyzed by the Batesville Wastewater Treatment Plant. Other data recorded included: air and water temperature using a standard mercury thermometer, time, depth of collection, visual (presence of oil, foam, etc.) and amount of rain in the week prior to the collection. The Permit Compliance System (PCS) Facility Report (1992) for the City of Ash Flat was obtained from the Arkansas Department of Pollution Control and Ecology for the study period.

Aquatic macroinvertebrates were collected approximately every two weeks at each station using a Turtox

Indestructible™ Dip Net. Each sample was standardized by lasting for 1.5 man-h. An attempt was made to sample all microhabitats. The invertebrates were manually sorted from the materials and preserved in 70% ethanol. After identification all specimens were catalogued and housed in the Aquatic Macroinvertebrate Collection of the Arkansas State University Museum of Zoology (ASUMZ).

Shannon Diversity, Simpson Dominance, Shannon-Wiener Diversity, H' max and Evenness values were calculated using the AQUATIC ECOLOGY-PC disc of Oakleaf Systems, Decorah, IA. Simpson's Index of Diversity corresponds to the number of randomly selected pairs of individuals that must be drawn from a community in order to have an even chance of obtaining a pair with both individuals of the same species. It, therefore, expresses the dominance of or concentration of abundance of the one or two most common species of the community. Conversely, the Shannon-Wiener Diversity Index expresses the relative evenness of the abundances of all the species. Further, it is relatively independent of sample size. H' max is a calculated theoretical maximum diversity. The base 2 logarithm was selected for calculating diversity indices, as it is the most commonly utilized log (Cargill and Harp, 1987).

Results and Discussion

Rainfall varied from 0-9 cm per wk during the study period and had no discernable effect upon our results. The pH values were similar at both stations, with a mean of 7.2. Fecal coliform values were always higher at Station 1, on average by a factor of 4 (461.5/100 ml vs. 119.0/100 ml). Mean reactive phosphate values were 29% higher (mean = 0.49 vs. 0.38 mg/1) and mean nitrate values were 25% higher (mean = 0.35 vs. 0.28 mg/1) at Station 1. TSS and COD values were slightly higher at Station 1 (3.7 vs. 3.3 mg/1 and 14 vs. 12.2 mg/1 respectively). Finally, water temperature at Station 1 was 1-3°C cooler than at Station 2.

Station 1 was dominated by a spring habitat characterization. The aquatic macroinvertebrate community here had fewer taxa, more organisms and a less balanced distribution of organisms within those taxa (Tables 1, 2). Over 58% of the individuals collected were of the detritivorous snail *Campeloma*. This snail was favored by the extensive bed of water cress, while the cooler water temperatures discourage establishment by several taxa.

The impact of the effluent from the treatment plant on the stream is most obvious from the persistent presence of foam and moderate concentrations of filamentous algae at Station 2. The algal mats are apparently incorporating the nitrogen and phosphorous, resulting in lower values for these parameters in the water column. The treatment plant chlorinates the effluent, and this procedure reduces the fecal coliform count at least as far downstream as Station 2. The chlorine, however, did not impact the aquatic macroinvertebrate community at this station. Rather, the moderating water temperature and enhanced nutrient supply has allowed the development of a more complex, stable community here. Because the community structure is more balanced, the greater interplay of predation/competition results in lower numerical standing crop.

Two specimens collected at Station 2 are noteworthy. *Dixella* is quite infrequently collected in Arkansas and is represented by fewer than a dozen specimens in the ASUMZ. The single specimen of *Tropisternus ellipticus* collected is the eighth known for the state, the second specimen for Sharp County (Harp and Neasbitt, 1992).

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Table 1. Aquatic macroinvertebrates expressed as number collected/7.5 h at North Big Creek June-August 1992.

Taxa	Station 1	Station 2
Spongillidae	1	0
Dugesia	12	3
Oligochaeta	8	2
Branchiobdellidae	1	0
Hirudinea	2	1
Batrachobdella	1	0
Helobdella	1	2
Placobdella	1	0
Ferissia	0	2
Physa	77	120
Gyraulus	1	0
Campeloma	1043	576
Corbicula fluminea	8	15
Sphaeriidae	65	43
Anodonta grandis	0	1
Hydracarina	3	5
Lirceus	14	0
Hyalella azteca	60	43
Orconectes	141	62
Baetidae	2	3
Baetis	5	9
Caenis	35	55
Ephemerella	0	2
Hexagenia	0	1
Heptagenidae	0	1
Heptagenia	0	1
Nixe	1	0
Stenonema	5	61
S. femoratum	6	2
S. interpunctatum	4	12
S. mediopunctatum	1	12
S. pulchellum	2	0
S. terminatum	2	0
Choroterpes	1	13
Isonychia	0	11
Tricorythodes	1	46
Basiaeschna janata	21	8
Stylogomphus albistylus	4	0
Libellulidae	0	1
Macromia	0	1
Calopteryx maculata	1	0
Hetaerina americana	10	24
Coenagrionidae	1	1
Argia	4	6
Enallagma	12	19
Ischnura	9	4
Perlidae	1	0
Acroneuria	6	3
Anacroneuria	0	1
Neoperla	1	0
Phasganophora	0	1
Neogerris	0	1
Pheumatobates	0	1
Trepobates	1	2
Hebrus	0	1
Mesovelia	5	17
Neoplea	1	0
Microvelia	1	15
Rhagovelia	2	22
Corydalus cornutus	2	26
Sialis	0	3
Trichoptera	2	0
Helicopsyche (p)*	35	4
Cheumatopsyche	13	7
Hydroptilidae	1	0
Pycnopsyche	2	0
Chimarra	9	0
Petrophilia	3	4
Lixus (a)	0	1
Helichus (a)	1	2
Hydroporous (a)	1	2
Uvarus (a)	1	0
Dubiraphia (a)	2	2
Dubiraphia (1)	0	1
Optioservus (a)	0	1
Stenelmis	2	81
Dineutus (1)	0	3
Peltodytes dunavani (a)	0	1
P. duodecimpunctatus (a)	1	21
P. litoralis (a)	11	10
P. sexmaculatus (a)	0	6
Berosus (a)	1	3
Enochrus pygmaeus nebulosus (a)	0	2
Helophorous (a)	1	0
Paracymus (a)	1	2
Tropisternus (1)	2	8
Tropisternus ellipticus (a)	0	1
Lutrochus laticeps (a)	0	1
Ectopria nervosa	0	1
Psephenus herricki	33	27
Scirtes (1)	0	1
Ceratopogonidae	8	3
Chaoborus	0	1
Chrionomidae	54	55
Dixella	0	1
Simulium	7	0
Stratiomys	0	1
Tipula	3	1
Total no. of organisms	1780	1515
Total no. of taxa	70	77

*(a) denotes adult stage, (1) denotes larval stage, (p) denotes pupal stage

Table 2. Community and nested (combined) statistical values for North Big Creek, 1992.

Parameter	Station 1	Station 2
Number of Taxa	70	77
Mean no. of taxa/sample	29	36
Mean numerical standing crop	356	303
Simpson Diversity Index	0.643	0.836
Simpson Dominance	0.357	0.164
Shannon-Weiner Diversity Index	2.847	4.000
H' max	6.149	6.285
Evenness (H' / H' max)	0.463	0.636