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The Extent of Anthropogenic Disturbance on the Aquatic Assemblages of the East Branch of the DuPage River, Illinois, as Evaluated Using Stream Arthropods

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ABSTRACT

The extent of anthropogenic disturbance on the aquatic assemblages of the East Branch of the DuPage River was evaluated using arthropods as indicator species. Hilsenhoff's arthropod index measurements reflected a stream which is organically polluted. These findings were partially supported by selected chemical measurements of ammonia-nitrogen, nitrate-nitrogen, orthophosphate, and chloride. Sampling yielded an impoverished list of ten taxa dominated by *Simulium vittatum* and hydropsychid caddisflies. Another possible source of disturbance is the extensive physical disruption of the stream in the form of streambed stabilization and channelization.

INTRODUCTION

Prior to European settlement, DuPage County was covered by oak savanna and marshland (Lampa 1985). By the end of the 19th century, a large portion of the county had been converted to farmland. Urbanization followed and today the county is residence to over 760,000 people. Natural areas remaining are largely limited to the DuPage County Forest Preserves, of which many are located along two streams; the East and West Branches of the DuPage River (Figure 1). Despite the protection of the preserves, the streams are anthropogenically disturbed by effluents from municipal waste water treatment plants (MWWTP), surface runoff, and physical disturbance such as siltation, channelization, and streambed stabilization (Illinois Environmental Protection Agency [IEPA] 1988, Petersen 1991, Petersen et al. 1992). In this study, the extent of anthropogenic disturbance on the aquatic assemblages of the East Branch of the DuPage River (E. Branch) was evaluated using stream arthropods as indicator organisms.

The E. Branch joins the W. Branch just south of DuPage County to form the DuPage River (Figure 1). Physical characteristics of the E. Branch are given in Table 1. The stream has been extensively modified by efforts to stabilize the streambed and by channelization. These modifications have given the E. Branch the appearance of a canal, especially along its lower half. Larger substrates within the stream are commonly limited to cobble underneath bridges and fragmented concrete used to stabilize the streambed. Nine MWWTPs which service more than 300,000 residents in communities near the E. Branch discharge into it. Only 20% of the stream's length is within protected DuPage County Forest Preserves. Most of the remainder flows through residential areas and along or beneath roadways including Interstates 88 and 355 (Figure 1).

Aquatic arthropods were chosen as environmental indicators because they show a wide range of sensitivities to anthropogenic disturbance (Extence et. al. 1987, Hilsenhoff 1987, Ohio Environmental Protection Agency 1987, Paine and Gaufin 1956, Whitehurst and Lindsey 1990). Hilsenhoff's arthropod index (Hilsenhoff 1987) was used to quantify observations. The index was designed to measure the water quality in organically enriched waters. However, it may also be sensitive to other forms of anthropogenic disturbance such as stream modification (Petersen 1991).

Selected chemical measurements were taken to provide back-ground information. These included pH and measurements of chemicals commonly associated with organic pollution: ammonia-nitrogen, nitrate-nitrogen, orthophosphate, and chloride. Besides indicating possible MWWTP contributions to lower water quality, higher chloride concentrations during winter could indicate contributions from roadways in the form of salt runoff.

METHODS

Four sampling sites were located along the E. Branch (Figure 1). The procedures for collecting stream arthropods at these sites were those of Hilsenhoff (1987). Sampling sites were located in riffles with depths of <10cm. Collections were taken using a D-framed dip net at two to three week intervals from October, 1991, through April, 1992. Summer sampling was neglected because of a reduced fauna as many species emerge to reproduce. Each sample consisted of 100 arthropods. Specimens were preserved in 70% ethanol and identified to species when possible. Voucher specimens have been retained at College of DuPage.

Except for *Cheumatopsyche* spp. and *Simulium vittatum* Zetterstedt, pollution tolerance values (PTVs) used to calculate Hilsenhoff's index were taken from Hilsenhoff (1987). *Cheumatopsyche* spp. were assigned a PTV value of 6 (up from Hilsenhoff's PTV of 5) to continue with the assignment given to the genus in the W. Branch River System (Petersen 1991) and in view of similar chemical characteristics to streams of this system. The PTV of *S. vittatum* was raised from 7 to 8 after finding the black fly cohabiting severely polluted sections of the W. Branch River System with *Caecidotea intermedius* (Forbes) and *Chironomus* spp. (Petersen 1991, Petersen et. al. 1992). Hilsenhoff (1987) has assigned the latter two species PTVs of 8 and 10, respectively.

Chemical measurements of ammonia-nitrogen, nitrate-nitrogen, orthophosphate, and chloride were taken during arthropod collection periods from each sampling site using LaMotte chemical testing kits (LaMotte Chemical Products Company). Measurements of pH were begun March, 1992, and were taken during arthropod collections.

RESULTS AND DISCUSSION

An impoverished list of ten taxa was generated from the E. Branch (Table 2). Collections were dominated by a black fly (*Simulium vittatum* Zetterstedt) and caddisflies (*Cheumatopsyche* spp. and *Hydropsyche betteni* Ross). These species are relatively tolerant to anthropogenic disturbance (Hilsenhoff 1987, Ross 1944, Petersen 1991). Hilsenhoff's arthropod index measurements reflected a stream that is moderately disturbed (Table 3).

Concentrations of selected chemicals were somewhat elevated (Table 3), and as has been found by the IEPA (1988), ranged to levels which can be expected from organically polluted waters. The pH values were measured to be similar among sites on a given sampling event (all 7.75±0.29(4); x±s(n)). Chloride concentrations tended to be higher during the winter months of January through March among sites (Table 4). However, it is unknown if salt used to deice roads contributed to these higher measurements. More frequent sampling of sites, and of soil from road embankments near sites throughout the year, would be necessary to verify this.

Biotic indices and chemical measurements from the E. Branch tended to be similar or lower than those from the W. Branch River System obtained following similar procedures (Petersen 1991, Petersen et al. 1992). Among sampling sites along the W. Branch and its tributaries, mean biotic indices ranged from 6.28 to 8.94, mean ammonia-nitrogen measurements from 0.41 ppm to 7.00 ppm, mean nitrate-nitrogen measurements 0.32 to 2.53 ppm, mean chloride measurements from 104 ppm to 452 ppm, and mean orthophosphate measurements from 0.27 to 1.36 ppm. However, the W. Branch River System supports a richer arthropod fauna. Twenty-six taxa of arthropods [including *Psephenus herricki* (DeKay)] have been collected from the W. Branch. The number of arthropod taxa collected from the E. Branch is comparable to the 7 to 15 taxa collected from the small tributaries of the W. Branch River (see Table 1 for physical measurements of the W. Branch and its tributaries). The biotic index measurements and selected chemical analyses fail to explain the disparity between E. Branch and W. Branch arthropod faunas. While unidentified chemical pollution may contribute to the impoverished arthropod assemblages in the E. Branch, additional causes may be the lack of habitat heterogeneity and suitability as affected by extensive physical disruption. Future studies may want to discriminate among these forms of anthropogenic disturbance.

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Figure 1. Locations of the sampling stations within the East Branch of the DuPage River, DuPage County, Illinois. Also shown is the West Branch of the DuPage River and its major tributaries. Symbols: EB = E. Branch; A = Ackerman Park site; P = Prairie Path site; H = Hidden Lake Forest Preserve site; B = Burlington Avenue site; WB = W. Branch; Kl = Kline Creek, Kr = Kress Creek, SB = Spring Brook Creek, Wi = Winfield Creek, **O** identifies sampling sites and **Δ** identifies waste water treatment plants near the E. Branch sampling sites.

Sorry, figure not available for this volume's on-line version. Contact library or author for reproduction of Figure 1.

Table 1. Physical characteristics of the East Branch of the DuPage River, West Branch of the DuPage River, plus the tributaries of the West Branch of the DuPage River: Kline Creek, Kress Creek, Spring Brook Creek, and Winfield Creek as taken from the Northeastern Illinois Planning Commission (1978).

Stream	Length (km)	Average width (m)	Average gradient (m/km)	Drainage (km^2)
The East Branch of the DuPage River				
	39.5	9.8	0.74	218
The West Branch of the DuPage River				
	45.6	47.9	0.70	974
Kline Creek				
	7.4	2.4	2.88	32
Kress Creek				
	12.1	3.1	1.25	48
Spring Brook Creek				
	8.0	3.0	1.29	18
Winfield Creek				
	11.6	1.8	1.42	23

Table 2. Arthropods collected from the East Branch of the DuPage River according to sampling site and abundance. Symbols: PTV = pollution tolerance value; A = Ackerman Park site, P = Prairie Path site, H = Hidden Lake Forest Preserve site, and B = Burlington Avenue site.

Order Species	PTV	Abundance			
		A	P	H	B
Isopoda					
Caecidotea intermedius (Forbes)	8	115			10
Odonata					
Argia spp.	6	4		12	23
Hetaerina americana Fabricius	6			1	
Ephemeroptera					
Stenacron interpunctatum (Say)	7			1	8
Coleoptera					
Berosus sp.	6		1		
Stenelmis crenata (Say)	5	1	1		30
Trichoptera					
Cheumatopsyche spp.	6	302	201	139	456
Hydropsyche betteni Ross	6	248	101	190	279
Diptera					
Cricotopus spp.	7	229	60	8	41
Simulium vittatum Zetterstedt	8	101	136	649	153

Table 3. Mean biotic index values and selected chemical concentrations (ppm) ± standard deviations (sample size) (x±s(n)). The biotic indices are interpreted as follows: 0-3.50 indicates excellent water quality; 3.51-4.50 very good water quality; 4.51-5.50 good water quality; 5.51-6.50 fair water quality; 6.51-7.50 fairly poor water quality; 7.51-8.50 poor water quality; and 8.51-10.00 very poor water quality. Also included are chemical concentrations that can be expected from relatively unpolluted waters (Clark 1977, Klein 1962).

Location Biotic Index	Chemical Ammonia-nitrogen	Nitrate-nitrogen	Chloride	Ortho-phosphate
Ackerman Park				
6.76±0.74(10)	0.39±0.33(9)	1.84±1.29(9)	209±60(11)	0.30±0.15(9)
Prairie Path				
5.79±2.46(8)	1.21±2.78(7)	1.06±1.41(7)	212±90(8)	0.56±0.83(7)
Hidden Lake Forest Preserve				
7.37±0.29(11)	0.28±0.26(9)	1.47±0.81(9)	263±68(12)	0.30±0.11(9)
Burlington Avenue				
6.52±0.68(11)	0.28±0.26(9)	1.24±0.52(9)	250±63(12)	0.31±0.11(9)
Chemical concentrations that can be expected from relatively unpolluted waters.				
	<0.2	Virtually absent	<250	<0.3

Table 4. Chloride concentration measurements (ppm) according to sampling date and site.

Date	Ackerman Park	Prairie Path	Hidden Lake Forest Preserve	Burlington Avenue
22 October	200		340	324
19 November	100		180	156
2 December	136		178	188
18 December	212	248	278	260
2 January	260	280	332	300
3 February	308		368	368
2 March	268	264	304	268
9 March	220	188	240	260
6 April	236	240	288	232
20 April	200	212	212	220