

Water Quality Study of the West Branch of the DuPage River System Located in Northeastern Illinois

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ABSTRACT

A water quality study of the West Branch of the DuPage River (W. Branch) System in Northeastern Illinois was conducted with emphasis given to monitoring the tributaries Winfield Creek, Kress Creek, and Spring Brook Creek. Organic pollution of the tributaries was indicated by elevated Hilsenhoff's biotic indices, selected chemical analyses, and bacterial densities. Biotic indices ranged over 7 in all streams, providing evidence of poor water quality. Mean ammonia-nitrogen and nitrate-nitrogen concentrations ranged respectively from 0.41 ppm and 0.32 ppm for Winfield Creek to 1.18 ppm and 2.53 ppm for Spring Brook Creek. Mean coliform bacteria colony plate (coliform) counts ranged from a low of 1807 colonies/ml in Winfield Creek to 6383 colonies/ml in Kress Creek. Chloride concentrations were excessive in Spring Brook Creek, reaching a high of 584 ppm on October 4, 1990, just below the Wheaton waste water treatment plant. The water qualities of the W. Branch and the tributary, Kline Creek, also were monitored from April to July, 1991. Mean coliform counts ranged from 2477 colonies/ml from the lower stretch of the W. Branch to 12,945 colonies/ml in Kline Creek, just below the Carol Stream waste water treatment plant. Ammonia-nitrogen concentrations were excessively high in Kline Creek head water area, averaging 7 ppm and reaching a high of 20 ppm on July 8, 1991. Waste water treatment plants are believed to be the major source of organic pollution within the W. Branch river system with contributions also coming from septic fields and farmland.

INTRODUCTION

Since 1980, the population of DuPage County, Illinois, has grown over 15% to total more than 780,000 people. By the year 2010, the county's population is projected to approach one million. In an effort to evaluate the effect of anthropogenic disturbance on the natural environment and to provide baseline information for future research on the effects of such disturbance, a water quality study of the West Branch of the DuPage River System was begun in 1989. Stream analyses seemed to be a practical way to estimate the impact of development since the streams are effected by physical modification as well as contamination in the form of surface runoff, ground water, and direct discharge.

Between October 1989 and April 1990, water quality measurements were taken along the lengths of the West Branch of the DuPage River (W. Branch) and a tributary, Kline Creek (Petersen 1991). The W. Branch and Kline Creek were found to be moderately and severely organically polluted, respectively, as quantified by arthropod indicators using Hilsenhoff's biotic index (Hilsenhoff 1987) and selected water quality measurements (ammonia-nitrogen, nitrate-nitrogen, chloride, and orthophosphate). Sewage inputs from waste water treatment plants and from septic fields were believed to be the causes of this lower water quality. In the following investigation, the study was expanded to evaluate the water quality of three other W. Branch tributaries: Winfield Creek, Kress Creek, and Spring Brook Creek. Evaluation methods included those used in the initial study. Water quality monitorings of the W. Branch and Kline Creek also were continued. Locations of streams and sampling stations are illustrated in Figure 1.

DESCRIPTION OF THE STUDY SITES

The 50 km W. Branch is part of the 3553 km² Des Plaines River drainage basin located mostly in Northeastern Illinois (Illinois Environmental Protection Agency 1988). Physical measurements of it and four of its tributaries are given in Table 1. Over 70% of the W. Branch flows through DuPage County forest preserves which encompass some 2340 hectares of mostly mesophytic forests. The four tributaries flow largely through residential areas. A waste water treatment plant is located at the headwater of both Kline Creek and Spring Brook Creek. Daily discharge volumes from the Kline Creek and Spring Brook Creek plants are roughly 9000 Kl/day and 33,000 Kl/d, respectively. However, these plants do not service all residents living along the streams. Residents living by the lower reaches of both streams, and also along the headwaters and middle sections of Winfield Creek, have private septic fields.

Winfield Creek is an intermittent stream as were Kline Creek and Spring Brook Creek prior to receiving effluents from the treatment plants. During summer and early fall, Winfield Creek commonly ceases to flow. Kress Creek is slated for Superfund priority toxic cleanup. The creek has been contaminated by radioactive thorium from the since abandoned Kerr-McGee Chemical Corporation owned chemical-processing plant in West Chicago, Illinois. The final 2 km of Kress Creek flows through farmland before reaching the W. Branch.

MATERIALS AND METHODS

Winfield Creek, Kress Creek, and Spring Brook Creek monitoring

Water qualities of the streams were assessed using Hilsenhoff's biotic index (Hilsenhoff 1987), selected chemical analyses, and coliform bacteria colony plate (coliform) counts. Hilsenhoff's biotic index is based on the average tolerance of an arthropod sample to organic pollution. Stream arthropods were collected according to the procedure described by Hilsenhoff (1987). Stations were located in riffles having depths of <10cm. A D-framed aquatic net was used in collections which were taken at bimonthly intervals between October, 1990, through April, 1991, when not interrupted by icing over. One hundred arthropods composed each sample. Specimens were preserved in 70% ethanol and identified to species if possible or to genus if not.

Monthly chemical measurements were taken between September, 1990, and October, 1991, from each station using LaMotte chemical kits (LaMotte Chemical Products

Company) when weather and flow permitted. Concentrations of four chemicals commonly associated with organic pollution were measured: ammonia-nitrogen, nitrate-nitrogen, chloride, and orthophosphate. Chloride testing was of special value as a waste water indicator. Besides being a component of human waste, chloride enters the streams from waste water treatment plants after having first been used in the form of salt by local residents to soften hard drinking water. The Wheaton Sanitary District estimates that an average customer uses 45 kg of salt per week to recharge water softening systems (Robert Clavel, personal communication). Measurements were taken at all five stations within a 4-hour period during each sampling day.

Water samples for coliform counts were taken on three occasions during April and May, 1991, from each station except at the Spring Brook Creek-downstream station. Samples were collected in sterile bottles and refrigerated over night at 4°C before testing was conducted. After first confirming for the presence of fecal coliforms, coliform counts were taken using a quantitative pour plate test (Seeley 1991).

W. Branch and Kline Creek monitoring

Water qualities were monitored on seven occasions along the W. Branch and Kline Creek beginning in April and proceeding into July, 1991, using chemical analyses and quantitative pour plate tests as described earlier. During each sampling day, samples were collected from all five stations within a 3-hour period.

RESULTS AND DISCUSSION

A list of arthropods collected from the streams and their assigned pollution tolerance values are given in Table 2. Biotic index, chemical, and coliform measurements provided evidence that the West Branch of the DuPage River system is organically polluted (Tables 3 and 4). Winfield Creek showed slightly elevated nitrogenous and chloride concentrations, especially near the head water. The likely source of this pollution is septic field seepage from upstream sites. Coliform counts within Winfield Creek were also higher than can be expected from unpolluted waters. Hilsenhoff's biotic indices taken along Winfield Creek were comparable to those taken along Spring Brook Creek, a stream which showed much higher chemical concentrations. We question if the higher biotic indices measured from Winfield Creek also reflect the intermittent nature of the stream. Arthropods inhabiting an intermittent stream can be expected to be tolerant of differential chemical concentrations as the stream ceases to flow and chemicals concentrate in pools, or as the stream resumes flowing and there is a sudden flush of chemicals. Thus arthropods that tend to inhabit intermittent streams may also be those that are tolerant to organic pollution.

The higher ammonia and nitrate nitrogen concentrations recorded from Kress Creek may partially be due to the runoff of fertilizer from farmland that borders the stream near its downstream location. Waste water inputs seem less likely in view of the low chloride measurements recorded. Elevated nitrogen levels may explain the higher coliform counts recorded. In view that the stream is on the list for Superfund cleanup, we question the effects that industrial pollution may have on the arthropod community. Hilsenhoff's biotic index reflected poor water quality in the stream.

Chloride concentrations were extremely high in Spring Brook Creek, especially along the downstream location which was located below the Wheaton waste water treatment plant.

Concentrations recorded at the site exceeded the Illinois Environmental Protection Agency (IEPA) General Use standard of 500 ppm (IEPA 1988) on five occasions out of 14 sampling events. A maximum reading of 584 ppm was recorded on October 4, 1990. The Wheaton waste water treatment plant is suspected as being the primary source of chloride. Nitrate and orthrophosphate concentrations were also high at the site. The upstream location showed little improvement, with high ammonia-nitrogen and chloride concentrations from unidentified sources. The biotic indices from both stream locations reflected fairly poor to poor water quality.

Coliform and nitrogen measurements taken along the W. Branch and Kline Creek continue to characterize streams that are moderately to severely polluted (Table 4). Measurements were especially high from the upstream Kline Creek station which was located just below the Carol Stream waste water treatment plant. Ammonia-nitrogen concentrations exceeded the IEPA General Use Standard of 1.5 ppm on six of seven sampling episodes from each Kline Creek station and reached a maximum of 20 ppm at both stations on July 8, 1991. These maximum readings were taken two days after a major fish kill was observed in the W. Branch near the junction with Kline Creek.

The West Branch of the DuPage River System is moderately to severely organically polluted. This is evident from arthropod communities composed of pollution tolerant species, by high coliform counts, ammonia-nitrogen, nitrate-nitrogen, and chloride concentrations. Waste water treatment plants are believed to be a major source of this pollution with contributions also coming from septic fields and farmland.

ACKNOWLEDGEMENTS

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Figure 1. Locations of the sampling stations within the West Branch of the DuPage River System, DuPage County, Illinois. The distance (km) of a station from the mouth or junction with the West Branch of the DuPage River is given after station identification. Symbols: WB = West Branch of the DuPage River (ML = Mallard Lake site; TR = Timber Ridge site; MG = McDowell Grove site); KC = Kline Creek; W = Winfield Creek; K = Kress Creek; SB = Spring Brook Creek; U = upstream; D = downstream and ▲ = waste water treatment plant.

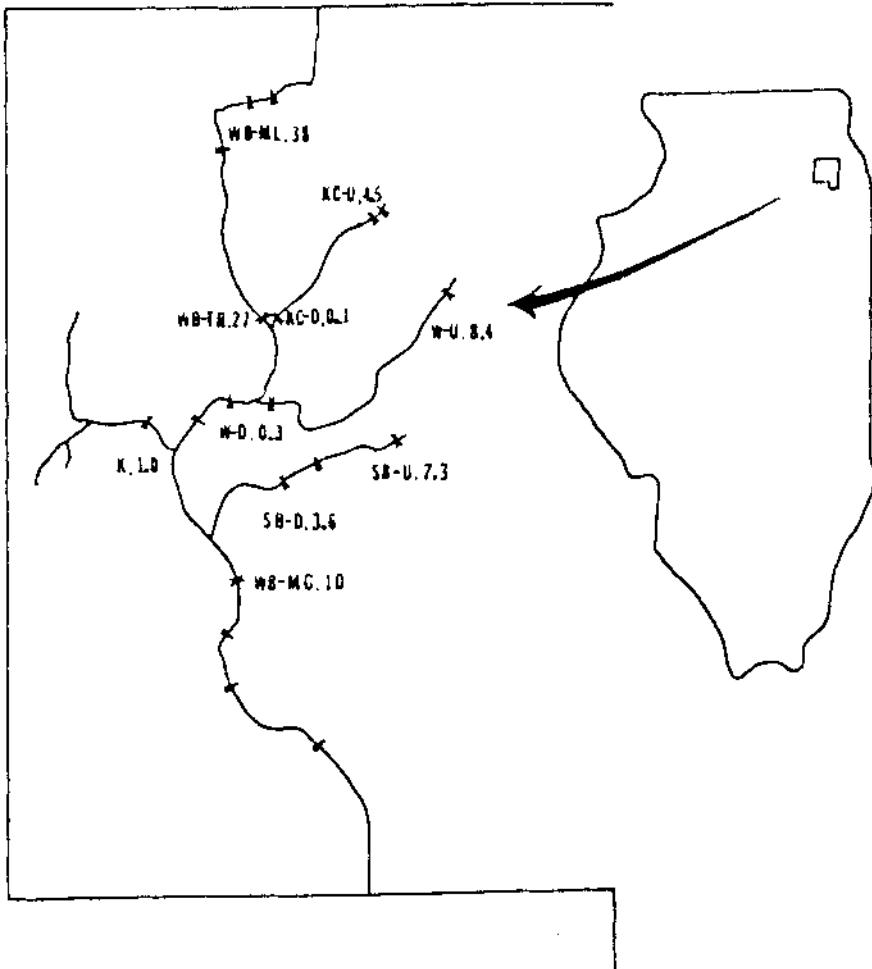


Table 1. Physical characteristics of the West Branch of the DuPage River, Winfield Creek, Kress Creek, Spring Brook Creek, and Kline Creek as taken from the Northeastern Illinois Planning Commission (1978).

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

Table 2. Arthropods collected from Winfield Creek, Kress Creek, and Spring Brook Creek according to pollution tolerance value (PTV) and sampling station. Symbols: W = Winfield Creek, K = Kress Creek; SB = Spring Brook Creek; U = upstream; and D = downstream.

Order Species	PTV	W-U	W-D	K	SB-U	SB-D
Amphipoda						
<i>Hyalloa azteca</i> Saussure	8			X		
Isopoda						
<i>Asellus intermedius</i> Forbes	8	X	X	X	X	
Odonata						
<i>Argia</i> spp.	6					X
<i>Boyeria</i> spp.	2	X				
<i>Enallagma</i> spp.	9	X				X
<i>Ischnura</i> spp.	9	X				
Ephemeroptera						
<i>Baetis intercalaris</i> McDunnough	6			X		
<i>Stenacron interpunctum</i> (Say)	7			X		
Coleoptera						
<i>Stenelmis vittipennis</i> Zimmerman	5			X		
Trichoptera						
<i>Cheumatopsyche</i> spp.	6			X		
<i>Hydropsyche bettini</i> Ross	6			X		X
Diptera						
<i>Chironomus</i> spp.	10				X	X
<i>Cricotopus</i> spp.	7	X	X	X	X	X
<i>Guttipelopia</i> spp.	6	X			X	
<i>Odontomyia</i> spp.	8				X	
<i>Polypedilium</i> spp.	6				X	
<i>Simulium vittatum</i> Zetterfield	8	X	X	X	X	X

Table 3. Mean biotic index values \pm standard deviations ($\bar{x} \pm s$) as calculated from the Winfield Creek, Spring Brook, and Kress Creek sampling stations. The biotic indices are interpreted as follows: 0-3.50 indicated 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. Symbol: n = sample size; U = upstream; and D = Downstream.

Location	$\bar{x} \text{ BI} \pm s$	n
Winfield Creek-U	7.64 \pm 0.48	12
Winfield Creek-D	8.00 \pm 0.00	3
Kress Creek	7.26 \pm 0.35	12
Spring Brook-U	8.94 \pm 1.58	12
Spring Brook-D	8.12 \pm 0.52	15

Table 4. Mean \pm standard deviation (Sampling size)($\bar{x} \pm s(n)$) chemical concentrations(ppm) and coliform bacteria colony plate counts from Winfield Creek, Spring Brook, Kress Creek, West Branch of the DuPage River, and Kline Creek sampling stations. Also included are chemical concentrations and coliform densities that can be expected from relatively unpolluted waters (American Public Health Association 1985, Clark 1977, Klein 1962). Symbols: P04 = orthophosphate; W = Winfield Creek; SB = Spring Brook; K = Kress Creek; WB = West Branch of the DuPage River (ML = Mallard Lake station; TR = Timber Ridge station; and MG = McDowell Grove station); KC = Kline Creek; U = upstream; and D = downstream.

Location	Chemical				Coliform colonies/ml
	Ammonia-nitrogen	Nitrate-nitrogen	Chloride	PO4	
W-U	0.47 \pm 0.49(14)	0.35 \pm 0.42(14)	240 \pm 120(14)	0.34 \pm 0.32(14)	1807 \pm 1067(3)
W-D	0.41 \pm 0.49(11)	0.32 \pm 0.21(11)	190 \pm 86(11)	0.27 \pm 0.27(11)	3410 \pm 1943(3)
K	0.79 \pm 0.69(12)	0.94 \pm 1.28(12)	104 \pm 26(12)	0.28 \pm 0.26(12)	6383 \pm 5468(3)
SB-U	1.18 \pm 0.80(14)	0.93 \pm 0.53(14)	327 \pm 125(14)	0.47 \pm 0.46(14)	2012 \pm 1014(3)
SB-D	0.68 \pm 0.37(14)	2.53 \pm 2.15(14)	452 \pm 101(14)	1.36 \pm 1.08(14)	
WB-ML	1.00 \pm 0.29(7)	1.14 \pm 0.43(7)	113 \pm 13(7)	0.57 \pm 0.37(7)	6119 \pm 7920(7)
WB-TR	1.57 \pm 1.97(7)	0.77 \pm 0.27(7)	122 \pm 47(7)	0.49 \pm 0.30(7)	7373 \pm 7137(7)
WB-MG	1.07 \pm 0.89(7)	0.57 \pm 0.18(7)	122 \pm 47(7)	0.44 \pm 0.29(7)	2477 \pm 1670(7)
KC-U	7.00 \pm 6.38(7)	0.91 \pm 0.69(7)	185 \pm 79(7)	0.31 \pm 0.25(7)	12945 \pm 7512(7)
KC-D	5.57 \pm 1.23(7)	1.23 \pm 0.90(7)	162 \pm 51(7)	0.34 \pm 0.24(7)	3403 \pm 4057(7)
Concentrations that can be expected from relatively unpolluted waters.					
	<0.2	Virtually absent	<250		<200