Midwest Biodiversity Institute
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Biological and Water Quality Study of the E. Branch DuPage River Watershed 2019

DuPage and Will Counties, Illinois

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East Branch DuPage River ust. Short Street (EB31)

Peter A. Precario, Executive Director
Dr. David J. Horn, Board President

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Biological and Water Quality Study of the East Branch DuPage River Watershed 2019

DuPage and Will Counties, Illinois

Final Report

Technical Report MBI/2020-12-12
-- FINAL REPORT--

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ACKNOWLEDGEMENTS

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FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. The latter is the case with this study in that the E. Branch DuPage River and its tributaries represent a watershed of approximately 81 square miles with a complex mix of overlapping stressors and sources in a highly developed urban and suburban landscape. This assessment is a follow-up to previous surveys of the E. Branch DuPage River and its tributaries performed in 2007 (MBI 2008), 2011 (MBI 2014), 2014 (MBI 2016). Previous assessments by Illinois EPA and DNR were performed at a less intensive level of spatial detail. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply as well as human health concerns could also be assessed with the inclusion of additional indicators.

Scope of the E. Branch DuPage Watershed Biological and Water Quality Assessment

Standardized biological, chemical, and physical monitoring and assessment techniques were employed to meet three major objectives:

1) determine the extent to which biological assemblages are impaired (using Illinois EPA guidelines);

2) determine the categorical stressors and sources that are associated with those impairments; and,

3) add to the broader databases for the DuPage River and Salt Creek watersheds to track and understand changes through time in response to abatement actions or other influences.

The data presented herein were processed, evaluated, and synthesized as a biological and water quality assessment of aquatic life use status. The assessments are directly comparable to those accomplished in 2007, 2011, and 2014 such that trends in status can be examined and causes and sources of impairment can be confirmed, amended, or removed. This study contains a summary of major findings and recommendations for future monitoring, follow-up investigations, and any immediate actions that are needed to resolve readily diagnosed impairments. It was not the role of this study to identify specific remedial actions on a site specific or watershed basis.

The 2019 assessment is the first to utilize the analyses and outputs of the most recent Northeastern Illinois Integrated Prioritization System (NE IL IPS; MBI 2020). Specifically, biological effect thresholds for five biological condition categories (i.e., excellent, good, fair, poor, and very poor) were developed for 87 chemical water quality, sediment chemistry, and habitat attributes that are more regionally relevant than what has been used previously. For nutrients, this includes not only more refined thresholds for nutrient parameters, but a nutrient index that synthesizes IPS variables into a more tractable scale of overall nutrient. The IPS also yields a Restorability factor for impaired sites, reaches, and watersheds and a Threat/Susceptibility factor for attaining sites. In combination with improved and regionally relevant stressor thresholds across five condition categories, this has provided more certainty in the assignment and weighting of causes and sources of impairments and threats.

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INTRODUCTION

A biological and water quality study of the E. Branch DuPage River and its tributaries was conducted in 2019 to assess aquatic life condition status, identify proximate stressors, and examine chemical/ physical water quality and biological conditions relative to publicly owned treatment works and physical habitat modifications. Survey data were also used to assess trends relative to previous watershed surveys conducted in 2007, 2011, a 2012 follow-up survey (fish only) of the upper East Branch following the removal of the Churchill Woods dam, and 2014. Results of past surveys were published in the *Biological and Water Quality Study of the East and West Branches of the DuPage River and the Salt Creek Watersheds* (MBI 2008) and *Biological and Water Quality Study of the E. Branch DuPage River Watershed 2011* (MBI 2012) and a follow-up survey in 2014 (MBI 2016).

The East Branch watershed survey design is based on descending geometric drainage area categories that selects sites from 150, 75, 38, 19, 9, 5 and 2 sq. mi. panels. The E. Branch is a "trellised" watershed (as opposed to "dendritic") in that the tributaries tend to be short and occupy smaller drainage areas in relation to a long mainstem. Eighty-five (85%) of the tributaries drain 0.8-5 sq. miles while 86% of the mainstem sites are >5 square miles. From a stressor standpoint, all except two of the municipal point source discharges are located on mainstem reaches $\geq$5 sq. mi.; the exceptions are the Bloomingdale Reeves WWTP (RM 23.3; 2 sq. mi.) and the Glendale WWTP on Armitage Ditch at the E. Branch confluence. For these reasons, the 2011-12 report aggregated the results as *Tributary* sites and *East Branch Mainstem* sites. The mainstem results were further subdivided into upper (RM 23.5-19) and lower (RM 18-1.3) segments to better highlight the Churchill Woods dam removal (RM 18.7). The 2019 results are presented in a similar manner.

SUMMARY

Biological assemblages in the E. Branch watershed continued to be rated in poor to fair condition at almost all locations in 2019. As in the two previous surveys, no fish IBI values met the IEPA criterion for the General Use. The macroinvertebrates in 2019 were limited to a single mainstem site towards the mouth (RM 4.0) meeting the General Use mIBI criterion as in 2014 compared to three sites meeting in the lower 7.6 miles in 2011. Because of the poor biological performance, no sites fully supported the Illinois EPA General Use for aquatic life.

Compared to the most recent watershed surveys in 2011 and 2014, biological sampling in 2019 found the condition of fish was mixed with some sites scoring lower and others slightly improved while the macroinvertebrate assemblage was within the range of previous years in quality (Figure 1). However, a portion of the macroinvertebrate results are based on samples collected in mid to late August after a series of high flow events that occurred 1-2 weeks prior to sample collection. For this reason, and while the general quality of the 2019 collections is in line with previous surveys, caution should be used when making broad characterizations about trends.

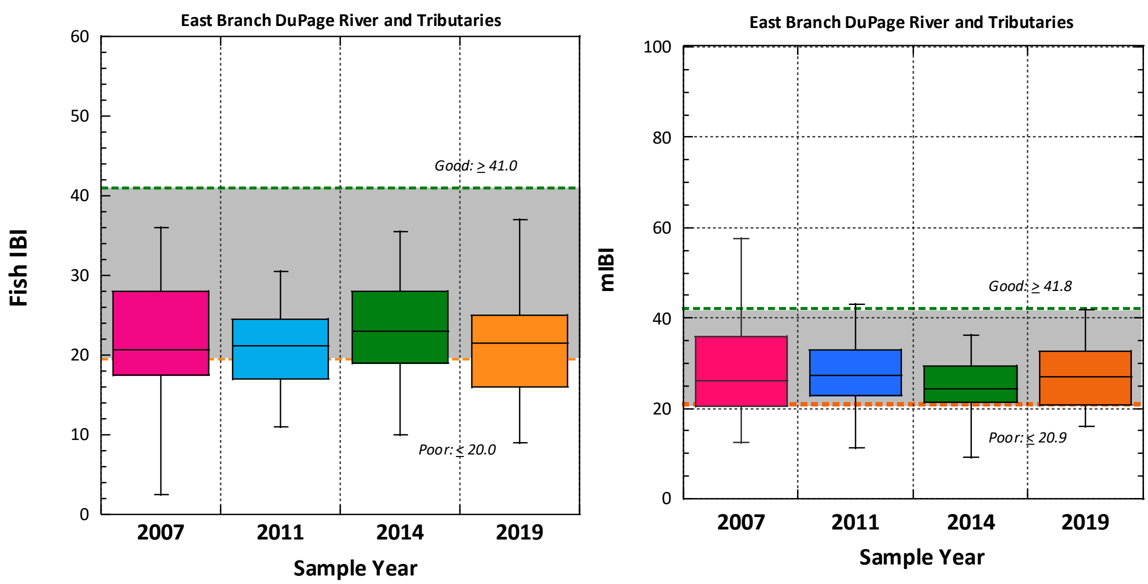


Figure 1. *Box and whisker plots of fish (left) and macroinvertebrate (right) IBI scores at in common sampling sites in the E. Branch DuPage River watershed in 2007, 2011, 2014, and 2019.*

As in previous surveys, the poorest quality biological assemblages occurred in the headwaters and tributaries, particularly drainages <5 mi^2. The negative influences of stormwater and associated pollutants, sometimes in tandem with habitat alterations, were especially severe. Moderate-severe substrate embeddedness is universal at tributary sites, and the watershed as a whole. While exceedances of parameters with water quality criteria were not detected in grab samples, highly elevated levels of chloride and TDS were found throughout the watershed particularly in the tributaries and smaller drainages. Leaching of residual chlorides from winter road salt applications in the surrounding urban landscape is likely a significant source. Elevated BOD_5 levels were observed in three tributaries and were particularly elevated at RM 1.0 in Prentiss Creek (EB03), which provided evidence of organic wastes. Biological index scores in Prentiss Creek were among the lowest in the 2019 survey.

In contrast to the tributaries, the mainstem macroinvertebrate assemblages were mostly in the fair range. The fish assemblages, however, had sites in the poor range downstream of Glendale Heights and Downers Grove.

As in 2011, mainstem nutrients continued to show sharp increases below the series of major WWTP discharges. In addition, continuous monitors routinely detected low D.O. levels, particularly upstream from the former Churchill Woods dam impoundment. Mainstem TDS and chloride concentrations were consistently above biological effect thresholds.

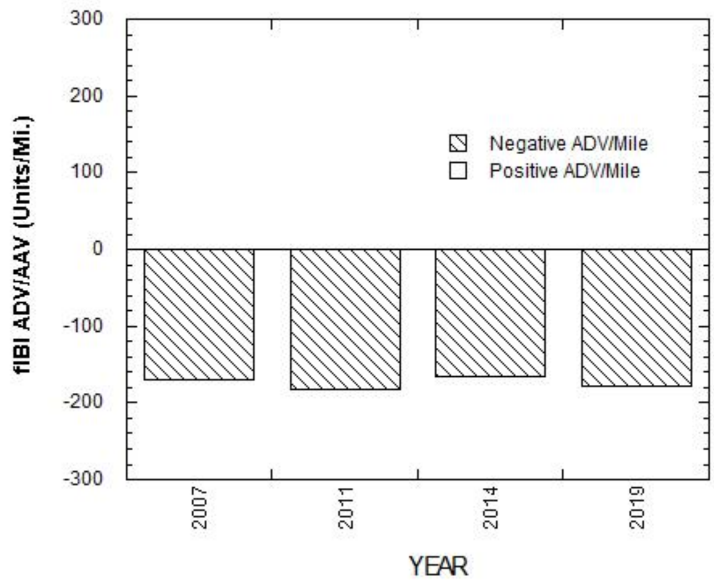
Within the remnants of the former Churchill Woods dam impoundment, fish assemblage performance was slightly reduced in 2019 compared to the steady increases observed through 2012. The continued presence of a small, residual impoundment and the heavy deposits of soft muck and peat have resulted in a slow or even stalled recovery. Mainstem D.O. depletion measured by continuous monitors was also most severe in the upper mainstem, between West Lake and the former Churchill Woods dam location.

The more extreme concentrations of PAH compounds in sediment have declined substantially since 2007. Peak concentrations of sediment metals have also shown a declining trend although the number of parameters or “hits” above threshold effect levels has trended up over the same period.

Visualization of Trends in the East Branch DuPage River Mainstem: Area of Degradation and Attainment Values

The Area of Degradation (ADV; Yoder and Rankin 1995b) was originally developed to quantify the extent and severity of departures from the biological index thresholds within a defined river reach. For reaches that exceed the Illinois benchmarks for the General aquatic life use it is expressed as an Area of Attainment Value (AAV) that quantifies the extent to which use attainment thresholds are surpassed (Yoder et al. 2005). The ADV/AAV correspond to the area of the polygon formed by the longitudinal profile of fIBI and mIBI scores and the straight line boundary formed by the applicable fIBI or mIBI threshold, the ADV below and the AAV above. The results of the historical dataset between 2007-2019 was used to quantify the degree to which overall aquatic life conditions have changed through time up to and including the 2019 survey. As such, it is a quantification of the “totality” of biological attainment and impairment. When normalized to a standard distance (e.g., per mile) it is an effective indicator of the degree of change which has taken place through time.

Figure 2 shows plots of the ADV and AAV by year for the East Branch DuPage River mainstem. The results for each of the two indices show some minor variation from year-to-year, but no substantial trend between 2007-2019. There were no positive AAV values for fish in any year and only slight positive AAV values for macroinvertebrates in 2007, 2011, and 2019. There were only minor changes in negative ADV values between years (Figure 2). The spatial distribution of aquatic life attainment status, consisting of uniform non-attainment and either fair or poor conditions are illustrated on a map in Figure 3.



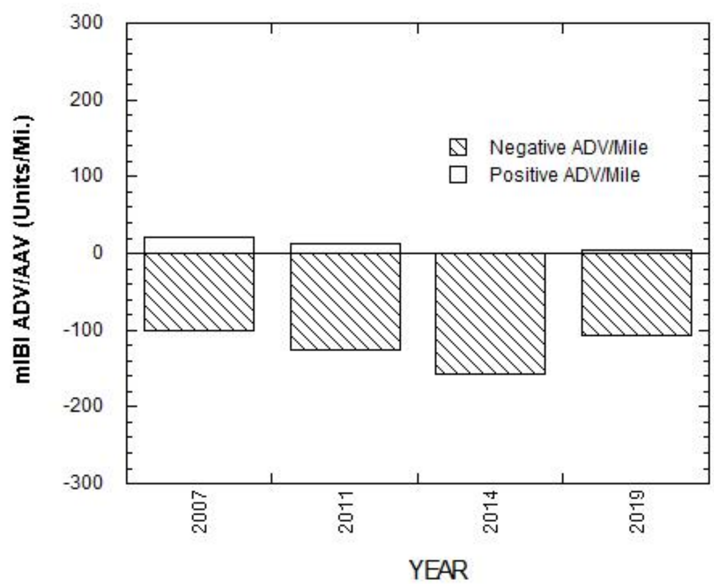


Figure 2. *Area of Degradation (ADV) and Area of Attainment (AAV) values for the IBI (top) and mIBI (bottom) in the East Branch DuPage River mainstem between 2007 and 2019.*

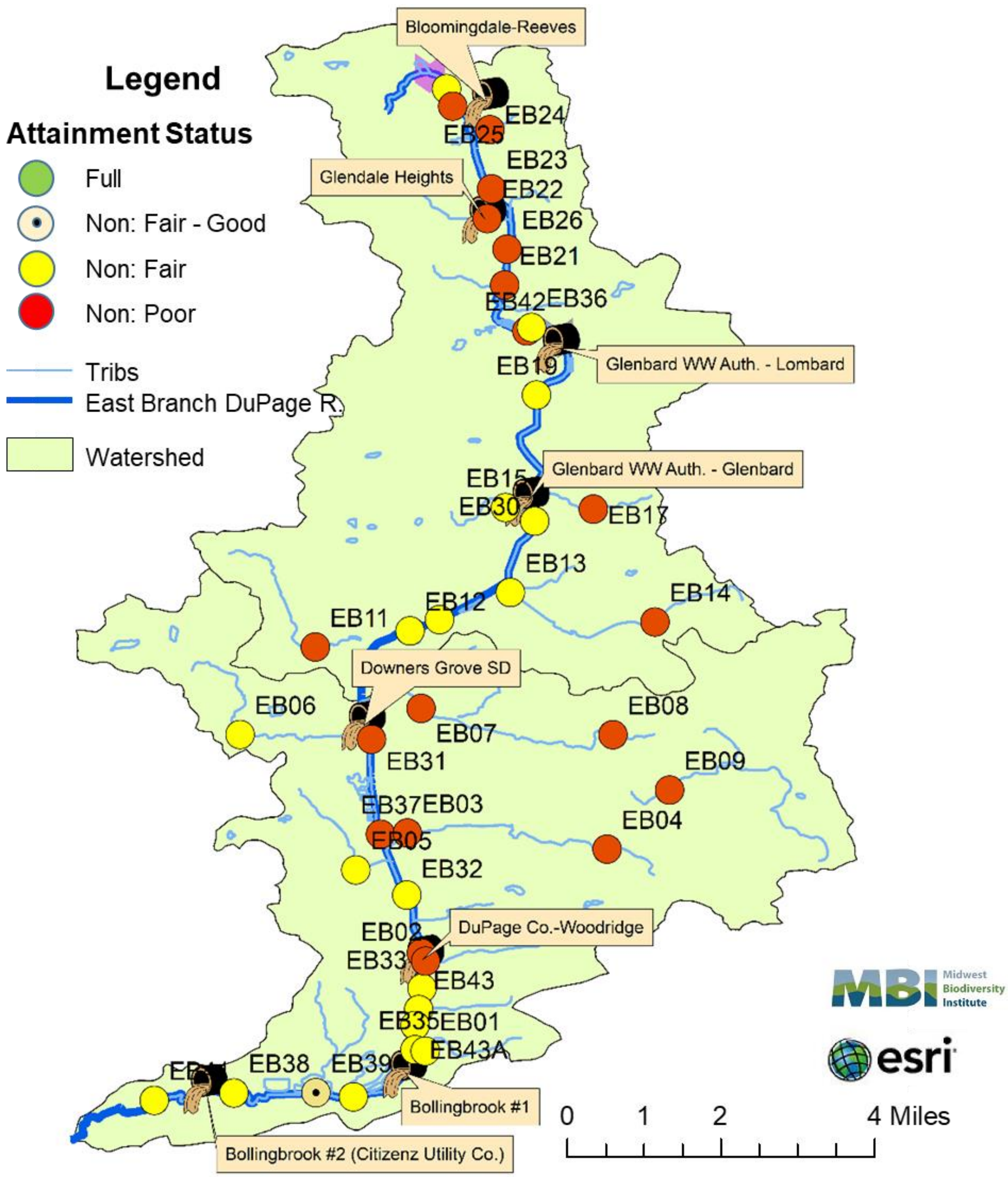


Figure 3. *East Branch DuPage River watershed attainment status in 2019.*

Table 1. *Status of aquatic life use support for sites sampled in the E. Branch DuPage River study area in 2019. Site codes with poor biological performance are shaded in red; fair quality sites are shaded in yellow and index scores in the good range are bold. IPS assigned causes associated with impaired fIBI and/or mIBI are listed.*

Site ID	River Mile	Drainage Area (sq. mi.)	fIBI	mIBI	QHEI	AQLU Status	2019 Causes by IPS Stressor Threshold Narrative Category			2019 Sources	IPS Restora-bility Score (0-100)
							Very Poor[1]	Poor[1]	Fair[1]		
Army Trail Creek (Trib to E. Br. DuPage at RM 23.1) - 95-951											
EB24	0.25	0.30	**18.0**	**21.0**	50.5	Non - Poor	Urban-WS;Dev-WS; Chloride;	Conduct; TDS;	Imperv-500m;	Urban stormwater, Habitat alteration	69.8
Armitage Ditch (Trib to E. Br DuPage at RM 21.9) - 95-952											
EB22	0.50	2.20	**16.0**	**23.9**	53.5	Non - Poor	Urban-WS;Dev-WS;	Chan;	Imperv-500m;Imperv-30;Imperv-30C; BOD; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	45.1
Glencrest Creek (Trib to E. Br DuPage at RM 16.0) - 95-953											
EB15	0.50	3.00	**21.0**	**21.3**	57.0	Non - Fair	Urban-WS;Dev-WS;		Imperv-500m; QHEI; Chan;	Urban stormwater, Habitat alteration	55.2
Lacey Creek (Trib to E. Br DuPage at RM 14.6) - 95-954											
EB14	2.00	2.00	**9.0**	**16.1**	45.5	Non - Poor	Urban-WS;Dev-WS; TSS;	QHEI; Substr; Chan;	Imperv-500m;TP; TKN; BOD; Chloride;	Urban stormwater, Habitat alteration	34.7
EB13	0.25	6.00	**23.0**	**21.3**	57.0	Non - Fair	Substr; Chan;	Urban-WS;Dev-WS; QHEI; WC Metals;	TP; BOD; Nitrate; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration	30.6
Willoway Brook (Trib to E. Br DuPage at RM 12.77) - 95-955											
EB11	1.00	3.00	**16.0**	**32.7**	42.0	Non - Poor	Urban-WS;Dev-WS;		BOD; QHEI; Substr;	Urban stormwater, Habitat alteration	60.9
22nd St.(Trib to E. Br. DuPage @ RM 16.46) - 95-956											
EB17	1.00	0.80	**26.0**	**20.3**	32.5	Non - Poor	Urban-WS;Dev-WS; TSS;	Imperv-500m;Imperv-30C; QHEI; Substr;	Imperv-30; Chan;	Urban stormwater, Habitat alteration	42.7
Rott Creek (Trib to E. Br. DuPage @ RM 11.5) - 95-957											
EB06	2.00	4.00	**20.0**	**28.7**	65.5	Non - Fair		Imperv-500m;	Urban-WS;Imperv-30C;Dev-WS; BOD; QHEI; Chan;	Urban stormwater, Habitat alteration	54.2
East Branch DuPage River - 95-980											
EB29	23.50	2.00	**23.0**	**24.4**	39.0	Non - Fair	Urban-WS;Dev-WS; BOD; Substr;	Imperv-500m; TKN; QHEI; Chan;	Chloride;	Urban stormwater, Habitat alteration	34.4
EB25	23.00	2.00	**26.0**	**18.6**	48.0	Non - Poor	Urban-WS;Dev-WS;	Imperv-500m; BOD; QHEI; Substr; WC Metals;	TP; TKN; Nitrate; Chan;	Urban stormwater, Habitat alteration, WWTP Effluent	45.2
EB23	22.00	5.00	**23.0**	**20.7**	74.3	Non - Poor	Urban-WS;Dev-WS; WC Metals;	TP;	Imperv-500m; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	50.2
EB26	21.00	12.00	**13.0**	**27.8**	44.0	Non - Poor	Urban-WS;Dev-WS; Nitrate Substr; WC Metals;	TP; QHEI; Chan;	Imperv-500m;Imperv-30;Imperv-30C; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	35.9
EB21	20.50	14.20	**15.0**	**26.4**	49.5	Non - Poor	Urban-WS;Dev-WS; Chan; WC Metals;	TP; QHEI; Substr;	Imperv-500m; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	34.8
EB42	19.50	12.30	**15.0**	**21.1**	38.5	Non - Poor	Substr;	QHEI; Chan;		Urban stormwater, Habitat alteration, WWTP Effluent	57.6
EB36	19.00	16.00	**22.0**	**33.3**	50.0	Non - Fair	Urban-WS;Dev-WS; Substr; WC Metals;	TP; QHEI;	Imperv-500m; Nitrate; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	40.4
EB19	18.00	16.80	**25.0**	**27.9**	47.5	Non - Fair	Urban-WS;Dev-WS; WC Metals;	QHEI; Substr;	Imperv-500m;TP; BOD; Nitrate; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	41.2

Site ID	River Mile	Drainage Area (sq. mi.)	fIBI	mIBI	QHEI	AQLU Status	2019 Causes by IPS Stressor Threshold Narrative Category			2019 Sources	IPS Restora-bility Score (0-100)
							Very Poor[1]	Poor[1]	Fair[1]		
EB30	15.50	27.20	28.0	27.5	62.0	Non - Fair	Urban-WS;Dev-WS;	TP;	Imperv-500m;Imperv-30C; QHEI; Substr; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	43.0
EB12A	13.50	31.50		31.7		Non - Fair	Dev-WS;			Urban stormwater, Habitat alteration, WWTP Effluent	77.9
EB12	13.00	32.20	22.0	33.4	57.0	Non - Fair	Urban-WS;Dev-WS;		Imperv-500m;TP; QHEI; Substr; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	43.8
EB31	11.00	58.00	17.0	32.2	51.0	Non - Poor	Urban-WS;Dev-WS; WC Metals;	Imperv-500m;TP; QHEI; Chan;	Nitrate; Substr; Conduct; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.9
EB37	9.50	60.10	18.0	32.9	46.5	Non - Poor	Urban-WS;Dev-WS;	TP; QHEI;	Imperv-500m; Nitrate; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.9
EB32	8.50	61.00	25.0	37.4	55.5	Non - Fair	Urban-WS;Imperv-30C;Dev-WS;		Imperv-500m;Imperv-30;TP; Nitrate; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.6
EB40	7.60	68.60	18.0	27.9	62.5	Non - Poor	Urban-WS;Dev-WS;		TP; Nitrate; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	49.6
EB33	7.00	70.90	23.0	31.2	69.0	Non - Fair	Urban-WS;Dev-WS;		TP; Nitrate; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration	45.4
EB43	6.60	71.60	24.0		72.0	Non - Fair	Urban-WS;Dev-WS;		QHEI;	Urban stormwater, Habitat alteration	64.9
EB43A	6.30	71.70	21.0		64.0	Non - Fair	Dev-WS;		QHEI; Chan;	Urban stormwater, Habitat alteration	56.3
EB35	6.00	76.40	26.0	40.4	52.8	Non - Fair	Urban-WS;Dev-WS;	Chan;	Imperv-500m;TP; Nitrate; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	51.1
EB34	5.00	76.40	23.0	40.4	67.3	Non - Fair	Urban-WS;Dev-WS;		TP; Nitrate; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	55.5
EB39	4.00	78.00	23.0	42.0	50.5	Partial	Urban-WS;Dev-WS;	QHEI; Chan;	TP; BOD; Nitrate; Substr; Chloride;	Urban stormwater, Habitat alteration	37.2
EB38	3.00	81.00	37.0	40.8	77.0	Non - Fair	Urban-WS;Dev-WS;		Imperv-500m;TP; Nitrate; Chloride;	Urban stormwater, Habitat alteration	61.7
EB41	1.30	77.90	30.0	35.3	74.5	Non - Fair	Urban-WS;Dev-WS;		Imperv-30;Imperv-30C;TP; BOD; Nitrate; QHEI; Chloride;	Urban stormwater, Habitat alteration	54.7
Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6) - 95-986											
EB04	3.80	2.30	14.0	14.7	45.0	Non - Poor	Urban-WS;Dev-WS;	Imperv-500m;	TKN; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration	54.9
EB03	1.10	6.60	7.0	24.8	52.5	Non - Poor	Urban-WS;Dev-WS;	Imperv-500m;	Imperv-30C; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration	52.5
St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9) - 95-987											
EB10	6.00	2.00	11.0	17.3	57.0	Non - Poor	Urban-WS;Dev-WS;	QHEI; Substr; Chan;	Imperv-500m; BOD;	Urban stormwater, Habitat alteration	46.3
EB08	4.00	4.00	14.0	18.6	31.0	Non - Poor	Urban-WS;Dev-WS; Low DO;		Imperv-500m; QHEI; Substr; Chan;	Urban stormwater, Habitat alteration	46.8
EB07	1.00	10.00	21.0	19.0	55.0	Non - Poor	Urban-WS;Dev-WS;	Imperv-500m;	Imperv-30C; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration	59.6

Site ID	River Mile	Area (sq. mi.)	fIBI	mIBI	QHEI	AQLU Status	2019 Causes by IPS Stressor Threshold Narrative Category: Very Poor[1]	Poor[1]	Fair[1]	2019 Sources	bility Score (0-100)
Trib. to E. Br. DuPage River at RM 6.15 - 95-988											
EB01	0.25	0.80	**23.0**	**33.6**	61.0	Non - Fair		Urban-WS;Dev-WS; QHEI; Substr; Chan;	Imperv-500m; Chloride;	Urban stormwater, Habitat alteration	48.9
Trib. # 6 to E. Br. DuPage River @ RM 9.35 - 95-989											
EB05	0.60	1.00	**24.0**	**33.7**	66.0	Non - Fair	Urban-WS;Dev-WS;		Imperv-500m; TKN; BOD; QHEI; Substr; Chan;	Urban stormwater, Habitat alteration	57.1
Crabtree Creek, Trib to E. Br. DuPage @ RM 7.8 - 95-990											
EB02	0.20	1.40	**Dry**	**17.4**	Dry	Non - Poor	Urban-WS;Dev-WS;		Imperv-500m; Chloride;	Urban stormwater, Habitat alteration	73.8
UT to St Joseph Creek - 95-991											
EB09	1.10	0.22	**18.0**	**28.7**	31.0	Non - Poor	Substr; Chan;	QHEI;	TKN; BOD;	Urban stormwater, Habitat alteration	29.3
Trib. to East Br. DuPage @ RM 19.9 - 95-992											
EB20	0.12	0.30				Dry Site		Conduct; TDS; Chloride;	Dev-WS; TKN;	Urban stormwater, Habitat alteration	74.8
	Narrative Category		**fIBI**	**mIBI**	**QHEI**	**AQLU Status**					IPS Ranking
	Excellent		>50	>73	>84.5	FULL					Very High
	Good		>41-49	41.8-72.9	>75.9	FULL					High
	Fair		30-<41	30-41.7	<75.9	PARTIAL					Moderate
	Poor		>15-29	>15-29	<50.1	NON-Fair					Low
	Very Poor		<15	<15	<25.0	NON-Poor					Very Low

[a] Underlined nutrient causes refer to "severe" exceedances of the least stringent target criteria (i.e., red shaded values in Table); nutrients listed in ("plain text") exceeded lower IPS targets (yellow shaded in Table 7). Listings of metals or D.O as "Causes" represent WQ criteria exceedances. TSS or BOD_5 *(i.e.,* Organic Enrichment) listings exceeded "upper limit of unpolluted streams" benchmarks in Figure. [b] – sites sampled in 2012 within the former Churchill Woods impoundment.

Narrative Ranges for Illinois fIBI and mIBI scores (IEPA 2013)

	fIBI		mIBI
Poor	0 - 20	Poor	0.0 - 20.9
Fair	>20 - <41	Fair	>20.9 - <41.8
Good	≥41	Good	≥41.8

METHODS

Sampling sites (Table 2, Figure) were determined systematically using a geometric design supplemented by an intensive pollution survey design. The geometric site selection process starts at the downstream terminus or "pour point" of the watershed (Level 1 site), then continues by deriving each subsequent "panel" at descending intervals of one-half the drainage area (D.A.) of the preceding level. Thus, the drainage area of each successive level decreases geometrically. For the East Branch this resulted in seven drainage area levels in the watershed, starting at 150 sq. mi. and continuing through successive panels of 75, 38, 19, 9, 5 and 2 sq. mi. Targeted sites were added to fill gaps left by the geometric design and assure complete spatial coverage in order to capture all significant pollution gradients including reaches that are impacted by wastewater treatment plants (WWTPs), major stormwater sources and dams. The resulting total number of sampling sites was 41. Thirteen (13) reference sites have been established in adjacent watersheds and included Big Rock Creek and Forked Creek, but these two sites were not sampled in 2019 (Table 1).

For this report, some aspects of the data presentation vary from the baseline *Bioassessment Report* (MBI 2008). Chemical and biological data from 2007 were first reported within the seven geometric panels and those results showed a strong differentiation between the smaller (2-5 sq. mi.) sites and the larger drainage area panels. Within this construct, it was obvious that the drainage area panels efficiently segregated data between small drainage sites, located mostly on tributaries, and larger drainage sites on the East Branch mainstem. In fact, 85% of tributary sites fell within a 0.8-5 sq. mile range while 86% of the mainstem sites were >5 square miles. Also, from a stressor standpoint, all of the major municipal point source discharges in the East Branch watershed were restricted to reaches ≥5 sq. mi. with the exception of the Bloomingdale Reeves WWTP (RM 23.3) at 2 sq. mi. and the Glendale Hts. WWTP, located on Armitage Ditch. For these reasons, the 2011-12 results presentation grouped and separated the *tributary* and East Branch mainstem sites. The mainstem results in 2011 were further subdivided into an upper (RM 23.5-19) and lower (RM 18-1.3) reach to better display and assess the February 2011 removal of the Churchill Woods dam (RM 18.7). For 2019 the results are grouped as tributary and mainstem sites.

Each 2019 site was sampled for macroinvertebrates, fish, and habitat. Water quality was sampled at 35 of the 37 sites and included nutrients (nitrates and phosphorus), indicators of organic enrichment (5-day biochemical oxygen demand, ammonia-nitrogen, total Kjeldahl nitrogen), indicators of ionic strength (chloride, conductivity, total dissolved solids), total suspended solids, dissolved oxygen (D.O.), pH, and water temperature. Water column metals (Ca, Cd, Cu, Fe, Mg, Pb and Zn) were analyzed at 24 sites and water column organics were analyzed at 11 locations. Continuous D.O. monitoring was conducted at five locations. Sediment samples were analyzed for heavy metals, polycyclic aromatic hydrocarbons (PAHs), and pesticides at 11 sites.

Table 2. *Sites sampled during the 2019 survey of the E. Branch DuPage River study area.*

Site ID	Basin Code	Stream Code	River	Fish/Macro River Miles	Latitude	Longitude	Drainage Area (sq mi)	Location
EB24	95	951	Army Trail Creek (Trib to E. Br. DuPage at RM 23.1	0.25/0.25	41.93127	-88.05212	0.30	Dst. Valley View Rd.
EB22	95	952	Armitage Ditch (Trib to E. Br DuPage at RM 21.9)	0.50/0.50	41.91108	-88.05273	2.20	Dst. Wayne Ave.
EB15	95	953	Glencrest Creek (Trib to E. Br DuPage at RM 16.0)	0.50/0.50	41.84551	-88.04858	3.00	Ust. Glencrest Dr.
EB14	95	954	Lacey Creek (Trib to E. Br DuPage at RM 14.6)	2.00/2.00	41.81955	-88.01464	2.00	Ust. Saratoga Ave.
EB13	95	954	Lacey Creek (Trib to E. Br DuPage at RM 14.6)	0.25/0.25	41.82622	-88.04749	6.00	Morton Arboretum
EB11	95	955	Willoway Brook (Trib to E. Br DuPage at RM 12.77)	1.00/1.00	41.81386	-88.0918	3.00	Ust. Arboretum walkway bridge
EB17	95	956	22nd St.(Trib to E. Br. DuPage @ RM 16.46)	1.00/1.00	41.84514	-88.02864	0.80	Dst. Finley Rd.
EB06	95	957	Rott Creek (Trib to E. Br, DuPage @ RM 11.5)	2.00/2.00	41.79399	-88.10888	4.00	Fender Rd.
EB29	95	980	East Branch DuPage River	23.50/23.50	41.94055	-88.06197	2.00	Dst. Glen Ellyn Rd.
EB25	95	980	East Branch DuPage River	23.00/23.00	41.93661	-88.06057	2.00	Ust. Brookdale
EB23	95	980	East Branch DuPage River	22.00/22.00	41.91784	-88.05173	5.00	behind Liberty Dr.
EB26	95	980	East Branch DuPage River	21.00/21.00	41.90415	-88.04826	12.00	Ust. IL-64
EB21	95	980	East Branch DuPage River	20.50/20.50	41.89602	-88.04876	14.20	behind apartments
EB42	95	980	East Branch DuPage River	19.50/19.50	41.88558	-88.04377	12.30	Church Hill Woods ust. south riffle
EB36	95	980	East Branch DuPage River	19.00/19.00	41.88638	-88.0427	16.00	ust. foot bridge
EB19	95	980	East Branch DuPage River	18.00/18.00	41.87103	-88.04153	16.80	adj. to Indian Dr.
EB30	95	980	East Branch DuPage River	15.50/15.50	41.84243	-88.04195	27.20	behind Westfield Elementary
EB12A	95	980	East Branch DuPage River	0.00/13.50	41.82008	-88.06358	31.50	Dst. Arboretum riffle
EB12	95	980	East Branch DuPage River	13.00/13.00	41.81753	-88.0703	32.20	Ust. Arboretum entrance bridge
EB31	95	980	East Branch DuPage River	11.00/11.00	41.79292	-88.07903	58.00	Ust. Short St.
EB37	95	980	East Branch DuPage River	9.50/9.50	41.77138	-88.07698	60.10	ust. Seven Bridge Golf Course
EB32	95	980	East Branch DuPage River	8.50/8.50	41.75755	-88.07102	61.00	Dst. golf course
EB40	95	980	East Branch DuPage River	7.60/7.60	41.74439	-88.0677	68.60	ust. WWTP
EB33	95	980	East Branch DuPage River	7.00/7.00	41.73644	-88.06754	70.90	Ust. foot bridge
EB43	95	980	East Branch DuPage River	6.60/0.00	41.73156	-88.06831	71.60	Green Valley FP
EB43A	95	980	East Branch DuPage River	6.30/0.00	41.72796	-88.06916	71.70	Ust. quarry outfall
EB35	95	980	East Branch DuPage River	6.00/6.00	41.72246	-88.06915	76.40	Ust. Royce Rd.
EB34	95	980	East Branch DuPage River	5.00/5.00	41.7118	-88.08315	76.40	Ust. food bridge at Bolingbrook Ponds
EB39	95	980	East Branch DuPage River	4.00/4.00	41.71274	-88.09165	78.00	Hidden Lakes
EB38	95	980	East Branch DuPage River	3.00/3.00	41.71269	-88.11028	81.00	at DuPage River Park
EB41	95	980	East Branch DuPage River	1.30/1.30	41.71101	-88.12839	77.90	Dst. Washington St.
EB04	95	986	Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6)	3.80/3.80	41.76798	-88.0255	2.30	Dst. Springside Ave.
EB03	95	986	Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6)	1.10/1.10	41.77165	-88.07091	6.60	Dst. Lincoln Ave.
EB10	95	987	St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9)	6.00/6.00	41.78575	-88.99171	2.00	at 56th St.
EB08	95	987	St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9)	4.00/4.00	41.79396	-88.02417	4.00	Ust foot bridge
EB07	95	987	St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9)	1.00/1.00	41.79993	-88.06777	10.00	Dst. bridge at condos
EB01	95	988	Trib. to E. Br. DuPage River at RM 6.15	0.25/0.25	41.72217	-88.06684	0.80	Ust. landscape Co. bridge
EB05	95	989	Trib. # 6 to E. Br. DuPage River @ RM 9.35	0.60/0.60	41.76327	-88.08259	1.00	Dst. Green Trails Dr.
EB02	95	990	Crabtree Creek, Trib to E. Br. DuPage @ RM 7.8	0.20/0.20	41.74256	-88.06673	1.40	dst. WWTP entrance
EB09	95	991	UT to St Josepth Creek	1.10/1.10	41.78139	-88.0113	0.22	Ust Carapenter Street
EB20	95	992	Trib. to East Br. DuPage @ RM 19.9	0.12/0.00	41.89095	-88.04766	0.30	ust. Swift Rd.

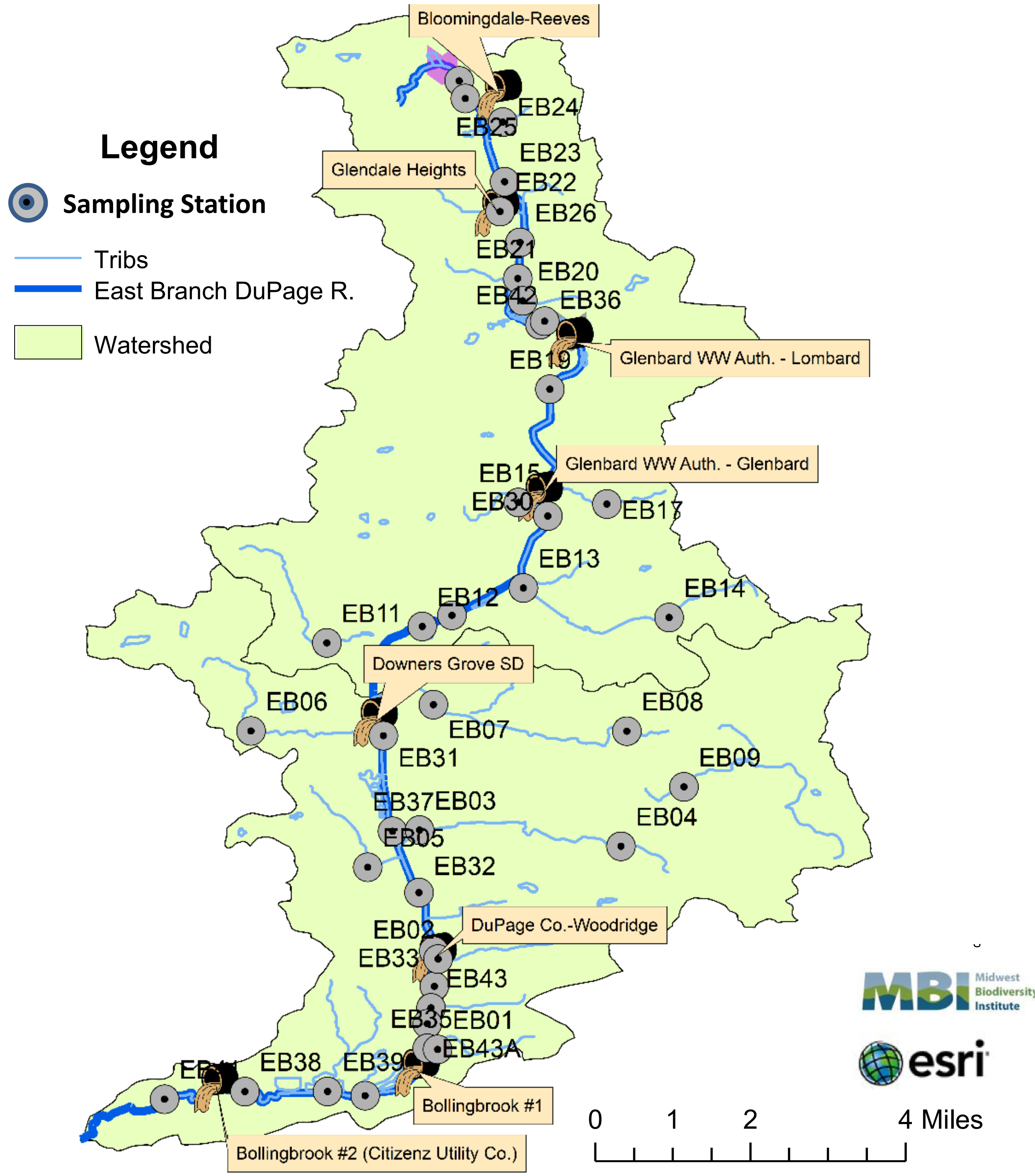


Figure 4. *Sampling locations (grey dots with associated "EB" station numbers), municipal WWTP discharges (outfalls), and significant mainstem dam impoundments (purple chevron) in the E. Branch DuPage River study area, June-Oct. 2019. Note: the Churchill Woods dam (grey chevron, see call out) was removed in Feb. 2011.*

Macroinvertebrate Assemblage

The macroinvertebrate assemblage was sampled using the Illinois EPA (IEPA) multi-habitat method (IEPA 2005). The method involves the selection of a sampling reach that has instream and riparian habitat conditions typical of the assessment reach. The sampling reach should contain one riffle/pool sequence (or analog such as a run/bend meander or alternate point-bar sequence), be at least 300 feet in length, and not have any highly influential tributary streams. The method is applicable only when stream conditions allow the efficient collection of macroinvertebrates (i.e., to take samples with a dip net) in all bottom-zone and bank-zone habitat types that occur in a sampling reach. Flow conditions should be typical of summer base flows. Habitat types are explicitly defined in Appendix E of the project QAPP (MBI 2006b). Conditions must also allow the sampler to apply the 11-transect habitat-sampling method, as described in Appendix E of the QAPP[1] or to estimate with reasonable accuracy via visual or tactile cues the amount of each of several bottom-zone and bank-zone habitat types. If conditions (e.g., inaccessibility, water turbidity, or excessive water depths) prohibit the sampler from estimating with reasonable accuracy the composition of the bottom zone or bank zone throughout the entire sampling reach, then the multi-habitat method is not applicable. In most cases, if more than one-half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of the bottom-zone and bank-zone habitat types are attainable, thus, the multi-habitat method is not applicable. Multi-habitat samples were field preserved in 10% formalin then transferred to 70% ethyl alcohol at the MBI lab in Hilliard, OH.

Laboratory procedures followed the IEPA (2005) methodology for processing multi-habitat samples by producing a 300-organism subsample with a scan and pre-pick of large and/or rare taxa from a gridded tray. Taxonomic resolution was performed to the lowest practicable resolution for the common macroinvertebrate assemblage groups such as mayflies, stoneflies, caddisflies, midges, and crustaceans, which goes beyond the genus level requirement of IEPA (2005). However, calculation of the macroinvertebrate IBI followed IEPA methods in using genera as the lowest level of taxonomy for mIBI calculation and scoring.

Fish Assemblage

Methods for the collection of fish at wadeable sites was performed using a tow-barge or long-line pulsed D.C. electrofishing apparatus utilizing a T&J 1736 DCV electrofishing unit described by MBI (2006b). A Wisconsin DNR battery powered backpack electrofishing unit was used as an alternative to the long line in the smallest streams and in accordance with the restrictions described by Ohio EPA (1989). A three-person crew carried out the sampling protocol for each type of wading equipment sampling in an upstream direction. Sampling effort was indexed to lineal distance and ranged from 150-200 meters in length. Non-wadeable sites were sampled with a raft-mounted pulsed D.C. electrofishing device in a downstream direction. A Smith-Root 2.5 GPP unit was mounted on a 14' raft following the design of MBI (2007). Sampling effort was indexed to lineal distance over 0.5 km. A summary of the key aspects of each method appears in the project QAPP (MBI 2006b). Sampling distance was measured with a GPS unit or laser

[1] http://www.drscw.org/reports/DuPage.QAPP_AppendixE.07.03.2006.pdf

range finder. Sampling locations were delineated using the GPS mechanism and indexed to latitude/longitude (UTM coordinates) at the beginning, mid-point, and end of each site. The location of each sampling site was indexed by river mile (using river mile zero as the mouth of each stream). Sampling was conducted during a June 15-October 15 seasonal index period.

Samples from each site were processed by enumerating and recording weights by species and by life stage (y-o-y, juvenile, and adult). All captured fish were immediately placed in a live well, bucket, or live net for processing. Water was replaced and/or aerated regularly to maintain adequate D.O. levels in the water and to minimize mortality. Fish not retained for voucher or other purposes were released back into the water after they had been identified to species, examined for external anomalies, and weighed either individually or in batches. Weights were recorded at level 1-5 sites only. Larval fish were not included in the data and fish measuring less than 15-20 mm in length were generally excluded from the data as a matter of practice. The incidence of external anomalies was recorded following procedures outlined by Ohio EPA (1989, 2006a) and refinements made by Sanders et al. (1999). While the majority of captured fish were identified to species in the field, any uncertainty about the field identification required their preservation for later laboratory identification. Fish were preserved for future identification in borax buffered 10% formalin and labeled by date, river or stream, and geographic identifier (e.g., river mile and site number). Identification was made to the species level at a minimum and to the sub-specific level if necessary. A number of regional ichthyology keys were used including Fishes of Illinois (Smith 1979) and updates available through the Illinois Natural History Survey (INHS). Vouchers were deposited and verified at The Ohio State University Museum of Biodiversity (OSUMB) in Columbus, OH.

Habitat

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995; Ohio EPA 2006b) and as modified by MBI for specific attributes. Attributes of habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient used to determine the QHEI score which generally ranges from 20 to less than 100. While the QHEI is used to evaluate the characteristics of a sampling site, the average over a stream segment is equally important. As such, a site may have poor physical habitat due to a localized disturbance yet still support assemblages closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are not limiting. QHEI scores from hundreds of segments in the Midwestern U.S. have indicated that values greater than 60 are *generally* conducive to the existence of good quality warmwater faunas whereas scores less than 45 generally do not support assemblages consistent with Clean Water Act goal expectations (e.g., the General Use in Illinois). QHEI scores greater than 75 often typify habitat conditions capable of supporting exceptional fish assemblages. These rules-of-thumb have been altered by the NE IL IPS analyses and the newer thresholds were used to assess habitat quality. A QHEI matrix (Rankin 1989, 1995) showing the occurrence of good and modified attributes was also developed to evaluate the overall capacity of the stream habitat to support the General Use at each site and to diagnose potential deficiencies that might be limiting to the aquatic assemblages.

Data Management and Analysis

MBI employed the data storage, retrieval, and calculation routines available in the Ohio ECOS system as described in the project QAPP (MBI 2006b). Fish and macroinvertebrate data were reduced to relative abundance (numbers and weights) and species/taxa richness and composition metrics. The Illinois Fish Index of Biotic Integrity (fIBI) was calculated with the fish data using the Illinois EPA metrics in a program in Ohio ECOS. The macroinvertebrate data were analyzed using the Illinois macroinvertebrate Index of Biotic Integrity (mIBI).

Determination of Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine biological status (i.e., unimpaired or impaired, narrative ratings of quality) and assigning associated causes and sources of impairment utilizing the accompanying chemical/physical data and source information (e.g., point source loadings, land use). The identification of impairment in rivers and streams is straightforward - the numerical biological indices are the principal arbiter of aquatic life use attainment and impairment following the guidelines of Illinois EPA (2008). The rationale for using the biological results in the role as the principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a, b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995).

Describing the causes and sources associated with observed biological impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures (Yoder and Rankin 1995; Yoder and DeShon 2003; Miltner et al. 2010). The Northeastern Illinois Integrated Prioritization System (NE IPS; MBI 2020a) produced regionally derived stressor thresholds for more than 70 chemical and habitat variables (Table 3-5) as well as Restorability rankings for impaired sites and Susceptibility and Threat rankings for sites that attained the Illinois General Use biological criteria. These were used along with other stressor thresholds to evaluate the severity of any observed exceedances that correspond to biological impairments and response signatures.

Thus the assignment of principal associated causes and sources of biological impairment in this report represents the association of impairments (based on response indicators) with stressor and exposure indicators using linkages to the biosurvey data based on previous experiences within the strata of analogous situations and impacts. The reliability of the identification of associated causes and sources is increased where many such prior associations have been observed. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research that experimentally or statistically links symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experiences in interpreting symptoms (*i.e.,* multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and well-being of the patient, the ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including assemblage structure and function.

Hierarchy of Water Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively based on environmental results. A tiered approach that links the results of administrative actions with true environmental measures was employed by our analyses. The integrated approach (outlined in Figure) includes a hierarchical continuum, from administrative to true environmental indicators.

The six "levels" of indicators include:

1) actions taken by regulatory agencies (permitting, enforcement, grants);
2) responses by the regulated community (treatment works, pollution prevention);
3) changes in discharged quantities (pollutant loadings);
4) changes in ambient conditions (water quality, habitat);
5) changes in uptake and/or assimilation (tissue contamination, biomarkers, assimilative capacity); and,
6) changes in health, ecology, or other effects (ecological condition, pathogens).

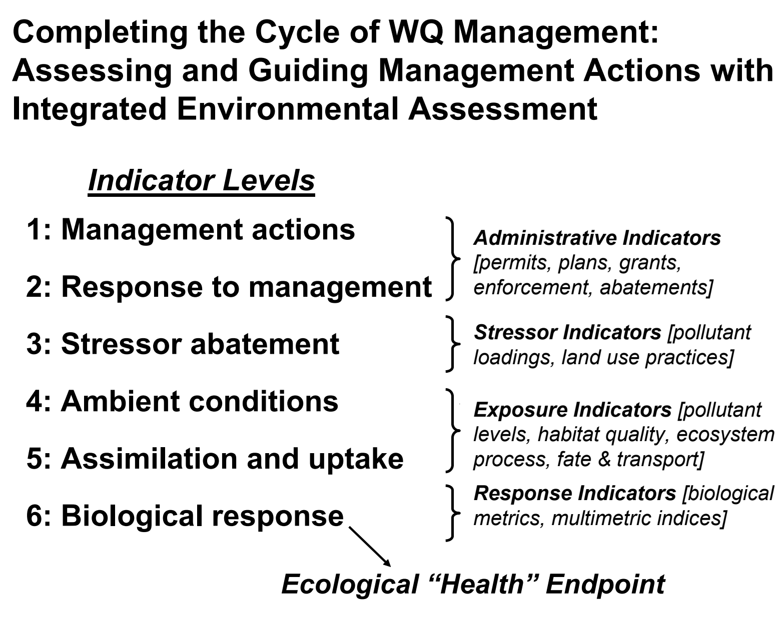


***Figure 5**. Hierarchy of administrative and environmental indicators that can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995) and further enhanced by Karr and Yoder (2004).*

In this process, the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). An example is the aggregate effect of billions of dollars spent on water pollution control since the early 1970s that have been determined with quantifiable measures of environmental condition (Yoder et al. 2005). Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise the Illinois EPA biological endpoints. Other response indicators can include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels that serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each (Yoder and Rankin 1998).

Illinois Water Quality Standards: Designated Aquatic Life Uses

The Illinois Water Quality Standards (WQS; IL Part 303.204-206) consist of designated uses and chemical criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad categories, aquatic life and non-aquatic life uses. Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each use. For example, the biological thresholds for the mIBI and the fIBI are listed at the end of Table 1 and most Illinois water chemistry criteria are available on the Illinois EPA web site (http://www.epa.state.il.us/water/water-quality-standards/water-quality-criteria-list.pdf). The system of use designations employed in the Illinois WQS constitutes a general approach in that one or two levels of protection are provided and extended to all water bodies regardless of size or position in the landscape. In applications of state WQS to the management of water resource issues in rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality assessments. In addition, an emphasis on protecting for aquatic life generally results in water quality suitable for all other uses.

Aquatic life use support for a water body in Illinois is determined by examining all available biological and water quality information. Where information exists for both fish and macroinvertebrate indicators, and both indicators demonstrate full support, the water body is considered in full support independent of the water chemistry results. Where information for both biological indicators exists, and one indicator suggests full support while the other shows moderate impairment, a use decision of full support can be made if the water chemistry data show no indication of impairment. Where one biological indicator is severely impaired, non-support is demonstrated. If information for only one biological indicator exists, water chemistry information is used to inform the use support decision in that a biological result of full support can be overridden if the water chemistry results clearly demonstrate impairment. However, in the E. Branch DuPage River survey biological data was available for each site.

Background Concentrations of Chemical Stressors

For this analysis, MBI compared water chemistry results to water quality criteria where they exist. However, comparisons to levels in reference or "unpolluted" waters are also useful when a risk-based approach is used to estimate likely causes of impairment. In this respect, the IPS report (MBI 2020a) derived local thresholds where correlational analyses were used to derive benchmarks, above which fish or macroinvertebrate impairment would be more likely (Tables 3-5). In some cases, if an IPS or WQC thresholds are not available, other literature-based thresholds may be applied where references.

Table 3. *Biological effect thresholds derived from Northeast Illinois streams and rivers for 31 water column parameters as part of the NE Illinois IPS development and used to assess results from the Year 3 Upper Des Plaines River study area. The most limiting of the fish or macroinvertebrate assemblages for each parameter are indicated along with thresholds for excellent, good, fair, poor, and very poor biological condition and reference site values (median and 2 times the interquartile range).*

Parameter Code	Variable Name	Units	Parameter Group	Limiting Assemblage	FIT Score	Sample N	Thresholds by Narrative Condition Category					Reference Site Values (Median-2X IQR)	Refer-ence Site N
							Excellent	Good	Fair	Poor	Very Poor		
P665	Total Phosphorus	mg/L	Nutrients	Fish	0.04	1464	≤0.106	>0.106	>0.277	>1.002	>1.726	0.088 (0.062-0.115)	35
P94	Conductivity	µS/cm	Ionic	Fish	0.05	1464	≤739	≥739	>1038	>1208	>1378	922 (705-1158)	40
P70300	Total Dissolved Solids	mg/L	Ionic	Fish	0.10	1464	≤453.8	>453.8	>558.0	>651.2	>744.5	614 (512-664)	28
DO_MIN	Minimum DO	mg/L	Demand	Macros	0.10	985	>8.0	≥6.5	>5.47	<4.44	<3.4	8.6 (6.5-9.6)	29
P1092	Zinc, Total	µg/L	Metal_Tox	Fish	0.13	1464	≤7.47	>7.47	>9.78	>11.00	>12.22	2.0 (2.0-7.0)	23
P625	Total Kjeldahl Nitrogen	mg/L	Demand	Macros	0.14	985	≤1.07	>1.07	>1.12	>1.63	>2.14	0.74 (0.30-0.99)	30
P940	Chloride, Total	mg/L	Ionic	Fish	0.17	1464	≤40.00	>40.00	>120.0	>184.9	>249.8	154 (80.3-171.3)	33
P299	Mean Dissolved Oxygen	mg/L	Demand	Macros	0.21	985	≥9.42	<9.42	<9.25	<6.11	<3.05	8.6 (7.9-9.0)	40
P310	BOD (5-Day)	mg/L	Demand	Macros	0.21	985	≤1.30	>1.30	>2.35	>3.45	>4.54	2 (2.0-2.2)	27
P610	Total Ammonia	mg/L	Nutrients	Macros	0.28	985	≤0.084	>0.084	>0.100	>0.190	>0.280	0.1 (0.10-0.10)	34
P630	Nitrate-N	mg/L	Nutrients	Fish	0.29	1464	≤3.767	>3.767	>5.045	>7.344	>9.643	0.39 (0.29-0.97)	32
P929	Sodium, Total	mg/L	Ionic	Fish	0.29	1464	≤16275	>16275	>45000	>79056	>113112	14200 (10375-22500	21
P530	Total Suspended Solids	mg/L	Demand	Fish	0.32	1464	≤17.50	>17.50	>31.60	>35.15	>38.69	9.2 (5.4-20.3)	33
P615	Nitrite-N	mg/L	Nutrients	Macros	0.41	985	≤0.014	>0.014	>0.040	>0.068	>0.096	0.01 (0.01-0.01)	27
P1027	Cadmium, Total	µg/L	Metal_Tox	Fish	0.93	1464	≤0.937	>0.937	>0.974	>0.983	>0.991	<MDL (0.17)	23
DO_MAX	Maximum DO	mg/L	Demand	Macros	0.94	985	≤10.36	≥10.36	>12.21	>14.24	>16.28	8.74 (8.21-9.45)	29
P82078	Turbidity	NTU	Demand	Macros	2.61	985	--	≤19.3	>19.3	>25.9	>32.5	11.0 (4.5-24.5)	7
P549	Volatile Suspended Solids	mg/L	Demand	Fish	2.81	1464	≤5.000	>5.000	>7.769	>9.825	>11.88	6.0 (4.8-7.4)	5
P945	Sulfate, Total	mg/L	Ionic	Macros	6.49	985	≤58.27	>58.27	>73.10	>83.45	>93.81	74.6 (61.8-81.8)	4
Metals and Toxics													
P1042	Copper, Total	µg/L	Metal_Tox	Fish	1.75	1464	--	≤4.480 [CS: 18.65]	>4.480	>4.969	>5.458 [AS: 30.1]	2.00 (1.96-4.15)	22
P1051	Lead, Total	µg/L	Metal_Tox	Macros	2.11	985	≤2.851	>2.851 [CS; 18.0]	>3.335	>3.884	>4.434 [AS: 343]	0.24 (0.20-0.57)	23
P1082	Strontium	µg/L	Metal_Tox	Fish	2.69	1464	≤169.1	>169.1	>190.8	>280.4	>370.1	150 (135-181)	21
P1055	Manganese, Total	µg/L	Metal_Tox	Macros	2.74	985	≤53.71	>53.71 [CS: 3319]	>77.03	>107.1	>137.2 [AS: 7808]	32.0 (24.1-38.2)	23
P1067	Nickel, Total	µg/L	Metal_Tox	Macros	3.26	985	--	≤3.470 [CS: 103.6]	>3.470	>9.585	>15.70 [AS: 932]	5 (1.5-21)	14
P1105	Aluminum, Total	µg/L	Metal_Tox	Fish	4.54	1464	≤310.0	>310.0	>393.3	>560.2	>727.0	200 (128-449)	21
P1007	Barium, Total	µg/L	Metal_Tox	Fish	4.77	1464	≤74.1	>74.09	>84.88	>101.8	>118.6	56.3 (44.3-64.7)	21
P720	Cyanide, Total	µg/L	Metal_Tox	Macros	5.17	985	≤8	>8 [CS: 5.2]	>10	>10	>10 [AS: 22]	3 (2-10)	6
P1002	Arsenic	µg/L	Metal_Tox	Macros	9.19	985	--	≤3.616 [CS: 190]	>3.455	>5.029	>6.603 [AS: 360]	Insufficient Data	
P937	Potassium, Total	mg/L	Ionic	Macros	10.13	985	≤3158	>3158	>6300	>7718	>9129	2400 (1574-2817)	21
P1034	Chromium, Total	µg/L	Metal_Tox	Fish	10.17	1464	≤1.398	>1.398 [CS: 167]	>1.540	>2.682	>3.824 [AS: 3503]	1.73 (1.30-2.00)	6
P916	Calcium, Total	mg/L	Ionic	Fish	Unimodal	1464	≤84425	>84425	>86067	>86313	>86559	54,000 (80-74,250)	21

CS - Illinois WQS chronic standard equated to Good; AS - Illinois WQS acute standard equated to Very Poor.

Table 4. *Biological effect thresholds derived from Northeast Illinois streams and rivers for 25 habitat and land use parameters as part of the NE Illinois IPS development and used to assess results from the Year 2 Des Plaines River study area. The most limiting of the fish or macroinvertebrate assemblages for each parameter are indicated along with thresholds for excellent, good, fair, poor, and very poor biological condition.*

Parameter Code	Variable Name	Units	Parameter Group	Limiting Assemblage	FIT Score	Sample N	Thresholds by Narrative Condition Category					Reference Site Values (Median - 2X IQR)	Reference Site N
							Excellent	Good	Fair	Poor	Very Poor		
EMBEDDED	Embeddedness Score	QHEI Units	Habitat	Fish	0.03	1393	≤1.3	>1.3	>1.6	>2.4	>3.2	2 (2-2)	29
Urban	Urban (Ust. WS)	Wtd. %	Land Use	Fish	0.03	2657	≤8.8	>8.8	>45.0	>63.2	>81.3	8.7 (3.0-9.5)	48
QHEI	QHEI Score	QHEI Units	Habitat	Fish	0.04	1393	≥84.5	>75.9	<75.9	<50.1	<25.0	84 (76-90)	34
SUBSTRAT	Substrate Score	QHEI Units	Habitat	Fish	0.04	1393	≥16.0	<16.0	<15.0	<9.9	<5.0	8 (7-9)	33
WWH_ATTR	Good Habitat Attributes	Number	Habitat	Fish	0.04	1393	≥9	<9	<8	<5	<2	16 (15-17)	34
Imperv	Impervious (30 m)	Wtd. %	Land Use	Fish	0.04	2657	≤18.3	>18.3	>30.5	>53.4	>76.4	2.1 (0.0-14.7)	48
Imperv	Impervious (30 m Clipped)	Wtd. %	Land Use	Fish	0.04	2657	≤13.4	>13.4	>26.7	>50.9	>75.1	2.1 (0.0-6.1)	48
CHANNEL	Channel Score	QHEI Units	Habitat	Fish	0.07	1393	≥16.8	<16.8	<14.00	<9.2	<4.6	16 (13-19)	34
COVER	Cover Score	QHEI Units	Habitat	Fish	0.07	1393	≥16.0	<16.0	<14.0	<9.2	<4.6	16 (16-17)	34
SILTCOVE	Silt Cover Score	QHEI Units	Habitat	Fish	0.07	1393	≤2.0	<2.0	>2.0	>2.7	>3.33	2 (2-3)	29
Develop	Developed (Ust. WS)	Wtd. %	Land Use	Fish	0.07	2657	≤9.1	>9.1	>45.6	>63.6	>81.5	9.1 (2.9-9.6)	48
RIPARIAN	Riparian Score	QHEI Units	Habitat	Fish	0.10	1393	≥6.0	>6.0	<6.0	<4.0	<2.0	7.0 (6.0-9.5)	34
Imperv	Impervious (Ust. WS)	Wtd. %	Land Use	Macros	0.10	3096	≤5.6	>5.6	>13.2	>41.8	>70.5	5.2 (2.1-5.4)	48
DEPTH	Depth Score	QHEI Units	Habitat	Fish	0.11	1393	≥10.0	>10.0	<10.0	<6.6	<3.3	10 (9-11)	33
MWH_ATTR	Poor Habitat Attributes	Number	Habitat	Fish	0.12	1393	≤1	<1	>1	>3	>6	2 (1-5)	20
HYD_QHEI	Hydro-QHEI	QHEI Units	Habitat	Fish	0.13	1393	≥17.0	>17.0	<19.5	<12.9	<6.4	20 (14-22)	33
CURRENT	Current Score	QHEI Units	Habitat	Fish	0.14	1393	≥7.0	>7.0	<7.0	<4.6	<2.3	11 (5.8-11.0)	33
POOL	Pool Score	QHEI Units	Habitat	Fish	0.15	1393	≥11.3	<11.3	<10.0	<6.6	<3.3	11.5 (10-12)	34
Heavurb	Heavy Urban (Ust. WS)	Wtd. %	Land Use	Macros	0.17	3096	≤7.7	>7.7	>29.3	>52.6	>76.0	5.5 (1.1-6.0)	48
RIFFLE	Riff< Score	QHEI Units	Habitat	Fish	0.27	1393	≥5.8	≥5.8	<5.8	<3.9	<1.9	6 (5-7)	34
GRAD_S	Gradient Score	QHEI Units	Habitat	Fish	0.31	1393	≥10.0	>10.0	<10.0	<6.6	<3.3	10 (10-10)	34
Ag	Agricultural (Ust. WS)	Wtd. %	Land Use	Macros	4.82	3096	≤87.1	<87.1	>62.1	>74.6	>87.1	83.9 (11.7-85.4)	48
GRADIENT	Gradient (ft/mi)	feet/mile	Habitat	Fish	12.20	1393	≥8.8	<8.8	<4.3	<2.8	<1.4	8.6 (4.9-11.3)	34
Ag	Agricultural (30 m)	Wtd. %	Land Use	Macros	16.66	3096	≤87.2	<87.2	>43.2	>61.9	>80.7	0.0 (0.0-0.4)	48

***Table 5.** Biological effect thresholds derived from Northeast Illinois streams and rivers for 30 sediment chemical parameters as part of the NE Illinois IPS development and used to assess results from the Year 2 Des Plaines River study area. The most limiting of the fish or macroinvertebrate assemblages for each parameter are indicated along with thresholds for excellent, good, fair, poor, and very poor biological condition.*

Parameter			Parameter	Limiting			Thresholds by Narrative Condition Category					Literature Thresholds			
Code	Variable Name	Units	Group	Assemblage	FIT Score	Sample N	Excellent	Good	Fair	Poor	Very Poor	TEC/LEL	PEC/PEL	Short	Source
P1093	Zinc	mg/kg	Metal_Tox	Macros	2.22	985	≤75.00	>75.00	>100.0	>133.9	>167.8	121	459	170	MacDonald
P34524	Benzo(g,h,i)perylene	µg/kg	PAH	Macros	2.32	985	--	< 335.0	>335.0	>792.1	>1249	170	320		MacDonald
P34406	Indeno(1,2,3-cd)pyrene	µg/kg	PAH	Macros	2.41	985	--	< 260.5	>260.5	>623.3	>986.2	200	3200		MacDonald
P1043	Copper	mg/kg	Metal_Tox	Macros	2.42	985	≤19.00	>19.00	>29.78	>40.45	>51.12	31.6	149	37	MacDonald
P34233	Benzo(b)fluoranthene	µg/kg	PAH	Macros	2.51	985	--	<520.8	>520.8	>1437	>2354	240	13400		MacDonald
P1068	Nickel	mg/kg	Metal_Tox	Macros	2.67	985	--	<19.50	>19.50	>22.52	>25.53	22.7	48.6	26	MacDonald
P34250	Benzo(a)pyrene	µg/kg	PAH	Macros	2.85	985	--	<230.0	>230.0	>798.3	>1367	150	1450		MacDonald
P34472	Pyrene	µg/kg	PAH	Macros	2.85	985	--	< 393.0	>393.0	>1570	>2747	195	1520		MacDonald
P1052	Lead	mg/kg	Metal_Tox	Macros	3.01	985	≤15.50	>15.50	>24.80	>33.04	>41.27	35.8	128	60	MacDonald
P34529	Benzo[a]anthracene	µg/kg	PAH	Macros	3.48	985	--	< 239.0	>239.0	>699.4	>1160	108	1050		MacDonald
P34323	Chrysene	µg/kg	PAH	Macros	3.51	985	--	<266.0	>266.0	>958.3	>1651	166	1290		MacDonald
P34379	Fluoranthene	µg/kg	PAH	Macros	3.91	985	--	<774.0	>774.0	>2432	>4091	423	2230		MacDonald
P1083	Strontium	mg/kg	Metal_Tox	Macros	4.44	985	--	<81.80	>81.80	>106.8	>131.9	None	None		
P34559	Dibenz(a,h)anthracene	µg/kg	PAH	Macros	4.57	985	--	< 101.0	>101.0	>167.3	>233.7	33	135		MacDonald
P34223	Anthracene	µg/kg	PAH	Macros	5.10	985	--	<78.00	>78.00	>119.9	>161.8	46.9	245		CCME
P34464	Phenanthrene	µg/kg	PAH	Macros	5.10	985	--	< 243.5	>243.5	>803.3	>1363	204	1170		MacDonald
P1003	Arsenic	mg/kg	Metal_Tox	Macros	6.21	985	--	≤8.65	>8.65	>15.82	>23.67	9.79	33	7.2	MacDonald
P1029	Chromium	mg/kg	Metal_Tox	Macros	6.29	985	≤20.53	>20.53	>23.30	>26.22	>29.15	43.4	111	37	MacDonald
P1053	Manganese	mg/kg	Metal_Tox	Macros	7.08	985	≤841.0	>841.0	>845.5	>996.8	>1148	460	1100	1100	MacDonald
P1078	Silver	mg/kg	Metal_Tox	Macros	7.11	985	--	<0.483	>0.483	>1.261	>2.039	1.6	2.2		MacDonald
P1108	Aluminum	mg/kg	Metal_Tox	Macros	8.26	985	--	<6480	>6480	>8272	>10064				
P1008	Barium	mg/kg	Metal_Tox	Macros	8.88	985	--	≤141.0	>132.0	>150.3	>168.7			145	
P1028	Cadmium	mg/kg	Metal_Tox	Macros	11.00	985	--	≤0.933	>0.745	>1.354	>1.963	0.99	4.98	2	MacDonald
P1013	Beryllium	mg/kg	Metal_Tox	Macros	ND[a]	985	--	≤0.411	>0.411	>0.496	>0.581				
P1103	Tin	mg/kg	Metal_Tox	Macros	ND[a]	985	--	<8.86	>11.00	>16.73	>24.60				
P34203	Acenaphthylene	µg/kg	PAH	Macros	ND[a]	985	--	<86.38	>86.38	>103.6	>120.9	5.87	128		CCME
P34208	Acenaphthene	µg/kg	PAH	Macros	ND[a]	985	--	<84.25	>84.25	>104.8	>125.3	6.71	88.9		CCME
P34262	Delta-BHC	µg/kg	PAH	Macros	ND[a]	985	--	<2.098	>2.098	>6.19	>10.28				
P34384	Fluorene	µg/kg	PAH	Macros	ND[a]	985	--	<84.25	>84.25	>104.8	>125.3	77.4	536		MacDonald
P34445	Naphthalene	µg/kg	PAH	Macros	ND[a]	985	--	< 86.38	>86.38	>103.6	>120.9	34.6	391		CCME

[a] - Not determined (ND) due to a high number of non-detects

MacDonald - MacDonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39, 20–31.

CCME - Canadian Council of Ministers of the Environment (CCME). 1999. Canadian sediment quality guidelines for the protection of aquatic life. Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg, MB.

STUDY AREA DESCRIPTION

The E. Branch DuPage River watershed includes 81 square miles of central DuPage and northern Will Counties (Figure). The major tributaries are St. Joseph and Prentiss Creeks. The East Branch mainstem is approximately 26 linear miles, joining the West Branch DuPage River on the Bolingbrook municipal line to form the mainstem of the DuPage River, a tributary to the Des Plains River. Sixteen (16) municipalities are located within the watershed. Seven (7) publicly owned treatment plants discharge to the East Branch, as does one combined sewer overflow. The watershed has been largely developed and based on visual comparisons, land usage appears virtually identical to previous surveys (Table 6). From the 2011 report, over 85% of the watershed has been developed with nearly half (48.5%) composed of low intensity suburban development. Higher intensity development tends to be clustered in the municipalities and along major highways.

Table 6. *Land use types by area and percent for the E. Branch DuPage River watershed. Percentages are based on total watershed area. Land use data is based on Chicago Metropolitan Agency for Planning (CMAP) 2005 land use data.*

Land Use Category	E. Branch DuPage River Watershed	
	Area (acres)	Area (percent)
Developed, Low Intensity	25258	48.5
Developed, Medium Intensity	7774	14.9
Developed, High Intensity	3127	6.0
Developed, Open Space	8156	15.7
Forest	3572	6.9
Grassland/Herbaceous	1238	2.4
Wetland	970	1.9
Agriculture	859	1.7
Open Water	571	1.1
Shrub/Scrub	253	0.5
Barren Land (Rock/Clay/Sand)	248	0.5
Totals	**52,026**	**100.0**

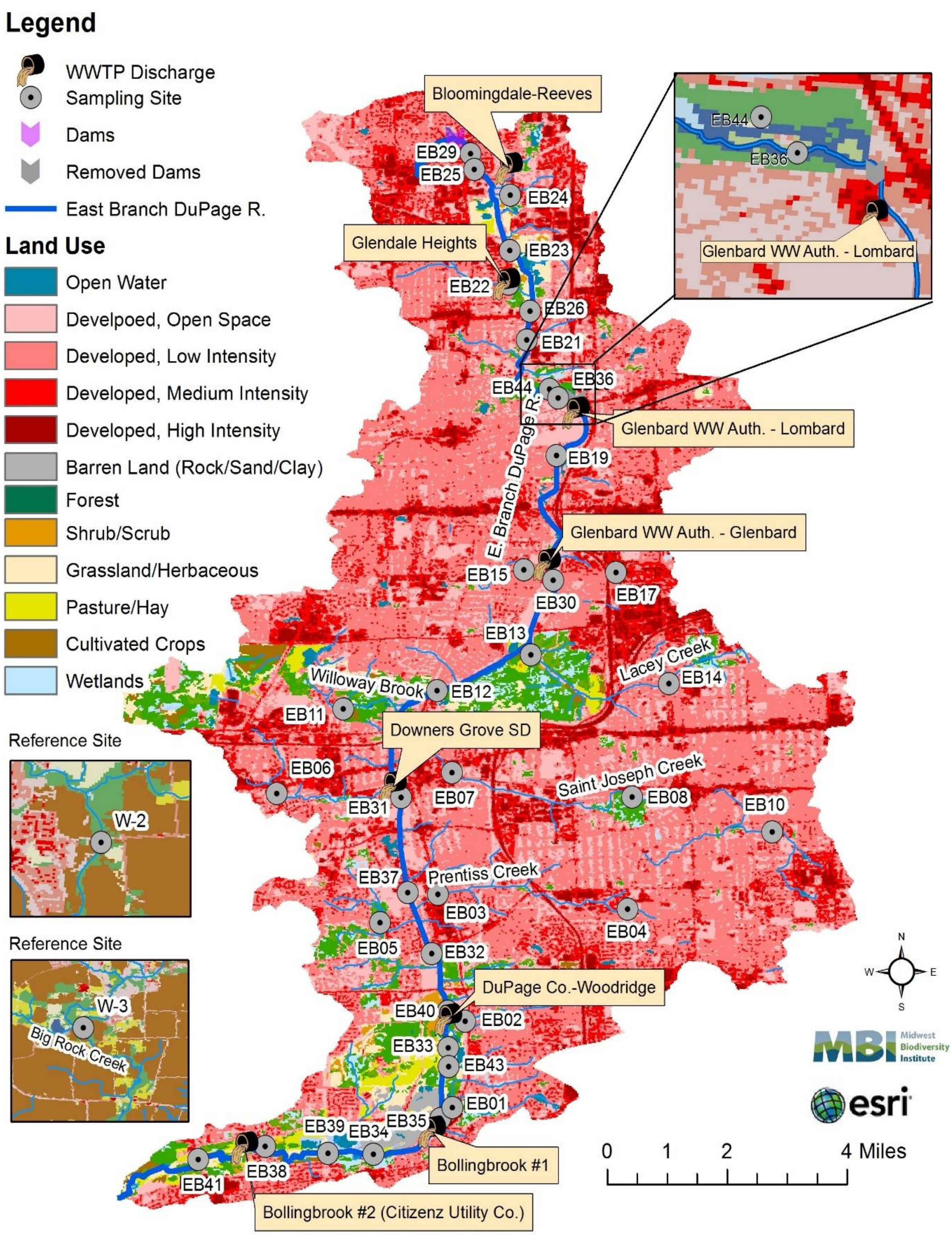


Figure 6. *Land use types in the E. Branch DuPage River watershed based on National Land Cover Dataset (NLCD).* http://www.mrlc.gov/nlcd2011.php

E. Branch DuPage River Dams

The status of dams in the East Branch watershed has remained unchanged since 2011. A summary of the dam status from the 2011 report appears in Table and the following texts.

West Lake Dam: Bloomingdale, West Lake Park, ½ mile north of Army Trail Road, 500 feet west of Glen Ellyn Road. The existing concrete inlet and outlet channels, and the existing lake outfall structure were constructed in the early 1970's in conjunction with the development of the Westlake Subdivision. The primary purpose of the lake is to provide retention for excess stormwater runoff from the upstream Westlake development. The secondary benefit of the lake is to provide for aesthetic benefits and recreational uses as a public park area, on land owned and operated by the Bloomingdale Park District. Maintenance to sustain the lake's function as a stormwater retention facility is handled by the Village.

Churchill Woods Dam: The Churchill Woods Dam was located on the E. Branch (RM 18.7) within the Churchill Woods Forest Preserve in Glen Ellyn. Originally built in the 1930's as part of the Works Progress Administration, the 50-foot long and 3.5 feet high concrete gravity dam was removed in February 2011. The former impoundment created by the dam was approximately 31 acres in size and extended from Crescent Boulevard to approximately St. Charles Road (RM 18.7-20.0). The river is still somewhat impounded at the site with the new elevation being set by three box culvers under Crescent Boulevard immediately downstream of the former dam wall. The remaining impoundment is approximately 12 acres in size.

Maryknoll Gabion Weir Dam: The Maryknoll gabion weir dam is located on the E. Branch, adjacent to the Maryknoll residential subdivision in Glen Ellyn. The dam is located east of Maryknoll Circle, approximately ¼ mile south of Route 38, and 200 feet west of I-355. Access to the dam is from Maryknoll Circle.

Table 7. *Known dams or bed control structures in the E. Branch DuPage River watershed. Impoundment sizes listed as N/A (not applicable) are stormwater control structures that do not maintain impoundments under dry weather conditions. Letters next to dam names correspond to those in the sampling site locations map (see Figure).*

Dam Name	Affected Waterway	River Mile	Impoundment Size (acres)	Impedes Fish Passage
a) West Lake Dam	East Branch	23.8	13	Y
d) Churchill Woods Dam[a] (modified and partially removed Feb. 2011)	East Branch	18.7	12	N
e) Mary knoll Gabion Weir	East Branch	16.8	None	N
g) Prentiss Creek flow-through Dam	Prentiss Cr.[b]/E. Branch	0.1/8.6	N/A	N

[a] The dam was removed in February 2011 and is no longer an impediment to fish passage – a small impounded area remains.
[b] A series of three additional dams w/impoundments on lower Prentiss Creek are impediments to fish passage.

Former Churchill Woods dam (E. Branch RM 18.6 at Crescent Rd. (Note: dam wall removed in February 2011).

The dam was constructed in the early 1980's as part of Maryknoll Development to provide stormwater detention for the development. Flow at normal water level is not impeded. The dam consists of gabions with no concrete caps. The impoundment does not extend further upstream than Route 38.

Prentiss Creek Dam (flow-through): The Prentiss Creek Dam is located on the E. Branch within the Seven Bridges Golf Club in Woodridge. The dam actually consists of two structures, one on the East Branch and one at the mouth of Prentiss Creek, both located immediately upstream from Hobson Road. The structures are owned by the Village of Woodridge and are 19 years old. Access to the dams is best granted from the golf course but it is possible to access the dam from Double Eagle Drive using the sidewalk.

The dam was constructed in 1989 to provide on line stormwater detention for the adjacent development. The dams are gravity structures consisting of rock-filled gabions that impound water at a greater rate as the flow increases. The East Branch structure is 20 feet wide while the Prentiss Creek structure is 10 feet wide.

Prentiss Creek stormwater control dam on E. Branch DuPage R. at the Seven Bridges Golf Club.

Point Source Discharges

Point sources in the East Branch watershed include seven major wastewater treatment plants WWTPs) that are designed to discharge an average of 52.77 MGD of treated wastewater (Table 8). As described in the 2011 report, the East Branch mainstem is effluent dominated during the July-October summer-fall base-flow period. WWTP effluent comprised 76% of river flow in September 2007 and reached 98% during a low flow period in September 2011 (see Figure). Since effluent volumes in the 3rd quarter of 2019 have remained consistent compared to previous survey years (Figure), the trend of effluent domination during summer low-flow-periods is a constant.

Table 8. *Municipal wastewater treatment plants located in the E. Branch DuPage River study area. DAF = design average flow; DMF = design maximum flow. Figure 7 shows the relative contribution as a percent of each plant to the average effluent volume in million gallons per day (MGD) for the 3rd quarter of 2019.*

NPDES	Name	DAF	DMF	Receiving Stream (RM)	Long.	Lat.
IL0021130	Bloomingdale-Reeves	3.45	8.63	East Branch (23.3)	-88.0528	41.9375
IL0028967	Glendale Heights	5.26	10.52	Armitage Ditch (21.4,0.4)	-88.0534	41.9111
IL0022741	Glenbard WW Auth.-Lombard (CSO)	-[2]	58.0	East Branch (18.6)	-88.0367	41.8817
IL0021547	Glenbard WW Auth.-Glenbard	16.02	47.0	East Branch (15.9)	-88.0436	41.8469
IL0028380	Downers Grove SD	11	22.0	East Branch (11.35)	-88.0808	41.7961
IL0031844	DuPage Co.- Woodridge (Greene Valley)	12	28.6	East Branch (7.59)	-88.0675	41.7429
IL0032689	Bolingbrook #1	2.04	4.51	East Branch (5.66)	-88.0714	41.7172
IL0032735	Bolingbrook #2 (Citizens Utility)	3.0	7.5	East Branch (2.8)	-88.1167	41.7136

Effluent quality data was evaluated against NPDES permit limits to gauge plant performance, especially with respect to plant flows relative to loadings of key constituents including 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), and ammonia-nitrogen (NH_3-N) (Figure). Effluent volumes have remained steady over time and continue to be dominated by the Glenbard, Woodridge, and Downers Grove WWTPs that contribute ≈75% of total effluent volumes. Loading contributions follow the pattern in effluent volume as the three largest WWTPs, along with Bollingbrook#2, contribute about 75% of ammonia loadings. Glenbard, Woodridge, and Downers Grove, along with Glendale Heights, also contribute the majority of the BOD_5 and TSS loadings (Figure). We also accessed the US EPA ECHO website (www.echo.epa.gov) for 2019 to identified any exceedances of NPDES permit limits. Based on monthly sampling, Bolingbrook #1 had two days with ammonia exceedances and four days with fecal coliform exceedances; Bolingbrook #2 had five days with ammonia exceedances, two days with TSS exceedances, five days with fecal coliform and 12 days with Mercury exceedances; Woodridge has two days with ammonia exceedances, one day with a TSS exceedances, one day with a pH exceedance and four days with fecal coliform exceedances; Downers Grove had two

[2] The Lombard facility discharges only during peak flow events.

days with fecal coliform exceedances and one day with a TSS exceedance; Glendale Heights has one day with a fecal coliform exceedances; and the rest had no reported exceedances. Based on a monthly sampling frequency this suggests that ammonia discharges, in particular, are likely contributing to the aquatic life impairment.

While flow volumes remained consistent over time, discharge data show a roughly 50% reduction in total ammonia-N loadings since 2008-11. The decline is largely attributed to improvements at the Woodbridge WWTP as loadings declined from 45 to 6.1 kg/day (Figure).

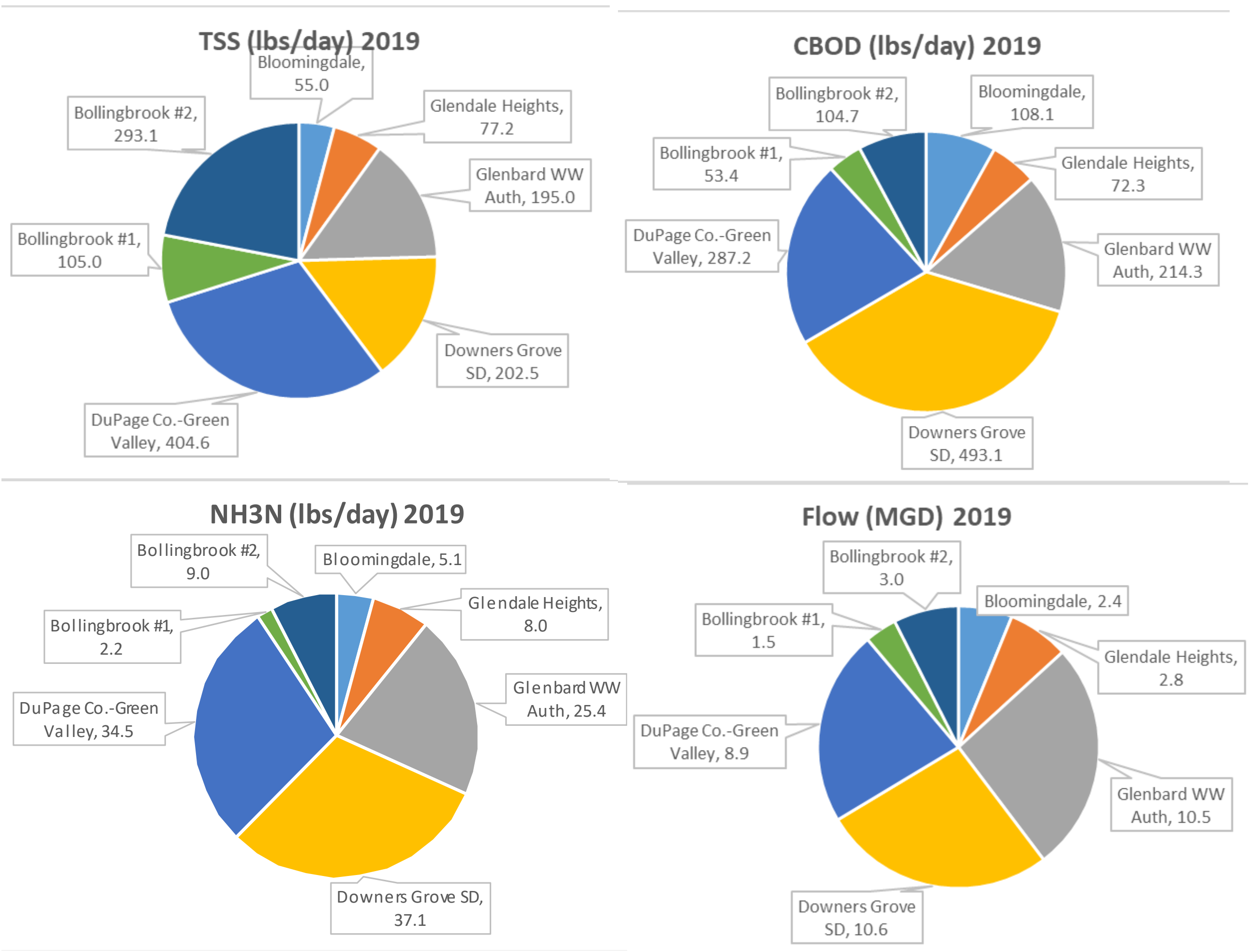


Figure 7. *Pie diagrams of East Branch DuPage River watershed WWTP loadings (lbs./day) and effluent flows (MGD) during the 3rd quarter of 2019 for TSS and BOD_5 (top row), ammonia NH3-N and effluent flow (middle row).*

WWTP Effluent Chloride Levels

We obtained readily available effluent chloride concentration data from five (5) major WWTPs in E. Branch study area from 2015 to 2019. This included the Downers Grove Sanitary District (DGSD); Green Valley (Woodridge) DuPage County (GVDC); Village of Bolingbrook #01 (VB01); Village of Bolingbrook #02 (VB02); and Village of Glendale Heights (VGH). Figure 8 shows box and whisker plots of the total chloride concentration (uncorrected for flow) for samples collected at the 5 WWTPs. Summer concentrations are elevated compared what should be collected at background levels and are at levels associated with impaired aquatic life based on IPS thresholds. Work in Illinois (Kelly and Wilson) found that "approximately 16% of the samples collected from municipal wells in northeastern Illinois in the 1990s had Cl- concentrations greater than 100 mg L-1; median values were less than 10 mg L-1 prior to 1960, before extensive road salting." shows that groundwater concentrations in the DuPage River watershed are high with average groundwater chloride concentrations of: "51 and 106 mg/L in the Salt Creek and East Branch watersheds, respectively." Panno et al. (2006) found that shallow groundwater aquifers in Northern Illinois generally have concentrations between 1 and 15 mg/L and that values > 15 mg/L are likely evidence for anthropogenic sources. Thus sources of chloride in municipal effluents are likely related to influent concentrations and perhaps infiltration of stream or groundwater flows into the influent.

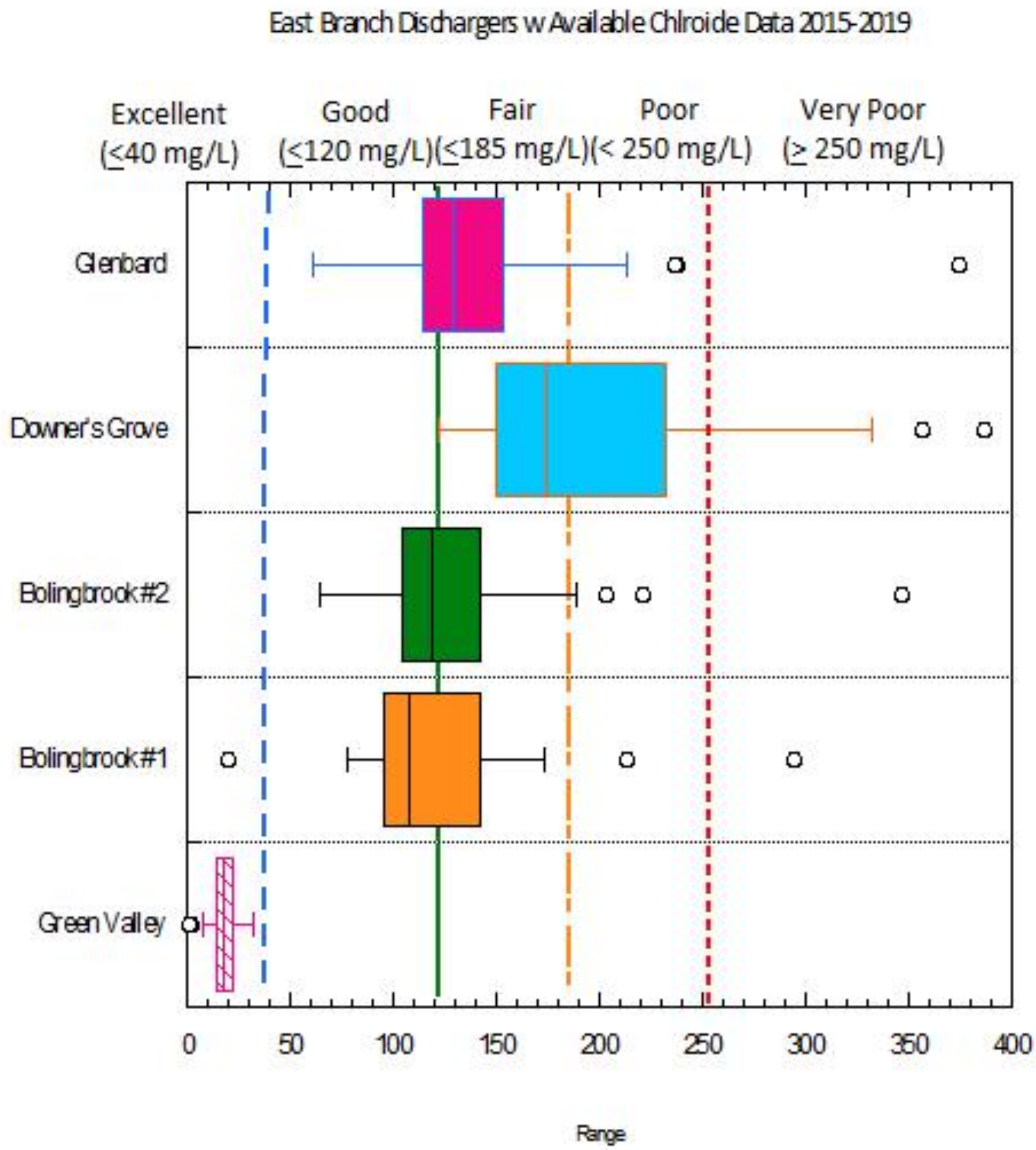


Figure 8. *Box-and-whisker plots of chloride concentrations (mg/L) collected at 5 of the major POTWs in the E Branch DuPage River study area between 2015 and 2019.*

E. Branch DuPage River Flow Conditions

Stream flows were seasonally variable in both the spring and summer of 2007-2019, but were generally highest during the 2019 survey (Figure 10). Daily minimum and peak flows measured at the USGS gage in Downers Grove were highest in 2019 during summer compared to other years (Figure 10).

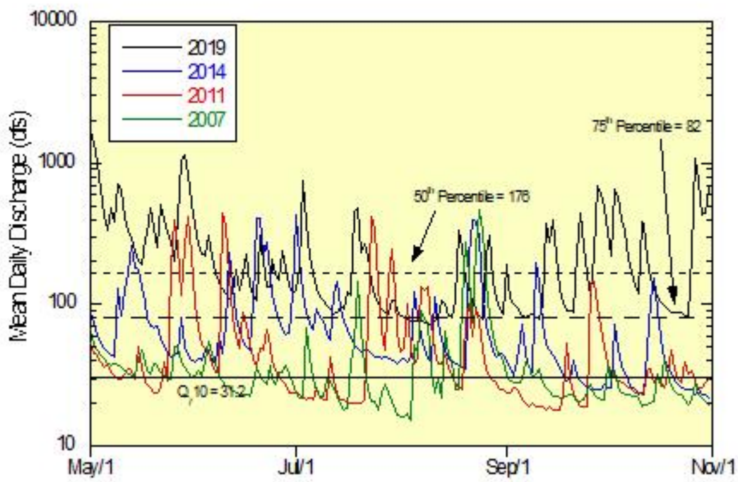


***Figure 9**. Flow hydrographs for the E. Branch DuPage River near Downers Grove (USGS station #05540160) during May-September 2007, 2011,2014 and 2019.*

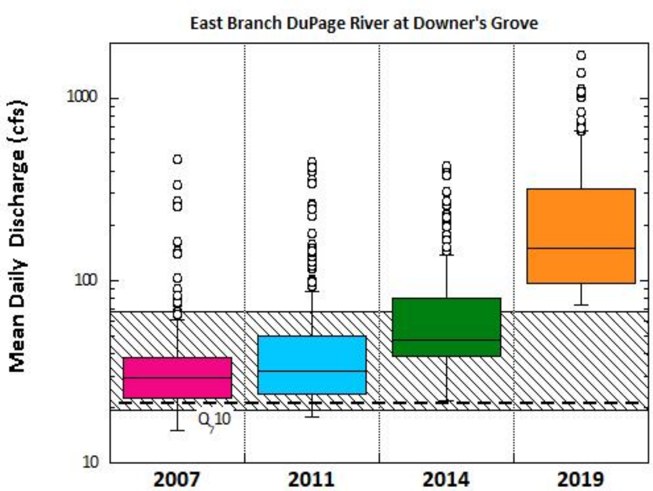


***Figure 10.** Box and whisker plot of flow trends in the East Branch DuPage River at Downers Grove, May-September 2007, 2011, 2014, and 2019.*

Percent of East Branch DuPage River Baseflow as Effluent

As previously documented in the 2011 and 2014 reports, the East Branch mainstem at summer-fall base flow is effluent dominated particularly when flows are low. Using the USGS gage at Bolingbrook to estimate the daily flow statistics for September 2019, the contribution of average daily flows from WWTPs upstream from the gage were plotted alongside the daily average flow (Figure 11). In 2014 the flow as percent effluent reach 98% in September 2011; because flows were higher through the summer in 2019, the maximum percent effluent was on 67%. Give that discharge levels have remained stable there is still a general trend of WWTP effluent domination during summer-fall base flows remains in the East Branch DuPage River.

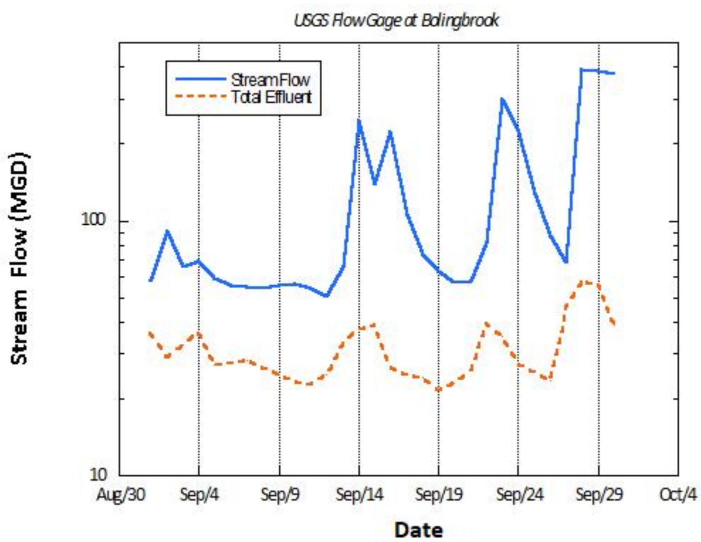


Figure 11. *Mean daily flow in September 2019 at the USGS gage at Bolingbrook [05540250] vs. the contribution of effluent flows from five upstream dischargers on the E. Branch DuPage River and tributaries.*

RESULTS

East Branch DuPage River - Chemical Water Quality

East Branch mainstem flows are effluent dominated during the late summer-early fall months, but were somewhat less so in 2019 compared to previous sampling years. Even so, chemical water quality is highly influenced by the concentration and composition of chemical constituents in WWTP effluents. The results in 2019 were consistent with 2011 and 2014 during low flow periods with respect to observing no ambient exceedances of Illinois water quality criteria for regulated parameters (i.e., BOD_5, TSS, NH_3-N) although there were scattered exceedances of NPDES permit limits for NH3-N and TSS. Ambient chemical exceedances were limited to D.O. measured by continuous monitors in the East Branch mainstem (9).

In 2019, although there were no exceedances of the ammonia-N water quality criteria, concentrations were elevated at most sites, in both the mainstem and tributaries compared to previous years at levels associated with impaired biological assemblages (Figures 12, 13). In 2019 ammonia concentrations increased downstream from the Bloomingdale WWTP, decreased downstream of the Glendale WWTP and then increased after the Glenbard CSO outfall (Figure 13, top). After that concentrations gradually decreased past the Glenbard WWTP (Lombard) (IPS very poor range) and Downers Grove WWTP (IPS poor to fair range) and then increased slightly downstream of the Bolingbrook #1 and #2 WWTPs into the fair-poor IPS range (Figure 13, top). Organic nitrogen (TKN) show an increase downstream of Bloomingdale followed by a decline to the good-excellent range where it stayed along the remainder of the mainstem (Figure 14, top).

Nitrate and phosphorus levels increased sharply downstream from the Bloomingdale-Reeves WWTP (the upstream most WWTP) and essentially mirrored the 2011 results downstream from the major WWTPs (Figure 14, bottom). The sharp increase in nitrate levels below point sources between 2007 and 2011-19 mirrors the trend observed in effluent dominated Ohio streams following improved wastewater treatment and reductions in ammonia-N (Figure 13, bottom). The overall condition of the mainstem was considered enriched with nutrient concentrations generally near or above levels associated with biological impairment (Figures 13 and 14).

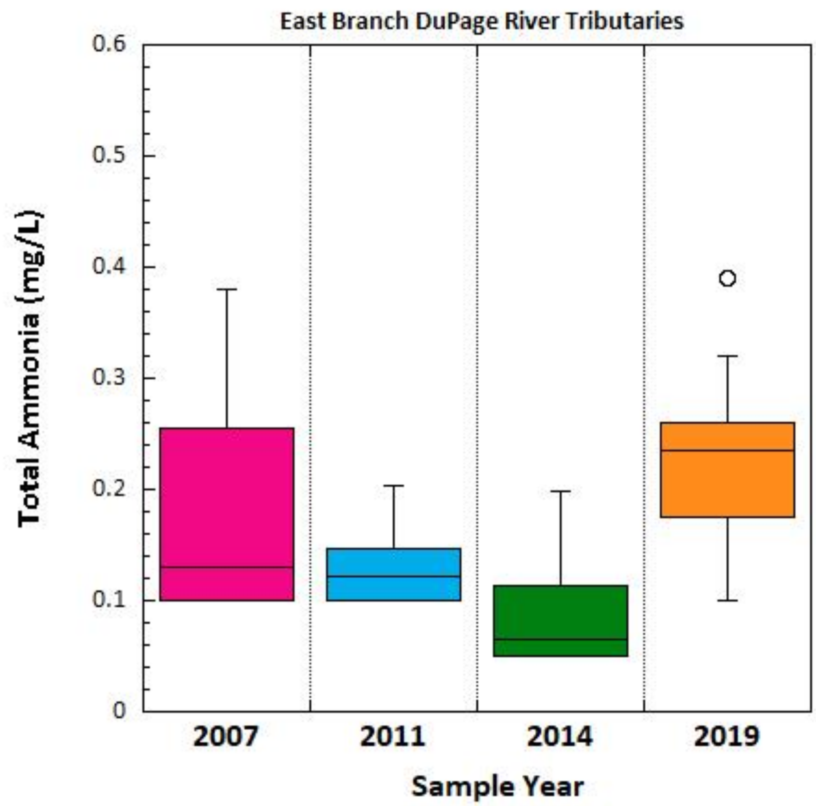


Figure 12. *Box and whisker plot of total ammonia values in tributaries of the East Branch DuPage River sampled in 2007, 2011, 2014, and 2019. Box presents the median, 25th and 75th percentiles, minimum and maximum values and outliers (> 2 times the interquartile range).*

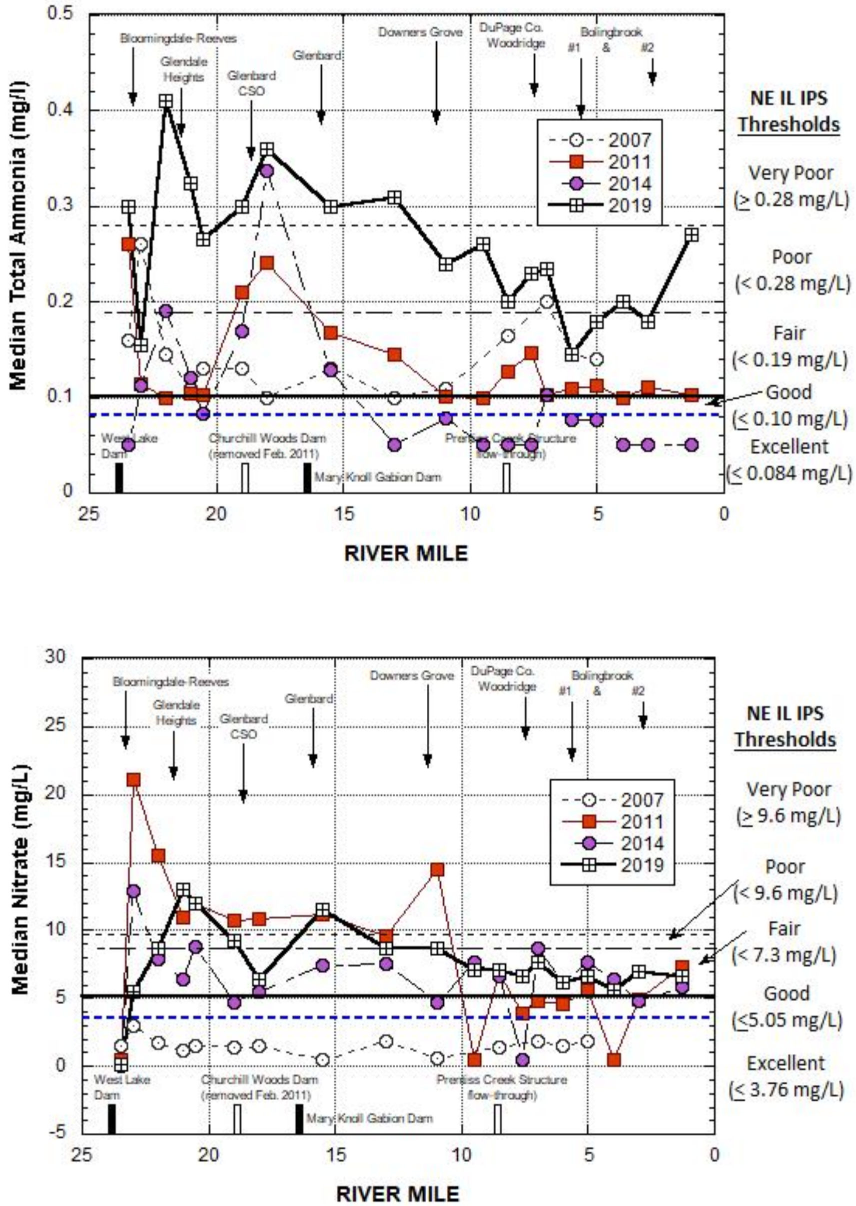


Figure 13. *Concentrations of ammonia-N (top panel) and nitrate + nitrite-N (lower panel) from E. Branch DuPage River samples in 2007, 2011, 2014, and 2019 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (only black bars for dams that impede fish passage Dashed and solid lines represent IPS derived effect thresholds correlated with ranges of biological quality as listed in Table 3.*

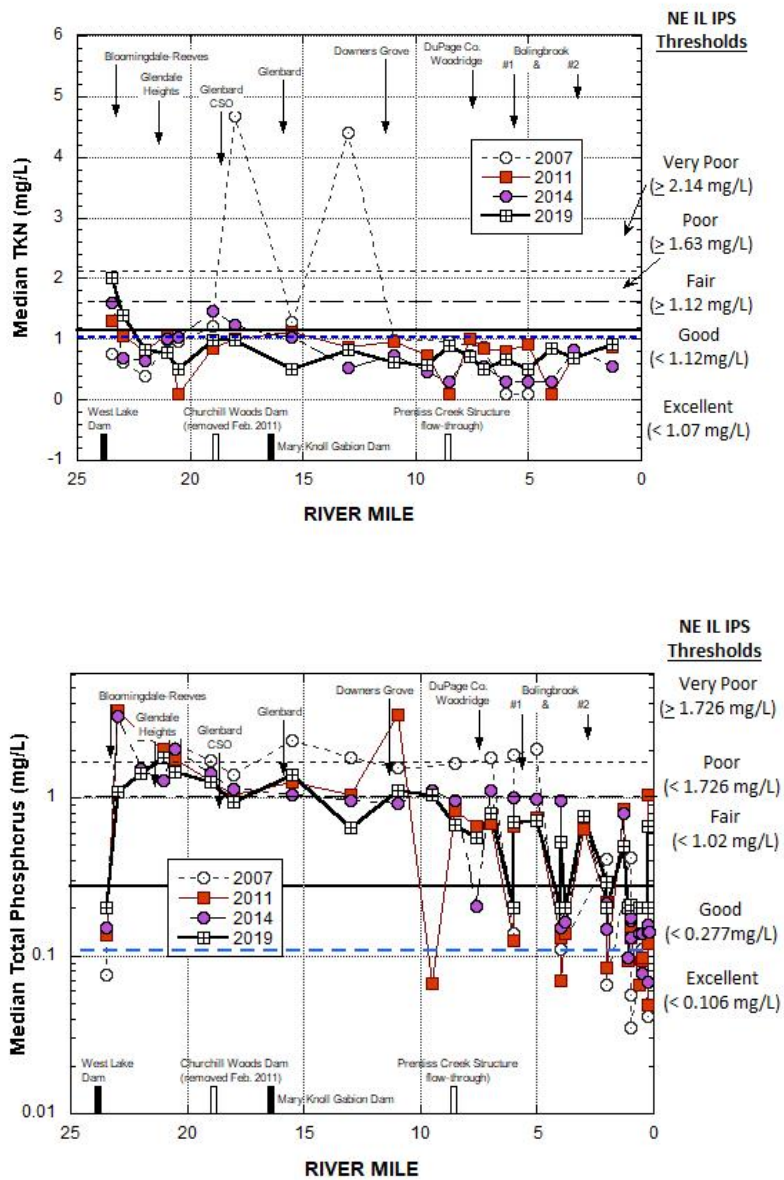


Figure 14. *Concentrations of total Kjeldahl nitrogen (TKN; top panel) and total phosphorus (lower panel) from E. Branch DuPage River samples in 2007, 2011, 2014 and 2019 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). Dashed and solid lines represent IPS derived effect thresholds correlated with ranges of biological quality as listed in Table 3.*

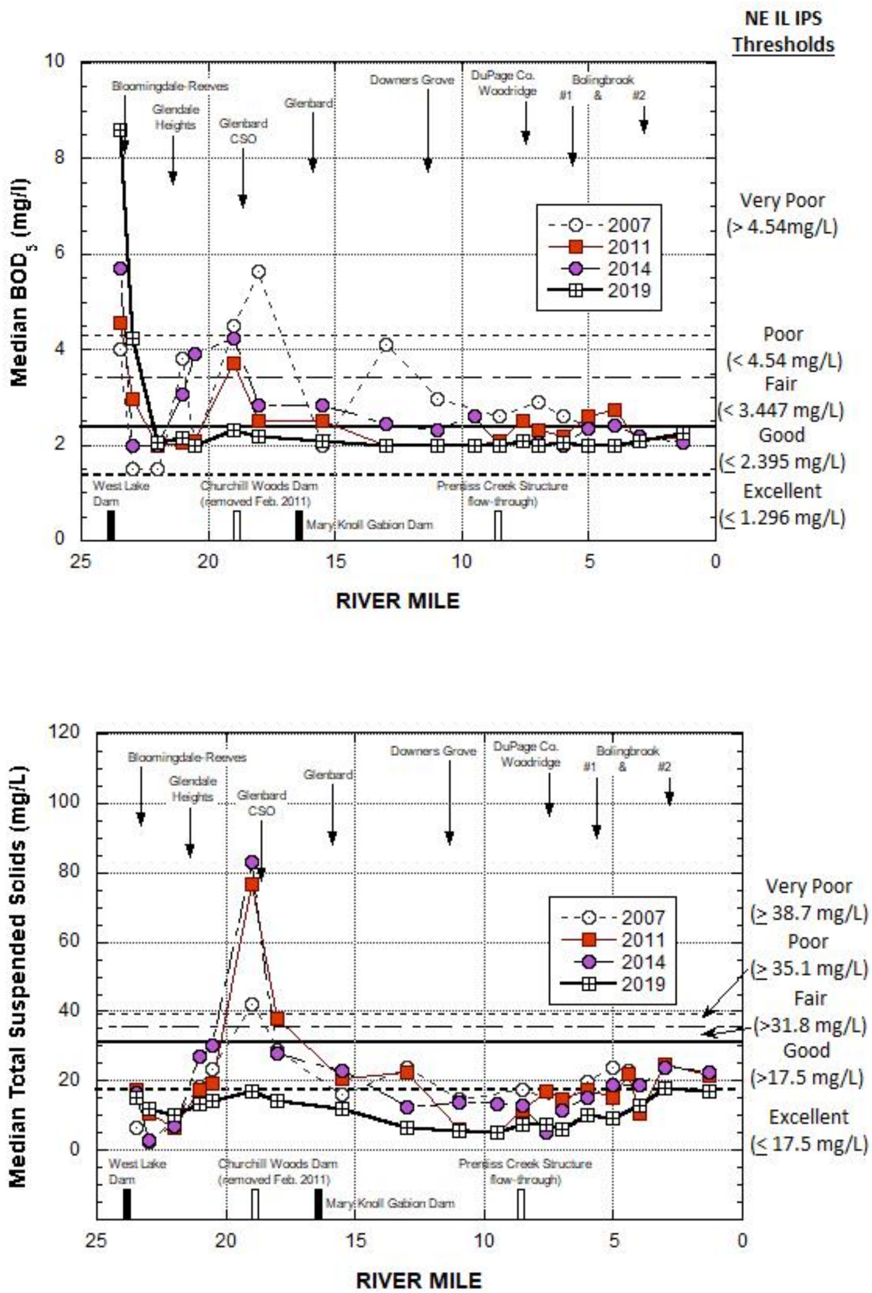


***Figure 15**. Concentrations of 5-day biochemical oxygen demand (top panel) and total suspended solids (lower panel) from E. Branch DuPage River samples in 2007, 2011, 2014 and 2019 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). Dashed and solid lines represent IPS derived effect thresholds correlated with ranges of biological quality as listed in Table 3.*

Although TKN concentrations were very poor in the very headwaters and downstream of the Bloomindale WWTP they then declined to the good range of the IPS threshold and remained that way the length of the mainstem of the East Branch (Figure 14). As in previous years mean BOD_5 concentrations were at their highest in the headwaters immediately downstream from West Lake (8.16 mg/l), that is upstream of all other point sources. BOD declined downstream of the Bloomingdale WWTP and then remained in the good range the along rest of the river. The pattern is different than in previous surveys when the BOD was still elevated at multiple sites in upper half of the watershed before declining in the lower half. Additional spikes in BOD_5 observed downstream in 2007 were largely attributed to autotrophic activity within impoundments and excess loadings from CSOs and WWTPs. Low BOD levels in 2019 suggest a general improving trend in the mainstem (Figure 15, top). TSS concentrations were lower in 2019 compared to any of the other years (Figure 15, bottom). The removal of the Churchill Woods dam is a significant factor as this approved instream assimilative capacity. However, while the impoundment has been substantially reduced, it was not completely eliminated. The continued presence of deposits of soft muck fines likely contributes to elevated solids levels downstream and oxygen depletion within the former impoundment (Table 9).

As in previous surveys, increased algal activity, possibly combined with sediment oxygen demand, drove wide diel swings in mainstem D.O., resulting in periodic exceedances of water quality criteria that continued in 2019. At the three continuous monitoring sites “minimum at any time” exceedances were detected at the two more upstream stations at some point during 2019 (Table), but not at the downstream site at RM 4.0. Pertinent dissolved oxygen concentrations (minimum values, 7-day rolling minimums, and 7-day rolling average values) at the three sites sampled in 2019 are depicted in .

Exceedances of rolling 7-day averages for both minimum and mean values were also listed in Table . Severe oxygen depletion as reflected by “minimum at any time” exceedances were the most numerous in the upper mainstem downstream from West Lake and the Bloomingdale Reeves WWTP (station RM 22.0) and within the residual Churchill Woods impoundment (Figure 16). The severe D.O. depletion tended to abate with increased distance downstream as minimum concentrations did not fell below the minimum criterion in the lower part of the river. In general, D.O. patterns reflected an enriched and historically modified system with D.O. values potentially limiting fish and macroinvertebrate assemblages during low summer flows.

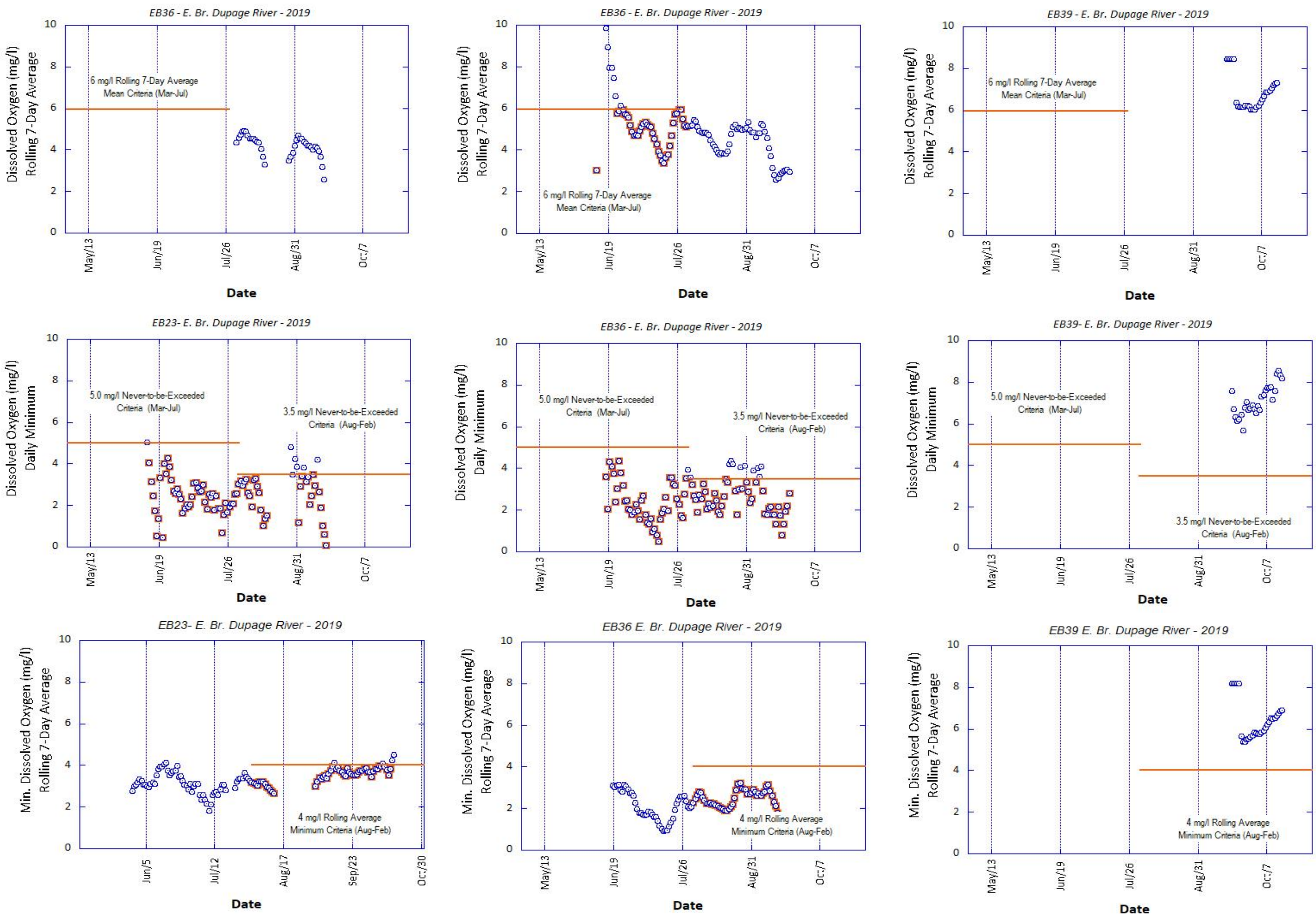


Figure 16. *Scatter plots of daily minimum D.O. concentrations at four East Br. DuPage River monitoring sites: RMs 22.0 (EB23), 19.0 (EB36), and 4.0 (EB39) in 2019.*

Table 9. Dissolved oxygen concentrations (mg/l) in exceedance of Illinois water quality standards from the East Branch DuPage River, 2019.

Site ID	River	Year	River Mile	Dates/Days	Pollutant	Criteria	Standard
EB23	East Branch Dupage River	2019	23.00	June - # Days:17	D.O.	<5.0 mg/l	Not to exceed
EB23	East Branch Dupage River	2019	23.00	July - # Days:31	D.O.	<5.0 mg/l	Not to exceed
EB23	East Branch Dupage River	2019	23.00	Aug - # Days:16	D.O.	<3.5 mg/l	Not to exceed
EB23	East Branch Dupage River	2019	23.00	Sep - # Days:14	D.O.	<3.5 mg/l	Not to exceed
EB36	East Branch Dupage River	2019	18.80	June - # Days:17	D.O.	<5.0 mg/l	Not to exceed
EB36	East Branch Dupage River	2019	18.80	July - # Days:31	D.O.	<5.0 mg/l	Not to exceed
EB36	East Branch Dupage River	2019	18.80	Aug - # Days:24	D.O.	<3.5 mg/l	Not to exceed
EB36	East Branch Dupage River	2019	18.80	Sep - # Days:20	D.O.	<3.5 mg/l	Not to exceed
EB23	East Branch Dupage River	2019	23.00	8/ 1 - 9/17	D.O.	<4.0 mg/l	7-day Minimum
EB36	East Branch Dupage River	2019	18.80	8/ 1 - 9/24	D.O.	<4.0 mg/l	7-day Minimum
EB23	East Branch Dupage River	2019	23.00	6/18 - 7/31	D.O.	<6.0	7-day Average
EB23	East Branch Dupage River	2019	23.00	6/13 - 6/17	D.O.	<6.0	7-day Average
EB36	East Branch Dupage River	2019	18.80	6/24 - 6/25	D.O.	<6.0	7-day Average
EB36	East Branch Dupage River	2019	18.80	6/27 - 7/31	D.O.	<6.0	7-day Average
EB36	East Branch Dupage River	2019	18.80	6/13 - 6/17	D.O.	<6.0	7-day Average

Nutrient Conditions in the E. Branch DuPage River Watershed

The impacts of nutrients on aquatic life has been well documented (e.g., Allan 2004), but the derivation of criteria and their form and application are only now emerging. Unlike toxicants, the influence of nutrients on aquatic life is largely indirect via pathways such as the effect of algal photosynthesis and respiration on diel D.O. swings or by the demand exerted by algal decomposition on D.O. concentrations. Nutrients can also affect food sources for macroinvertebrates and fish and the response of aquatic life to nutrient concentrations can be co-influenced by habitat (e.g., substrate composition), stream flow (e.g., scouring), temperature, and shading. Illinois is the leading state in terms of percent of nitrogen (16.8%) and phosphorus (12.9%) loadings exported to the Gulf of Mexico (U.S. EPA 2009) where a large anoxic zone has developed (U.S. EPA 2008). In Illinois, as in other Midwestern states, efforts are underway to modernize nutrient water quality criteria.

Table 10 lists key nutrient enrichment parameters in relation to the NE IL IPS benchmarks that were established to associate nutrient concentrations with impaired aquatic life. At this point, there are no established water quality criteria for aquatic life for nitrate-N, TKN, or total P in Illinois for streams and rivers. In previous reports we used a number of nutrient thresholds including U.S. EPA regional nutrient targets (U.S. EPA 2000) for the Central Corn Belt Plains (CCBP) ecoregion for nitrate-N and total P and which *"represent conditions of surface waters that are minimally impacted by human activities and protective of aquatic life and recreational uses"* (U.S. EPA, 2000) were used. We also used TKN and total ammonia-N thresholds that represented change points associated with aquatic assemblage impacts derived by quartile regressions in the firsts IPS report (Miltner et al. 2010). Illinois statistical thresholds termed "non-standards-based numeric criteria" for total P (0.61 mg/l) and nitrate-N (7.8 mg/l) were also used. These thresholds are based on 85th percentile values from a statewide dataset from the Illinois EPA Ambient Water Quality Monitoring Network (AWQMN) for water years 1978-1996 (Illinois EPA 2011). Finally, the 10 mg/l human health-based water quality criterion was used for nitrate + nitrite-N. The recent NE IL IPS thresholds (MBI 2020a) used in Table 10 are based on responses of nutrient sensitive fish species or macroinvertebrate taxa to nutrients that reflect attainment of the Illinois biological index thresholds for the fIBI or mIBI. We also used a IPS Nutrient Index (MBI 2020a) that is a composite measure using nutrient chemical parameters and DO statistics associated with the fIBI or mIBI.

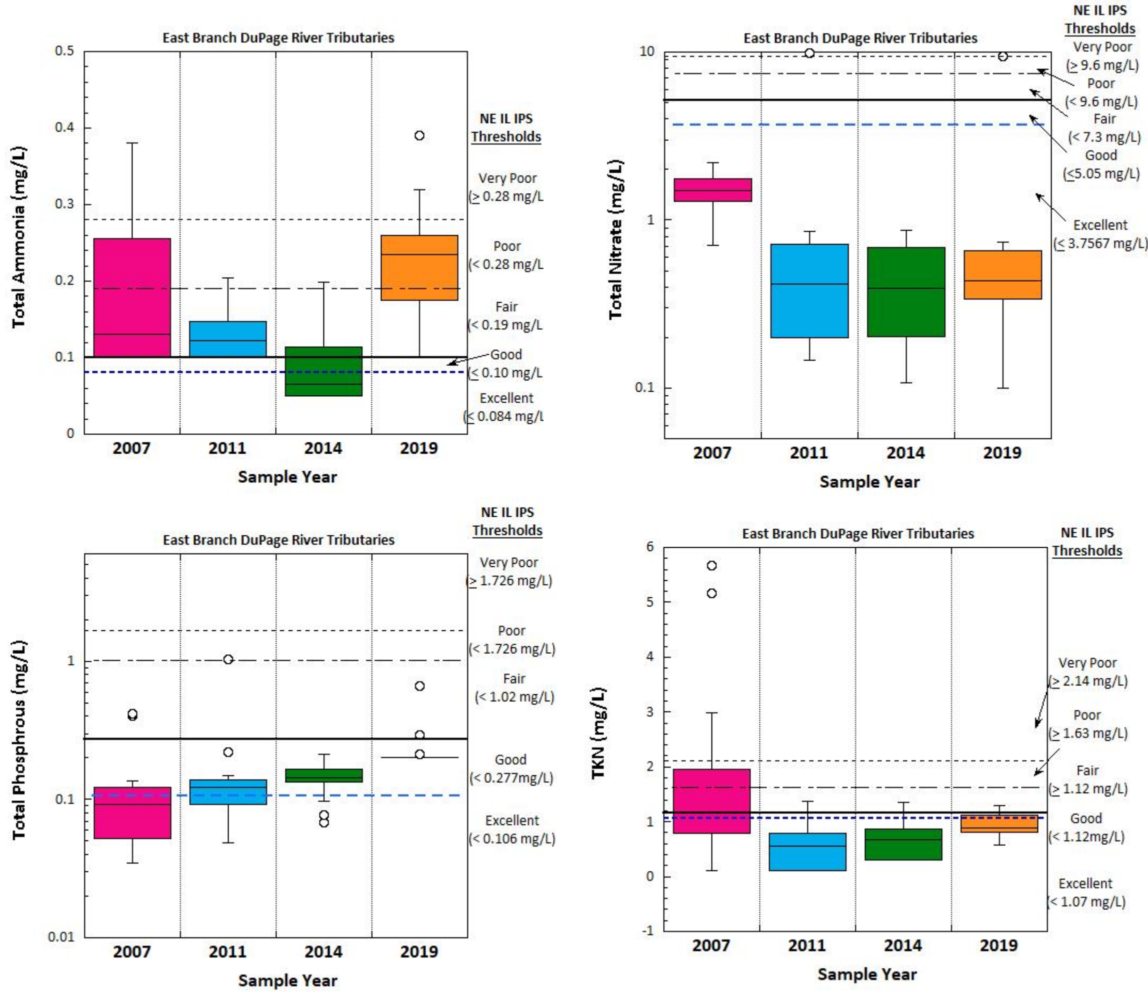
E. Branch DuPage River Mainstem

As was observed in previous surveys, the nutrient enriched condition of the East Branch mainstem continued in 2019 with elevated total P and nitrate-N levels observed along much of its length (Table). Mean total phosphorus concentrations were mostly elevated above 1.0 mg/l from river mile 23.0 to 9.5 which coincides with loadings from the series of major WWTPs. Nitrate + nitrite-N followed a similar pattern with upstream sites above the NE IL IPS very poor and poor threshold and lower sites (< RM 10) more typically in the NE IL IPS fair range (Figure 13, bottom. The higher river flows (i.e., increased dilution of effluent nutrients) in 2019 may have contributed to the decline in nutrient concentrations observed between the 2011 and 2014-2019 surveys.

As in previous surveys, no ammonia-N water quality criteria (standard) exceedances were detected in grab samples, but mean values often exceeded the aquatic life response derived NE IL IPS poor range target of 0.19 mg/l Figure 13, top). Ammonia values were higher in 2019 at most sites than any of the previous survey years (2007, 2011, 2014), but again did not exceed Illinois water quality criteria.

E. Branch DuPage River Tributaries
The 2019 results continued to reveal sharp contrasts between the highly elevated nutrients in the East Branch mainstem, particularly for phosphorus and nitrates, and lower levels in the tributaries (Table 10; Figure 18). One exception was a spike in ammonia-N concentrations in the tributaries above the other years that were below the water quality criteria, but often above the IPS poor range compared to past years. TKN exceedances at tributary sites were mostly in the good range with values in the fair range in Lacey Creek (with one site poor), Rott Creek, a site in Prentiss Creek and three sites in the smaller tributaries (Table 10). There was little trend in nitrate + nitrite-N concentrations with all good or better except for a poor site in Lacey Creek (9.5 mg/L; Table 10). The slightly increasing concentrations of TP and TKN (but still mostly in the good range, may be related to high flows (= higher runoff) in the tributaries in 2014 and 2019.

Slightly elevated levels (fair range) of BOD_5, an indicator of organic enrichment, were observed at six tributary sites, but no tributaries had BOD_5 levels in the poor or very poor range in 2019. The extremely high reading of 56.4 mg/l that was observed at the EB03 site on June 2, 2014 was in the good range in 2019 (mean = 2.17 mg/L). In general, BOD_5 levels were the lowest in 2019 compared to earlier survey data, where the highest median value occurred during 2007 (Figure 18).



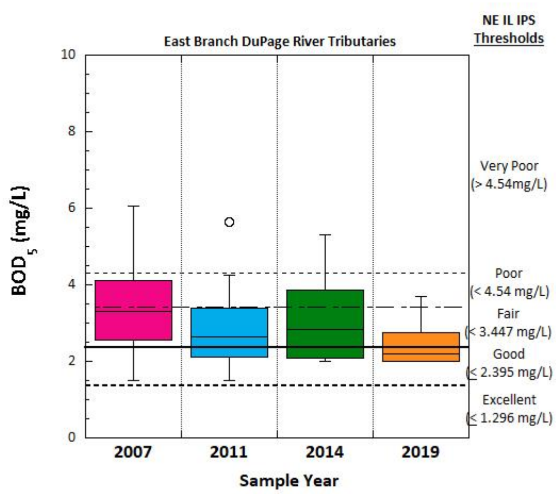


***Figure 17**. Box plots of total ammonia, Nitrate + nitrite-N, total phosphorus, TKN , and BOD5 concentrations from tributary sites in the East Branch DuPage River watershed in 2007, 2011, 2014, and 2019. Dashed and solid lines represent IPS derived effect thresholds.*

Table 10. *Concentrations of nutrient related parameters including nitrate + nitrite-N, TKN, total phosphorus and the IPS Nutrient Index in the E. Br. DuPage River study area in 2019. Shading represents exceedances of various thresholds for each parameter (see table bottom).*

					Continuous D.O.			Grab D.O.					
Site ID	**River Mile**	**Drainage Area (sq. mi.)**	**Median Total Phos-phorus (mg/L)**	**Median Nitrate-N (mg/L)**	**Max. D.O. (mg/L)**	**Min. D.O. (mg/L)**	**Max. D.O. Swing (mg/L)**	**Max. D.O. (mg/L)**	**Min. D.O. (mg/L)**	**Median TKN (mg/L)**	**Median TSS (mg/L)**	**IPS Nutrient Index**	**Sestonic Chlorophyll-a (mg/L)**
Army Trail Creek (Trib to E. Br. DuPage (95-951)													
EB24	0.25	0.30	0.20	0.41				6.87	6.52	0.59	11.20	12.76	1.2
Armitage Ditch (Trib to E. Br DuPage (95-952)													
EB22	0.50	2.20	0.20	0.52				8.50	7.82	0.92	7.30	14.34	14.2
Glencrest Creek (Trib to E. Br DuPage) (95-953)													
EB15	0.50	3.00	0.20	0.66				8.86	8.10	1.10	5.20	14.04	6.4
Lacey Creek (Trib to E. Br DuPage) (95-954)													
EB14	2.00	2.00	0.54	0.30				7.92	6.62	1.98	167.60	19.66	2.3
EB13	0.25	6.00	0.67	9.40				9.77	8.00	1.30	19.00	21.26	6.8
Willoway Brook (Trib to E. Br DuPage) (95-955)													
EB11	1.00	3.00	0.20	0.34				7.64	7.52	0.64	12.00	13.26	17.5
22nd St.(Trib to E. Br. DuPage @ RM 16.4 (95-956)													
EB17	1.00	0.80	0.21	0.43				7.70	7.36	0.84	94.20	13.36	4.9
Rott Creek (Trib to E. Br, DuPage) (95-957)													
EB06	2.00	4.00	0.20	0.34				7.22	6.64	1.13	23.00	15.76	21.0
East Branch DuPage River (95-980)													
EB29	23.50	2.00	0.20	0.10				9.75	6.99	2.00	15.00	24.16	43.3
EB25	23.00	2.00	1.08	5.50				8.00	7.52	1.40	12.00	23.16	18.5
EB23	22.00	5.00	1.40	9.60	11.36	0.06	9.47	10.76	7.49	0.80	8.60	24.04	4.1
EB26	21.00	12.00	1.79	13.00				9.65	7.76	0.57	12.00	24	4.7
EB21	20.50	14.20	1.45	12.00				8.85	7.09	0.50	14.00	21.06	4.1
EB36	19.00	16.00	1.36	9.05	22.97	0.50	18.22	8.85	6.67	1.02	17.50	23.3	5.0
EB19	18.00	16.80	0.85	6.45				8.05	7.50	0.96	16.50	22.72	4.3
EB30	15.50	27.20	1.39	11.55				8.95	7.62	0.50	12.00	22.7	4.5
EB12	13.00	32.20	0.64	8.70				8.75	7.06	0.82	6.60	20.56	3.4
EB31	11.00	58.00	1.11	8.65				8.35	7.46	0.62	5.60	20.64	3.8
EB37	9.50	60.10	1.04	7.05				8.25	7.40	0.59	5.20	21.14	4.5
EB32	8.50	61.00	0.73	6.80				8.56	7.36	0.92	7.70	19.94	6.0
EB40	7.60	68.60	0.56	7.00				7.96	6.70	0.61	7.00	19.54	5.4
EB33	7.00	70.90	0.79	7.70				8.55	7.26	0.50	5.90	19.96	3.7
EB35	6.00	76.40	0.71	6.15				8.75	7.32	0.68	10.20	19.06	5.5
EB34	5.00	76.40	0.67	6.30				9.45	7.32	0.80	10.50	19.8	4.7
EB39	4.00	78.00	0.53	5.60	9.75	5.70	2.69	8.95	7.52	0.84	13.00	19.66	4.7
EB38	3.00	81.00	0.76	7.00				8.55	7.62	0.68	18.00	19.08	5.2
EB41	1.30	77.90	0.50	6.65				9.05	7.30	0.91	17.00	19.66	4.2
Condition Category Thresholds	Excellent		<0.106	<3.767	< 10.36	>6.9	< 2.0	< 10.36	>6.9	<1.07	≤17.50	≤10	<2.5
	Good		<0.277	<5.045	> 10.36-12.2	6-6.9	2.0-4.0	10.36-12.	6-6.9	<1.12	>17.50	>10-15	>2.5-5.1
	Fair		<1.022	<7.344	> 12.2-14.2	4.0-5.9	4.0-5.0	> 12.2-14.2	4.0-5.9	<1.63	>31.60	>15-25	>5.1-13.8
	Poor		<1.726	<9.643	> 14.2-16.3	2.0-3.9	5.0-6.5	> 14.2-16.3	2.0-3.9	<2.14	>35.15	>25-35	>13.8-28.9
	Very Poor		>1.726	>9.643	≥ 16.3	<2.0	>6.5	≥ 16.3	<2.0	>2.14	>38.69	>35	>28.9
Source	**IPS**		**IPS**	**IPS**	**IPS**	**IPS**	**MBI/SNAI**	**IPS**	**IPS**	**IPS**	**IPS**	IPS	**MBI/NSAC**

***Table 10**. continued.*

Site ID	River Mile	Drainage Area (sq. mi.)	Median Total Phos-phorus (mg/L)	Median Nitrate-N (mg/L)	Continuous D.O. Max. D.O. (mg/L)	Continuous D.O. Min. D.O. (mg/L)	Continuous D.O. Max. D.O. Swing (mg/L)	Grab D.O. Max. D.O. (mg/L)	Grab D.O. Min. D.O. (mg/L)	Median TKN (mg/L)	Median TSS (mg/L)	IPS Nutrient Index	Sestonic Chlorophyll-a (mg/L)
Prentiss Creek (Trib to E. Br. DuPage) (95-986)													
EB04	3.80	2.30	0.20	0.50				8.37	7.66	1.20	5.80	14.74	10.1
EB03	1.10	6.60	0.20	0.57				10.36	8.82	1.00	10.00	13.64	5.8
St. Joseph Creek (Trib to E. Br. DuPage) (95-987)													
EB10	6.00	2.00	0.20	0.34				7.42	7.36	0.82	15.50	14.56	10.7
EB08	4.00	4.00	0.20	0.74				8.66	0.20	0.88	5.20	21.82	6.1
EB07	1.00	10.00	0.20	0.69				9.05	6.92	0.70	5.20	13.22	2.3
Trib. to E. Br. DuPage River at RM 6.15 (95-988)													
EB01	0.25	0.80	0.20	0.44				8.00	6.90	1.14	9.50	14.16	3.8
Trib. # 6 to E. Br. DuPage River (95-989)													
EB05	0.60	1.00	0.20	0.30				6.96	6.54	1.22	8.80	16.46	7.6
Crabtree Creek, Trib to E. Br. DuPage (95-990)													
EB02	0.20	1.40	0.20	0.49				8.50	8.27	0.70	12.90	12.34	7.6
UT to St Joseph Creek (95-991)													
EB09	1.10	0.22	0.20	0.30				7.92	6.57	0.84	5.60	16.36	2.8
Trib. to East Br. DuPage @ RM 19.9 (95-992)													
EB20	0.12	0.30	0.24	0.34				7.80	7.07	1.16	18.50	14.56	1.6
Condition Category Thresholds	Excellent		<0.106	<3.767	< 10.36	>6.9	< 2.0	< 10.36	>6.9	<1.07	≤17.50	≤10	<2.5
	Good		<0.277	<5.045	> 10.36-12.2	6-6.9	2.0-4.0	10.36-12.	6-6.9	<1.12	>17.50	>10-15	>2.5-5.1
	Fair		<1.022	<7.344	> 12.2-14.2	4.0-5.9	4.0-5.0	> 12.2-14.2	4.0-5.9	<1.63	>31.60	>15-25	>5.1-13.8
	Poor		<1.726	<9.643	> 14.2-16.3	2.0-3.9	5.0-6.5	> 14.2-16.3	2.0-3.9	<2.14	>35.15	>25-35	>13.8-28.9
	Very Poor		>1.726	>9.643	≥ 16.3	<2.0	>6.5	≥ 16.3	<2.0	>2.14	>38.69	>35	>28.9
Source	IPS		IPS	IPS	IPS	IPS	MBI/SNAI	IPS	IPS	IPS	IPS	IPS	MBI/NSAC

Dissolved Materials in Urban Runoff

Urban runoff, with its typically high concentration of dissolved constituents, can become limiting when concentrations reach toxic thresholds. Of particular concern in Northern climates in urban areas with high road density is the concentration of chlorides from nonpoint sources such as road salt applications and point sources with loadings from water softening salts. Research in Illinois and elsewhere has identified the increased salinization of surface and groundwater from increased loadings of chlorides over time. Illinois EPA conducted a total chloride TMDL for the East Branch DuPage River in 2004 (CH2MHill 2004) and identified road salt and WWTP effluents as two sources in the watershed. Kelly et al. (2012) demonstrated that the recent increase in chloride concentrations in the Chicago area correlated with increased road salt applications, particularly over the past 20 years. Kelly et al. (2012) also identified a steadily increasing trend in chloride levels in the Illinois River at Peoria where the median increased from 20 mg/l in 1947 to nearly 100 mg/l in 2004 with high values in the 1940s of <40 and spikes in 2003 of >300. Elevated dissolved ion concentrations in the East Branch watershed, observed during each of the 2007-2019 surveys, are generally associated with high snowfalls which are common in the study area (Figure 18).

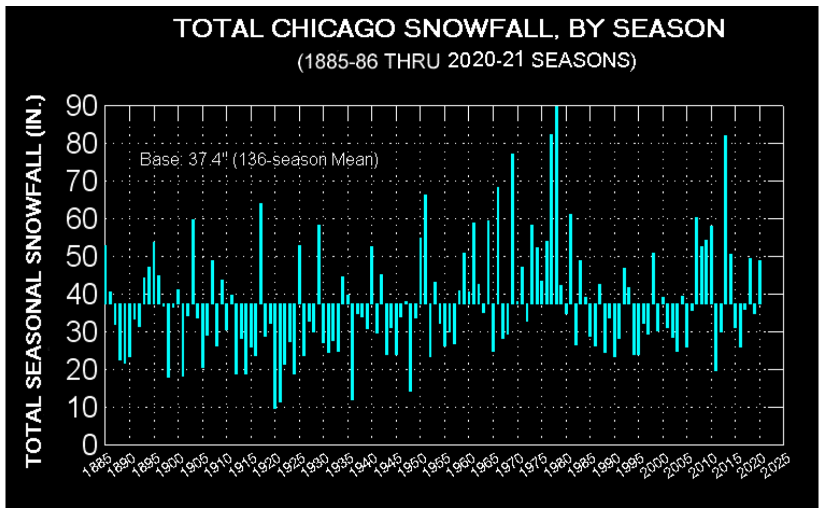


Figure 18*. Total seasonal snowfall in inches in Chicago by year, 1885/86 to 2020/21. Data from ClimateStations.com:* https://www.climatestations.com/wp-content/uploads/2021/06/chisnow.gif

Table shows a group of parameters associated with urban runoff. The highlighted values are color coded by narrative magnitudes that values exceed NE IL IPS derived thresholds. For chloride, IPS thresholds for 120 mg/l are lower than the Illinois (500 mg/l) and U.S. EPA (230 mg/l) criterion for aquatic life. The IPS thresholds were exceeded throughout the watershed (Table 11, Figure 19 and Figure 20) and concentrations varied between survey years. Similar trends of elevated and increased concentrations of dissolved materials, particularly chlorides, have also been documented in the adjacent West Branch and Lower DuPage River watersheds (MBI 2013, 2014) and in the literature for Illinois (Kelly 2008).

Rather than a simple runoff and export mode of effect, chlorides accumulate in groundwater (Kelly 2008), soils, and land surfaces adjacent to streams. Seasonal sampling studies have shown that elevated summer concentrations are correlated with acute concentrations during late winter and spring periods (Kaushal et al. 2005). Research in New England (Kaushal et al. 2005) and Minnesota (Novotny et al. 2008) show that chlorides can accumulate in watersheds and that there is a strong association between high winter and elevated summer concentrations. Novotny et al. (2008) identified that 78% of road salt applied in a Minnesota watershed accumulated in a given year and contributed to an increased summer chloride concentration. High levels of chloride during summer in all of the tributaries studied indicate late winter and early spring chloride levels are much higher during runoff events and likely contribute to the extent of impairment in headwater streams.

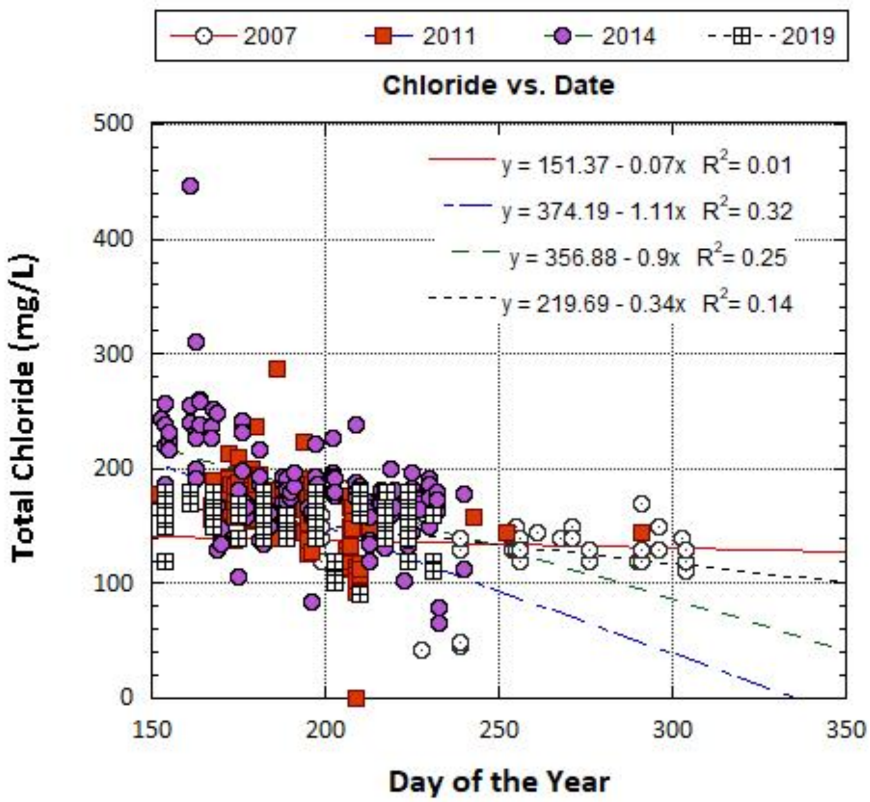


Figure 19. *Chloride concentrations by date (day-of-the-year) from the East Branch DuPage River during the summers of 2007, 2011, 2014, and 2019.*

To evaluate the fate of residual chloride contributions from nonpoint sources and WWTP discharges in the DuPage watershed, we examined total chloride concentrations in the East Branch mainstem by day-of-the-year during June through October from 2007-2019. The results showed elevated, but gradually declining concentrations over time (Figure 19) within in any given year. The data suggest initial, nonpoint related contributions decrease over the summer months, resulting in residual, point-source related concentrations under late-season, low-flow conditions. Given the observed "tail off" in chloride concentrations, it seems that point sources only dictate ambient concentrations between September and December when deicing operations resume for the winter months. The lower chloride concentrations in 2019 (Figure 20) may indicate some dilution of chloride from high flows. Regardless, while the thresholds generated by the IPS reflect a correlation between summer chloride concentrations and biological effects, it may not necessarily reflect the absolute concentration when toxic levels

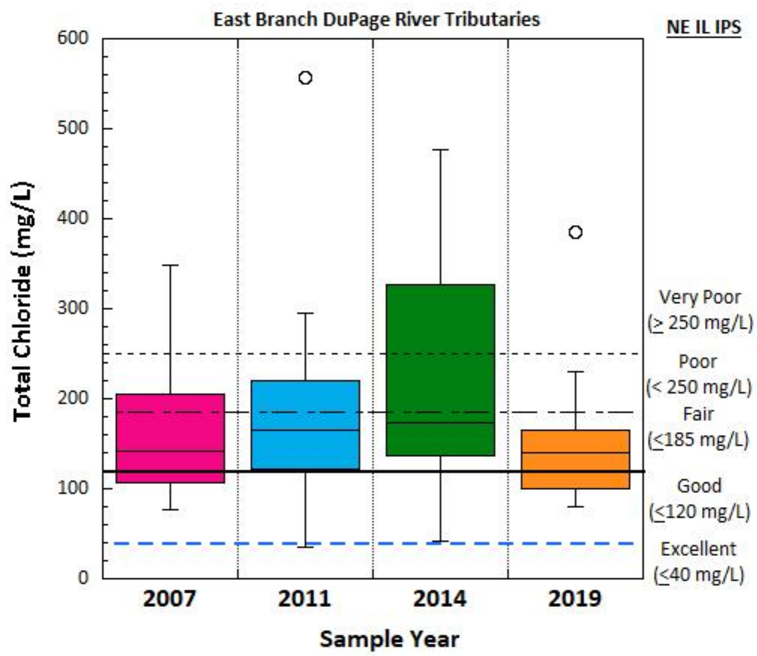


***Figure 20**. Box plot of summer chloride concentrations in East Branch DuPage River tributary sites in 2007, 2011, 2014 and 2019. Dashed and solid lines represent IPS derived effect thresholds correlated with ranges of biological quality as listed in Table 3.*

occur (i.e., during the winter months). Actual concentrations that result in adverse effects on fish and invertebrates likely occur during peak runoff events in late winter and early spring when values approach or exceed the 230 mg/ U.S. EPA recommended chronic criterion or the 500 mg/l Illinois criterion.

Water Column Heavy Metals

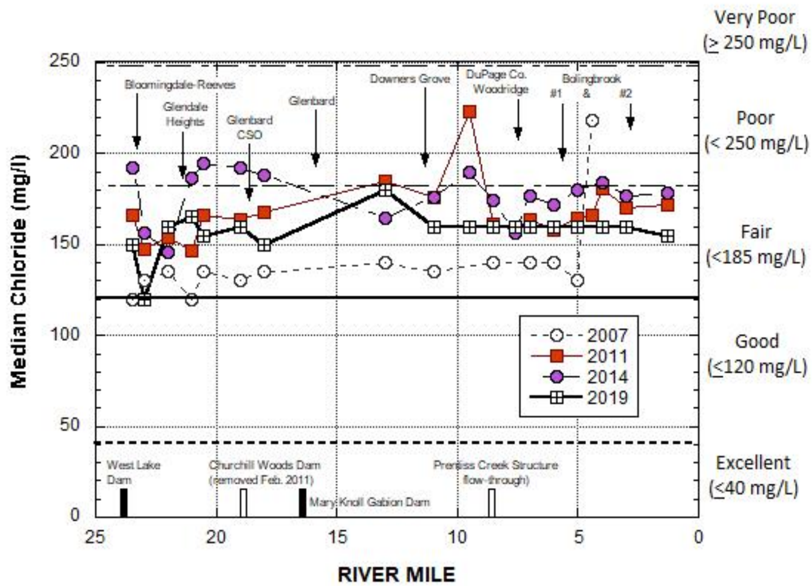
No heavy metals exceeded water quality criteria in 2019. Many values were below detection, but there were values above the IPS very poor thresholds associated with impaired conditions. The lack of data with very high concentrations in the IPS data, that likely occurred during historical periods, makes the IPS thresholds somewhat difficult to interpret and they may be related to other parameters that are more meaningful causes of impairment. Since 2007, mean copper and lead concentrations in the water column did not show a strong trend. At similar sampling sites throughout the watershed, the number of sites that increased or decreased was roughly equal between surveys. If heavy metals are a problem, they would more likely occur at high flows from road and urban runoff and not likely captured by low flow grab sampling. Surficial sediment concentrations of heavy metal are likely a better signal for this episodic loading of metals.

Table 11. *Urban parameter results in the E. Branch DuPage River study area, summer 2019. Values that exceeded IPS threshold levels (table bottom) are highlighted by the magnitude of value.*

Site ID	River Mile	Drainage Area (sq. mi.)	Specific Conduct-ivity µS/cm	TDS (mg/L)	TSS (mg/L)	Chloride (mg/L)	TKN (mg/L)
Army Trail Creek (Trib to E. Br. DuPage (95-951)							
EB24	0.25	0.50	1640.0	905	11.2	385.0	0.59
Armitage Ditch (Trib to E. Br DuPage (95-952)							
EB22	0.50	2.20	946.0	480	7.3	190.0	0.92
Glencrest Creek (Trib to E. Br DuPage) (95-953)							
EB15	0.50	2.80	798.0	440	5.2	120.0	1.10
Lacey Creek (Trib to E. Br DuPage) (95-954)							
EB14	2.00	1.80	911.0	470	167.6	195.0	1.98
EB13	0.25	4.60	1140.0	640	19.0	180.0	1.30
Willoway Brook (Trib to E. Br DuPage) (95-955)							
EB11	1.00	4.30	685.5	335	12.0	120.0	0.64
22nd St.(Trib to E. Br. DuPage @ RM 16.4 (95-956)							
EB17	1.00	0.50	832.5	455	94.2	117.5	0.84
Rott Creek (Trib to E. Br. DuPage) (95-957)							
EB06	2.00	4.50	619.5	310	23.0	97.5	1.13
East Branch DuPage River (95-980)							
EB29	23.50	2.00	823.0	420	15.0	160.0	2.00
EB25	23.00	2.00	751.5	410	12.0	120.0	1.40
EB23	22.00	5.00	907.0	470	8.6	160.0	0.80
EB26	21.00	12.00	976.0	490	12.0	160.0	0.57
EB21	20.50	14.20	970.5	500	14.0	155.0	0.50
EB36	19.00	16.00	1002.5	530	17.5	170.0	1.02
EB19	18.00	18.00	1130.0	585	16.5	155.0	0.96
EB30	15.50	27.20	1125.0	595	12.0	165.0	0.50
EB12	13.00	50.00	1110.0	600	6.6	180.0	0.82
EB31	11.00	58.00	1055.0	565	5.6	160.0	0.62
	Excellent		<739	<453.8	<17.5	<40.0	<1.07
	Good		<1038	<558.0	<31.6	<120.0	<1.12
	Fair		<1208	<651.2	<35.2	<184.9	<1.63
	Poor		<1378	<744.5	<38.7	<249.8	<2.14
	Very Poor		>1378	≥744.5	>38.7	>249.8	>2.14
	IPS		IPS	IPS	IPS	IPS	IPS
	Illinois WQS		None	None	None	500.0	None

***Table 11**. continued.*

Site ID	River Mile	Drainage Area (sq. mi.)	Specific Conduct-ivity µS/cm	TDS (mg/L)	TSS (mg/L)	Chloride (mg/L)	TKN (mg/L)
EB37	9.50	60.10	1035.0	545	5.2	160.0	0.59
EB32	8.50	61.00	1030.0	535	7.7	160.0	0.92
EB40	7.60	63.00	1025.0	535	7.0	160.0	0.61
EB33	7.00	64.00	988.0	540	5.9	160.0	0.50
EB35	6.00	76.40	1050.0	555	10.2	160.0	0.68
EB34	5.00	78.00	1065.0	570	10.5	160.0	0.80
EB39	4.00	78.00	1050.0	550	13.0	160.0	0.84
EB38	3.00	81.00	1060.0	570	18.0	160.0	0.68
EB41	1.30	85.00	1050.0	535	17.0	155.0	0.91
Prentiss Creek (Trib to E. Br. DuPage) (95-986)							
EB04	3.80	2.30	869.5	420	5.8	165.0	1.20
EB03	1.10	6.60	949.0	490	10.0	140.0	1.00
St. Joseph Creek (Trib to E. Br. DuPage) (95-987)							
EB10	6.00	1.80	523.0	265	15.5	80.0	0.82
EB08	4.00	6.00	738.0	370	5.2	100.0	0.88
EB07	1.00	9.70	938.0	470	5.2	140.0	0.70
Trib. to E. Br. DuPage River at RM 6.15 (95-988)							
EB01	0.25	0.70	731.0	350	9.5	140.0	1.14
Trib. # 6 to E. Br. DuPage River (95-989)							
EB05	0.60	1.00	539.5	255	8.8	87.5	1.22
Crabtree Creek, Trib to E. Br. DuPage (95-990)							
EB02	0.20	1.40	804.0	405	12.9	150.0	0.70
UT to St Joseph Creek (95-991)							
EB09	1.10	0.20	858.0	440	5.6	87.5	0.84
Trib. to East Br. DuPage @ RM 19.9 (95-992)							
EB20	0.12	0.30	1549.0	840	18.5	297.5	1.16
	Excellent		<739	<453.8	<17.5	<40.0	<1.07
	Good		<1038	<558.0	<31.6	<120.0	<1.12
	Fair		<1208	<651.2	<35.2	<184.9	<1.63
	Poor		<1378	<744.5	<38.7	<249.8	<2.14
	Very Poor		>1378	≥744.5	>38.7	>249.8	>2.14
	IPS		IPS	IPS	IPS	IPS	IPS
	Illinois WQS		None	None	None	500.0	None



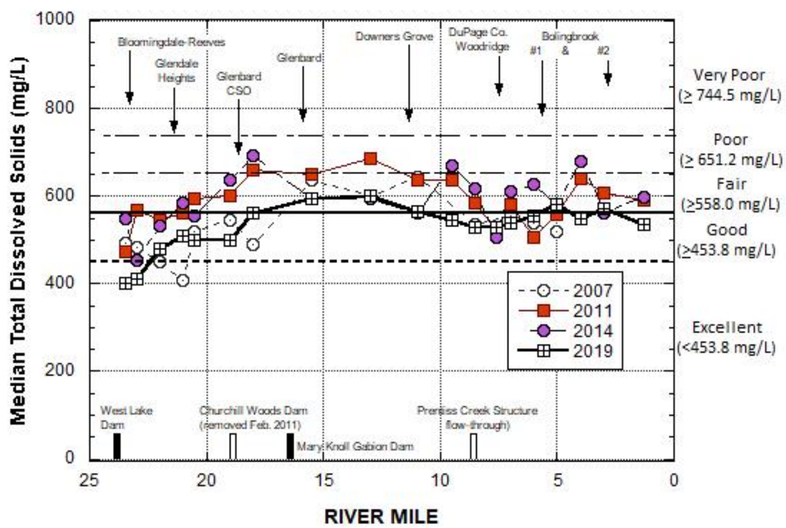


Figure 21. *Concentrations of total chloride (top panel) and TDS (lower panel) from E. Branch DuPage River samples in 2007, 2011, 2014, and 2019. Municipal WWTP discharges are shown by arrows while bars along the x-axis depict mainstem dams or weirs (only black bars impede fish passage). Dashed and solid lines represent IPS derived effect thresholds correlated with ranges of biological quality as listed in Table 3.*

E. Branch DuPage River Watershed - Sediment Chemistry

Sediment samples were primarily evaluated against the IL IPS thresholds generated for NE Illinois in relations to sensitive fish or macroinvertebrate taxa related to the fIBI and mIBI benchmarks for the General aquatic life use for Illinois (Table 5. The samples were also compared to literature guidelines compiled by McDonald et al. (2000) and the Ontario Ministry of Environment (1993) that list ranges of contaminant values by probable effects on aquatic life. Specifically, threshold effect levels (TEL) are where toxic effects are initially apparent and likely to affect the most sensitive organisms. Probable effect levels (PEL) are where toxic effects are more likely to be observed over a wider range of organism sensitivities. We also compared concentrations against NE IL IPS threshold (thresholds for parameters where there was a sufficient number and range of values paired with biological assemblage data to generate meaningful comparisons). For 2019 data for most PAH and other organic parameters, nearly all sample results were below detection levels, so tables were not compiled. There were elevated levels of sediment metals in sites sampled for metals and these are listed in Table 12.

Polycyclic aromatic hydrocarbons (PAHs) result from the incomplete combustion of hydrocarbons and are a common component of stormwater runoff in urban areas. Threshold effect levels for these compounds were exceeded in all East Branch samples in 2007, 2011, and 2014 (Table 11). However, 2014 sampling confirmed the precipitous decline first observed between the 2007 and 2011 surveys in both the numbers and locations of PEL exceedances (see previous report). These parameters were all below detection in 2019. The exceedances averaged much lower in 2011 compared to 2007 (9.2 vs. 1.1) and the 2011 number was matched in 2014 (1.1). Remaining 2014 mainstem sites with PEL exceedances were restricted to the lower 7 river miles at EB33, 35, 39, and 07 and to the most extreme upstream site (EB29) immediately downstream from West Lake. Again, there we no values above detection levels in 2019. These results confirm that the most extreme PAH concentrations have declined since 2007.

No PCBs or pesticides were detected above TEL or PEL guidelines in 2014 or 2019. These results are similar to previous surveys although elevated PCBs were recorded at one site (EB35) in 2011 and elevated pesticides were found at four 2007-11 mainstem sites between RMs 13.0 and 8.5.

Table 12. *Concentrations of 11 sediment metals collected at ten sites in the East Branch DuPage River study area during 2019. Sites are color coded based on NE IL IPS thresholds listed at the bottom of the table. Other thresholds are provided for reference.*

Site ID	River Mile	Drainage Area (sq. mi.)	Barium (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Iron (mg/Kg)	Lead (mg/Kg)	Manganese (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Potassium (mg/Kg)	Zinc (mg/Kg)
East Branch DuPage River (95-980)													
EB23	22	5	85	-	23	32	24000	20	200	-	21	3400	93
EB21	20.5	14.2	150	-	33	48	30000	32	340	-	25	3900	190
EB36	19	16	160	-	31	59	27000	31	250	-	21	3600	190
EB19	18	16.8	140	-	26	54	25000	67	260	-	21	3200	230
EB30	15.5	27.2	190	-	39	60	39000	53	480	-	29	4700	210
EB12	13	32.2	160	-	30	45	37000	30	360	-	24	4100	170
EB31	11	58	160	0.82	45	65	36000	65	730	-	30	4400	220
EB35	6	76.4	74	-	18	28	15000	22	290	-	13	2200	110
EB34	5	76.4	150	-	41	60	30000	40	640	-	30	4400	220
St. Joseph Creek (95-987)													
EB07	1	10	120	1.2	45	68	29000	100	480	0.32	34	4400	270
MacDonald et al. 2000		TEC	None	0.990	43.40	31.60	20000	35.80	460	0.180	22.70	None	121.0
		PEC	None	4.980	111.0	149.0	40000	128.0	1100	1.06	48.60	None	459.0
Short 1998		Elevated	145.0	2.000	37.00	37.00	26100	60.00	1100	0.280	26.00	None	170.0
		Highly Elev.	230.0	9.300	110.0	170.0	53000	245.0	2300	1.40	45.00	None	760.0
NE Illinois IPS		Excellent	None	None	<20.53	<19.00	None	<15.50	<841.0	None	None	None	<75.0
		Good	<141.0	<0.933	<23.30	<29.78	None	<24.80	<845.5	None	<19.50	None	<100.0
		Fair	>141.0	>0.933	>23.30	>29.78	None	>24.80	>845.5	None	>19.50	None	>100.0
		Poor	>150.3	>1.354	>26.22	>40.45	None	>33.04	>996.8	None	>22.52	None	>133.9
		Very Poor	>168.7	>1.963	>29.15	>51.12	None	>41.27	>1148	None	>25.53	None	>167.8

Table 12 depicts the concentrations of sediment metal found at 10 sites in 2019. Nine sites were on the mainstem and one site was on St Joseph Creek (EB07). There were numerous exceedances of the very poor IPS threshold on the mainstem of the East Branch at or downstream of RM 19.0 for chromium, copper, lead, nickel, and zinc (Table 12). None of these was above the PEC thresholds for these parameters, although there were numerous values above the TEC thresholds for these parameters (Table 12). These were in the range of values observed in previous years, suggesting continual export of these metals into the river, likely from roads and other urban sources. Samples are taken from the upper surface levels of the sediment indicator relatively recent exports. Excessive levels of heavy metals in urban landscapes are commonly associated with runoff from roads and highways and industrial and municipal sources

E. Branch DuPage River Watershed Physical Habitat Quality for Aquatic Life - QHEI

The physical habitat of a stream is a primary determinant of biological quality. Streams in the glaciated Midwest, left in their natural state, typically possess riffle-pool-run sequences, high sinuosity, and well-developed channels with deep pools, heterogeneous substrates and cover in the form of woody debris, glacial tills, and aquatic macrophytes. The Qualitative Habitat Evaluation Index (QHEI) categorically scores the basic components of stream habitat into ranks according to the degree to which those components are found in a natural state, or conversely, in an altered or modified state. In the E. Branch study area, QHEI scores and physical habitat attribute were recorded in conjunction with fish collections from each site (Table 13).

E. Branch DuPage River Mainstem

Based on QHEI scores, mainstem habitat quality fell mostly in the fair to good ranges, but varied by location (Figure , Figure 23). Substrate embeddedness was a common characteristic of the mainstem as riffle or pool embeddedness was recorded at all but one location (EB23/RM 22.0).

In the upper East Branch, conditions within and upstream from the former Churchill Woods low head dam impoundment were similar to the most recent 2012 survey that indicated an incremental improvement following the removal of the dam in February 2011 (Figure). QHEI scores in this reach had averaged an approximate 9-point increase by 2012 reflecting the appearance of riffles and increased habitat heterogeneity. As of 2014 and 2019, minimal additional changes were observed in the small, residual impounded habitat at RM 19.3 (EB44), but QHEI scores continued to increase just upstream from the impounded section at RM 20.5 (EB21) and RM 21.5 (EB26). The 2011 East Branch report predicted additional improvement in this reach given its increased habitat heterogeneity and scattered deposits of coarse tills. Given the low stream gradient and lingering accumulations of fine depositional substrates, additional recovery in the residual impoundment is likely to be limited.

In the 18-mile reach between Churchill Woods and the river mouth, QHEI scores were in the fair and good ranges and reached exceptional near the mouth; the 2014 and 2019 scores were very similar to those recorded in in 2007 and slightly higher than in 2011 (Figure 23). Silted substrates and variable flow conditions that influenced the habitat features (e.g., shoreline, vegetation) are still prevalent in 2019. The lower 18 miles of the East Branch, while largely unimpounded, consists mostly of pools and runs rarely interrupted by riffle habitats. Habitat reflect a long-term effects of past channelization (most sites still classified as “recovering” from channelization, extensive embeddedness and silt cover and low sinuosity and fair-poor riffle pool development. These conditions tend to result in a low diversity of riffle and fast flow habitat features (e.g., lack of helical flows), conditions basic to many of more sensitive fish species in Illinois streams and rivers that are fluvial and habitat specialists (e.g., darters, redhorse, sensitive minnows).

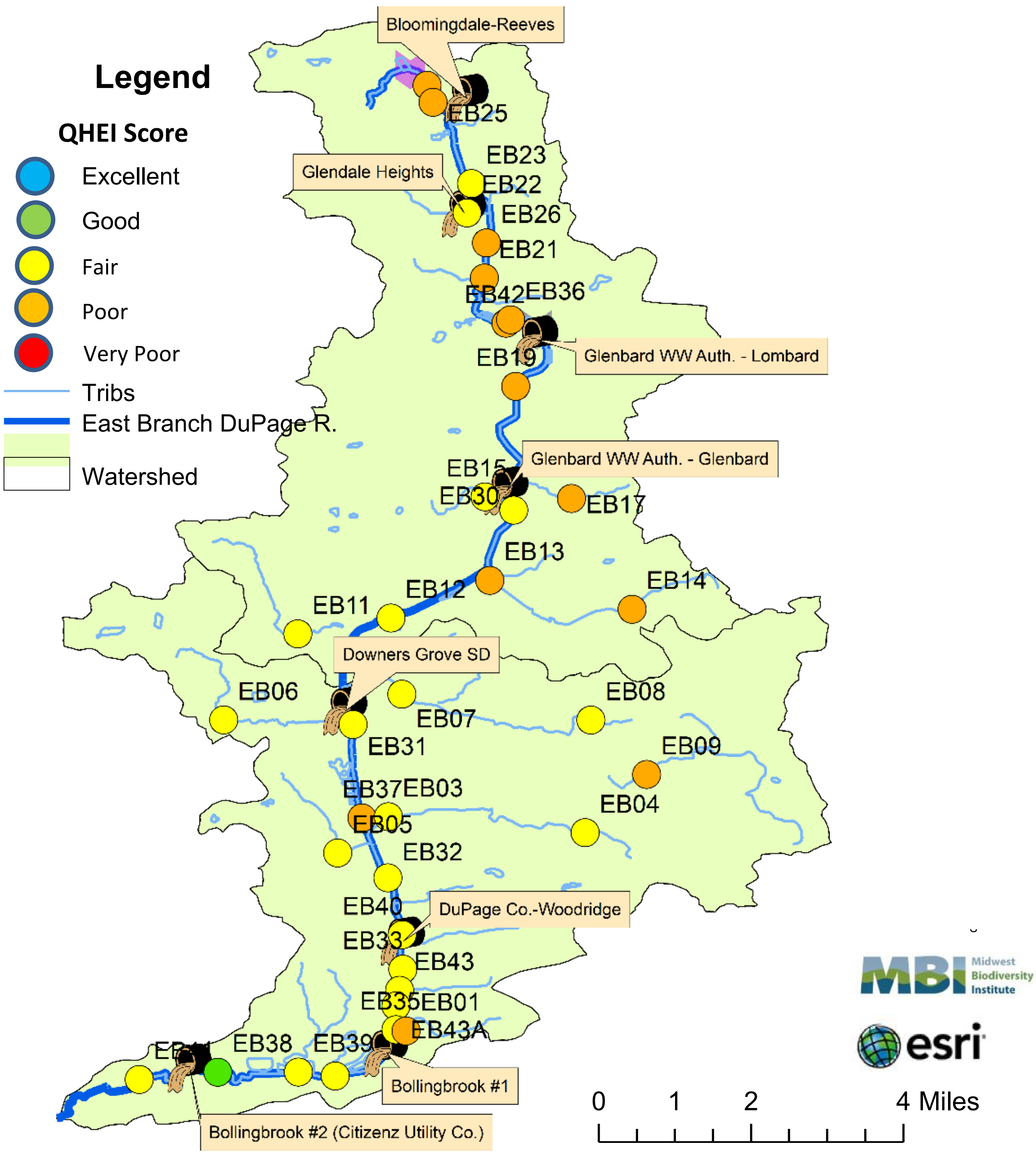


***Figure 22**. East Branch DuPage River watershed QHEI scores, 2019.*

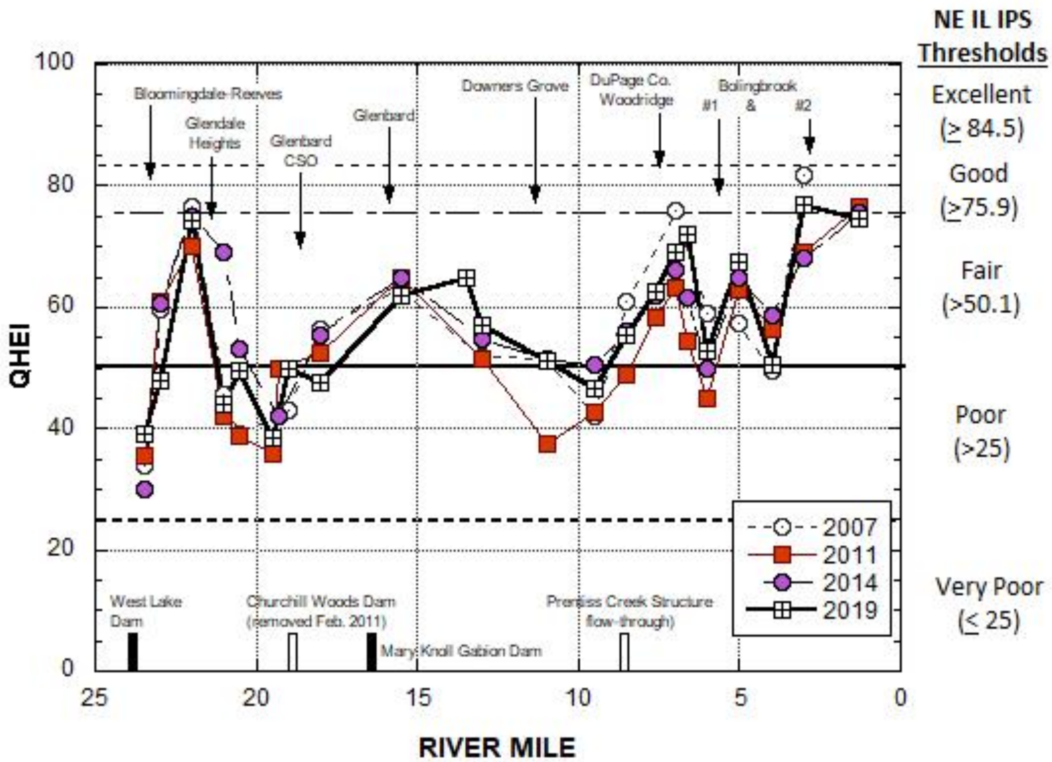


Figure 23. *Qualitative Habitat Evaluation Index (QHEI) scores for the E. Branch DuPage River in 2007, 2011-12, 2014 and 2019 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). The shaded region depicts the range of QHEI scores where habitat quality is marginal and limiting to aquatic life. QHEI scores less than 45 are typical of highly modified habitat.*

E. Branch DuPage River Tributaries

Habitat ratings from comparable East Branch tributary sites showed a general decline between 2007 and 2019 (Figure 24). As with the mainstem, tributaries showed high embeddedness and silt cover, fair-pool riffle-pool development, and low sinuosity as many channels are recovering from past channelization. A number of sites lacked any riffles. Again, such conditions are sub-optimal for fluvial specialist and benthic invertivore fish species that would be expected in streams and watersheds with more natural habitat features. As seen in Table 1, habitat is a common cause of aquatic life impairment, along with stormwater and urban land use condition in the tributaries of the East Branch DuPage River.

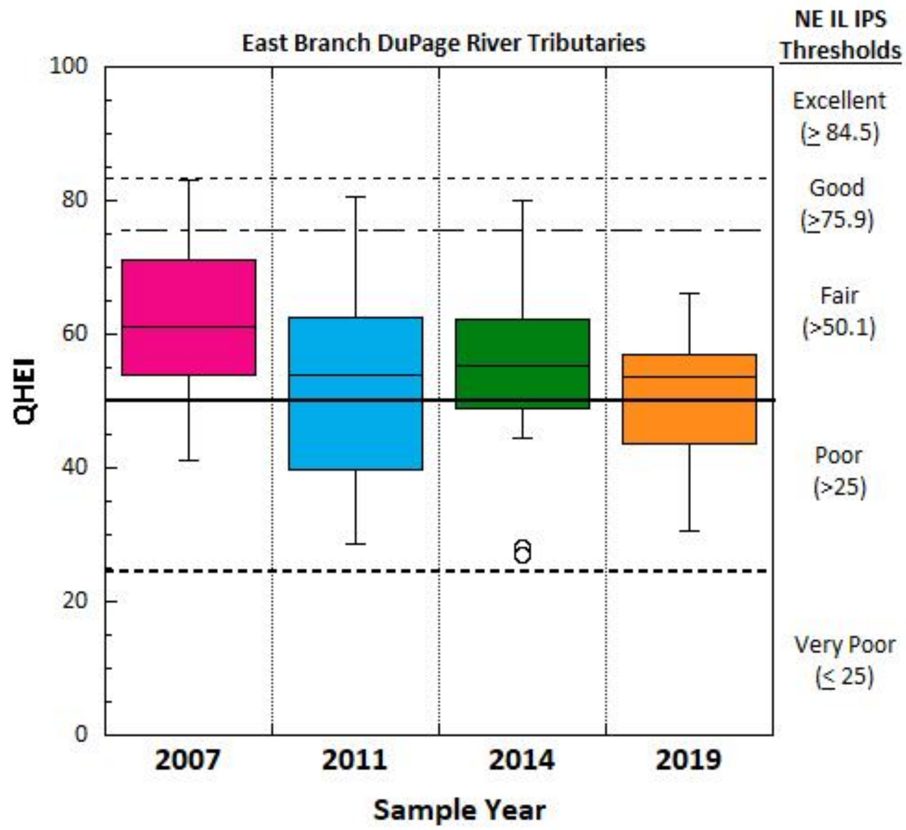


Figure 24. *Box-and-whisker plots of QHEI scores at comparable E. Branch DuPage tributary sites in 2007 (salmon), 2011 (blue), 2014 (green) and 2019 (orange).*

Table 13. *Qualitative Habitat Evaluation Index (QHEI) scores showing Good and Modified Habitat attributes at sites in the E. Branch DuPage River study area during 2019. (■- good habitat attribute; ● - high influence modified attribute; ●- moderate influence modified attribute).*

			Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
Site ID	River Mile	QHEI	No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	≤ 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embed.	No Riffle	Poor Habitat Attributes	Ration of Poor (High) to Good	Ration of Poor (All) to Good
95-980 E. Branch DuPage River																																		
EB29	23.5	**30**									■		1	●	●	●	●		4		●			●	●			●	●		●	6	0.29	3.5
EB25	23.0	**60.5**		■		■	■	■			■		5						0	●	●			●	●			●	●	●		7	0.75	1.33
EB23	22.0	**75**	■	■		■	■	■		■	■	■	8						0									●				1	4.5	0.22
EB26	21.0	**69**		■		■		■	■		■		5						0	●	●			●	●				●	●		6	0.86	1.17
EB21	20.5	**53**		■							■		2	●			●		2	●	●			●	●			●	●		●	7	0.38	2.67
EB44	19.3	**42**							■			■	2	●	●		●	●	4	●	●			●	●			●	●	●		7	0.38	2.67
EB19	18.0	**55.5**		■				■	■		■		4				●		1	●	●			●	●				●	●		6	0.71	1.4
EB30	15.5	**65**		■		■		■	■		■		5				●		1	●	●				●				●	●		5	1	1
EB12	13.0	**54.8**		■				■		■	■		4						0	●	●			●	●			●	●	●		7	0.63	1.6
EB31	11.0	**51.5**		■				■	■		■		4			●	●		2	●				●		●			●	●		5	0.83	1.2
EB37	9.5	**50.5**		■				■	■		■		4	●		●	●		3	●	●			●					●	●		5	0.83	1.2
EB32	8.5	**56**		■		■		■	■		■		5				●		1	●	●			●	●				●	●		6	0.86	1.17
EB40	7.6	**62**		■				■			■		3						0	●	●			●	●			●	●	●		7	0.5	2
EB33	7.0	**66**		■		■	■	■	■		■		6				●		1	●	●			●	●				●	●		6	1	1
EB43	6.6	**61.5**		■			■	■	■		■		5						0	●				●	●				●	●		5	1	1
EB35	6.0	**50**						■	■		■		3		●				1	●	●			●	●				●	●		6	0.57	1.75
EB34	5.0	**65**		■		■	■	■	■		■		6						0	●	●							●	●	●		5	1.17	0.86
EB39	4.0	**58.8**		■				■	■		■		4						0	●	●			●	●			●	●	●		7	0.63	1.6

Site ID	River Mile	QHEI	Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
			No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	≤ 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embed.	No Riffle	Poor Habitat Attributes	Ration of Poor (High) to Good	Ration of Poor (All) to Good
EB38	3.0	**68**	■	■		■	■	■	■	■	■	■	9						0										●	●		2	3.33	0.3
EB41	1.3	**75.5**	■	■			■	■	■	■	■		7						0					●					●	●		3	2	0.5
95- 951 Army Trail Creek																																		
EB24	0.25	**47**	■				■	■			■		4		●				1		●			●	●			●	●		●	6	0.71	1.4
EB24	0.25	**50.5**					■	■			■		3		●				1	●	●		●	●				●	●	●	●	8	0.44	2.25
95-952 Armitage Ditch (trib. to E. Branch DuPage)																																		
EB22	0.8	**52.5**		■					■	■	■		4				●		1	●	●			●	●				●	●		6	0.71	1.4
EB22	0.5	**44.5**		■									1			●	●	●	3	●	●			●				●	●	●		6	0.29	3.5
95-953 Glencrest Creek																																		
EB15	0.5	**55**		■					■		■		3				●		1	●				●	●				●	●		5	0.67	1.5
95-954 Lacey Creek																																		
EB14	2	**44.8**						■			■		2				●		1	●	●			●	●			●	●	●		7	0.38	2.67
EB13	0.25	**27**									■		1	●	●	●	●		4		●			●		●		●	●		●	6	0.29	3.5
95-955 Willoway Brook																																		
EB11	1	**80**	■	■		■	■	■	■	■	■	■	9				●		1									●		●		2	3.33	0.3
95-956 22nd St. trib. to E. Branch DuPage River																																		
EB17	1	**56**	■	■		■	■	■	■		■		7						0	●	●			●					●	●		5	1.33	0.75
95-957 Rott Creek																																		
EB06	2	**55.3**		■		■		■	■		■		5						0	●	●			●	●				●	●		6	0.86	1.17
95-986 Prentiss Creek																																		
EB04	3.8	**63**	■	■		■		■	■		■		6						0	●	●			●	●				●	●		6	1	1
EB03	1.1	**67.5**		■		■	■	■	■		■	■	7				●		1	●	●			●	●				●	●		6	1.14	0.88

			Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes													Ratios	
Site ID	**River Mile**	**QHEI**	**No Channelization**	**Boulder, Cobble, Gravel**	**Silt Free**	**Good-Excellent Development**	**Moderate-High Sinuosity**	**Moderate-Extensive Cover**	**Fast Flow w Eddies**	**Little to No Embeddedness**	**Max Depth > 40 cm**	**No Riffle Embeddedness**	**"Good" Habitat Attributes**	**Channelized or No Recovery**	**Silt/Muck Substrates**	**No Sinuosity**	**Sparse No Cover**	**Max Depths <40 cm**	**High Influence Poor Attributes**	**Recovering from Channelization**	**Mod-High Silt Cover**	**Sand Substrates (Boatable sites)**	**Hardpan Origin**	**Fair- Poor Development**	**Low Sinuosity**	**≤ 2 Cover Types**	**Intermittent Flow or Pools <20 cm**	**No Fast Current Types**	**Mod-Extensive Embeddedness**	**Mod-Extensive Riffle Embed.**	**No Riffle**	**Poor Habitat Attributes**	**Ration of Poor (High) to Good**	**Ration of Poor (All) to Good**
95-987 St. Joseph Creek																																		
EB10	6	**55**		■				■			■		3			●			1	●	●			●	●			●	●	●		7	0.5	2
EB08	4	**62.3**		■				■	■		■		4				●		1	●	●			●	●				●	●		6	0.71	1.4
EB07	1	**66.3**		■		■			■		■		4				●		1	●	●			●	●				●	●		6	0.71	1.4
95-988 Trib. to E. Br. DuPage River																																		
EB01	0.25	**28**											0	●	●	●	●	●	5	●	●			●	●			●	●	●		7	0.13	8
95-989 Trib. to E. Br. DuPage River, #6																																		
EB05	0.6	**56.3**		■		■	■		■		■	■	6				●		1	●	●								●	●		4	1.4	0.71
95-990 Crabtree Creek																																		
EB02	0.2	**56**		■		■					■		3				●		1	●				●	●			●	●	●		6	0.57	1.75
95-982 Big Rock Creek																																		
W-3	11	**90.5**	■	■		■	■	■	■	■	■	■	9						0													0	10	0.1
95-985 Forked Creek																																		
W-2	2	**79**	■	■				■	■	■	■	■	7						0					●	●							2	2.67	0.38

E. Branch DuPage River Watershed Biological Assemblages – Macroinvertebrates

Macroinvertebrate collections from the 2019 East Branch watershed survey fell entirely within the fair or poor quality ranges with the exception of a single "good" site on lower mainstem (Figure 25). As in past years, assemblages throughout the study area were predominated by facultative and tolerant organisms (e.g., Oligochaeta, *Polypedilum illinoense*) most often associated with elevated nutrients, dissolved solids, and low D.O (Table 14, Table 15). Many of the same populations, particularly from low-gradient reaches, are common to sluggish, impounded, or wetland influenced habitats with mucky or silty substrates.

Table 14. *Top ten macroinvertebrate taxa by percent collected in the East Branch DuPage River study area in 2019.*

Taxa Code	Taxa Name	OH Toler-ance	IL Toler-ance	IL Func. Feeding Group	Taxa Group	Abund-ance	Pct Abund-ance	Samples Found In
03600	Oligochaeta	T	10	CG		1418	11.97	38
84470	Polypedilum (P.) illinoense	T	6	SH		1233	10.41	34
74100	Simulium sp	F	6	CF		1134	9.57	26
05800	Caecidotea sp	T	6	CG		941	7.94	30
06201	Hyalella azteca	F	4	CG		938	7.92	25
01801	Turbellaria	F	6	PR		804	6.78	34
95100	Physella sp	T	9	SC		476	4.02	18
22001	Coenagrionidae	T	5.5	PR		431	3.64	29
84450	Polypedilum (Uresipedilum) flavum	F	6	SH		392	3.31	25
52200	Cheumatopsyche sp	F	6	CF	CA	362	3.05	21

Important macroinvertebrate biological signatures of condition are summarized in Table 15 for the entire study area. Signature percent taxa for organic enrichment ranged from the fair to very poor range with many sites in the poor narrative category (Table 15). Fewer sites reflected toxic impacts with no sites rated as very poor and only two sites rated poor (both in St Joseph Creek (Table 15). Trends in important mIBI metrics are summarized by year for entire watershed, tributaries and the lower and upper mainstem of the East Branch DuPage River in Table 16. Metrics that reflect the most severe impacts for each year and site category are highlighted in yellow. Few sensitive macroinvertebrate taxa were observed in the East Branch watershed and the total number of distinct mayfly, caddisfly of stonefly (i.e., EPT) taxa numbered 15 in 2019 compared to only nine in 2014 and 16 distinct EPT taxa in 2011. EPT taxa are generally considered positive indicators of water quality, but the some of the taxa observed were facultative or tolerant varieties within the group. No stonefly (Plecoptera) individuals have ever been found in the study area.

***Table 15**. Macroinvertebrate biological signature metrics from the East Branch DuPage River study area in 2019. Values are color code by narrative ranges of condition (bottom of table).*

Site ID	River Mile	Drainage Area (sq mi)	mIBI	Total Taxa	Intolerant Taxa	%Tolerant Taxa	EPT Taxa	%EPT	MBI	%Toxic Tolerant Taxa	%Organic Enrich. Taxa
Army Trail Creek (Trib to E. Br. DuPage at RM 23.1											
EB24	0.25	0.30	21.01	12	0	24.58	1	0.34	6.6	0	35.4
Armitage Ditch (Trib to E. Br DuPage at RM 21.9)											
EB22	0.50	2.20	23.86	17	1	11.05	1	4.56	5.3	0	21.8
Glencrest Creek (Trib to E. Br DuPage at RM 16.0)											
EB15	0.50	3.00	21.28	18	1	14.79	2	0.61	6.9	0	71.3
Lacey Creek (Trib to E. Br DuPage at RM 14.6)											
EB14	2.00	2.00	16.05	14	0	8.79	1	0.28	6	1.4	37.8
EB13	0.25	6.00	21.27	18	1	12.73	0	0	5.9	3.3	20.1
Willoway Brook (Trib to E. Br DuPage at RM 12.77)											
EB11	1.00	3.00	32.67	19	2	8.28	3	12.29	6.3	5.9	59.1
22nd St.(Trib to E. Br. DuPage @ RM 16.46)											
EB17	1.00	0.80	20.34	16	2	17.20	0	0	7.1	2.5	64.9
Rott Creek (Trib to E. Br, DuPage @ RM 11.5)											
EB06	2.00	4.00	28.74	18	1	5.45	2	14.52	5.9	3.3	17.5
East Branch DuPage River											
EB29	23.50	2.00	24.37	13	0	42.65	0	0	8.4	0.6	83.7
EB25	23.00	2.00	18.57	20	1	8.99	1	0.33	6.4	25.8	46.1
EB23	22.00	5.00	20.66	19	1	12.76	3	1.2	6.3	5.4	40.2
EB26	21.00	12.00	27.8	26	2	14.98	5	5.96	6.3	0	42.6
EB21	20.50	14.20	26.38	27	2	14.56	1	2.79	6	12.8	14.8
EB42	19.50	12.30	21.12	18	1	14.58	2	1.25	6.4	0.3	28.5
EB36	19.00	16.00	33.31	23	1	5.65	4	25.43	5.3	0.3	11.9
EB19	18.00	16.80	27.93	24	1	7.11	2	0.65	5.6	16.8	12.9
EB30	15.50	27.20	27.53	21	1	4.27	3	11.28	5.6	6.7	42.1
EB12A	0.00	31.50	31.69	27	2	14.33	4	7.46	6.5	5.7	63.1
EB12	13.00	32.20	33.36	28	3	12.97	3	8.12	6.2	16.2	35.3
EB31	11.00	58.00	32.16	28	3	9.86	5	6.17	6.2	8	46.8
EB37	9.50	60.10	32.9	28	3	12.83	5	23.36	6.1	5.6	23.0
EB32	8.50	61.00	37.44	30	3	10.16	7	18.9	6	4.1	31.3
EB40	7.60	68.60	27.92	21	1	4.30	5	5.34	6.2	20.8	53.7
EB33	7.00	70.90	31.24	26	2	1.64	6	21.13	5.8	31.3	14.3
EB35	6.00	76.40	40.42	33	5	2.56	6	16.99	5.8	16	20.4
EB34	5.00	76.40	40.35	26	3	5.94	6	36.14	5.4	0.7	17.4
EB39	4.00	78.00	41.99	33	4	9.55	8	23.62	6.2	27.8	24.3
EB38	3.00	81.00	40.84	29	2	2.24	5	33.65	5.6	2.6	41.7
EB41	1.30	77.90	35.32	30	3	6.07	7	15.02	6.1	31.6	13.1

***Table 15**. continued.*

Site ID	River Mile	Drainage Area (sq mi)	mIBI	Total Taxa	Intolerant Taxa	%Tolerant Taxa	EPT Taxa	%EPT	MBI	%Toxic Tolerant Taxa	%Organic Enrich. Taxa
Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6)											
EB04	3.80	2.30	14.73	11	1	36.06	0	0	8.7	0.6	70.8
EB03	1.10	6.60	24.78	17	1	4.03	2	6.19	6	1.5	10.2
St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9)											
EB10	6.00	2.00	17.34	16	0	9.69	0	0	6.5	53.7	21.8
EB08	4.00	4.00	18.6	17	1	13.80	1	0.38	6.7	21.9	48.3
EB07	1.00	10.00	18.97	14	0	13.06	2	12.71	6.8	45.4	29.9
Trib. to E. Br. DuPage River at RM 6.15											
EB01	0.25	0.80	33.64	22	2	21.94	1	0.31	7.1	16	34.2
Trib. # 6 to E. Br. DuPage River @ RM 9.35											
EB05	0.60	1.00	33.72	24	2	12.31	3	6.71	6.2	6.4	31.5
Crabtree Creek, Trib to E. Br. DuPage @ RM 7.8											
EB02	0.20	1.40	17.38	14	0	6.15	0	0	6.4	3	20.7
UT to St Joseph Creek											
EB09	1.10	0.22	28.67	10	0	16.56	0	0	6.2	0.3	15.0
	Exceptional		>65.0							0.0	<5
	Good		≥41.8	≥23	≥3	≤7.5	≥3	>24.5	≤4.9	<5	<15
	Fair		<41.8	≤23	2	≤28	2	≥7.7	>4.9	<20	≥15
	Poor		≤20.9	<16	1	>28.1	1	<7.7		≥35	≥35
	Very Poor				0		0			<60	>60

EPT taxa were still especially lacking in tributaries where 6 of 17 (35%) samples had zero EPT taxa and five had only one, but several tributaries had between 2-3 EPT taxa, an improvement over 2014. Mainstem EPT richness, while comparatively higher than tributary sites, followed a similar trend (Figure 25). Lowest EPT taxa occurred upstream and in the vicinity of Churchill Woods and downstream sites all had mayflies, but were lowest in 2014. The same reach coincides with the area of lowest mainstem mIBI scores (Figure 28). Outside of the East Branch watershed, the reference sites in Big Rock Creek and Forked Creek had the highest mIBI scores in the survey and scored in the "good" range. The site drainage areas (mean 107 sq. mi.) were larger than East Branch sites, but roughly matched EB41 the East Branch mainstem site near the mouth (85 sq. mi.). EB41 was the only 2019 East Branch site where the mIBI also reached the good range.

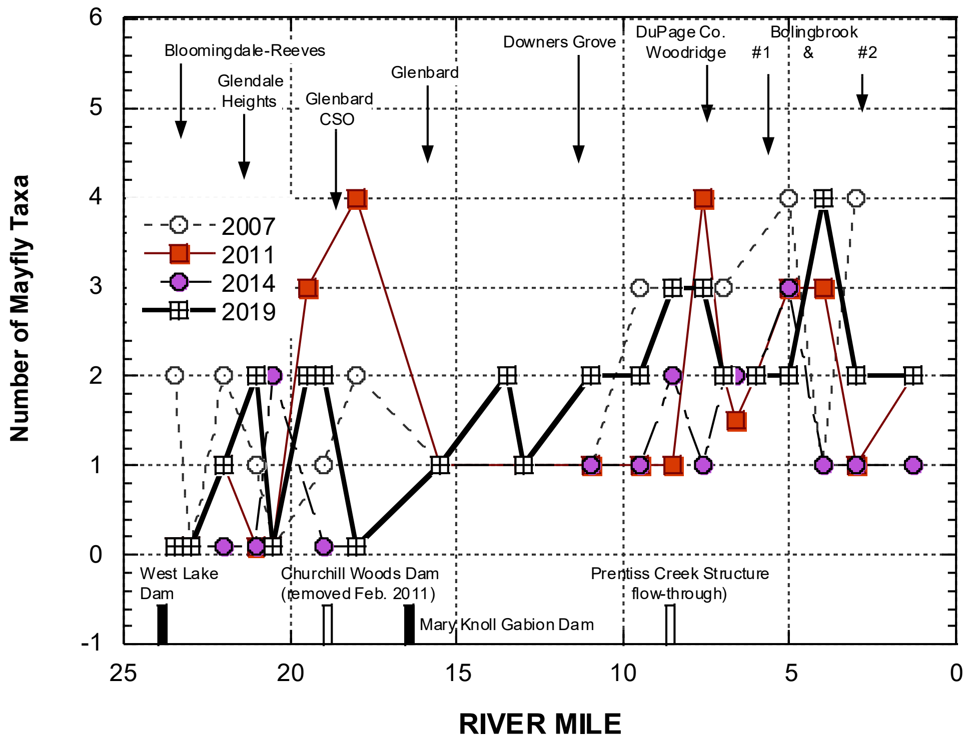


Figure 25. *Plot of the number of mayfly taxa vs. river mile in the East Branch DuPage River mainstem during 2007, 2011, 2014, and 2019,*

E. Branch DuPage River Tributaries

As in 2007 through 2014, all 2019 East Branch tributaries had mIBI scores in the poor or fair ranges (Figure 27 right). The distribution of mIBI scores in tributaries fluctuated slightly from year to year which is somewhat expected given the preponderance of stressors and changes in flow from year-to-year in these small streams. Occasionally, the swing in index scores can be large, particularly where there has been a change in stressor load or variability induced in flow changes or changes in habitat. Variability in index scores can be a signal for moderate to high environmental stressors that can episodically impact the assemblages in these streams. Figure 29 shows the maximum change in both mIBI and fIBI scores observed in tributaries of the East Branch DuPage River from 2007-2019. Variation in indices in stable reference sites would be expected to have much lower fluctuations in index score within and between years of sampling (i.e., a lower "signal-noise" ration, Kauffmann et al. 1999; IL EPA 2005b; Whittier et al. 2007).

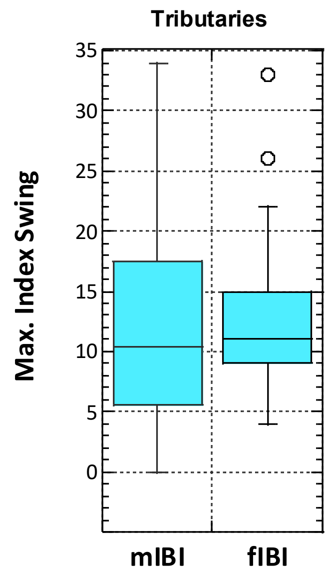


Figure 29. *Max index score change observed in the East Branch DuPage River tributaries between 2007 and 2019.*

High Water Influences

On average the 2019 mIBI narrative ratings from the East Branch watershed were not appreciably different compared to previous surveys (Figure 27a), but the distribution of score was slightly higher in the mainstem (Figure 27b, 29) and slightly lower in the tributaries (Figure 27c). A more detailed inspection of the tabulated data found that metrics such as Total Taxa, Ephemeroptera (mayfly), Coleoptera (beetle), and EPT taxa richness, EPT percentage, and mIBI scores were lower in 2014 and 2019 than in 2007 or 2011 (Table). The 2014 report identified high flow events are a possible cause of lower metric values observed that year, particularly preceding the time of sample collection in 2014. The flows in 2019 were high throughout the sampling season (Figure 9 and 10) which may also have had an influence on macroinvertebrate assemblages.

Table 16. *A comparison of taxa richness and taxa percentages for selected macroinvertebrate mIBI metrics and index scores in samples from the East Branch DuPage River watershed, 2007-19. Values highlighted in yellow are the lowest in each category during the four survey years.*

Sites	Year	No. Samples	Total Taxa	Mayfly Taxa	Coleop. Taxa	Percent EPT	Total EPT Taxa	Percent Scrapers	mIBI
Watershed	2007	32	27.8	1.5	1.0	11.8	3.9	5.7	30.7
Watershed	2011	39	29.5	1.2	0.8	10.1	3.4	5.4	27.4
Watershed	2014	36	23.9	0.7	0.5	4.6	1.5	9.7	25.4
Watershed	2019	38	21.2	1.2	0.5	8.5	2.9	3.5	27.5
Tributaries	2007	15	25.5	1.0	0.9	8.5	2.3	6.2	28.1
Tributaries	2011	18	24.7	0.7	0.4	4.7	1.9	6.8	22.7
Tributaries	2014	16	21.6	0.2	0.1	0.8	0.3	13.9	22.7
Tributaries	2019	17	16.3	0.7	0.4	3.5	1.3	4.1	23.1
Upper Mainstem[a]	2007	6	24.8	1.0	0.3	9.3	1.8	3.8	23.9
Upper Mainstem	2011	6	35.7	0.5	0.5	4.4	2.7	4.0	25.7
Upper Mainstem	2014	6	23.8	0.5	0.2	0.2	0.5	10.0	21.8
Upper Mainstem	2019	7	20.9	1.0	0.1	5.3	2.3	6.2	24.6
Lower Mainstem[b]	2007	11	32.7	2.4	1.4	17.7	7.3	5.9	38.2
Lower Mainstem	2011	15	32.9	1.9	1.4	18.9	5.4	4.3	33.5
Lower Mainstem	2014	14	26.7	1.4	1.1	10.8	3.4	4.8	30.1
Lower Mainstem	2019	14	27.4	2.0	0.9	16.3	5.1	1.6	34.4

[a]Upper mainstem = East Branch DuPage Ust. former Churchill Woods dam

[b]Lower mainstem = East Branch DuPage Churchill Woods dam to mouth

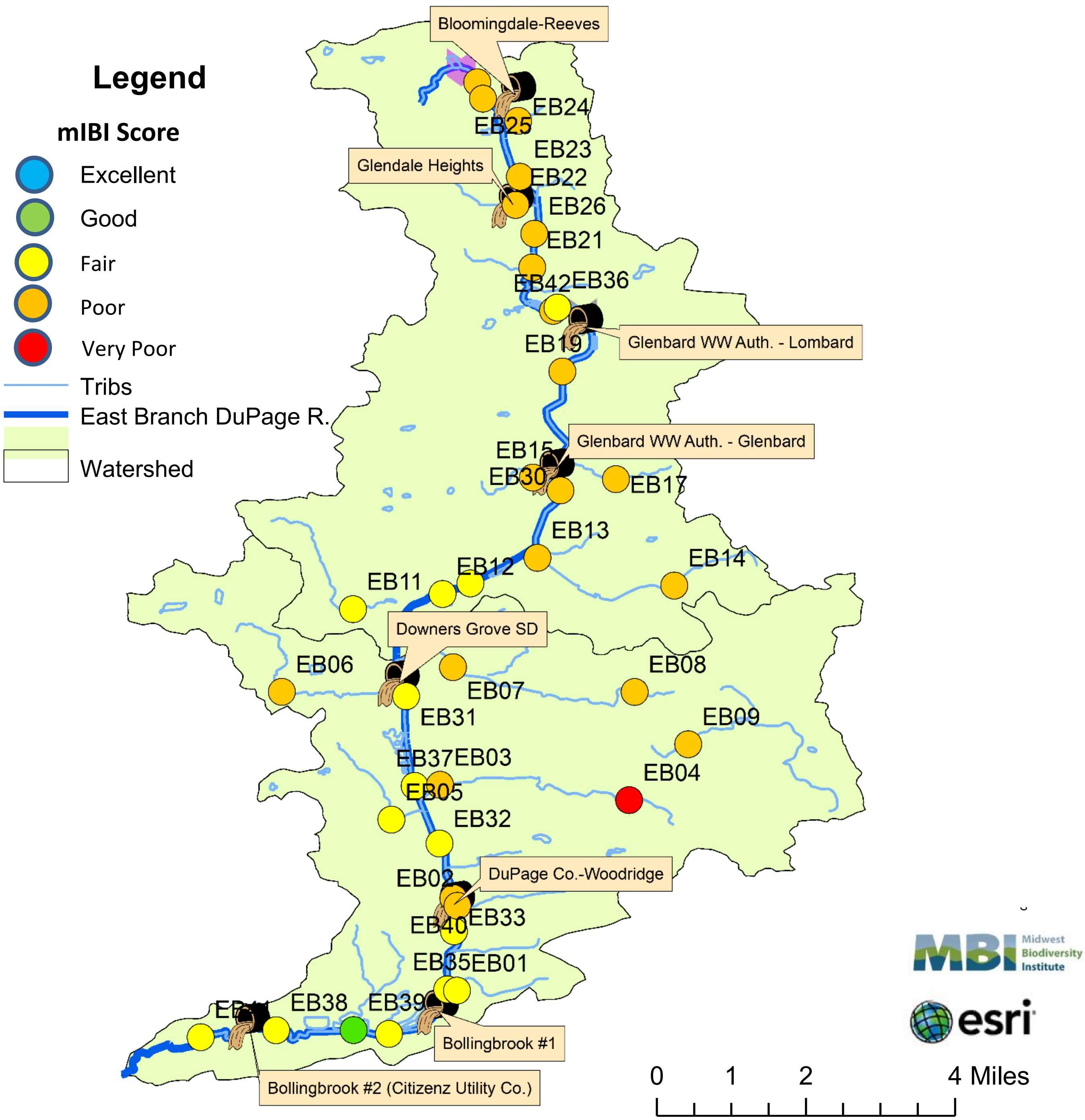


Figure 26. *Macroinvertebrate IBI (mIBI) scores from 2019 in the E. Branch DuPage River study area rated by Illinois EPA narrative ranges. Chevron symbols denote dams and outfalls denote WWTP locations.*

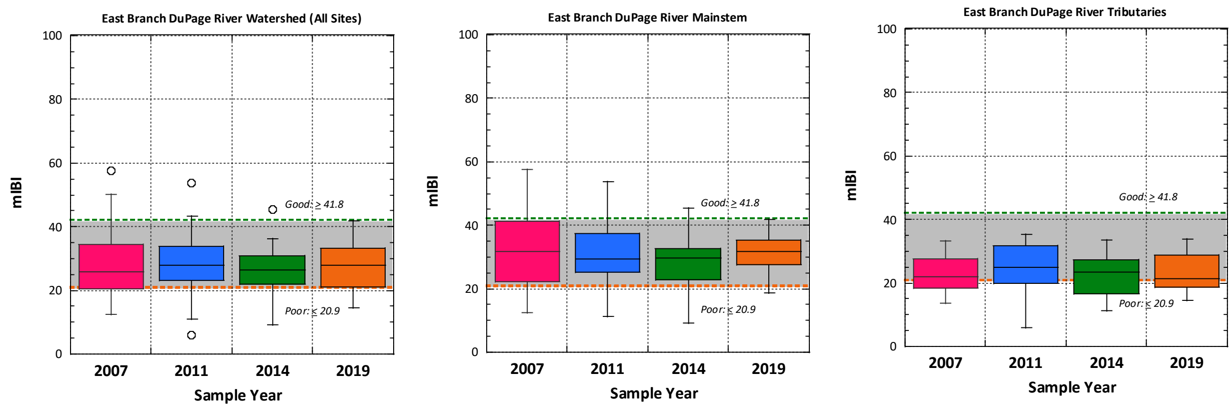


Figure 27. *Box-and-whisker plots of mIBI scores from the E. Branch DuPage River study area in 2007 (salmon), 2011 (blue), 2014 (green) and 2019 (orange). Scores are displayed by watershed (left), mainstem (middle), and tributaries (right).*

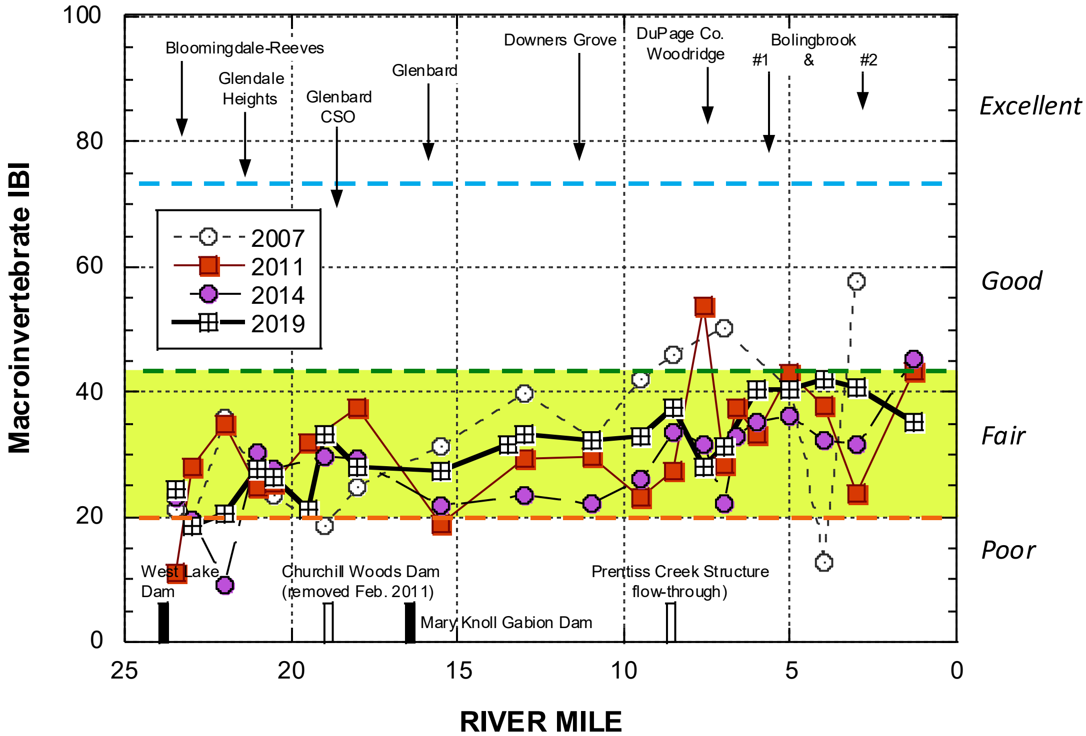


***Figure 28**. Macroinvertebrate IBI scores for samples collected from the E. Branch DuPage River, 2019, 2014, 2011 and 2007 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). The shaded area demarcates the “fair” narrative range.*

E. Branch DuPage River Watershed Biological Assemblages – Fish

Like previous surveys in 2007 through 2014 fish assemblage condition throughout the East Branch DuPage River watershed remained in the poor and fair ranges in 2019 (Figure 30, Figure 31). Mainstem assemblages were lower than previous years downstream of Glendale Heights and Downers Grove, higher than previous years in the vicinity of Glenbard and near the mouth (Figure 31). Tributary assemblages have remained largely in the upper portion of the poor range since 2007 with the 2019 results were similar to the 2014 results (Figure 30, right).

Prior to removal of the Churchill Woods dam the East Branch fish assemblages were essentially that of a pond, predominated by sunfish, bullheads, golden shiner, and mosquito fish. Downstream from the dam the fish assemblage reflected more lotic, stream like conditions with populations of Sand Shiner, Johnny Darter, Hornyhead Chub, and Rock bass. In the two years following the dam removal, eight new species were recorded upstream in 2011-12 (Table) and other populations (e.g., Sand Shiner) expanded their ranges above the former dam site. In 2014 no new species were found in the upstream reach, but two species (Banded Darter and Round Goby) not previously recorded in the East Branch were found downstream. In 2019, again, no new species were found in the upstream reach, but Northern Hog Sucker was collected in the lower reach of the East Branch. The appearance of Banded Darter and Northern Hog Sucker, both sensitive species, are a sign of improved quality in the lower miles of the mainstem. Fish performance within the former impoundment remains degraded and erratic with a localized decline in fIBI scores from fair in 2007 and 2011 to poor (fIBI = 16 at EB44) in 2014 and still poor in 2019 (fIBI = 15 at EB42). A small, residual impoundment with heavy deposits of fine muck and peat still exists behind the former dam site (this is a low gradient area) and the corresponding fish and habitat quality are still among the lowest in the mainstem.

Table 17. *Fish species collected only downstream from the Churchill Woods Dam, species collected upstream from the dam in 2011- 2019 following removal, and fish species collected upstream from the dam prior to 2011, but not after removal.*

Fish Species Collected Downstream and Not Upstream	Fish Species Collected Upstream Only After Dam Removal	Fish Species Collected Upstream Only Before Dam Removal
Golden Redhorse	*Quillback Carpsucker*	*Western Mosquitofish*
Shorthead Redhorse	*River Carpsucker*	*Central Mudminnow*
Lake Chubsucker	*Hornyhead Chub*	
Striped Shiner	*Blackstripe Topminnow*	
Common Shiner	*Channel Catfish*	
Bullhead Minnow	*Goldfish*	
Stonecat Madtom	*Pumpkinseed*	
Rock Bass	*Johnny Darter*	
Banded Darter (2014)	*Tadpole Madtom*	
Round Goby (2014)		
Northern Hog Sucker (2019)		

The fish assemblage gradually improved with increased distance downstream from the Churchill Woods dam site and reflected an improvement compared to all previous results (Figure 32). The fish assemblage then declined into the poor range below Downers Grove and then improved until the mouth site (downstream of Bolingbrook #2) where the fIBI declined again. The site at EB38 (RM 3.0) had the highest fIBI score (37) in the mainstem. That site also had the highest species richness (22), most intolerant species (4) and lowest percent tolerant (22.7%) in the mainstem and helps set a short-term target for improvement in other nearby mainstem sites. Like much of the East Branch, the lower reach remains nutrient enriched and effluent dominated particularly during late summer base flows.

E. Branch DuPage River Tributaries

Fish IBI scores from tributary sites continue to reflect mostly poor to marginally fair quality (Figure 31). Pollution tolerant populations, or those characteristic of lakes and ponds, frequently dominated the tributary sites and included Green Sunfish, Bluegill, Black and Yellow Bullhead, Fathead Minnow, White Sucker, and Common Carp. Intolerant species were entirely absent from tributaries (Table 18).

Fish assemblage quality in Lacey Creek RM 0.25 (EB13; see photo at left) continues to be erratic, ranging from fair (fIBI 24) to virtually fishless (fIBI 0) from 2007 to 2011, returning to fair (fIBI 21.5) in 2014 and remaining fair (fIBI 23) in 2019. The upstream site on Lacey Creek (EB14, RM 2.0) had the second lowest fIBI (9) along the tributaries and all individuals were tolerant.

Lacey Creek site (EB 14).

Prentiss Creek RM 1.0 (EB03) had the lowest fIBI score in 2014 (6) and 2019 (7) in both surveys. Despite very good habitat quality in all years (QHEI 66.0-68.5), only four tolerant fish species were found in both 2014 and 2019. In 2011, the site was described as silted and nearly intermittent, but was free flowing in 2014 with no obvious, visual sources of impairment. However, chemical sampling at the same location found extremely high BOD_5 levels (56.4 mg/l) in June 2014, an indication of severe organic enrichment; several BOD values were above detection in 2019, but below any threshold concentrations. Prior to 2019, BOD values were elevated with a mean of 3.95 in 2007, 2.95 in 2011, and 16.1 in 2014, so there is a history of organic enrichment at that site.

Crabtree Creek was sampled for the first time in 2014 and the fIBI score (29.5), while fair, was the highest tributary score in the survey. Given the small drainage size (<2 sq. mi.) the QHEI of 56 suggests habitat was not a limiting factor. In 2019, the site was dry when visited for sampling and an index score was not calculated. Willoway Creek (EB11) has consistently had the highest habitat quality of any of the tributaries (QHEI scores 65.5-83.0, but has always had fIBI scores in the poor range (< 20). Chemistry data from this site show some previous elevated BOD concentrations (maximum of 8.3 mg/L in 2007), elevated TKN concentrations (maximum of 3.13 in 2007), elevated summer chloride concentrations (maximum of 360 mg/L in 2014) and a specific conductivity maximum of 1442 u/S in 2014. All these values are greater than the very poor thresholds from the NE IL IPS study (Figure 3) and suggest some episodic or strong stormwater impacts (i.e., causing elevated chloride/conductivity). The general poor-fair condition of the fish assemblages in the East Branch DuPage River tributaries suggest such impacts are widespread in the watershed.

***Table 18**. Macroinvertebrate biological signature metrics from the East Branch DuPage River study area in 2019. Values are color code by narrative ranges of condition (bottom of table).*

Site ID	River Mile	Drainage Area (sq mi)	fIBI	MIwb	Native Sp.	% DELT	Intolerant sp.	%Mineral Spawners	Percent Tolerant
Army Trail Creek (Trib to E. Br. DuPage at RM 23.1									
EB24	0.25	0.30	18		1	0	0	0.00	0.00
Armitage Ditch (Trib to E. Br DuPage at RM 21.9)									
EB22	0.50	2.20	16		7	6.12	0	0.00	71.43
Glencrest Creek (Trib to E. Br DuPage at RM 16.0)									
EB15	0.50	3.00	21		5.5	0	0	23.81	55.00
Lacey Creek (Trib to E. Br DuPage at RM 14.6)									
EB14	2.00	2.00	9		2	0	0	0.00	100.00
EB13	0.25	6.00	23		8	0	0	0.00	62.50
Willoway Brook (Trib to E. Br DuPage at RM 12.77)									
EB11	1.00	3.00	16		5	0	0	0.00	20.00
22nd St.(Trib to E. Br. DuPage @ RM 16.46)									
EB17	1.00	0.80	26		3	0	0	0.00	66.67
Rott Creek (Trib to E. Br, DuPage @ RM 11.5)									
EB06	2.00	4.00	20		9	0	0	5.26	55.56
East Branch DuPage River									
EB29	23.50	2.00	23		7	1.3	0	0.00	42.86
EB25	23.00	2.00	26		10	0	0	14.77	40.00
EB23	22.00	5.00	23		16	0.16	0	4.86	50.00
EB26	21.00	12.00	13		8	0	0	0.62	62.50
EB21	20.50	14.20	15		10	0	0	0.00	50.00
EB42	19.50	12.30	15		4	0	0	0.00	25.00
EB36	19.00	16.00	22		12	0	0	4.39	50.00
EB19	18.00	16.80	25		15	0.41	0	0.83	40.00
EB30	15.50	27.20	28	5.84	13	0	0	1.15	53.85
EB12	13.00	32.20	22	5.85	10	0	0	1.41	40.00
EB31	11.00	58.00	17	4.16	8	0.52	0	0.00	62.50
EB37	9.50	60.10	18	3.16	7	0	0	0.00	28.57
EB32	8.50	61.00	25	3.3	10	0	1	0.84	50.00
EB40	7.60	68.60	18	3.91	7	0	1	0.00	42.86
EB33	7.00	70.90	23	6.58	12	0.34	1	0.32	41.67
EB43	6.60	71.60	24	5.61	11	0	1	1.24	36.36
EB43A	6.30	71.70	21	4.73	8	0	1	0.00	25.00
EB35	6.00	76.40	26	8.75	15	0.86	1	2.29	26.67
EB34	5.00	76.40	23	8.97	14	0	1	6.46	35.71
EB39	4.00	78.00	23	7.54	14	0	1	2.89	42.86
EB38	3.00	81.00	37	8.74	22	0	4	4.86	22.73
EB41	1.30	77.90	30	7.99	16	0	2	7.55	50.00

***Table 18**. continued.*

Site ID	River Mile	Drainage Area (sq mi)	fIBI	MIwb	Native Sp.	% DELT	Intolerant sp.	%Mineral Spawners	Percent Tolerant
Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6)									
EB04	3.80	2.30	14		5	0	0	0.00	40.00
EB03	1.10	6.60	7		4	0	0	0.00	100.00
St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9)									
EB10	6.00	2.00	11		3	0	0	0.00	66.67
EB08	4.00	4.00	14		7	0	0	0.00	57.14
EB07	1.00	10.00	21		9	0	0	9.57	55.56
Trib. to E. Br. DuPage River at RM 6.15									
EB01	0.25	0.80	23		3	0	0	0.00	33.33
Trib. # 6 to E. Br. DuPage River @ RM 9.35									
EB05	0.60	1.00	24		2	0	0	0.00	0.00
Crabtree Creek, Trib to E. Br. DuPage @ RM 7.8									
EB02	0.20	1.40	Dry						
UT to St Joseph Creek									
EB09	1.10	0.22	18		1	0	0	0.00	0.00
Trib. to East Br. DuPage @ RM 19.9									
EB20	0.12	0.30	Dry						
	Exceptional		>50	>9.6	>29	0.00	≥ 5		≤16.1
	Good		≥41.0	>8.5	>14	≤0.10	≥4	>40.7	<30.3
	Fair		<41.0	>5.8	>12	>0.10	≤3	<40.7	<40
	Poor		≤20	<5.8	>7	>10	≤1	<10	>50
	Very Poor		<12	<4.0	≤7	>20		<0.8	≥70

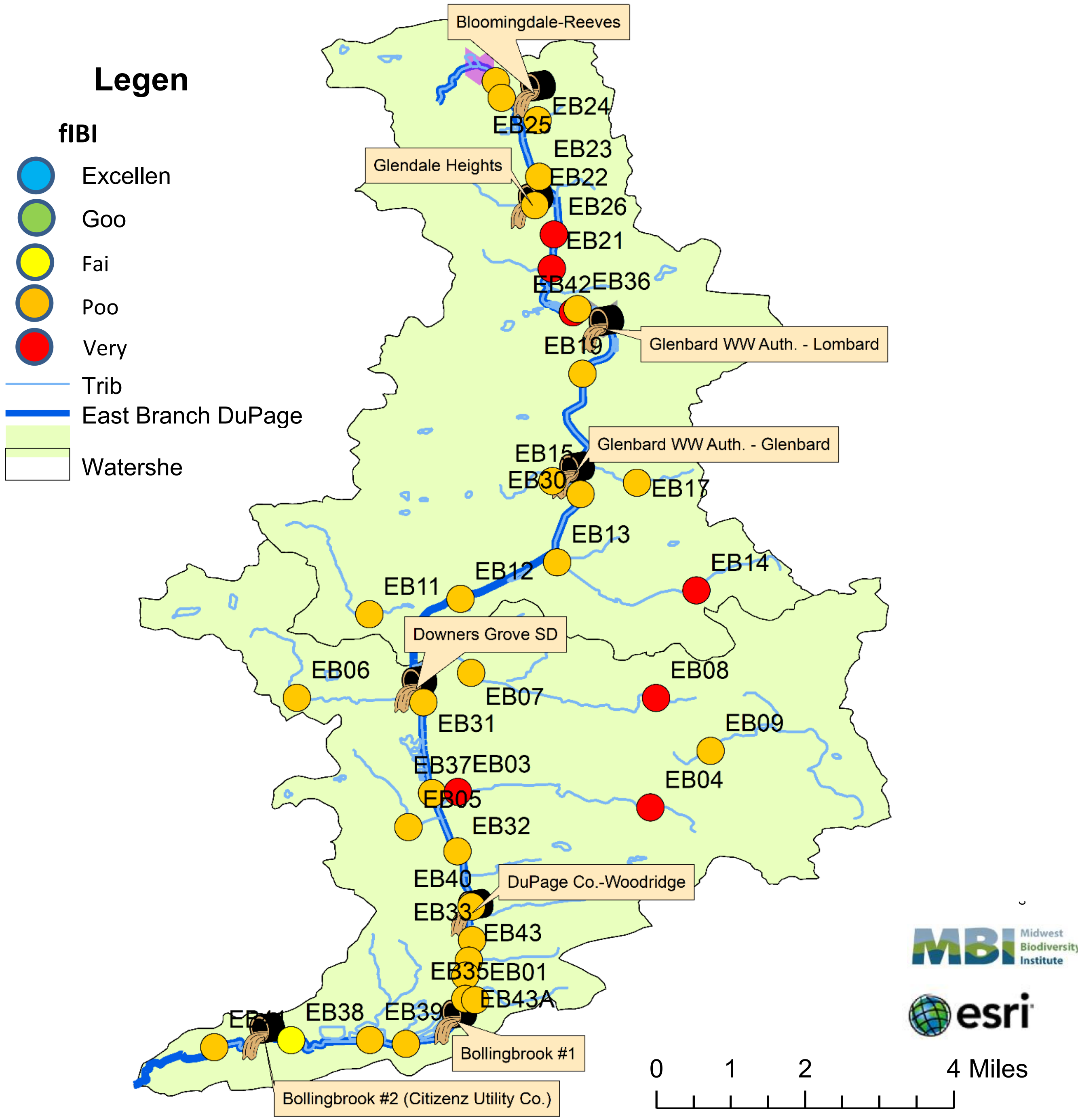


Figure 30. *Fish IBI (fIBI) scores from 2019 in the E. Branch DuPage River study area rated by Illinois EPA narrative ranges. Square symbols denote dams and outfalls denote WWTP locations.*

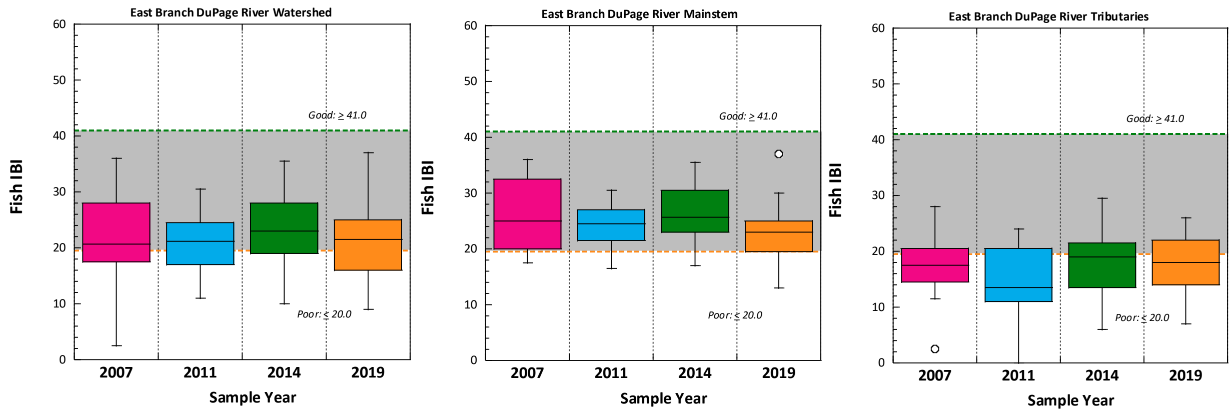


Figure 31. *Box-and-whisker plots of fIBI scores and trends at comparable sites from the E. Branch DuPage River study area in 2007 (salmon), 2011-12 (blue), 2014 (green) and 2019 (orange). Scores are displayed by watershed (left), mainstem (middle), and tributaries (right).*

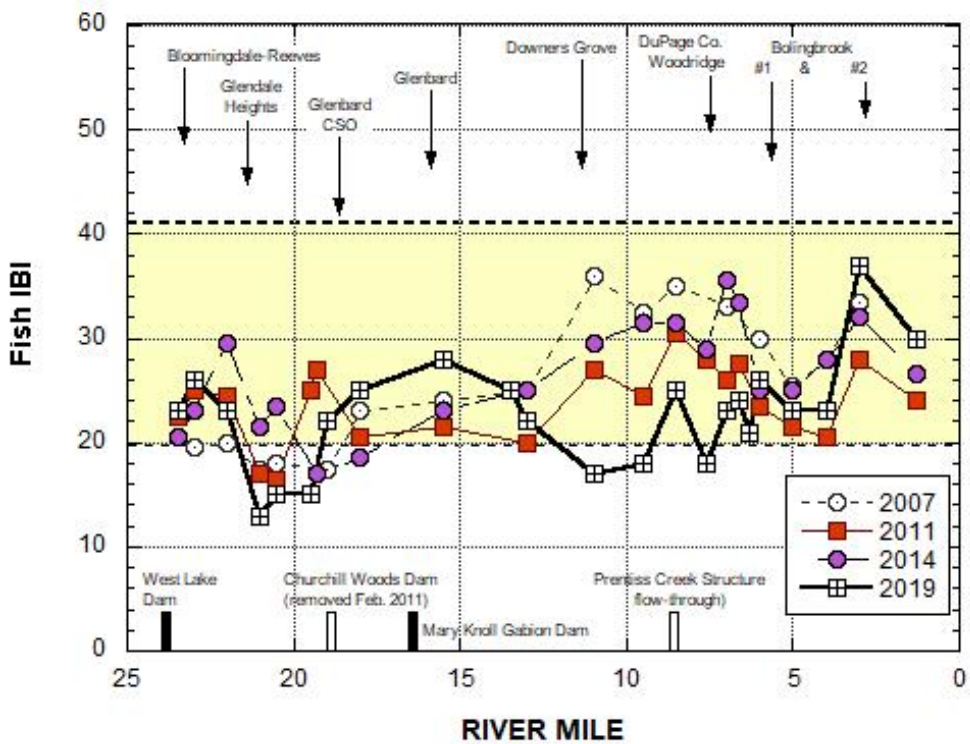


Figure 32*. Fish IBI scores in the E. Branch DuPage River, 2019, 2014, 2011-12 and 2007 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (only black bars impede fish passage). The shaded area demarcates the "fair" narrative range.*

Synthesis

The East Branch of the DuPage River watershed is challenged by urban sources many of which are a product of the impervious nature of the watershed (see land use map in Figure 7). Table 19 is a synthesis of the major causes of impairment identified during this study. The biological criteria for fish and macroinvertebrates used by Illinois EPA (2018) establish the thresholds by which impaired sites and reaches are determined. The assignment of causes in this analysis generally follows the overall intent of the Illinois Integrated Report assessment guidelines, but is supplemented by the more extensive biological effect thresholds (Tables 3-5) provided by the recently developed IPS tools and indicators (MBI 2020a) and are more spatially refined by the intensive pollution survey design. The delineation of causes and sources was based on integrating and synthesizing the preceding analyses of categorical and parameter-specific stressor threshold exceedances. The most influential of these in 2019 are included in Table 19 along with the fish and macroinvertebrate IBI scores and other indicators of stress and response. Habitat alteration is represented by the QHEI and the QHEI modified:good attributes ratio, D.O. includes the minimum measured by Datasondes, the effect of nutrient enrichment by the diel D.O. swing narrative, the nutrient enrichment effect status, the new IPS nutrient index, new IPS chemical threshold exceedances for water and sediment, and biological response signatures for organic enrichment and toxic tolerant indicators.

The baseline biological condition East Branch DuPage River and its subwatersheds has been shaped by the urban nature (i.e., stormwater impacts), high percent effluent and past stream physical modifications. Both the direct and indirect influences of the altered hydrology and habitat were evident in the chemical, habitat, and bioassessment results. The legacy of these alterations is evidenced in excessive siltation, embedded substrates, poor riffle/pool development that are further exacerbated by the altered flows and habitat (Table 19). Phosphorus and nitrate concentrations are elevated in the mainstem and in combination with altered habitats result in low D.O. concentrations and high to wide diel D.O. swings in sites where continuous DO data was collected which likely occur elsewhere in the mainstem.

Recently derived IPS thresholds for water and sediment chemistry and physical habitat attributes (MBI 2020a) were available to better assess causes of impairment and their comparative severity. The approach for deriving these thresholds included a more refined stratification of biological effect threshold values for parameters that showed valid relationships with biological responses based on species and taxa level analyses and then correlated with the corresponding fish and macroinvertebrate IBI attainment thresholds and narrative ratings (MBI 2020a). This produced thresholds across four or five narrative categories of quality (excellent, good, fair, poor, and very poor). This replaces the formerly used binary (i.e., “pass/fail”) approach to evaluating exceedances of chemical and physical effect thresholds and criteria providing for a graded approach to the assignment of causes and sources of Illinois General Use biological impairments.

Table 19. *Key chemical, physical, and biological response indicators of impairment observed at each site in the 2019 East Branch DuPage River study area. The causes associated with biological impairments are drawn from analyses of habitat, nutrient effects, chemical IPS and other threshold exceedances, sediment chemical IPS exceedances, and biological response signatures. Causes of impairment are classified as fair, poor, or very poor in accordance with the severity of exceedance of corresponding thresholds. See footnotes for table references and biological, physical, and chemical threshold intervals.*

Site ID	River Mile	Drainage Area (sq. mi.)	fIBI	mIBI	QHEI	AQLU Status	QHEI Modified: Good Ratio	Min. DO (Sonde) <WQC	Diel DO Swing	Chemical WQ Exceed-ances	≥ Poor Chemical IPS Thresholds	≥ Poor Sediment Metals	% Toxic Tolerant Signatures	% Organic Enrichment Signatures	2019 Causes by IPS Stressor Threshold Narrative Category			2019 Sources	IPS Restora-bility Score (0-100)
															Very Poor[1]	Poor[1]	Fair[1]		
Army Trail Creek (Trib to E. Br. DuPage at RM 23.1) - 95-951																			
EB24	0.25	0.30	18.0	21.0	50.5	Non - Poor	4.00				Chloride		0	35.4	Urban-WS;Dev-WS; Chloride;	Conduct; TDS;	Imperv-500m;	Urban stormwater, Habitat alteration	69.8
Armitage Ditch (Trib to E. Br DuPage at RM 21.9) - 95-952																			
EB22	0.50	2.20	16.0	23.9	53.5	Non - Poor	4.00						0	21.8	Urban-WS;Dev-WS;	Chan;	Imperv-500m;Imperv-30;Imperv-30C; BOD; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	45.1
Glencrest Creek (Trib to E. Br DuPage at RM 16.0) - 95-953																			
EB15	0.50	3.00	21.0	21.3	57.0	Non - Fair	1.80						0	71.3	Urban-WS;Dev-WS;		Imperv-500m; QHEI; Chan;	Urban stormwater, Habitat alteration	55.2
Lacey Creek (Trib to E. Br DuPage at RM 14.6) - 95-954																			
EB14	2.00	2.00	9.0	16.1	45.5	Non - Poor	4.00				TSS		1.4	37.8	Urban-WS;Dev-WS; TSS;	QHEI; Substr; Chan;	Imperv-500m;TP; TKN; BOD; Chloride;	Urban stormwater, Habitat alteration	34.7
EB13	0.25	6.00	23.0	21.3	57.0	Non - Fair	10.00						3.3	20.1	Substr; Chan;	Urban-WS;Dev-WS; QHEI;	TP; BOD; Nitrate; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration	30.6
Willoway Brook (Trib to E. Br DuPage at RM 12.77) - 95-955																			
EB11	1.00	3.00	16.0	32.7	42.0	Non - Poor	0.29						5.9	59.1	Urban-WS;Dev-WS;		BOD; QHEI; Substr;	Urban stormwater, Habitat alteration	60.9
22nd St.(Trib to E. Br. DuPage @ RM 16.46) - 95-956																			
EB17	1.00	0.80	26.0	20.3	32.5	Non - Poor	4.00						2.5	64.9	Urban-WS;Dev-WS; TSS;	Imperv-500m;Imperv-30C; QHEI; Substr;	Imperv-30; Chan;	Urban stormwater, Habitat alteration	42.7
Rott Creek (Trib to E. Br. DuPage @ RM 11.5) - 95-957																			
EB06	2.00	4.00	20.0	28.7	65.5	Non - Fair	1.50						3.3	17.5		Imperv-500m;	Urban-WS;Imperv-30C;Dev-WS; BOD; QHEI; Chan;	Urban stormwater, Habitat alteration	54.2
East Branch DuPage River - 95-980																			
EB29	23.50	2.00	23.0	24.4	39.0	Non - Fair	2.67				BOD		0.6	83.7	Urban-WS;Dev-WS; BOD; Substr;	Imperv-500m; TKN; QHEI; Chan;	Chloride;	Urban stormwater, Habitat alteration	34.4
EB25	23.00	2.00	26.0	18.6	48.0	Non - Poor	2.33				BOD		25.8	46.1	Urban-WS;Dev-WS;	Imperv-500m; BOD; QHEI; Substr;	TP; TKN; Nitrate; Chan;	Urban stormwater, Habitat alteration, WWTP Effluent	45.2
EB23	22.00	5.00	23.0	20.7	74.3	Non - Poor	0.50	0.06	9.47	Min DO	TP		5.4	40.2	Urban-WS;Dev-WS; Min DO	TP;	Imperv-500m; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	50.2
EB26	21.00	12.00	13.0	27.8	44.0	Non - Poor	4.00				Nitrate		0	42.6	Urban-WS;Dev-WS; Nitrate Substr;	TP; QHEI; Chan;	Imperv-500m;Imperv-30;Imperv-30C; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	35.9
EB21	20.50	14.20	15.0	26.4	49.5	Non - Poor	4.50				TP		12.8	14.8	Urban-WS;Dev-WS; Chan;	TP; QHEI; Substr;	Imperv-500m; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	34.8
EB42	19.50	12.30	15.0	21.1	38.5	Non - Poor	2.67						0.3	28.5	Substr;	QHEI; Chan;		Urban stormwater, Habitat alteration, WWTP Effluent	57.6
EB36	19.00	16.00	22.0	33.3	50.0	Non - Fair	1.50	0.5	18.22	Min DO	TP	Cr, Cu, Zn	0.3	11.9	Urban-WS;Dev-WS; Substr; Min DO; Sed. Metals	TP; QHEI;	Imperv-500m; Nitrate; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	40.4
EB19	18.00	16.80	25.0	27.9	47.5	Non - Fair	1.50					Cu, Pb, Zn	16.8	12.9	Urban-WS;Dev-WS; Sed. Metals	QHEI; Substr;	Imperv-500m;TP; BOD; Nitrate; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	41.2

Table 21. Continued.

Site ID	River Mile	Drainage Area (sq. mi.)	fIBI	mIBI	QHEI	AQLU Status	QHEI Modified: Good Ratio	Min. DO (Sonde) <WQC	Diel DO Swing	Chemical WQ Exceed-ances	> Poor Chemical IPS Thresholds	> Poor Sediment Metals	% Toxic Tolerant Signatures	% Organic Enrichment Signatures	2019 Causes by IPS Stressor Threshold Narrative Category: Very Poor[1]	Poor[1]	Fair[1]	2019 Sources	IPS Restora-bility Score (0-100)
EB30	15.50	27.20	**28.0**	**27.5**	62.0	Non - Fair	0.83				TP	Ba, Cr, Pb, Ni, Zn	6.7	42.1	Urban-WS;Dev-WS; Sed. Metals	TP;	Imperv-500m;Imperv-30C; QHEI; Substr; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	43.0
EB12A	13.50	31.50		**31.7**		Non - Fair	1.40						5.7	63.1	Dev-WS;			Urban stormwater, Habitat alteration, WWTP Effluent	77.9
EB12	13.00	32.20	**22.0**	**33.4**	57.0	Non - Fair	1.50					Cr, Zn	16.2	35.3	Urban-WS;Dev-WS; Sed. Metals		Imperv-500m;TP; QHEI; Substr; Chan; Conduct; TDS; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	43.8
EB31	11.00	58.00	**17.0**	**32.2**	51.0	Non - Poor	1.25				TP	Cr, Cu, Pb,Ni, Zn	8	46.8	Urban-WS;Dev-WS; Sed. Metals	Imperv-500m;TP; QHEI; Chan;	Nitrate; Substr; Conduct; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.9
EB37	9.50	60.10	**18.0**	**32.9**	46.5	Non - Poor	3.00				TP		5.6	23.0	Urban-WS;Dev-WS;	TP; QHEI;	Imperv-500m; Nitrate; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.9
EB32	8.50	61.00	**25.0**	**37.4**	55.5	Non - Fair	1.00						4.1	31.3	Urban-WS;Imperv-30C;Dev-WS;		Imperv-500m;Imperv-30;TP; Nitrate; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	42.6
EB40	7.60	68.60	**18.0**	**27.9**	62.5	Non - Poor	1.75						20.8	53.7	Urban-WS;Dev-WS;		TP; Nitrate; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration, WWTP Effluent	49.6
EB33	7.00	70.90	**23.0**	**31.2**	69.0	Non - Fair	0.67						31.3	14.3	Urban-WS;Dev-WS;		TP; Nitrate; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration	45.4
EB43	6.60	71.60	**24.0**		72.0	Non - Fair	0.29								Urban-WS;Dev-WS;		QHEI;	Urban stormwater, Habitat alteration	64.9
EB43A	6.30	71.70	**21.0**		64.0	Non - Fair	1.25								Dev-WS;		QHEI; Chan;	Urban stormwater, Habitat alteration	56.3
EB35	6.00	76.40	**26.0**	**40.4**	52.8	Non - Fair	2.33						16	20.4	Urban-WS;Dev-WS;	Chan;	Imperv-500m;TP; Nitrate; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	51.1
EB34	5.00	76.40	**23.0**	**40.4**	67.3	Non - Fair	0.29					Cr, Cu, Ni, Zn	0.7	17.4	Urban-WS;Dev-WS; Sed. Metals		TP; Nitrate; QHEI; Substr; Chloride;	Urban stormwater, Habitat alteration	55.5
EB39	4.00	78.00	**23.0**	**42.0**	50.5	Partial	3.50	5.7	2.69				27.8	24.3	Urban-WS;Dev-WS;	QHEI; Chan;	TP; BOD; Nitrate; Substr; Chloride;	Urban stormwater, Habitat alteration	37.2
EB38	3.00	81.00	**37.0**	**40.8**	77.0	Non - Fair	0.25						2.6	41.7	Urban-WS;Dev-WS;		Imperv-500m;TP; Nitrate; Chloride;	Urban stormwater, Habitat alteration	61.7
EB41	1.30	77.90	**30.0**	**35.3**	74.5	Non - Fair	0.25						31.6	13.1	Urban-WS;Dev-WS;		Imperv-30;Imperv-30C;TP; BOD; Nitrate; QHEI; Chloride;	Urban stormwater, Habitat alteration	54.7
Prentiss Creek (Trib to E. Br. DuPage @ RM 9.6) - 95-986																			
EB04	3.80	2.30	**14.0**	**14.7**	45.0	Non - Poor	1.50						0.6	70.8	Urban-WS;Dev-WS;	Imperv-500m;	TKN; QHEI; Chan; Chloride;	Urban stormwater, Habitat alteration	54.9
EB03	1.10	6.60	**7.0**	**24.8**	52.5	Non - Poor	0.83						1.5	10.2	Urban-WS;Dev-WS;	Imperv-500m;	Imperv-30C; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration	52.5
St. Joseph Creek (Trib to E. Br. DuPage @ RM 11.9) - 95-987																			
EB10	6.00	2.00	**11.0**	**17.3**	57.0	Non - Poor	4.00						53.7	21.8	Urban-WS;Dev-WS;	QHEI; Substr; Chan;	Imperv-500m; BOD;	Urban stormwater, Habitat alteration	46.3
EB08	4.00	4.00	**14.0**	**18.6**	31.0	Non - Poor	2.33						21.9	48.3	Urban-WS;Dev-WS; Low DO;		Imperv-500m; QHEI; Substr; Chan;	Urban stormwater, Habitat alteration	46.8
EB07	1.00	10.00	**21.0**	**19.0**	55.0	Non - Poor	1.50					Cr,Cu, Pb, Ni, Zn	45.4	29.9	Urban-WS;Dev-WS; Sed, Metals	Imperv-500m;	Imperv-30C; QHEI; Substr; Chan; Chloride;	Urban stormwater, Habitat alteration	59.6
Trib. to E. Br. DuPage River at RM 6.15 - 95-988																			
EB01	0.25	0.80	**23.0**	**33.6**	61.0	Non - Fair	10.00						16	34.2		Urban-WS;Dev-WS; QHEI; Substr; Chan;	Imperv-500m; Chloride;	Urban stormwater, Habitat alteration	48.9
Trib. # 6 to E. Br. DuPage River @ RM 9.35 - 95-989																			
EB05	0.60	1.00	**24.0**	**33.7**	66.0	Non - Fair	1.75						6.4	31.5	Urban-WS;Dev-WS;		Imperv-500m; TKN; BOD; QHEI; Substr; Chan;	Urban stormwater, Habitat alteration	57.1
Crabtree Creek, Trib to E. Br. DuPage @ RM 7.8 - 95-990																			
EB02	0.20	1.40	**Dry**	**17.4**	Dry	Non - Poor	Dry								Urban-WS;Dev-WS;		Imperv-500m; Chloride;	Urban stormwater, Habitat alteration	73.8
UT to St Joseph Creek - 95-991																			
EB09	1.10	0.22	**18.0**	**28.7**	31.0	Non - Poor	9.00						3	20.7	Substr; Chan;	QHEI;	TKN; BOD;	Urban stormwater, Habitat alteration	29.3
Trib. to East Br. DuPage @ RM 19.9 - 95-992																			
EB20	0.12	0.30	Dry Site								Chloride					Conduct; TDS; Chloride;	Dev-WS; TKN;	Urban stormwater, Habitat alteration	74.8
	Narrative Category		**fIBI**	**mIBI**	**QHEI**	**AQLU Status**	QHEI Ratio	**Min. DO**	**DO Swing**				**Toxic Sign.**	**Org, Enrich.**					IPS Ranking
	Excellent		>50	>73	>84.5	FULL	<0.50	>6.9	< 2.0				0.0	<5					Very High
	Good		>41-49	41.8-72.9	>75.9	FULL	0.50-1.00	6-6.9	2.0-4.0				<5	<15					High
	Fair		30-<41	30-41.7	<75.9	PARTIAL	1.01-3.99	4.0-5.9	4.0-5.0				<20	>15					Moderate
	Poor		>15-29	>15-29	<50.1	NON-Fair	4.00-5.99	2.0-3.9	5.0-6.5				>35	>35					Low
	Very Poor		<15	<15	<25.0	NON-Poor	>6.00	< 2.0	>6.5				<60	>60					Very Low

Table 20. *Summary of causal agents and categories identified from the synthesis of key chemical, physical, and biological response indicators of impairment observed at each site in the 2019 East Branch DuPage River study area. Total and weighted observations by very poor, poor, and fair exceedances are tallied for each causal agent and category to provide a relative accounting for the study area.*

East Branch Dupage River 2019 Watershed Causes by Severity

Causal Agents	Very Poor	VP%	VP Wtd.	VP Wtd.%	Poor	Poor%	Poor Wtd.	Poor Wtd.%	Fair	Fair%	Fair Wtd.%	Total	Total%	Total Wtd.	Wtd. %
QHEI Score	0	0.0%	0	0.0%	14	5.9%	42	8.6%	23	9.6%	4.7%	14	15.5%	65	13.2%
QHEI Ratios	3	1.3%	15	3.1%	7	2.9%	21	4.3%	19	7.9%	3.9%	10	12.1%	55	11.2%
Substrate	5	2.1%	25	5.1%	6	2.5%	18	3.7%	18	7.5%	3.7%	11	12.1%	61	12.4%
Channel Condition	3	1.3%	15	3.1%	10	4.2%	30	6.1%	19	7.9%	3.9%	13	13.4%	64	13.0%
Habitat Related	**11**	**2.2%**	**55**	**11.2%**	**37**	**15.5%**	**111**	**22.6%**	**79**	**33.1%**	**16.1%**	**127**	**53.1%**	**245**	**49.9%**
TKN	0	0.0%	0	0.0%	1	0.4%	3	0.6%	6	2.5%	1.2%	1	2.9%	9	1.8%
Ammonia-N	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0%	0	0.0%	0	0.0%
Organic Enrichment	5	2.1%	25	5.1%	12	5.0%	36	7.3%	14	5.9%	2.9%	17	13.0%	75	15.3%
Nutrient_Enrichmen	**5**	**1.0%**	**25**	**5.1%**	**13**	**5.4%**	**39**	**7.9%**	**20**	**8.4%**	**4.1%**	**38**	**15.9%**	**84**	**17.1%**
Minimum D.O.	2	0.8%	10	2.0%	0	0.0%	0	0.0%	0	0.0%	0.0%	2	0.8%	10	2.0%
Maximum D.O.	2	0.8%	10	2.0%	0	0.0%	0	0.0%	0	0.0%	0.0%	2	0.8%	10	2.0%
Diel D.O.	2	0.8%	10	2.0%	0	0.0%	0	0.0%	0	0.0%	0.0%	2	0.8%	10	2.0%
D.O. Related	**6**	**2.5%**	**30**	**6.1%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0.0%**	**6**	**2.5%**	**30**	**6.1%**
Chlorides	2	0.8%	10	2.0%	1	0.4%	3	0.6%	25	10.5%	5.1%	3	11.7%	38	7.7%
Conductivity	0	0.0%	0	0.0%	2	0.8%	6	1.2%	5	2.1%	1.0%	2	2.9%	11	2.2%
TSS_VSS	2	0.8%	10	2.0%	1	0.4%	3	0.6%	0	0.0%	0.0%	3	1.3%	13	2.6%
Urban Related	**4**	**1.7%**	**20**	**4.1%**	**4**	**1.7%**	**12**	**2.4%**	**30**	**12.6%**	**6.1%**	**38**	**15.9%**	**62**	**12.6%**
Metals	7	2.9%	35	7.1%	4	1.7%	12	2.4%	0	0.0%	0.0%	11	4.6%	47	9.6%
PAH	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0%	0	0.0%	0	0.0%
Toxicity	0	0.0%	0	0.0%	2	0.8%	6	1.2%	17	7.1%	3.5%	2	7.9%	23	4.7%
Toxics	**7**	**2.9%**	**35**	**7.1%**	**6**	**2.5%**	**18**	**3.7%**	**17**	**7.1%**	**3.5%**	**30**	**12.6%**	**70**	**14.3%**
Total Observations	**33**	**10.4%**	**165**	**33.6%**	**60**	**25.1%**	**180**	**36.7%**	**146**	**61.1%**	**29.7%**	**239**	**100.0%**	**491**	**100.0%**

The new IPS framework also offers the semblance of a tiered aquatic life use (TALU) stratification of goals and thresholds that has been incorporated into all IPS outputs to support local restoration and protection efforts by the respective watershed groups and stakeholders.

A total of 16 causes associated with varying degrees of impairment of the General Use for aquatic life were determined by relating threshold exceedances of the various physical and chemical parameters measured alongside the biological assemblages in a synthesis analysis (Table 19). These were then tallied and grouped into five (5) categories and weighted in accordance with the exceedance eclipsing a fair, poor, or very poor threshold (Table 20). Most of the thresholds are from the NE Illinois IPS (MBI 2020a), but other sources were used for parameters and indicators not directly included or yet derived in the IPS. The weighting was done as follows – 5 times for very poor, 3 times for poor, and none for fair parameter exceedances and other indicator values. This amplifies the very poor threshold exceedances as being more likely to exert a true causal influence as opposed to simply being associated with an impairment on a spatial basis. Habitat related causes comprised 49.9% of the weighted causes. Nutrient and organic enrichment indicators included TKN, ammonia-N, and organic enrichment responses in the biota comprised 15.9% of the weighted causes (Table 20) which was identical to the weighted percentage (15.9%) or urban related stressors (i.e., chlorides, conductivity). These were followed by toxics and toxicity (12.6%) mostly related to toxic biological response signatures and metals in sediment. Although direct indication of D.O. related causes were only registered as 2.5% of causes, this was likely underestimated because of few continuous samplers and the fact that the poor and very poor organic enrichment macroinvertebrate indicators also likely reflect depressed dissolved oxygen.

Restorability, Susceptibility, and Threat Factors

The NE Illinois IPS was developed to provide an organized and robust framework for determining restoration and protection priorities and options for both impaired and attaining watersheds, reaches, and sites (MBI 2020a). A Restorability factor is derived for impaired sites and Susceptibility and Threat factors are derived for attaining sites. No attaining sites were located in the East Branch DuPage River watershed. These factors are provided in the synthesis (Table 19) and aquatic life use attainment (Table 1) tables. Five narrative ranges of Restorability from very high to very low have been established on an interim basis – these are subject to revision as these factors are applied in NE Illinois watersheds by the watershed groups. Narrative ranges for Susceptibility and Threat from very low to very high run in the reverse of the Restorability narratives.

In the 2019 East Branch DuPage River watershed no sites were in full attainment. No sites were considered to have *very high* Restorability scores; such sites would be close to attainment and have stressors considered readily restorable. Five sites were considered to have high restorability. Three were on the mainstem and these tended to have either fair biological condition and/or good or excellent physical habitat and exceeded fewer chemical stressor thresholds. One of the two sites with high restorability on the tributaries was on Willoway

Brook which have excellent habitat, but poor biota with the high habitat scores providing good biological potential if nutrient enrichment and chloride issues could be reconciled.

No sites were considered to have very low Restorability and seven sites had low Restorability scores and the remainder (27 sites) had moderate Restorability scores. While the urban nature of the watershed may make restorability challenging, habitat (and floodplain improvement where feasible) projects can work to reduce stormwater impacts that continue to deliver fine substrates that result in siltation and embeddedness of stream substrate, enhance nutrient assimilation and dissolved oxygen conditions that are also limiting factors.

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