ILLINOIS NATURAL HISTORY SURVEY
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I-294 CORRIDOR

BIOTIC INTEGRITY OF MACROINVERTEBRATE COMMUNITIES ALONG THE I-294 CORRIDOR

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EXECUTIVE SUMMARY

- Sampled macroinvertebrates following ILEPA protocol at 7 sites in August–September 2015 in the I-294 corridor and calculated biotic integrity metrics
- Assessed sites based on the Qualitative Stream Habitat Assessment Procedure (SHAP)
- Measured physical (width, depth, velocity) and chemical (pH, conductivity, salinity, total dissolved solids) characteristics
- Habitat assessment showed impairment compared to Illinois reference conditions at all sites
- Macroinvertebrate Index of Biotic Integrity rated 6 sites as "Poor" and one as "Fair"
  - ▷ Total taxa richness ranged from 10 to 19 across sites
  - ▷ 4 of the 7 sites had no EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa
  - ▷ No Plecoptera (stoneflies) were collected at any site

INTRODUCTION

The Illinois State Toll Highway Authority (ISTHA) is currently in the planning phases for conducting maintenance and rehabilitation work along the central Tri-State (I-294) from Balmoral Road south to 95th Street. The work is part of their Move Illinois Program, which includes various improvements and maintenance work to the tollway road network. Although the current planning is for rehabilitation, the ISTHA is currently assessing whether construction should include additional capacity (lanes) to ease current traffic congestion. Within the ISTHA network, I-294 is one of their most heavily trafficked roads. Because of the potential to impact biota and habitats, the ISTHA contracted the Illinois Natural History Survey to perform surveys and habitat assessments of streams and ecologically important areas within a one-mile buffer of the existing roadway. The results of this report summarize survey efforts for aquatic macroinvertebrates.

Macroinvertebrates (e.g., insects, crustaceans, mollusks) have multiple functional roles in stream ecosystems. They are a key linkage between primary producers and higher-level consumers in aquatic food webs and are a particularly important food resource for fish (Wallace and Webster, 1996). Due to their various feeding modes, or functional feeding groups, they play a role in both nutrient cycling and organic matter processing. Furthermore, aquatic insects connect aquatic and terrestrial ecosystems; they spend the larval portion of their life cycle in freshwater and then emerge as terrestrial adults.

In addition to their ecological significance, macroinvertebrates are the most commonly and widely used group of freshwater organisms to assess lotic environments

Table 1. Stream name, description, and coordinates for the seven sites sampled in the I-294 corridor.

Stream Name	Description	Latitude (N)	Longitude
Willow Creek	Ruby St. Bridge, near Rosemont, IL	41.98774	-87.86917
Crystal Creek	Wehrman Ave, near Schiller Park, IL	41.95684	-87.87820
Addison Creek	I-294, near Northlake, IL	41.92659	-87.91978
Salt Creek	I-294, near Westchester, IL	41.82860	-87.91790
Salt Creek	Bemis Woods Forest Preserve, near Westchester, IL	41.82730	-87.90670
Flag Creek	Spring Rock Creek Park, near Western Springs, IL	41.80520	-87.91087
Flag Creek	Plainfield Rd. overpass, near Willowbrook, IL	41.77465	-87.90692

Table 2. Habitat metrics and habitat quality categories for the qualitative Stream Habitat Assessment Procedure (SHAP). Minimum and maximum values for metrics from (DWPC-ILEPA, 1994; Table 5.1).

			Habitat Quality Categories							
			Poor		Fair		Good		Excellent	
		Metric	Min	Max	Min	Max	Min	Max	Min	Max
Substrate and In-stream Cover	1	Bottom Substrate	1	5	6	10	11	15	16	20
	2	Deposition	1	3	4	6	7	9	10	12
	3	Substrate Stability	1	4	5	8	9	12	13	16
	4	In-stream Cover	1	3	4	6	7	9	10	12
	5	Pool Substrate	1	5	6	10	11	15	16	20
Channel Morphology and Hydrology	6	Pool Quality	1	4	5	8	9	12	13	16
	7	Pool Variability	1	4	5	8	9	12	13	16
	8	Channel Alteration	1	2	3	4	5	6	7	8
	9	Channel Sinuosity	1	3	4	6	7	9	10	12
	10	Width/Depth	1	4	5	8	9	12	13	16
	11	Hydrolic Diversity	1	3	4	6	7	9	10	12
Riparian and Bank Features	12	Canopy Cover	1	3	4	6	7	9	10	12
	13	Bank Vegetation	1	4	5	8	9	12	13	16
	14	Immediate Land Use	1	2	3	4	5	6	7	8
	15	Flow-Related Refugia	1	3	4	6	7	9	10	12

(Rosenberg and Resh 1993). They exhibit a wide range in tolerances to point and nonpoint source pollution. They are ubiquitous in freshwater habitats, are sedentary relative to fish, and have long life cycles relative to other organisms. Therefore, temporal variation in environmental conditions is integrated into their community composition (Rosenberg and Resh, 1993, Merritt et al. 2008). The Illinois Environmental Protection Agency (ILEPA) has used macroinvertebrates in some capacity for stream assessment since the agency's beginnings (ILEPA, 2007). Protocols for rapid bioassessment typically integrate habitat and water quality characteristics along with biological measures as a means of identifying potential stressors to detected impacts (Barbour et al., 1999). In the current study, we sampled seven stream crossings in the targeted I-294 Project corridor in August or September 2015 (Table 1) for the purpose of assessing the biotic integrity of resident macroinvertebrate communities.

METHODS

Habitat assessment.—We selected sites based on suitable habitat for sampling macroinvertebrates, i.e., we avoided culverts, artificial substrates, and channelized stream segments. We completed the Qualitative Stream Habitat Assessment Procedure (SHAP) described in detail in Section 5.0—Qualitative Stream Habitat Assessment Procedures (SHAP) of the DWPC Field QA Manual (DWPC-ILEPA, 1994; Appendix E-5.1). A total score based on 15 parameters provides an overall habitat quality rating for the stream reach. The total score could, theoretically, range from 15 to 208 (Table 2), but because

different metrics may be better or worse, extreme values for the total score are unlikely. Overall score cutoff points for "Poor", "Fair", "Good", and "Excellent" are not provided by ILEPA. Rather, habitats are standardized and compared to reference conditions based on relative percent similarity (Table 3). We standardized the habitat scores from each site on a scale of 0 to 100 based on the maximum value for each metric.

Physical and chemical measurement.—At each site, we measured temperature (°C), pH, Total Dissolved Solids (TDS; ppm), conductivity (µS/cm), and salinity (ppm) concordantly with macroinvertebrate sampling. We used an Oakton multi-parameter handheld tester (35 Series, Eutech Instruments) for pH, TDS, temperature, conductivity, and salinity. We also recorded stream width at three randomly selected transects with multiple depth readings across each transect. We measured streamflow (m/s) using a Flowatch scientific portable flowmeter (NTech USA) with the 60-mm water impeller. Velocity measurements were combined with the width/depth measurements to calculate stream discharge (m/s) via the cross-sectional area method. Percent mineral substrate composition was also estimated at each site.

Macroinvertebrate sampling and laboratory procedures.—We carried out aquatic macroinvertebrate sampling and sample processing using the ILEPA 20-Jab Allocation method for wadeable streams (ILEPA, 2011a; ILEPA, 2011c; Barbour et al., 1999). The 20 jabs were allocated to appropriate bank and bottom habitats across an approximately 300-ft-long stream reach, as outlined by ILEPA (ILEPA, 2011b). Aquatic macroinvertebrates and associated organic and mineral material were collected with a D-frame net (500-micron mesh), and the 20 jabs combined in the field to produce a single sample, preserved with 95% ethanol and transported to the laboratory. Laboratory subsampling requires a random subsample comprising ~300 (+/- 60) aquatic macroinvertebrate specimens (ILEPA, 2011c). Specimens were identified to the lowest taxonomic level possible, but in the interest of time, chironomid midges were not identified beyond family or subfamily (Tanypodinae were distinguished from non-Tanypodinae for functional feeding group analyses). We enumerated each taxon for analyses.

Calculation of macroinvertebrate metrics.—Each taxon was assigned a tolerance value (from 0–10) and functional feeding group category (i.e., scraper, predator, collector-gatherer, filterer-collector, shredder, parasite, piercer) based on values and designations from ILEPA (2010). Using the identifications, counts, tolerance values, and functional feeding groups, we calculated site-level scores for seven metrics (Table 4). The seven metrics included four richness metrics (i.e., total number of taxa, intolerant taxa, Ephemeroptera, and Coleoptera), two percent-composition metrics (Percent Scrapers and Percent Ephemeroptera + Trichoptera + Plecoptera, or EPT), and the Macroinvertebrate Biotic Index (MBI). The MBI is calculated as,

> MBI = Σ (n_i*t_i)/N, where, n_i is the number of individuals of each taxon, t_i is the tolerance value assigned to the given taxon, and N is the total number of individuals in the subsample.

We standardized the calculated metrics based on Illinois Best Values (Table 4) and then averaged them by site to produce the final Macroinvertebrate Index of Biotic Integrity (mIBI). The mIBI provides a basis for categorizing sites into one of four mIBI quality categories (i.e., "Exceptional," "Good," "Fair," "Poor") based upon analyses of the aquatic macroinvertebrate fauna (Table 5).

We used R statistical analysis software (R Core Team,

Table 3. Stream habitat percent similarity categories for site comparability assessments (from Michigan DNR [1991], as given in the DWPC Field QA Manual [DWPC-ILEPA 1994; Table 5.2]).

Habitat Quality Category	Description	Percent Similarity
Excellent	Very Similar to Reference	>= 90%
Good	Slightly Different	75-89%
Fair	Moderately Different	60-74%
Poor	Substantially Different	<=59%

Table 4. Metrics calculated for aquatic macroinvertebrates with the response of metric to perturbation and best values (ILEPA, 2011c; Table 1).

Metric	Response to Perturbation	Best Value
Total Taxa	Decrease	46
Intolerant Taxa	Decrease	9
Ephemeroptera	Decrease	10.2
Coleoptera	Decrease	5
MBI	Increase	4.9
Percent Scraper	Decrease	29.6
Percent EPT	Decrease	74

2012) to calculate the seven metrics and mIBI score for each site. The calculations involved reading in a reference file of ILEPA tolerance values and functional feeding groups for all Illinois aquatic macroinvertebrates (ILEPA, 2010). We utilized packages *plyr* (Wickham, 2011) and reshape (Wickham, 2007) for the analyses.

RESULTS

Habitat.—Habitat conditions at six of the seven sites in the study differed substantially from reference conditions (standardized SHAP scores less than 60) and received a "Poor" rating (Table 6). Salt Creek at I-294, the best-rated site based on habitat, had a standardized SHAP of 60.7, barely categorizing it as "Fair." The other Salt Creek site (at Bemis Woods) had a similar score at 57.5. Crystal Creek had the lowest score of 29.7.

Physical-chemical parameters.—Flow was below detection by our flowmeter at many sampling points; thus, we were not able to calculate stream discharge for comparison across sites. Individual width, depth, and flow measurements only are reported with site-specific results in the Appendix. Conductivity, TDS, and salinity were high at all sites (Table 7). Crystal Creek had the highest concentrations of ions, as measured via conductivity, TDS, and salinity (values = 1586 µS/cm, 1160 ppm and 856 ppm, respectively). pH was similar across sites and ranged from 7.9 in Flag Creek at Plainfield Rd. to 8.6 in Crystal Creek. Water quality measurement results represent a single sample event and, therefore, do not take into account temporal variability.

Macroinvertebrate communities.—We identified 56 taxa across all 7 sites (see site-specific taxa lists in Appendix). Because of the qualitative collection and fixed-count organism approaches used with the protocol, comparison of absolute numbers of macroinvertebrates is not appropriate. mIBI scores ranged from 15.2 in Flag Creek at Spring Rock Creek Park to 34.9 in Salt Creek at I-294 (Table 8). Compared to Illinois reference streams, biotic integrity of macroinvertebrate communities was "Poor" at three of the seven sites: Flag Creek at Spring Rock Creek Park, Crystal Creek, and Addison Creek. No Coleoptera, EPT, or intolerant taxa were collected at any of the "Poor" sites. Communities at the remaining four sites, Flag Creek at Plainfield Rd., Willow Creek, and both Salt Creek sites scored as "Fair." Three of the four sites in the "Fair" category had at least one Coleoptera (beetle) taxon. The riffle beetle *Stenelmis* sp. (Elmidae) was present in Flag Creek at I-294 and both Salt Creek sites. Additionally, the riffle beetle *Dubiraphia* sp. (Elmidae) was collected in Salt Creek at I-294. The crawling water beetle *Peltodytes* sp., though present in both Salt Creek at Bemis Woods and Flag Creek at Plainfield Rd., was not included in the calculation of Coleoptera richness because it does not have an ILEPA-assigned tolerance value. EPT richness was 5 at Willow Creek and both Salt Creek sites, but we found no Plecoptera at any site. The Ephemeroptera at these sites were represented by taxa in the families Baetidae, Leptohyphidae, and Heptageniidae, and taxa in the Hydropsychidae and Hydroptilidae represented the Trichoptera. Total taxa richness at the best-rated site (Salt Creek at I-294; 19) in this study was almost double the total taxa richness at the lowest ranked site (Flag Creek at Spring Rock Creek Park; 10). Collecter-gatherers were the most relatively abundant functional feeding group at all sites, but the highest proportion of scrapers was found in Salt Creek at Bemis Woods (14.7%).

Table 5. Macroinvertebrate IBI quality categories (ILEPA, 2011c; Table 2).

mIBI Index Score			
Lower Boundary	Upper Boundary	Comparison to Reference	Narrative Description
73.0	100.0	>75th percentile	Exceptional
41.8	72.9	>10th percentile	Good
20.9	41.8	bisect 10th percentile (upper)	Fair
0.0	20.8	bisect 10th percentile (lower)	Poor

Table 6. SHAP scores and standardized SHAP scores with categorical assessment.

Site	SHAP Score	Standardized SHAP Score	Category
Crystal Creek	71	29.7	poor
Flag Creek at SRC Park	80	36.2	poor
Willow Creek	99	43.3	poor
Addison Creek	102	45.6	poor
Flag Creek at Plainfield Rd.	107	44.2	poor
Salt Creek at Bemis Woods	127	57.5	poor
Salt Creek at I-294	134	60.7	fair

CONCLUSIONS

Macroinvertebrate communities from the seven sites

Table 7. Summary of water chemistry variables and date of measurement at each of the 7 sites.

Site	Collection Date	Water Temp (°C)	pH	Conductivity (µS/cm)	Salinity (ppm)	TDS (ppm)
Willow Creek	8/4/15	23.5	8.37	1012	498	716
Crystal Creek	8/4/15	26.0	8.57	1586	856	1160
Addison Creek	8/4/15	26.4	8.06	1060	536	742
Salt Creek at I-294	9/16/15	22.1	8.46	1010	495	715
Salt Creek at Bemis Woods	9/16/15	21.2	8.55	1026	502	727
Flag Creek at Plainfield Rd.	8/5/15	21.7	7.90	1196	590	840
Flag Creek at SRC Park	8/5/15	19.8	8.45	1234	610	879

Table 8. Summary of results of the mIBI at each site and the seven metrics used in its calculation. Sites are listed in order of increasing mIBI score.

Site	mIBI	Total	Intolerant	Ephemeroptera	Coleoptera	MBI	% Scrapers	% EPT
Flag Creek at SRC Park	15.2	10	0	0	0	6.0	0.8	0
Crystal Creek	16.6	11	0	0	0	6.0	3.0	0
Addison Creek	17.1	11	0	0	0	6.0	4.2	0
Flag Creek at Plainfield Rd.	23.3	14	0	0	1	5.3	5.5	0
Willow Creek	25.6	18	1	2	0	5.4	4.6	1.8
Salt Creek at Bemis Woods	33.5	15	1	3	1	5.4	14.1	1.3
Salt Creek at I-294	34.9	19	1	3	2	5.2	7.5	1.4

in this study were characteristic of macroinvertebrate assemblages from sites in urbanized watersheds, largely comprising tolerant taxa (e.g., chironomid midges), with few or no mayflies, stoneflies, or caddisflies (EPT). The mIBI was designed to address macroinvertebrate community response primarily to nonpoint and habitat-related disturbances. Habitat degradation, both in-stream and near-stream, has direct consequences for macroinvertebrates. Stoneflies, or Plecoptera, are particularly sensitive to habitat conditions, requiring cool, fast-moving, and well-oxygenated streams. The lack of stoneflies (Plecoptera) collected at any site could indicate overall poor habitat conditions as the stream segments in the study lacked appropriate riffles, and water chemistry measurements pointed to problems with water quality. Conductivity, salinity, and TDS were high at all sites, indicative of streams in urbanized watersheds with high impervious surface cover and human population density (Roy et.al., 2001; Kratzer et al., 2006; Allan, 2004).

Due to limitations in taxonomy, or small or damaged specimens, richness values are commonly underestimated in bioassessment studies. Nevertheless, total taxa richness was almost reduced in half at the most poorly-rated site compared to the best-rated site in this study and demonstrates species loss with stream impairment.

Many of the sites along the I-294 corridor had fine, silt substrates with few cobbles, boulders, or otherwise stable substrates, and these characteristics were reflected in the FFG composition of macroinvertebrate assemblages. Scrapers are expected to decrease in impacted streams as availability of their food resource decreases. Scrapers are organisms that primarily feed on periphyton (algae) growing on stream bottom rocks and substrates. Periphyton development depends on stable substrates in silt-free areas. Collector-gatherers feed mostly on fine particles in areas of deposition and were the most common FFG represented. Most chironomid midges are collector-gatherers, and they were the commonest group collected at all sites.

Lastly, impaired water quality and habitat conditions reduce diversity and leave stream ecosystems susceptible to invasive and exotic taxa intrusions. Both the rusty crayfish, *Orconectes rusticus*, and the Asian clam, *Corbicula* sp., were present at sites in this study. More research is necessary to quantify the degree of invasion of these and other exotic taxa, but their presence signifies the vulnerability of these urban systems to potential new invaders.

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APPENDIX I

Site-specific Results. Site: Willow Creek, Ruby St. Bridge, near Rosemont, IL.

PLATE 1. Site photo of Willow Creek, Ruby St. Bridge (Cook County, IL). Photo by E. Bilger.

Site description and physical characteristics.—This site is near O'Hare International Airport. Macroinvertebrate sampling took place upstream of the Ruby St. Bridge upstream of the I-294 crossing (Plate 1). Surrounding land use was estimated to be 90% residential and 10% forest. The left bank riparian area had large concrete slabs, likely placed there as part of a bank stabilization effort. The right bank was bordered by a subdivision. Both banks were steep near the bridge, suggesting channelization of the stream channel has occurred (Figure 1). The water was visibly turbid though no recent rain events had taken place. Mineral substrate composition was primarily sand and silt (30% and 20%, respectively), with some gravel (30%) and cobble (20%).

Macroinvertebrates.—We collected 18 unique taxa at Willow Creek, 2 of which were mayflies, or Ephemeroptera (Table 9). Chironomid midges were the most relatively abundant taxa, reflected in the dominance of collector-gatherers (Figure 2). Worms and leeches (Clitellata) were found in greatest relative abundance at Willow Creek than all other sites, and most individual metrics scored in the low end of their respective ranges (Figure 3).

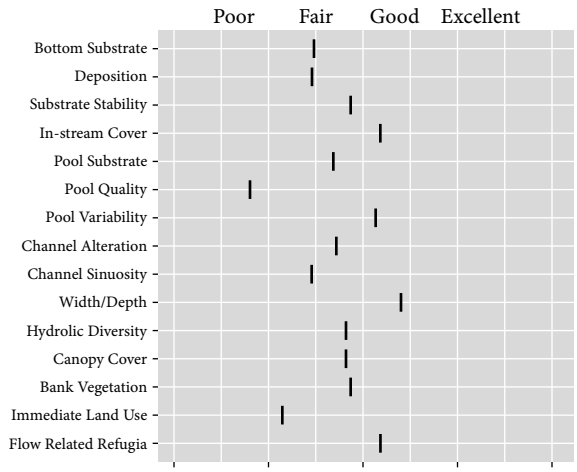

FIGURE 1. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score for Willow Creek (Cook County, IL) on 4 August 2015.

APPENDIX I [CONTD.]

Site-specific Results. Site: Willow Creek, Ruby St. Bridge, near Rosemont, IL. (contd.)

Table 9. List of taxa collected from Willow Creek on 4 August 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Platyhelminthes	Turbellaria	NA	NA	NA	Turbellaria	9
Annelida	Clitellata	NA	NA	NA	Clitellata	26
Annelida	Clitellata	Rhynchobdellida	NA	NA	Rhynchobdellida	1
Annelida	Clitellata	Arhynchobdellida	Erpobdellidae	NA	Erpobdellidae	10
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea*	*Caecidotea* sp.	29
Arthropoda	Crustacea	Amphipoda	Hyalellidae	*Hyalella*	*Hyalella* sp.	6
Arthropoda	Crustacea	Amphipoda	Crangonyctidae	*Crangonyx*	*Crangonyx* sp.	24
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis*	*Baetis* sp.	33
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes*	*Tricorythodes* sp.	1
Arthropoda	Insecta	Odonata	Coenagrionidae	*Enallagma*	*Enallagma* sp.	1
Arthropoda	Insecta	Hemiptera	Corixidae	NA	Corixidae	1
Arthropoda	Insecta	Hemiptera	Corixidae	*Trichocorixa*	*Trichocorixa* sp.	1
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*	*Cheumatopsyche* sp.	3
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	*Hydropsyche* sp.	1
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	*Hydroptila* sp.	9
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*Simulium* sp.	1
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	102
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	13
Mollusca	Gastropoda	Mesogastropoda	Hydrobiidae	NA	Hydrobiidae	4
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	NA	Sphaeriidae	9
Mollusca	Pelecypoda	Veneroida	Corbiculidae	*Corbicula*	*Corbicula* sp.	1

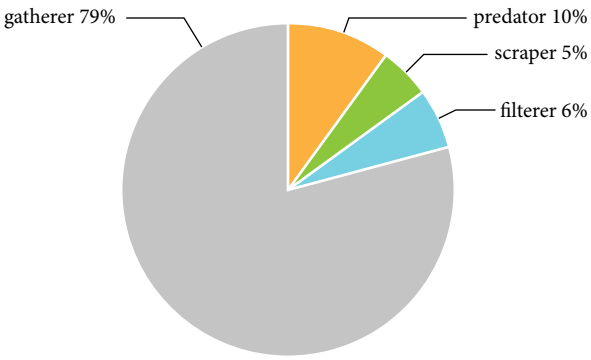

FIGURE 2. Macroinvertebrate functional feeding group (FFG) percent composition at Willow Creek.

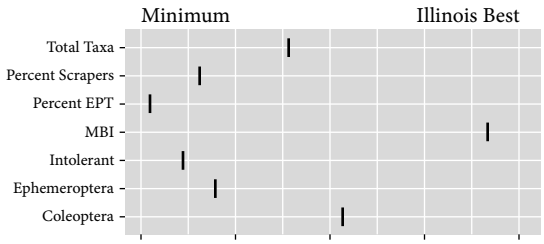

FIGURE 3. Standardized metrics used in calculation of mIBI for Willow Creek.

APPENDIX I [CONTD.]

Site-specific Results. Site: Crystal Creek, Wehrman Ave, near Schiller Park, IL.

PLATE 2. Site photo of Crystal Creek (Cook County, IL) taken from top of reach looking downstream. Photo by E. Bilger.

Site description and physical characteristics.—The Crystal Creek site was bordered by I-294 on the right and the Wehrman Ave neighborhood on the left (Plate 2). This was a small stream with an average width of 2 m. The stream was shallow with all depths less than 0.2 m. Substrate composition was primarily silt and clay (30%, each), with gravel (20%), sand (10%), and cobble (10%). Immediately upstream of the reach was a wetland. The downstream channel of the reach began to braid into a very low gradient stream with wetland vegetation (e.g., *Typha* sp.). Surrounding land use was 100% residential, though riparian vegetation was present on both stream banks (Figure 4).

Macroinvertebrates.—We collected 11 unique taxa at Crystal Creek. The macroinvertebrate assemblage at Crystal Creek had some taxa frequently encountered in wetlands, such as Libellulid dragonflies, *Notonecta* sp., Dytiscid beetle larvae, and Planorbid snails (Table 10). Both the proximity to a wetland upstream and the wetland-like conditions at the bottom of the reach could explain their presence. Predators were found in the highest percent composition at Crystal Creek, also a reflection of the presence of several weltand-associated taxa (Figure 5). Four of the mIBI 7 metrics were at or near 0 (Figure 6).

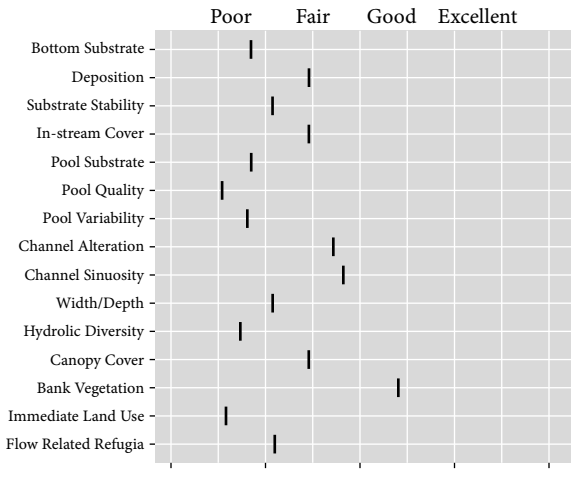

FIGURE 4. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score for Crystal Creek (Cook County, IL) on 4 August 2015.

APPENDIX I [CONTD.]

Site-specific Results. Site: Crystal Creek, Wehrman Ave, near Schiller Park, IL. (contd.)

Table 10. List of taxa collected from Crystal Creek on 4 August 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Annelida	Clitellata	NA	NA	NA	Clitellata	7
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	*Helobdella*	*Helobdella stagnalis*	2
Arthropoda	Insecta	Odonata	Libellulidae	NA	Libellulidae	4
Arthropoda	Insecta	Odonata	Coenagrionidae	NA	Coenagrionidae	20
Arthropoda	Insecta	Odonata	Coenagrionidae	*Ischnura*	*Ischnura* sp.	12
Arthropoda	Insecta	Hemiptera	Gerridae	*Aquarius*	*Aquarius* sp.	1
Arthropoda	Insecta	Hemiptera	Notonectidae	*Notonecta*	*Notonecta* sp.	1
Arthropoda	Insecta	Coleoptera	Haliplidae	*Peltodytes*	*Peltodytes* sp.	5
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Laccophilus*	*Laccophilus maculosus*	3
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	203
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	65
Mollusca	Gastropoda	Mesogastropoda	Physidae	NA	Physidae	4
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	NA	Lymnaeidae	1
Mollusca	Gastropoda	Basommatophora	Planorbidae	NA	Planorbidae	3
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Gyraulus*	*Gyraulus* sp.	1
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Planorbella*	*Planorbella* sp.	1

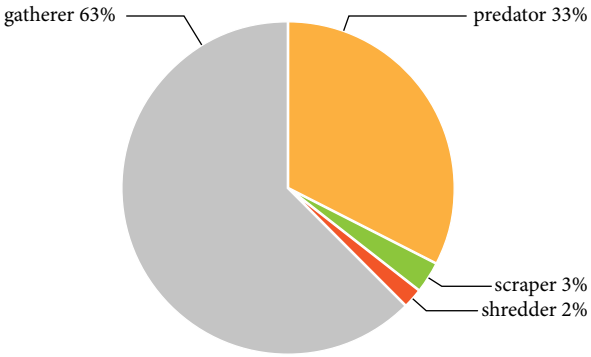

FIGURE 5. Macroinvertebrate functional feeding group (FFG) percent composition at Crystal Creek.

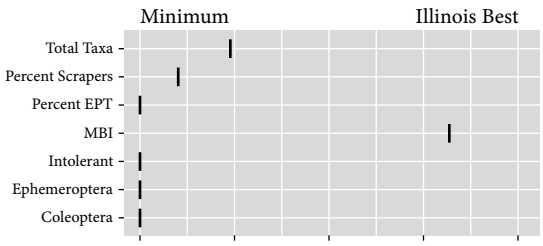

FIGURE 6. Standardized metrics used in calculation of mIBI for Crystal Creek.

APPENDIX I [CONTD.]

Site-specific Results. Site: Addison Creek, I-294, near Northlake, IL.

PLATE 3. Addison Creek (Cook County, IL) looking upstream toward top of reach at Northwest Ave. Photo by E. Bilger.

Site description and physical characteristics.—We sampled Addison Creek downstream of the I-294 crossing, just below the bridge at Northwest Ave. (Plate 3). The stream averaged 4 m wide, with depths averaging 0.3 m. The riparian area immediately adjacent to the stream was forested, but top of bank land use was 100% residential/industrial. The stream contained lots of trash and debris with evidence of recent high flow (trash in trees and dry snags). A large debris dam was across the stream in the top third of the reach. The substrate was mostly gravel and sand (40%, each) with some silt (20%). Gravelly riffles existed just above and below the large debris dam, and a deep pool was at the debris dam. Most individual habitat metrics were in the "Fair" range (Figure 7).

Macroinvertebrates.—We collected just 11 unique taxa at Addison Creek. Other than chironomid midges, few insect taxa were present (Table 11). The stream bottom was largely covered with *Corbicula* sp. shell in some place though we collected no live individuals. Though no larval mayflies were collected at Addison Creek, we did see an adult mayfly in flight. Percent composition of filterers was the highest of any site (13%) due to numerous small clams (Sphaeriidae) in the sample (Figure 8). Individual macroinvertebrate metric scores were poor for Addison Creek (Figure 9).

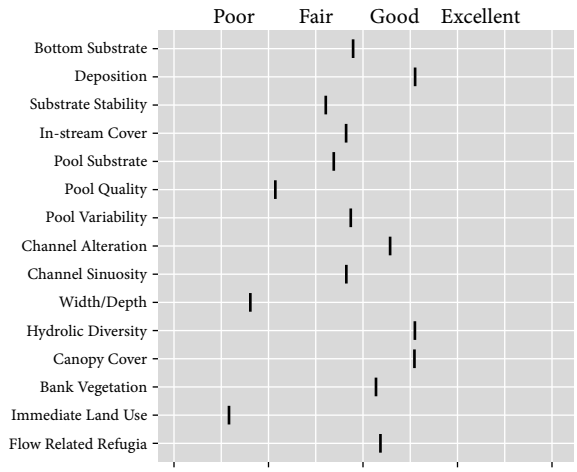

FIGURE 7. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score for Addison Creek (Cook County, IL) on 4 August 2015.

APPENDIX I [CONTD.]

Site-specific Results. Site: Addison Creek, I-294, near Northlake, IL. (contd.)

Table 11. List of taxa collected from Addison Creek on 4 August 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Platyhelminthes	Turbellaria	NA	NA	NA	Turbellaria	1
Annelida	Clitellata	NA	NA	NA	Clitellata	12
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	*Helobdella*	*Helobdella stagnalis*	1
Arthropoda	Crustacea	Amphipoda	NA	NA	Amphipoda	1
Arthropoda	Insecta	Odonata	Coenagrionidae	NA	Coenagrionidae	1
Arthropoda	Insecta	Hemiptera	Corixidae	NA	Corixidae	43
Arthropoda	Insecta	Hemiptera	Corixidae	*Trichocorixa*	*Trichocorixa* sp.	8
Arthropoda	Insecta	Coleoptera	Hydrophilidae	*Tropisternus*	*Tropisternus* sp.	1
Arthropoda	Insecta	Diptera	Culicidae	*Aedes*	*Aedes* sp.	1
Arthropoda	Insecta	Diptera	Culicidae	*Culex*	*Culex salinarius*	1
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	134
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	38
Mollusca	Gastropoda	Mesogastropoda	Physidae	NA	Physidae	10
Mollusca	Gastropoda	Basommatophora	Planorbidae	NA	Planorbidae	2
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	NA	Sphaeriidae	34

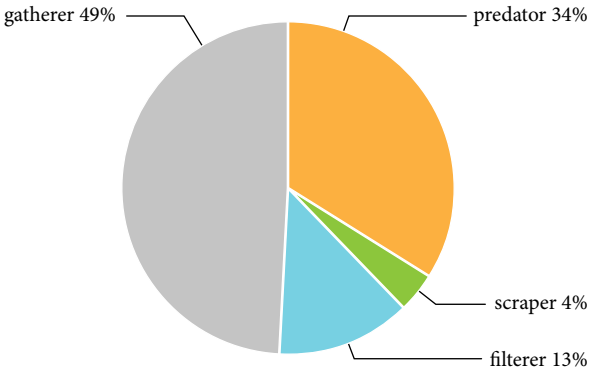

FIGURE 8. Macroinvertebrate functional feeding group (FFG) percent composition at Addison Creek.

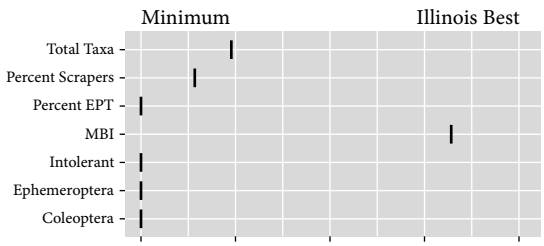

FIGURE 9. Standardized metrics used in calculation of mIBI for Addison Creek.

APPENDIX I [CONTD.]

Site-specific Results. Site: Salt Creek at I-294, near Westchester, IL.

PLATE 4. Salt Creek at I-294 (Cook County, IL) taken from near bottom of reach looking upstream at I-294 bridge. Photo by E. Bilger.

Site description and physical characteristics.—We sampled Salt Creek directly below the I-294 bridge (Plate 4) at the border of Dean Nature Sanctuary and Bemis Woods Forest Preserve. The right bank was forested and the left bank was a mix of trees and grass bordered by a bike trail. The surrounding land use was primarily forest (70%) with some residential (20%). We targeted a large riffle in our sampling effort. Substrate composition in the reach was 70% cobble, 20% gravel, and 10% silt, and was the best available substrate we encountered in this study (Figure 10). Average depth was 0.35 m, and stream width was approximately 10 m. Flow velocity averaged 0.34m/s.

Macroinvertebrates.—We collected 19 unique taxa, the most collected at any site in the study, at Salt Creek at I-294 (Table 12). Three genera of mayflies were identified from the site: *Baetis* sp., *Tricorythodes* sp., and *Stenacron* sp. The latter belongs to a family of mayflies (Heptageniidae) that are associated with cobble riffles and are scrapers. Salt Creek (both sites) was the only

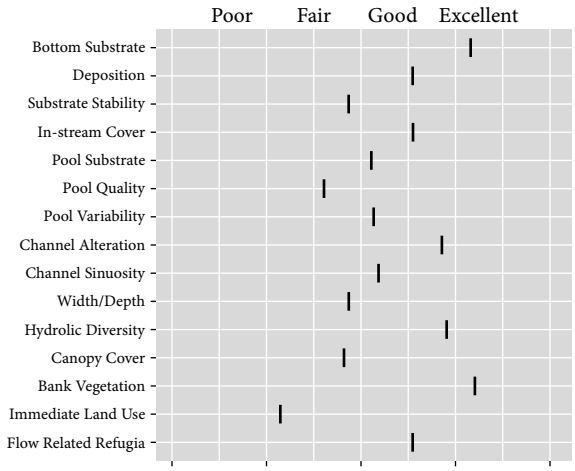

FIGURE 10. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score Salt Creek at I-294 (Cook County, IL) on 16 September 2015.

APPENDIX I [CONTD.]

Site-specific Results. Site: Salt Creek at I-294, near Westchester, IL. (contd.)

stream from which we collected the damselfly Argia sp. The invasive rusty crayfish, *Orconectes rusticus*, was collected at this site. Five FFG categories, collector-gatherers, predators, scrapers, shredders, and filterers, were represented (Figure 11) and points to increased functional diversity with increasing species diversity. Though this site had the highest number of taxa and the highest mIBI score, values for all metrics were relatively low (Figure 12), thus Salt Creek at I-294 rated at the low end of "Fair" for biotic integrity.

Table 12. List of taxa collected from Salt Creek at I-294 on 16 September 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Platyhelminthes	Turbellaria	NA	NA	NA	Turbellaria	3
Annelida	Clitellata	NA	NA	NA	Clitellata	2
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea*	*Caecidotea* sp.	4
Arthropoda	Crustacea	Amphipoda	Hyalellidae	*Hyalella*	*Hyalella* sp.	66
Arthropoda	Crustacea	Decapoda	Cambaridae	*Orconectes*	*Orconectes rusticus*	1
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis*	*Baetis* sp.	21
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenacron*	*Stenacron* sp.	2
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes*	*Tricorythodes* sp.	27
Arthropoda	Insecta	Odonata	Calopterygidae	*Calopteryx*	*Calopteryx maculata*	6
Arthropoda	Insecta	Odonata	Coenagrionidae	NA	Coenagrionidae	11
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia*	*Argia* sp.	11
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	*Hydropsyche* sp.	55
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	*Hydroptila* sp.	3
Arthropoda	Insecta	Coleoptera	Elmidae	*Dubiraphia*	*Dubiraphia vittata*	6
Arthropoda	Insecta	Coleoptera	Elmidae	*Stenelmis*	*Stenelmis* sp.	15
Arthropoda	Insecta	Diptera	Tipulidae	*Tipula*	*Tipula* sp.	1
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	92
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	14
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae	*Elimia*	*Elimia* sp.	6
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	NA	Sphaeriidae	1

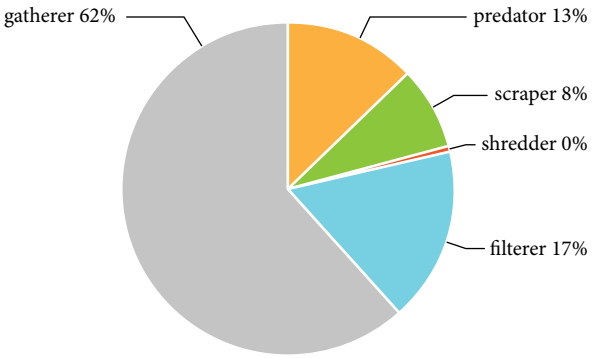

FIGURE 11. Macroinvertebrate functional feeding group (FFG) percent composition in Salt Creek at I-294.

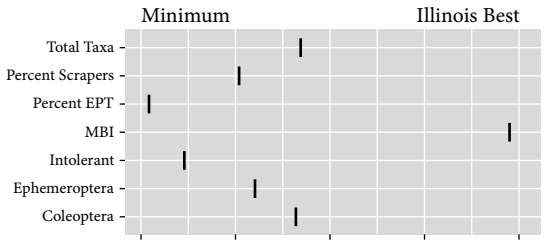

FIGURE 12. Standardized metrics used in calculation of mIBI for Salt Creek at I-294.

APPENDIX I [CONTD.]

Site-specific Results. Site: Salt Creek, Bemis Woods Forest Preserve, near Westchester, IL.

PLATE 5. Salt Creek at Bemis Woods (Cook County, IL) taken from middle of reach looking upstream. Photo by E. Bilger.

Site description and physical characteristics.—This site on Salt Creek was located in the Bemis Woods Forest Preserve about 200 m downstream of the pedestrian bridge near the Wolf Rd. parking lot (Plate 5). Average stream width was 30 m, and depth was 0.32 m. Flow velocity averaged 0.3m/s. Surrounding land use was 70% forest and 30% field/pasture. Substrate composition was 65% gravel, 20% sand, and 15% silt. We observed periphyton growth on rocks in this reach of stream. Several individual habitat parameters scored better than "Fair" (Figure 13).

Macroinvertebrates.—We collected 15 unique taxa in Salt Creek at Bemis Woods, including mayflies Baetidae, *Stenacron* sp., and *Tricorythodes* sp. (Table 13). Salt Creek was the only site with *Argia*, a common stream damselfly. The Bemis Woods site had the highest proportion of scrapers found at any site, 15%, due to the number of beetle larvae, *Stenelmis* sp. (Figure 14). Standardized metric scores showed that the Bemis Woods site, while still scoring low relative to best reference sites in Illinois, was one of the best sites in this study (Figure 15).

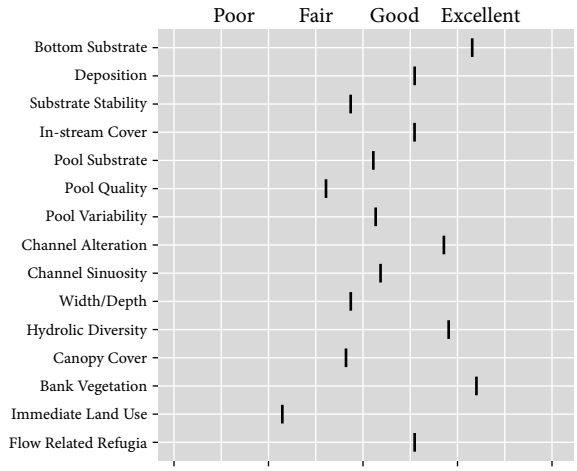

FIGURE 13. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score of Salt Creek at Bemis Woods (Cook County, IL) on 16 September 2015.

APPENDIX I [CONTD.]

Site-specific Results. Site: Salt Creek, Bemis Woods Forest Preserve, near Westchester, IL. (contd.)

Table 13. List of taxa collected from Salt Creek at Bemis Woods on 16 September 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Platyhelminthes	Turbellaria	NA	NA	NA	Turbellaria	7
Nematoda	NA	NA	NA	NA	Nematoda	5
Annelida	Clitellata	NA	NA	NA	Clitellata	2
Annelida	Clitellata	Arhynchobdellida	Erpobdellidae	NA	Erpobdellidae	7
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea*	*Caecidotea* sp.	1
Arthropoda	Crustacea	Amphipoda	Hyalellidae	*Hyalella*	*Hyalella* sp.	57
Arthropoda	Insecta	Ephemeroptera	Baetidae	NA	Baetidae	44
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenacron*	*Stenacron* sp.	2
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes*	*Tricorythodes* sp.	48
Arthropoda	Insecta	Odonata	Coenagrionidae	*Argia*	*Argia* sp.	9
Arthropoda	Insecta	Odonata	Coenagrionidae	*Enallagma*	*Enallagma* sp.	70
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*	*Cheumatopsyche* sp.	7
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila*	*Hydroptila* sp.	6
Arthropoda	Insecta	Coleoptera	Haliplidae	*Peltodytes*	*Peltodytes duodecimpunctatus*	2
Arthropoda	Insecta	Coleoptera	Elmidae	*Stenelmis*	*Stenelmis* sp.	39
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	66
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	4
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae	*Elimia*	*Elimia* sp.	7

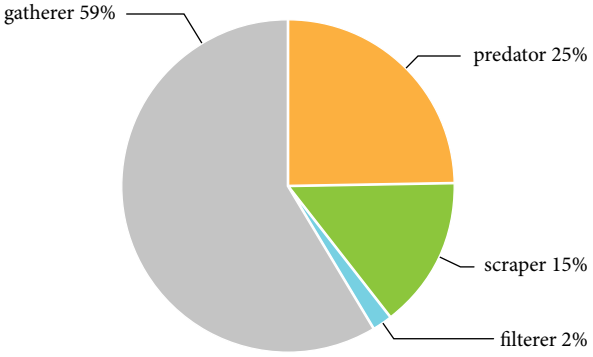

FIGURE 14. Macroinvertebrate functional feeding group (FFG) percent composition of Salt Creek at Bemis Woods.

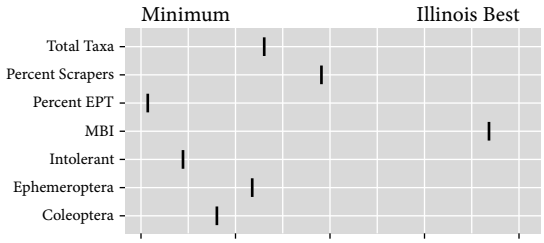

FIGURE 15. Standardized metrics used in calculation of mIBI for Salt Creek at Bemis Woods.

APPENDIX I [CONTD.]

Site-specific Results. Sites: Flag Creek, Spring Rock Creek Park, near Western Springs, IL.

PLATE 6. Site photo of Flag Creek at Spring Rock Creek Park (Cook County, IL) with 47th Street Bridge. Photo by E. Bilger.

Site description and physical characteristics.—This site on Flag Creek was located within Spring Rock Creek Park about 50 m downstream of the I-294 bridge (Plate 6). The stream was slow-moving. Stream depth averaged 0.15 m and width was approximately 3 m. Substrate composition was mostly (70%) with smaller amounts of silt (20%), gravel (5%), and cobble (5%). The riparian area was forested in this stream segment, but surrounding land use was mostly residential (95%). Habitat parameters were mostly in the "Poor" to "Fair" range (Figure 16).

Macroinvertebrates.—We collected only 10 unique macroinvertebrate taxa from this site, and despite chironomid midges being the most abundant taxa, few other insect taxa were represented (Table 14). Other insects found here were the mosquito *Anopheles* sp. and the blackfly *Simulium* sp., and semi-aquatic true bugs, *Notonecta* sp. and *Aquarius remigis*. Ninety-three percent of the organisms collected were collector-gatherers (Figure 17). The individual metrics used for the mIBI were all near the minimum values resulting in this site having the most impaired macroinvertebrate community in this study (Figure 18).

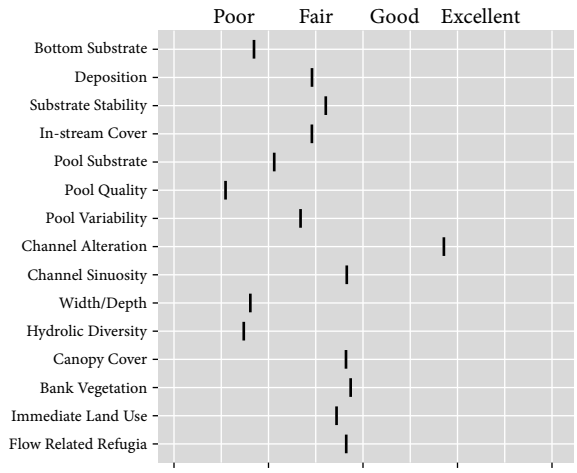

FIGURE 16. Summary of standardized values of the 15 metrics for Flag Creek at Spring Rock Creek Park (Cook County, IL) on 5 August 2015.

APPENDIX I [CONTD.]

Site-specific Results. Sites: Flag Creek, Spring Rock Creek Park, near Western Springs, IL. (contd.)

Table 14. List of taxa collected from Flag Creek at Spring Rock Creek Park on 5 August 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Platyhelminthes	Turbellaria	NA	NA	NA	Turbellaria	37
Annelida	Clitellata	NA	NA	NA	Clitellata	10
Annelida	Clitellata	Arhynchobdellida	Erpobdellidae	NA	Erpobdellidae	1
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea*	*Caecidotea* sp.	64
Arthropoda	Crustacea	Amphipoda	Crangonyctidae	NA	Crangonyctidae	5
Arthropoda	Insecta	Hemiptera	Gerridae	*Aquarius*	*Aquarius remigis*	2
Arthropoda	Insecta	Hemiptera	Notonectidae	*Notonecta*	*Notonecta* sp.	1
Arthropoda	Insecta	Diptera	Culicidae	*Anopheles*	*Anopheles* sp.	1
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	*Simulium* sp.	2
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	816
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	9
Mollusca	Gastropoda	Mesogastropoda	Physidae	*Physa*	*Physa* sp.	8
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	NA	Sphaeriidae	11

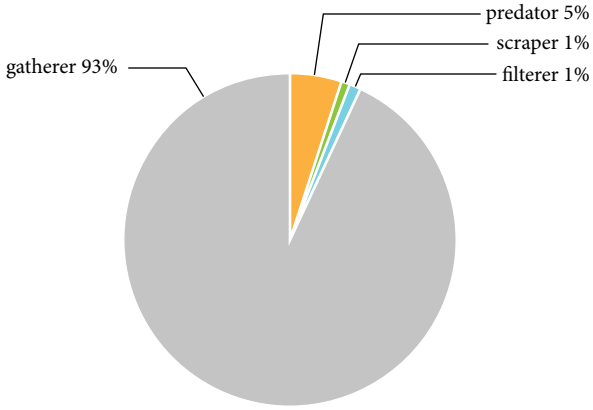

FIGURE 17. Macroinvertebrate functional feeding group (FFG) percent composition at Flag Creek at Spring Rock Creek Park.

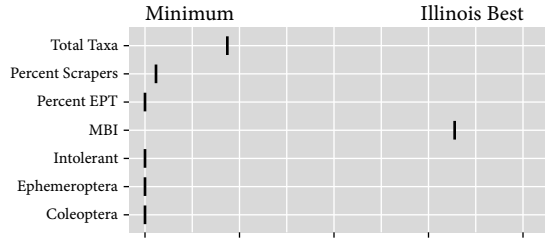

FIGURE 18. Standardized metrics used in calculation of mIBI for Flag Creek at Spring Rock Creek Park.

APPENDIX I [CONTD.]

Site-specific Results. Site: Flag Creek, Plainfield Rd. overpass, near Willowbrook, IL.

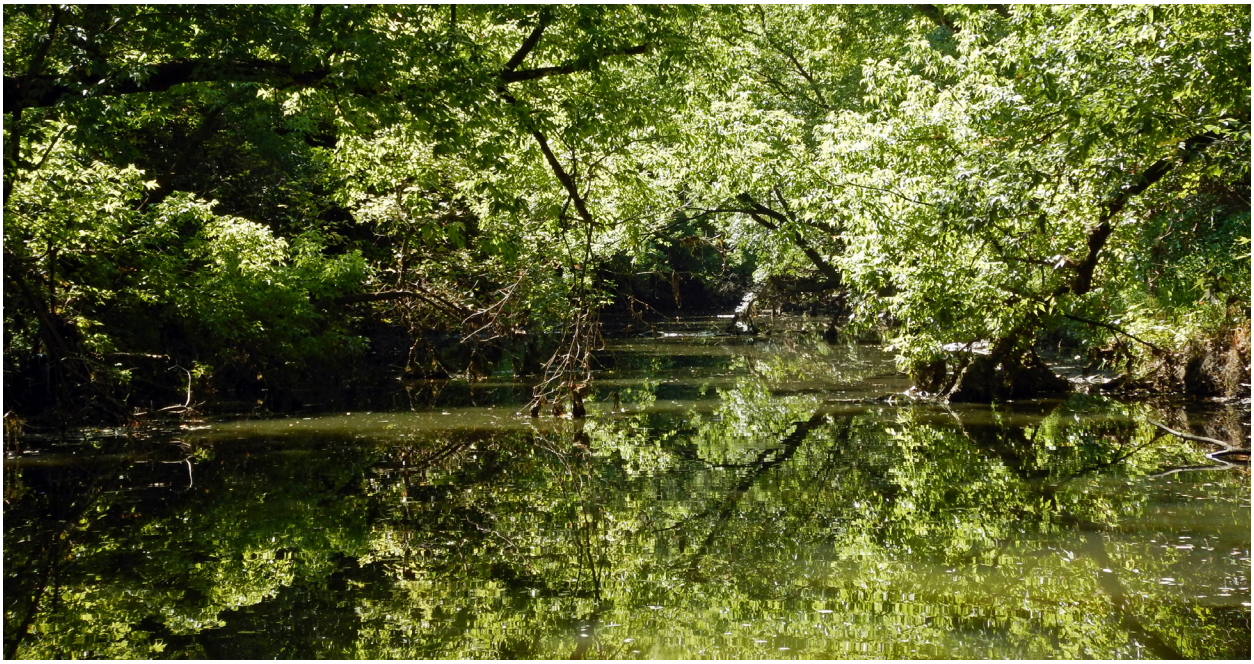

PLATE 7. Flag Creek at Plainfield Rd overpass (Cook County, IL) taken from middle of reach looking upstream. Photo by E. Bilger.

Site description and physical characteristics.—The stream segment sampled at this site on Flag Creek was just upstream of the Plainfield Rd. overpass of I-294. The substrate was mostly sand and silt (45% and 35%, respectively) with smaller amounts of gravel (20%) and cobble (5%). Areas of deep silt were noted along the wetted edge of the stream. The water was slow-moving and murky. Surrounding land use was 90% residential and 10% forest. A few snags were present in the stream, but there was also trash and other debris. Submerged vegetation beds were present at several places in the reach. Individual habitat parameters scored mostly in the "Poor" to "Fair" range, yet the stream had relatively good canopy cover (Figure 19).

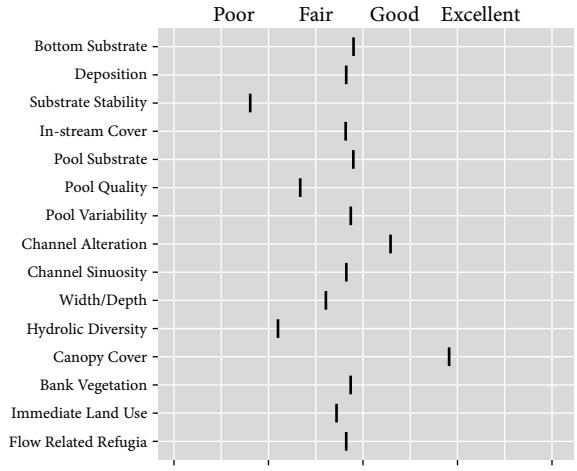

FIGURE 19. Summary of standardized values of the 15 metrics used to calculate the habitat assessment score for Flag Creek at the Plainfield Rd. overpass (Cook County, IL) on 5 August 2015.

Macroinvertebrates.—We identified 14 unique taxa in Flag Creek at Plainfield Rd. (Table 15). Scrapers made up 6% of functional feeding group composition due to physid snails, and shredders were present as the beetle *Peltodytes* sp. (Figure 20). This site had relatively high numbers of isopods and amphipods (Crustacea), and several leeches (Table 15). No EPT or intolerant taxa were collected from this Flag Creek site (Figure 21).

APPENDIX I [CONTD.]

Site-specific Results. Site: Flag Creek, Plainfield Rd. overpass, near Willowbrook, IL. (contd.)

Table 15. List of taxa collected from Flag Creek at the Plainfield Rd. overpass on 5 August 2015, using the 20 jab allocation method.

Phylum	Class	Order	Family	Genus	Taxon	N
Annelida	Clitellata	NA	NA	NA	Clitellata	2
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	NA	Glossiphoniidae	9
Arthropoda	Crustacea	Isopoda	Asellidae	*Caecidotea*	*Caecidotea* sp.	42
Arthropoda	Crustacea	Amphipoda	Hyalellidae	*Hyalella*	*Hyalella* sp.	177
Arthropoda	Crustacea	Decapoda	Cambaridae	NA	Cambaridae	1
Arthropoda	Insecta	Odonata	Libellulidae	NA	Libellulidae	1
Arthropoda	Insecta	Odonata	Coenagrionidae	NA	Coenagrionidae	22
Arthropoda	Insecta	Odonata	Coenagrionidae	*Ischnura*	*Ischnura* sp.	6
Arthropoda	Insecta	Hemiptera	Corixidae	NA	Corixidae	1
Arthropoda	Insecta	Coleoptera	Haliplidae	*Peltodytes*	*Peltodytes* sp.	10
Arthropoda	Insecta	Coleoptera	Elmidae	*Stenelmis*	*Stenelmis* sp.	1
Arthropoda	Insecta	Diptera	Chironomidae	NA	Chironomidae	98
Arthropoda	Insecta	Diptera	Chironomidae	NA	Tanypodinae	18
Arthropoda	Insecta	Diptera	Empididae	*Hemerodromia*	*Hemerodromia* sp.	1
Mollusca	Gastropoda	Mesogastropoda	Physidae	NA	Physidae	22
Mollusca	Pelecypoda	Veneroida	Sphaeriidae	NA	Sphaeriidae	3
Mollusca	Pelecypoda	Veneroida	Corbiculidae	*Corbicula*	*Corbicula* sp.	1

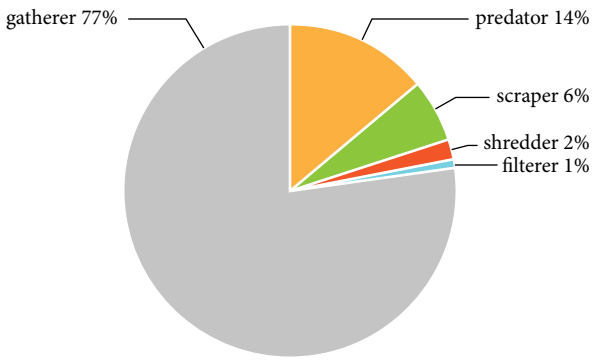

FIGURE 20. Macroinvertebrate functional feeding group (FFG) percent composition in Flag Creek at Plainfield Rd. overpass.

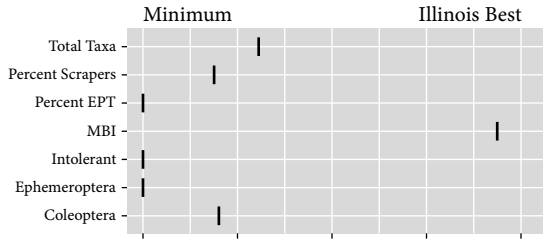

FIGURE 21. Standardized metrics used in calculation of mIBI for Flag Creek at the Plainfield Rd. overpass.