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Biological and Water Quality Study of the E. Branch DuPage River Watershed, 2014

DuPage and Will Counties, Illinois

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Final Report

Technical Report MBI/2016-9-8

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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) and 2011 (MBI 2014). 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 and 2011 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. However, the baseline data provided by this study contributes to the Integrated Priority System (IPS; Miltner et al. 2010) that was developed to help determine and prioritize remedial projects and which is being updated through 2017.

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INTRODUCTION

A biological and water quality study of the E. Branch DuPage River and its tributaries was conducted in 2014 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, and a 2012 follow-up survey (fish only) of the upper East Branch following the removal of the Churchill Woods dam. 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 2014).

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 ≥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 2014 results are presented in a similar manner except the mainstem is included in its entirety.

SUMMARY

Biological assemblages in the E. Branch watershed continued to be rated in poor to fair condition at almost all locations in 2014. As in the two previous surveys, no fish IBI values met the IEPA criterion for the General Use. The macroinvertebrates were limited to a single mainstem site near the mouth meeting the General Use mIBI criterion compared to three sites 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 2012 (upper mainstem/fish only), biological sampling in 2014 found the condition of fish were unchanged or slightly improved while the macroinvertebrate assemblage was unchanged or slightly lower in quality (Table 1, 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 2014 collections is in line with previous surveys, caution should be used when making broad characterizations about trends.

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 2014 survey.

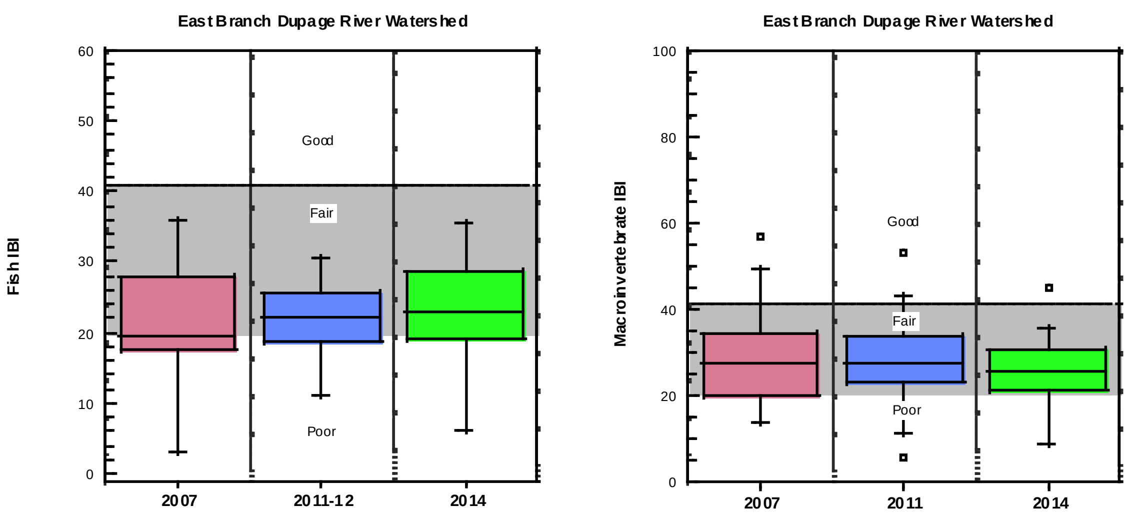

***Figure 1**. Box and whisker plots of fish (left) and macroinvertebrate (right) IBI scores at in common sampling sites in the E. Branch DuPage River watershed in 2007, 2011, and 2014.*

In contrast to the tributaries the mainstem assemblages were mostly in the fair range. Declines in the fish assemblage observed between 2007 and 2011 were largely reversed in 2014, particularly downstream from the Churchill Woods dam (Figure 2). In contrast, the macroinvertebrates continued to show a general declining trend compared to the previous surveys, although, as mentioned above, high flows may have been a factor. 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 2014 compared to the steady increases observed through 2012 (Figure 2). 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.

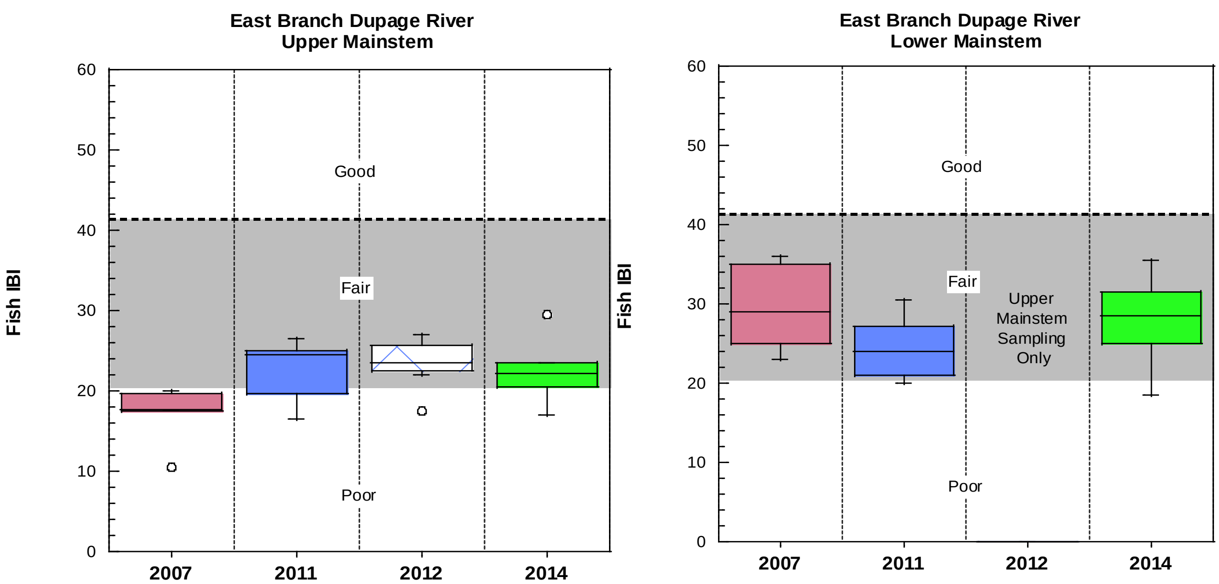

Figure 2. *Box and whisker plots of fish IBI scores from the upper East Branch DuPage River mainstem upstream from the Churchill Woods dam (left) and the lower mainstem, from Churchill Woods to the mouth (right) in 2007 (salmon), 2011 (blue), 2012 (blue hash mark-upper mainstem only) and 2014 (green).*

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.

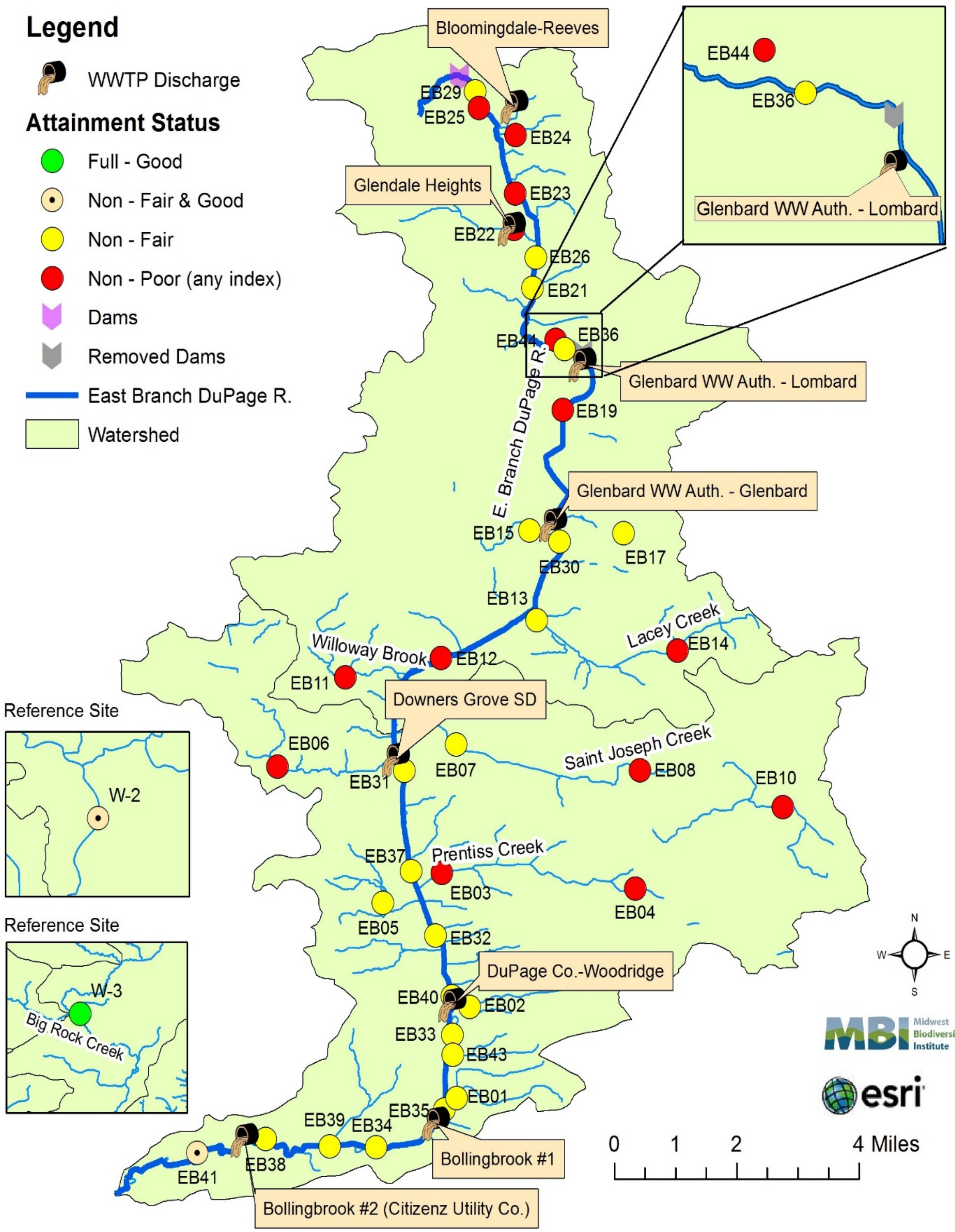

Figure 3. East Branch DuPage River watershed attainment status in 2014.

***Table 1**. Status of aquatic life use support for sites sampled in the E. Branch DuPage River study area in 2014. 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 mIBIs are listed.*

SITE ID	River Mile	DA (sq. mi.	fIBI	MIwb	mIBI	QHEI	Aquatic Life Use Attainment Status [Narrative]	MBI Associated Causes[a]	2011/12 fIBI	2011 mIBI
95-980	**E. Branch DuPage River Mainstem**									
EB29	23.50/23.50	2	20.5	na	23.2	30	Non [Fair]	TDS/Chloride, Org. Enrich., Habitat Alt., nutrients (TKN, NH_3)	17.5[b]	11.2
EB25	23.00/23.00	2	23.0	na	19.6	60.5	Non [Poor]	TDS/Chloride, D.O., nutrients (P,N) (Dst. Bloomingdale-Reeves WWTP)	25.5[b]	27.9
EB23	22.00/22.00	5	29.5	na	8.9	75	Non [Poor]	TDS/Chloride, nutrients (P,N,NH_3)	26.0[b]	34.9
EB26	21.00/21.00	12	21.5	na	30.2	69	Non [Fair]	TDS/Chloride, TSS, nutrients (P,N,TKN,NH_3) (Dst. Glendale WWTP)	23.5[b]	24.8
EB21	20.50/20.50	14.2	23.5	na	27.3	53	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P,N, TKN)	22.0[b]	25.4
EB44	19.30/-	16	17.0	na	-	42	Non [Poor]	TDS/Chloride, TSS, Habitat Alt., D.O., nutrients (P,N, TKN,NH_3) (no chem./causes match EB36)	23.0[b]	30.1
EB36	-/19.00	-	-	na	21.3	-	(Non) [Fair]	TDS/Chloride, TSS, Habitat Alt., D.O., nutrients (P,N, TKN,NH_3)	--	--
EB19	18.00/18.00	18	18.5	na	29.4	55.5	Non [Poor]	TDS/Chloride, Habitat Alt., nutrients (P,N,TKN) (Dst. Glenbard-Lombard WWTP)	20.5	37.5
EB30	15.50/15.50	27.2	23.0	5.73	21.7	65	Non [Fair]	TDS/Chloride, nutrients (P,N,TKN) (Dst.. Glenbard WWTP)	21.5	18.8
EB12	13.00/13.00	50	25.0	5.71	23.4	54.8	Non [Fair]	TDS/Chloride, Habitat Alt., D.O., nutrients (P,N)	20.0	29.0

SITE ID	River Mile	DA (sq. mi.	fIBI	MIwb	mIBI	QHEI	Aquatic Life Use Attainment Status [Narrative]	MBI Associated Causes[a]	2011/12 fIBI	2011 mIBI
EB31	11.00/11.00	58	29.5	5.66	22.3	51.5	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P,N) (Dst. Downers Grove WWTP)	27.0	29.8
EB37	9.50/9.50	60.1	31.5	7.37	26.2	50.5	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P,N)	24.5	23.0
EB32	8.50/8.50	61	31.5	6.78	33.7	56	Non [Fair]	TDS/Chloride, Habitat Alt., D.O., nutrients (P,N)	30.5	27.4
EB40	7.60/7.60	63	29.0	5.19	31.6	62	Non [Fair]	TDS/Chloride, nutrients (P)	28.0	53.4
EB33	7.00/7.00	64	35.5	7.31	21.9	66	Non [Fair]	TDS/Chloride, nutrients (P,N) (Dst.. Woodridge WWTP)	26.0	28.3
EB43	6.60/6.60	64	33.5	6.93	33.0	61.5	Non [Fair]	TDS/Chloride, nutrients (P,N) (no chem./ causes match EB33)	27.5	37.5
EB35	6.00/6.00	76.4	25.0	6.44	34.9	50	Non [Fair]	TDS/Chloride , Habitat Alt., nutrients (P,N)	23.5	33.4
EB34	5.00/5.00	78	25.0	7.32	36.0	65	Non [Fair]	TDS/Chloride, nutrients (P,N,TKN,NH_3) (Dst.. Bollingbrook #1 WWTP)	21.5	43.1
EB39	4.00/4.00	78	28.0	6.36	32.2	58.8	Non [Fair]	TDS/Chloride, Habitat Alt., D.O nutrients (P,N)	20.5	37.5
EB38	3.00/3.00	81	32.0	7.56	31.5	68	Non [Fair]	TDS/Chloride, nutrients (P,N)	28.0	23.7
EB41	1.30/1.30	85	26.5	5.62	45.2	75.5	Non [Good]	TDS/Chloride, nutrients (P,N) (Dst. Bolling-brook #2 WWTP)	24.0	43.4
95-951	**Army Trail Creek**									
EB24	0.25/0.25	0.5	21.5	na	15.9	48.8	Non [Poor]	TDS/Chloride, Habitat Alt., nutrients (P)	20.0	19.4

SITE ID	River Mile	DA (sq. mi.	fIBI	MIwb	mIBI	QHEI	Aquatic Life Use Attainment Status [Narrative]	MBI Associated Causes[a]	2011/12 fIBI	2011 mIBI
95-952	**Armitage Ditch**									
EB22	0.50/0.50	2.2	16.7	na	25.0	48.5	Non [Poor]	TDS/Chloride, Habitat Alt., nutrients (P)	17.5	34.1
95-953	**Glencrest Creek**									
EB15	0.50/0.50	2.8	21.5	na	27.0	55	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P)	13.5	25.8
95-954	**Lacey Creek**									
EB14	2.00/2.00	1.8	19.0	na	22.1	44.8	Non [Poor]	TDS/Chloride, Habitat Alt., nutrients (P,TKN)	13.0	21.2
EB13	0.25/0.25	4.6	21.5	na	28.7	27	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P)	0.0	32.7
95-955	**Willoway Brook**									
EB11	1.00/1.00	4.3	13.5	na	33.7	80	Non [Poor]	TDS/Chloride, nutrients (P), Org. Enrich.	13.5	30.7
95-956	**22nd St. trib. to E. Branch DuPage River**									
EB17	1.00/1.00	0.5	21.5	na	21.1	56	Non [Fair]	TDS/Chloride, Habitat Alt., nutrients (P), Org. Enrich.	21.0	23.6
95-957	**Rott Creek**									
EB06	2.00/2.00	4.5	19.0	na	26.5	55.3	Non [Poor]	Conductivity/Chloride, Habitat Alt., nutrients (P)	24.0	27.2
95-986	**Prentiss Creek**									
EB04	3.80/3.80	2.3	12.0	na	11.4	63	Non [Poor]	Nutrients (P,TKN)	13.5	5.8
EB03	1.10/1.10	6.6	6.0	na	26.0	67.5	Non [Poor]	TDS/Chloride, nutrients (P), Org. Enrich. (unknown source)	12.5	24.9
95-987	**St. Joseph Creek**									
EB10	6.00/6.00	1.8	13.0	na	16.3	55	Non [Poor]	Habitat Alt., nutrients (P)	13.0	19.6
EB08	4.00/4.00	6	10.0	na	17.2	62.3	Non [Poor]	TDS/Chloride, nutrients (P)	11.0	16.2

SITE ID	River Mile	DA (sq. mi.	fIBI	MIwb	mIBI	QHEI	Aquatic Life Use Attainment Status [Narrative]	MBI Associated Causes[a]	2011/12 fIBI	2011 mIBI
EB07	1.00/1.00	9.7	27.5	na	21.3	66.3	Non [Fair]	TDS/Chloride, nutrients (P)	24.0	33.5
95-988	**Trib. to E. Br. DuPage River**									
EB01	0.25/0.25	0.7	22.5	na	27.4	28	Non [Fair]	Conductivity/Chloride, Habitat Alt., nutrients (P)	22.0	11.1
95-989	**Trib. to E. Br. DuPage River, #6**									
EB05	0.60/0.60	1	28.0	na	30.0	56.3	Non [Fair]	Conductivity/Chloride, Flow Alt. (Intermittent), Habitat Alt., nutrients (P)	20.5	35.3
95-990 Crabtree Creek										
EB02	0.20/0.20	1.4	29.5	na	22.2	56	Non [Fair]	Conductivity/Chloride, TSS, Habitat Alt., nutrients (P)	--	--
Reference Sites										
95-982 Big Rock Creek										
W-3	11.00/11.00	106.7	**54.0**	7.9	**60.4**	90.5	**Full** [Good]			
95-985 Forked Creek										
W-2	2.00/2.00	109.1	35.5	7.44	**77.2**	79	Partial [Fair]	Unknown		

[a] Underlined nutrient causes refer to "severe" exceedances of the least stringent target criteria (i.e., red shaded values in Table 7); 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 13. [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 4) 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 37. Thirteen (13) reference sites have been established in adjacent watersheds and included Big Rock Creek and Forked Creek in 2014 (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 2014 the results are grouped as tributary and mainstem sites. To continue following progress after the 2011 Churchill Woods dam removal, seven upper mainstem sites were resampled for fish and habitat in 2014 between RM 23.5 and 19.3.

Each 2014 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 2014 survey of the E. Branch DuPage River study area.*

Site ID	Stream Name	River Code	River Mile	Latitude	Longitude	Location
EB 29	E. Br. DuPage R.	95-980	23.50	41.94090	-88.06220	Glen Ellyn Drive and Byron Ave.
EB 25	E. Br. DuPage R.	95-980	23.00	41.93730	-88.06130	Brookdale Ave.
EB 23	E. Br. DuPage R.	95-980	22.00	41.91870	-88.05270	End of Fullerton Ave. on E. Br. F.P.
EB 26	E. Br. DuPage R.	95-980	21.00	41.90490	-88.04790	North Ave., Dst. Glendale WWTP
EB 21	E. Br. DuPage R.	95-980	20.50	41.89830	-88.04860	Lyon St. Apts. Parking lot
EB 44	E. Br. DuPage R.	95-980	19.30	41.88566	-88.04312	Former Churchill Woods pool @art. riffle
EB 36	E. Br. DuPage R.	95-980	19.00	41.88510	-88.04110	Former Churchill Woods pool
EBCB	E. Br. DuPage R.	95-980	18.8	41.88510	-88.04110	Former Churchill Woods pool; Datasonde
EB 19	E. Br. DuPage R.	95-980	18.00	41.87190	-88.04150	End of Roslyn Road
EB 30	E. Br. DuPage R.	95-980	15.50	48.21100	-88.04220	School yard at end of 22nd St.
EBHL	E. Br. DuPage R.	95-980	14.00	41.82570	-88.05316	Hidden Lake Preserve (Datasonde only)
EB 12	E. Br. DuPage R.	95-980	13.00	41.81820	-88.07020	Ust. Park Blvd.-Morton Arboretum
EB 31	E. Br. DuPage R.	95-980	11.00	41.79360	-88.07900	Ust. Short St. bridge
EB 37	E. Br. DuPage R.	95-980	9.50	41.77110	-88.07730	Ust. footbridge at 7 Bridges GC
EB 32	E. Br. DuPage R.	95-980	8.50	41.76800	-88.07160	Ust. Hobson Rd (+ EBHR Datasonde)
EB 40	E. Br. DuPage R.	95-980	7.60	41.73672	-88.06777	Ust. footbridge
EB 33	E. Br. DuPage R.	95-980	7.00	41.73670	-88.06780	Ust. footbridge at Green Valley F.P.
EB 43	E. Br. DuPage R.	95-980	6.60	41.73211	-88.06749	Dst. F.P. footbridge
EB 35	E. Br. DuPage R.	95-980	6.00	41.72020	-88.06950	Ust. Royce Ave
EB 34	E. Br. DuPage R.	95-980	5.00	41.71210	-88.08560	Ust. Trout Farm canoe launch
EB 39	E. Br. DuPage R.	95-980	4.00	41.71230	-88.09160	Dst. 2nd mine discharge; (EBWL Sonde)
EB 38	E. Br. DuPage R.	95-980	3.00	41.71390	-88.11180	DuPage R. Park off Naperville/Royce Rd
EB 41	E. Br. DuPage R.	95-980	1.30	41.71090	-88.12797	S Washington St/Naperville Rd.
EB 24	Army Trail Cr.	95-951	0.25	41.93170	-88.05300	Dst. Valley View Road
EB 22	Armitage Ditch	95-952	0.50	41.91110	-88.05300	End of Armitage Rd. off Glen Ellyn
EB 15	Glencrest Creek	95-953	0.50	41.84550	-88.04860	Ust. Danby and Glencrest St.
EB 14	Lacey Creek	95-954	2.00	41.81940	-88.01490	Ust. Saratoga Ave.
EB 13	Lacey Creek	95-954	0.25	41.82680	-88.04830	Ust. culvert-Hidden Lake F.P.
EB 11	Willoway Brook	95-955	1.00	41.81410	-88.09230	Dst. Leask Lane at Morton Arboretum
EB 17	22nd St. trib. EB	95-956	1.00	41.84510	-88.02800	Dst. Finley Ave.
EB 06	Rott Creek	95-957	2.00	41.79400	-88.10890	Footbridge at end of Wellington Ave
EB 04	Prentiss Creek	95-986	3.80	41.768180	-88.02426	Dst. Bridge at Springside St.
EB 03	Prentiss Creek	95-987	1.10	41.77149	-88.07004	Dst. SR. 53 adj. to Mulligan Drive
EB 05	Trib. to E. Br. #6	95-989	0.60	41.76508	-88.08408	Dst. Caddie Corner Park bridge
EB 10	St. Joseph Cr.	95-987	6.00	41.78580	-87.99060	Deer Park Blvd. adj. 56th St.
EB 08	St. Joseph Cr.	95-988	4.00	41.79390	-88.02390	Dst. Jacquelyn Drive in park
EB 07	St. Joseph Cr.	95-989	1.00	41.79980	-88.06750	St. Joseph St. at St. Joseph condominiums
EB 01	Trib. to E. Br.	95-988	0.25	41.72274	-88.06653	East of Home Landscaping parking lot
EB 02	Crabtree Creek	95-990	0.20	41.74261	-88.06491	At DuPage Co. WWTP

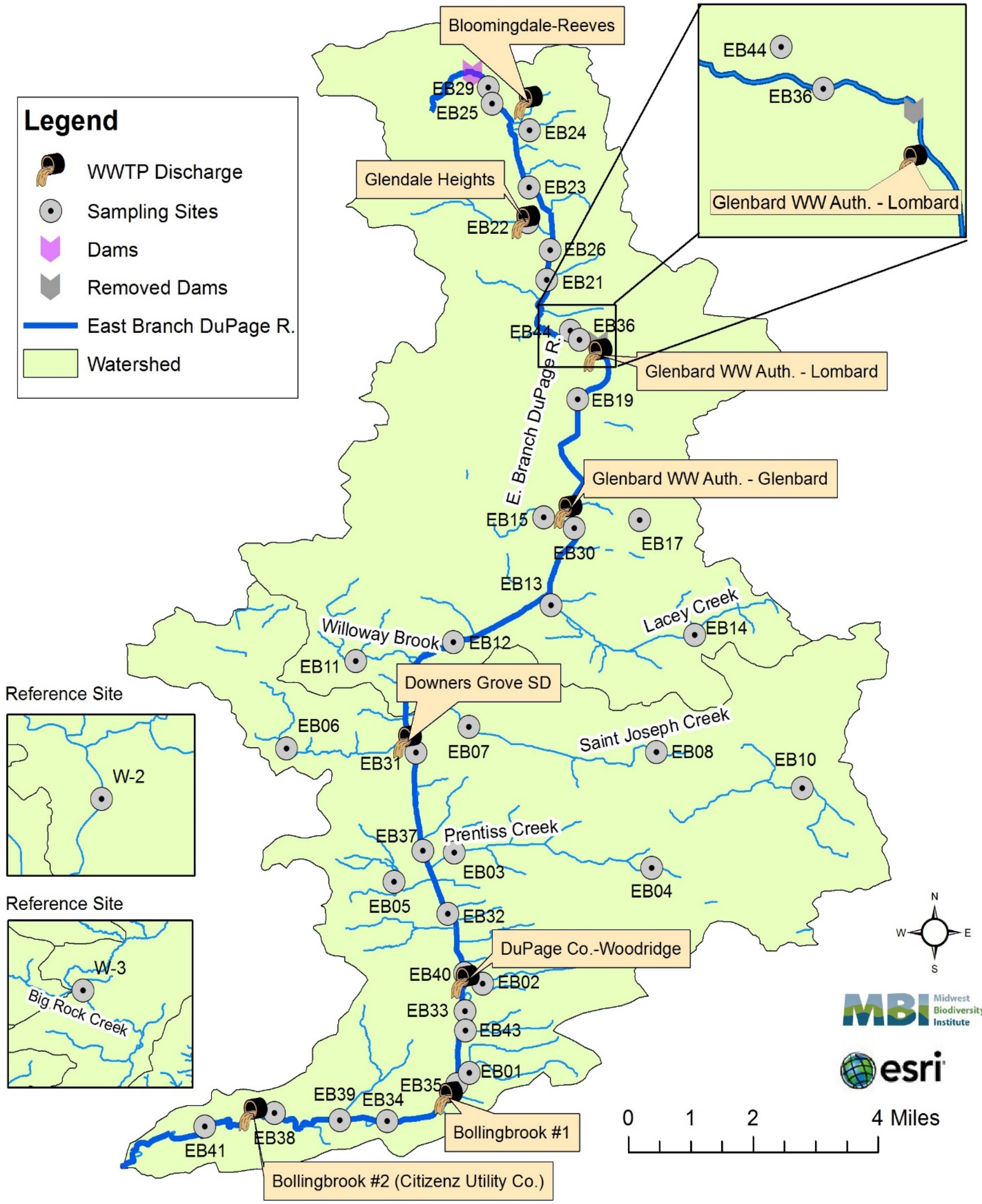

Figure 4. *Sampling locations (grey dots with associated "EB" station numbers), municipal WWTP discharges (outfalls), and significant mainstem dam impoundments (purple chevron) in the E. Branch DuPage River study area, June-Oct. 2014. Note: the Churchill Woods dam (grey chevron, see call out) was removed 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.

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 programming supplied by Illinois EPA. 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). 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 5) 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).

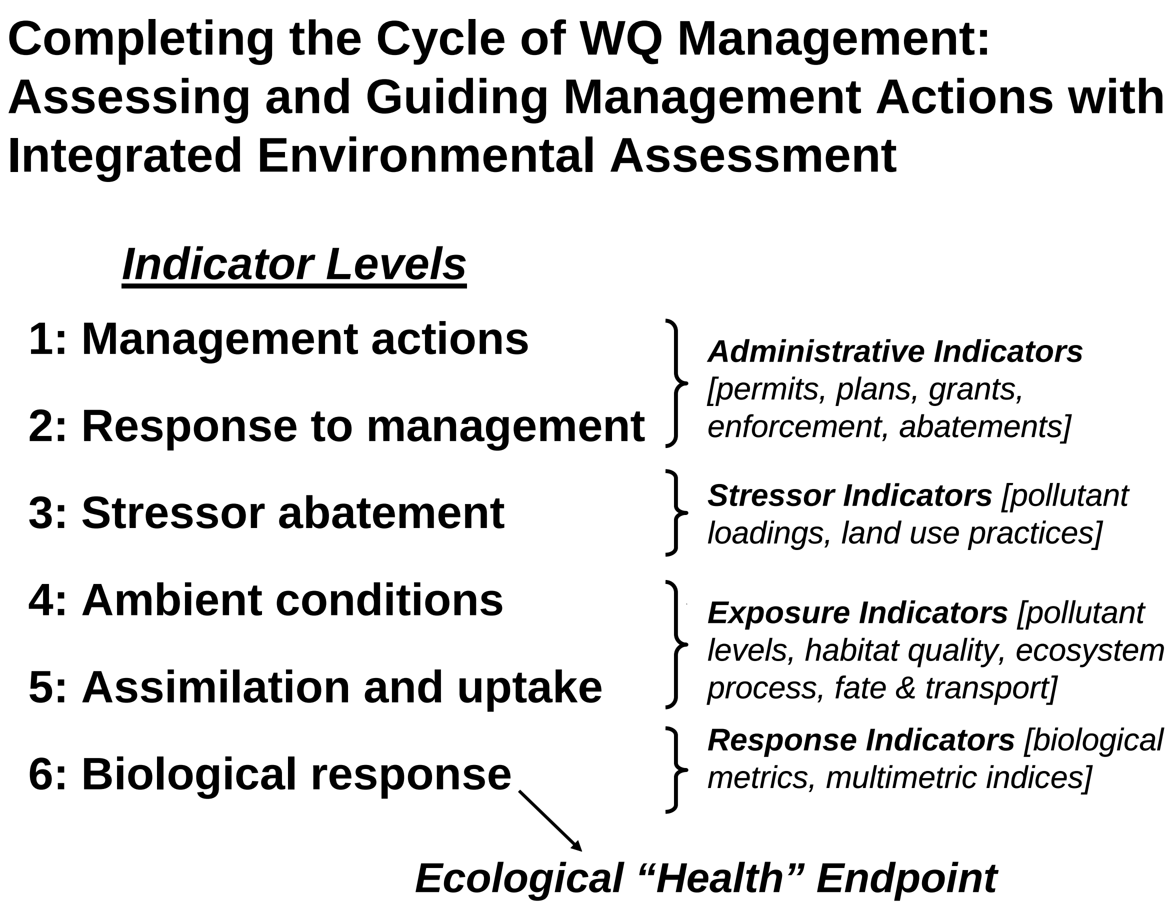

Figure 5. *Hierarchy of administrative and environmental indicators that can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995) and further enhanced 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 2010) derived local thresholds where correlational analyses were used to derive benchmarks, above which fish or macroinvertebrate impairment would be more likely. For example, for chloride, the mIBI threshold was 141 mg/l and the fIBI threshold was 112 mg/l. For TKN and ammonia, the mIBI relationships were continuous while fIBI thresholds were 1.0 and 0.15 mg/l, respectively. For some parameters, Ohio EPA's (1999) background concentrations associated with attaining IBI scores or reference sites were examined. Nutrient concentrations associated with "unpolluted" waters as derived by USGS NAWQA data by Mueller et al. (1995) include ammonia (0.1 mg/l), total phosphorus (0.1 mg/l), nitrate (0.6 mg/l) and total nitrogen (1.0 mg/l). In contrast, Illinois developed non-standards based nutrient criteria for total nitrate (7.8 mg/l) and total phosphorus (0.61 mg/l) that are substantially higher. These criteria were based on 85th-percentile values determined from a statewide set of observations from the Ambient Water Quality Monitoring Network, for water years 1978-1996 (Illinois EPA 2011). US EPA has also derived initial Ecoregion (54) reference targets for nitrate (1.798 mg/l) and total phosphorus (0.072 mg/l). A 1.0 mg/l effluent limit for total phosphorus is widely applied to WWTPs in Illinois with the goal of reducing ambient total phosphorus to prevent "nuisance algae" in streams and rivers. The 1.0 mg/l effluent limit will not be imposed in the DRSCW watersheds until 2026.

STUDY AREA DESCRIPTION

The E. Branch DuPage River watershed includes 81 square miles of central DuPage and northern Will Counties (Figure 6). 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 3). 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 3. *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**

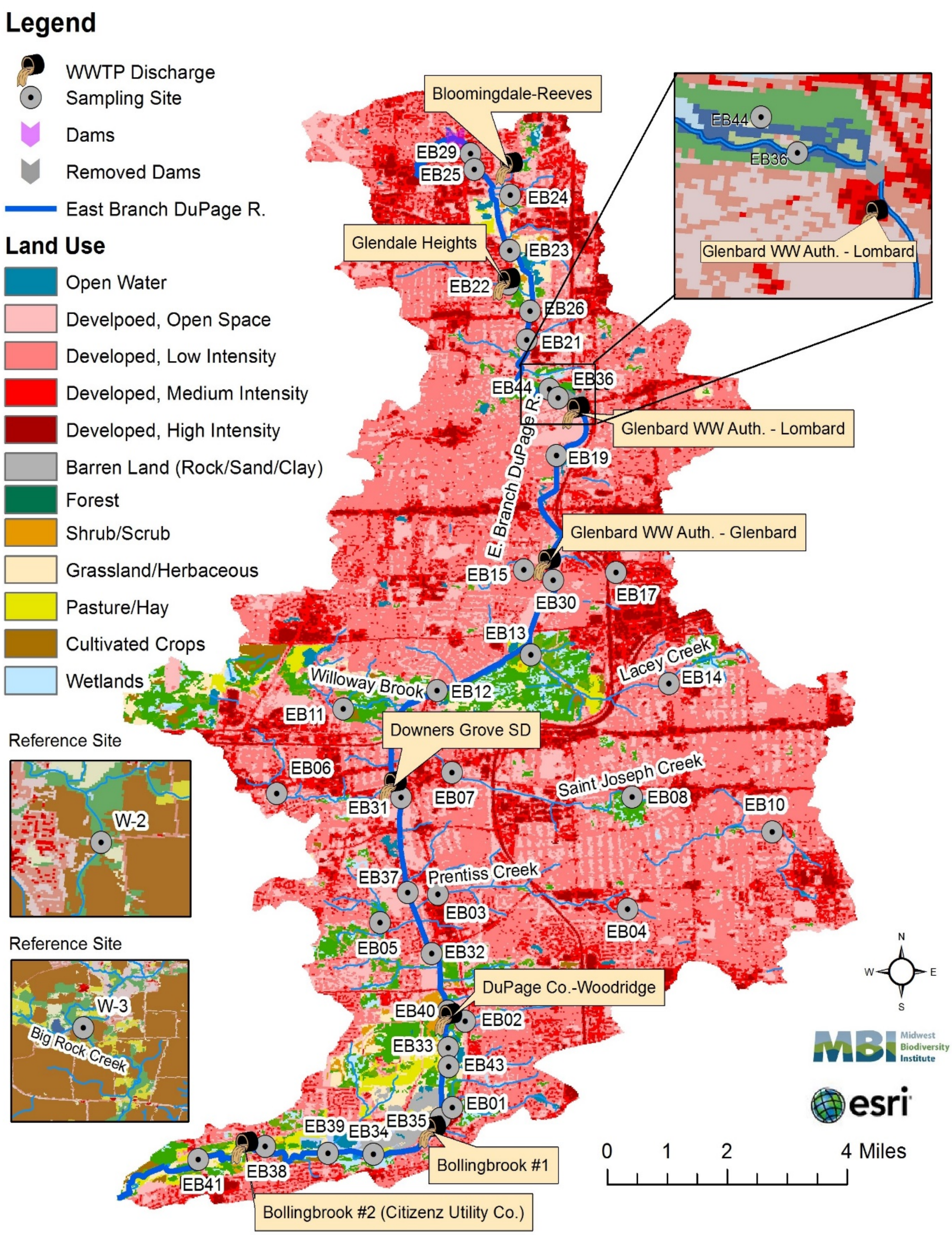

***Figure 6**. Land use types in the E. Branch DuPage River watershed based on National Land Cover Dataset (NLCD). http://www.mrlc.gov/nlcd2011.php*

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 4 and the following texts.

Table 4*. 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 4).*

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.

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.

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

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 5). 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 10). Since effluent volumes in the 3rd quarter of 2012-14 have remained consistent compared to previous survey years (Figure 7), the trend of effluent domination during summer low-flow-periods is a constant.

Table 5*. Municipal wastewater treatment plants located in the E. Branch DuPage River study area. DAF = design average flow; DMF = design maximum flow. Figure 10 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 2012-14.*

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	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 7). 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 7).

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 7).

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

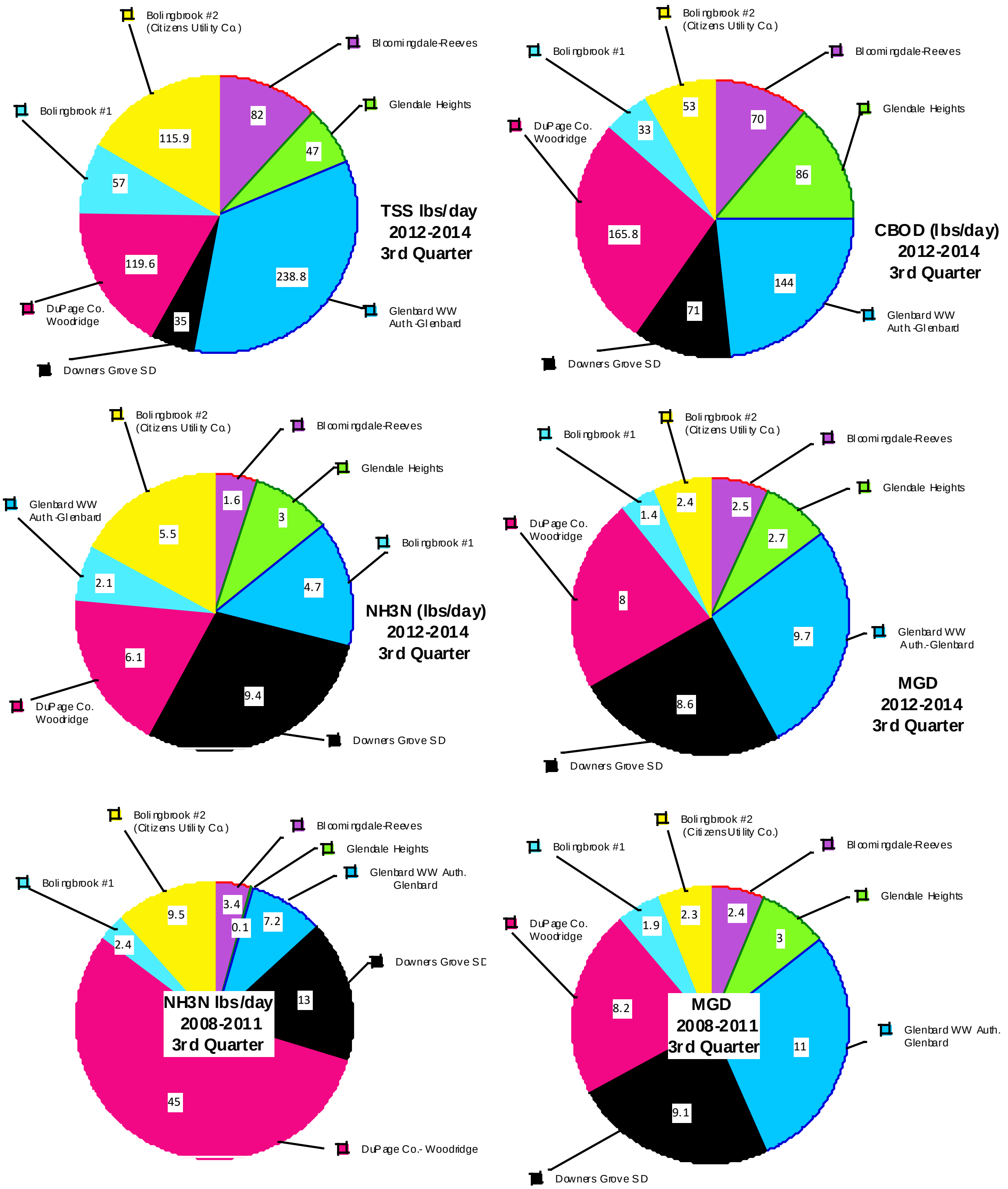

Figure 7. *Pie diagrams of East Branch DuPage River watershed WWTP loadings (lbs./day) and effluent flows (MGD) during the 3rd quarter of 2012-2014 for TSS and BOD5 (top row), ammonia NH3-N and effluent flow (middle row). Loadings of NH3-N and effluent flow (bottom row) during the 3rd quarter of 2008-2011 are included for comparison.*

WWTP Effluent Chloride Levels

Seven (7) major WWTPs in E. Branch study area monitored effluent chloride levels on 8 occasions per facility between December 10, 2015 and March 4, 2016. This included the Village of Roselle/Delvin (VRD); Downers Grove Sanitary District (DGSD); Green Valley DuPage County (GVDC); Village of Bolingbrook #01 (VB01); Village of Bolingbrook #02 (VB02); and Village of Bloomingdale (VBL), and Village of Glendale Heights (VGH). The median chloride concentration (uncorrected for flow) for the 56 samples collected at the 7 WWTPs was 158 mg/L with a maximum value of 317 mg/L at the Glendale Heights WWTP and a minimum value of 95.9 mg/L at the Roselle WWTP. Figure 8 depicts chloride concentrations by POTW. Additional evaluation is being conducted to determine the reasons behind the elevated chloride levels in the Village of Glendale Heights's effluent. Based on preliminary evaluations Infiltration/Inflow (I&I) is the likely source.

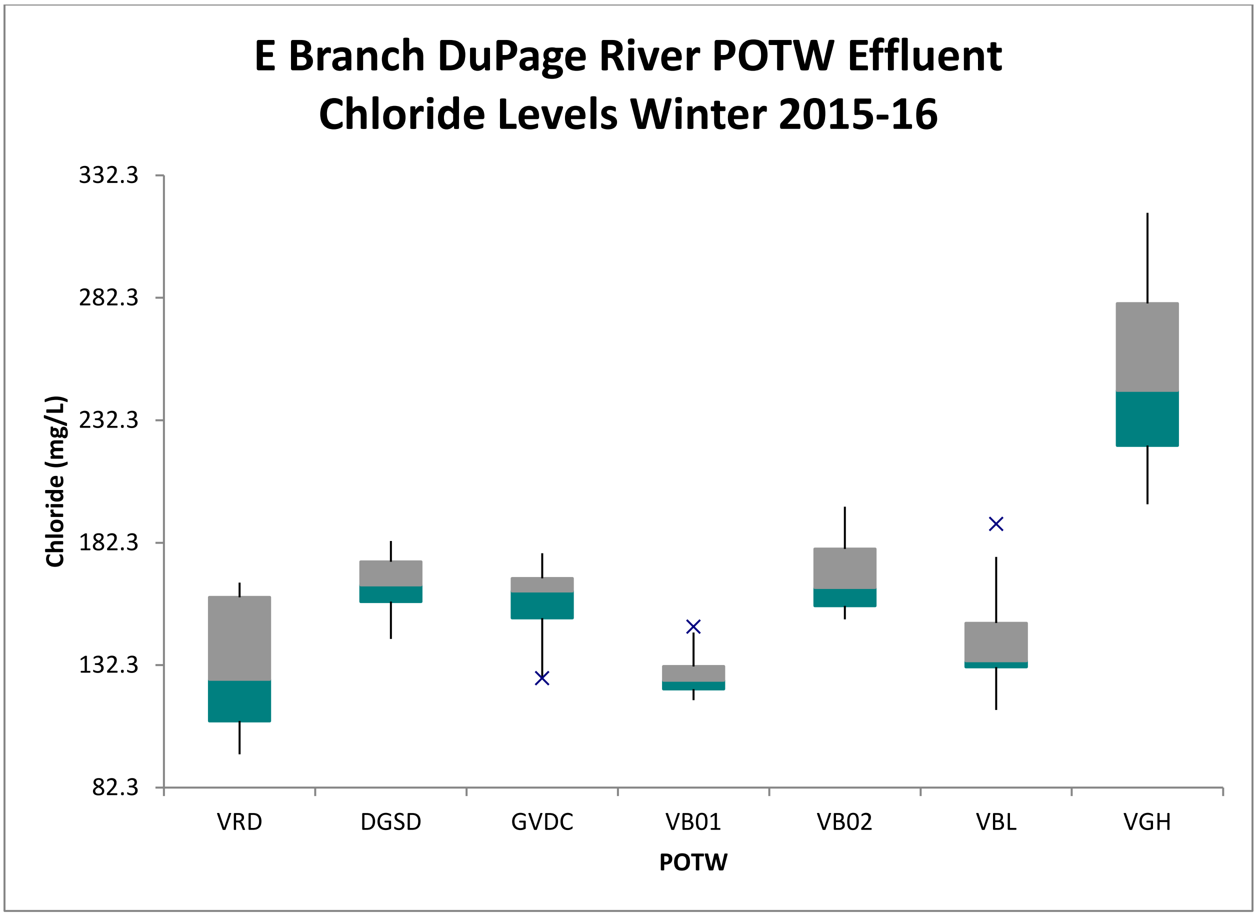

Figure 8. *Box-and-whisker plots of chloride concentrations (mg/L) collected at 7 the major POTWs in the E Branch DuPage River study area between December 10, 2015 and March 4, 2016. VRD - Village of Roselle/Delvin; DGSD - Downers Grove Sanitary District; GVDC - Green Valley DuPage County; VB01 - Village of Bolingbrook #01; VB02 - Village of Bolingbrook #02; VBL - Village of Bloomingdale, and VGH - Village of Glendale Heights.*

E. Branch DuPage River Flow Conditions

Stream flows were seasonally variable in both the spring and summer of 2007-2014, but were generally higher during the 2011 and 2014 surveys (Figure 9). Daily minimum and peak flows measured at the USGS gage in Downers Grove were nearly identical between surveys with the exception of one high flow event on June 16, 2014 when the discharge reached 818 cfs. Over the entire monitoring period the 2011 and 2014 flows averaged about 20 cfs higher than in 2007.

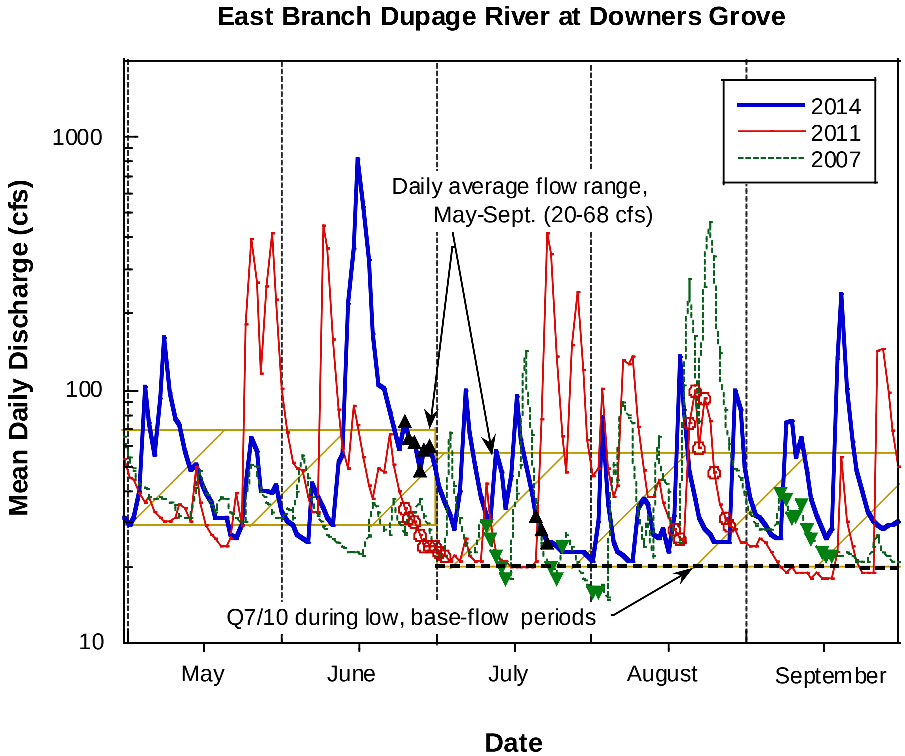

Figure 9. *Flow hydrographs for the E. Branch DuPage River near Downers Grove (USGS station #05540160) during May-September 2007, 2011 and 2014. Solid green triangles and open red circles indicate river discharge on macroinvertebrate and fish sampling dates, respectively in 2014.*

Percent of E. Branch DuPage River Baseflow as Effluent

As previously documented in the 2011 report, the East Branch mainstem at summer-fall base flow is effluent dominated (Figure 10). Using the USGS gage at Bolingbrook to estimate the daily flow statistics for September 2011, the contribution of average daily flows from WWTPs upstream from the gage were plotted alongside. The comparison reveals average effluent flow reached 98.1% of the median flow of 48 cfs in September 2011. Similar calculations were not made for 2014, but discharge levels have remained stable and the general trend of WWTP effluent domination during summer-fall base flows remains.

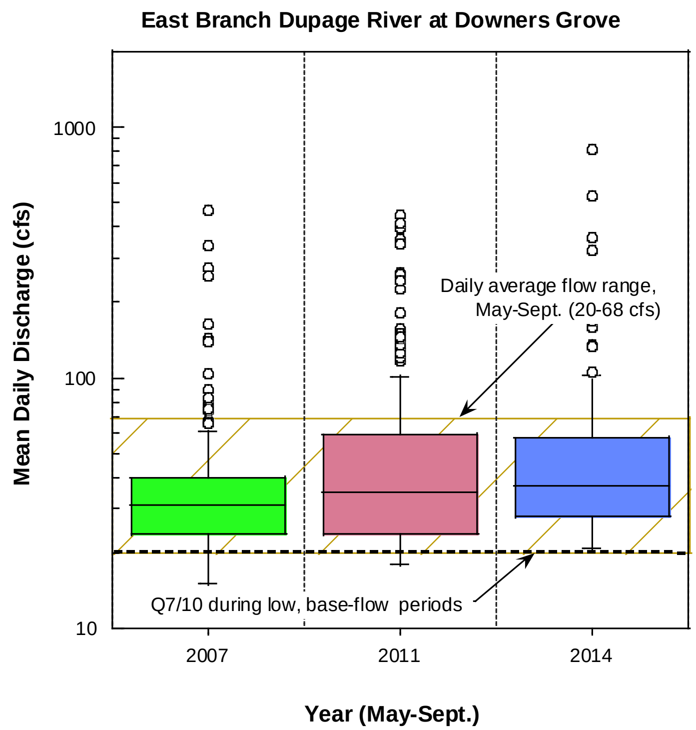

***Figure 10**. Box and whisker plot of flow trends in the East Branch DuPage River at Downers Grove, May-September 2007, 2011, and 2014.*

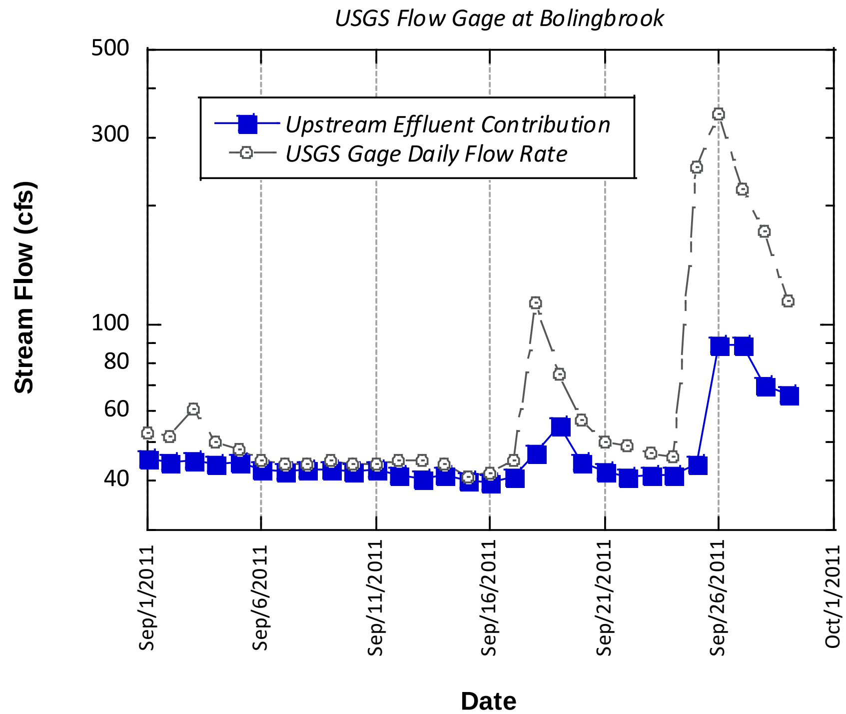

***Figure 11**. Mean daily flow in September 2011 at the USGS gage at Bolingbrook [05540250] vs. the contribution of effluent flows from five upstream dischargers on the E. Branch DuPage River and tributaries.*

RESULTS

E. Branch DuPage River - Chemical Water Quality

East Branch mainstem flows are effluent dominated during the late summer-early fall months (see Figure 10). As such, chemical water quality is highly influenced by the concentration and composition of chemical constituents in WWTP effluents. The results in 2014 were consistent with 2011 during low flow periods with respect to observing no exceedances of Illinois water quality criteria for regulated parameters (i.e., BOD_5, TSS, NH_3-N). Such exceedances were limited to D.O. measured by continuous monitors in the East Branch mainstem (Table 6).

Longitudinal trends in 2014 mainstem nutrient concentrations were very similar to 2011 (Figure 11, Figure 12). All 2014 ammonia-N concentrations were well below the 1.0 mg/l threshold associated with chronic toxicity, but the means were consistently close to the IPS (Miltner et al. 2010) threshold of 0.15 mg/l, a level associated with impaired biological assemblages. Concentrations ticked slightly above the IPS threshold downstream from the Glenbard (Lombard) and Downers Grove WWTPs and below that threshold over the lower 10 river miles. The increase in ammonia-N below Lombard in both 2011 and 2014 stood in contrast to no exceedances in other sewage related parameters (e.g., BOD_5, TKN). Total Kjeldahl Nitrogen (TKN), an indicator of the living or recently dead fraction of the sestonic algae, followed a pattern similar to ammonia-N as mean concentrations were consistently near the IPS threshold (Figure 12). 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 11, Figure 12). The sharp increase in nitrate levels below point sources between 2007 and 2011-14 mirrors the trend observed in effluent dominated Ohio streams following improved wastewater treatment and reductions in ammonia-N. The overall condition of the mainstem was considered enriched with nutrient concentrations generally near or above levels associated with biological impairment.

BOD_5 and TSS also followed a similar pattern to 2011 (Figure 13). As in previous years mean BOD_5 concentrations were at their highest in the headwaters immediately downstream from West Lake (6.03 mg/l), that is upstream of all other point sources . Both BOD_5 and TSS concentrations declined sharply downstream from the Bloomingdale-Reeves WWTP (which dominates the flow regime) before gradually increasing downstream from the Glendale Heights WWTP and the former Churchill Woods dam pool. Additional spikes in BOD_5 observed downstream in 2007 were largely attributed to autotrophic activity within impoundments and excess loadings from CSOs and WWTPs. Reductions in oxygen demanding substances in 2011-14 suggest a general improving trend in the mainstem. The removal of the Churchill Woods dam is a significant factor as this improved 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 6).

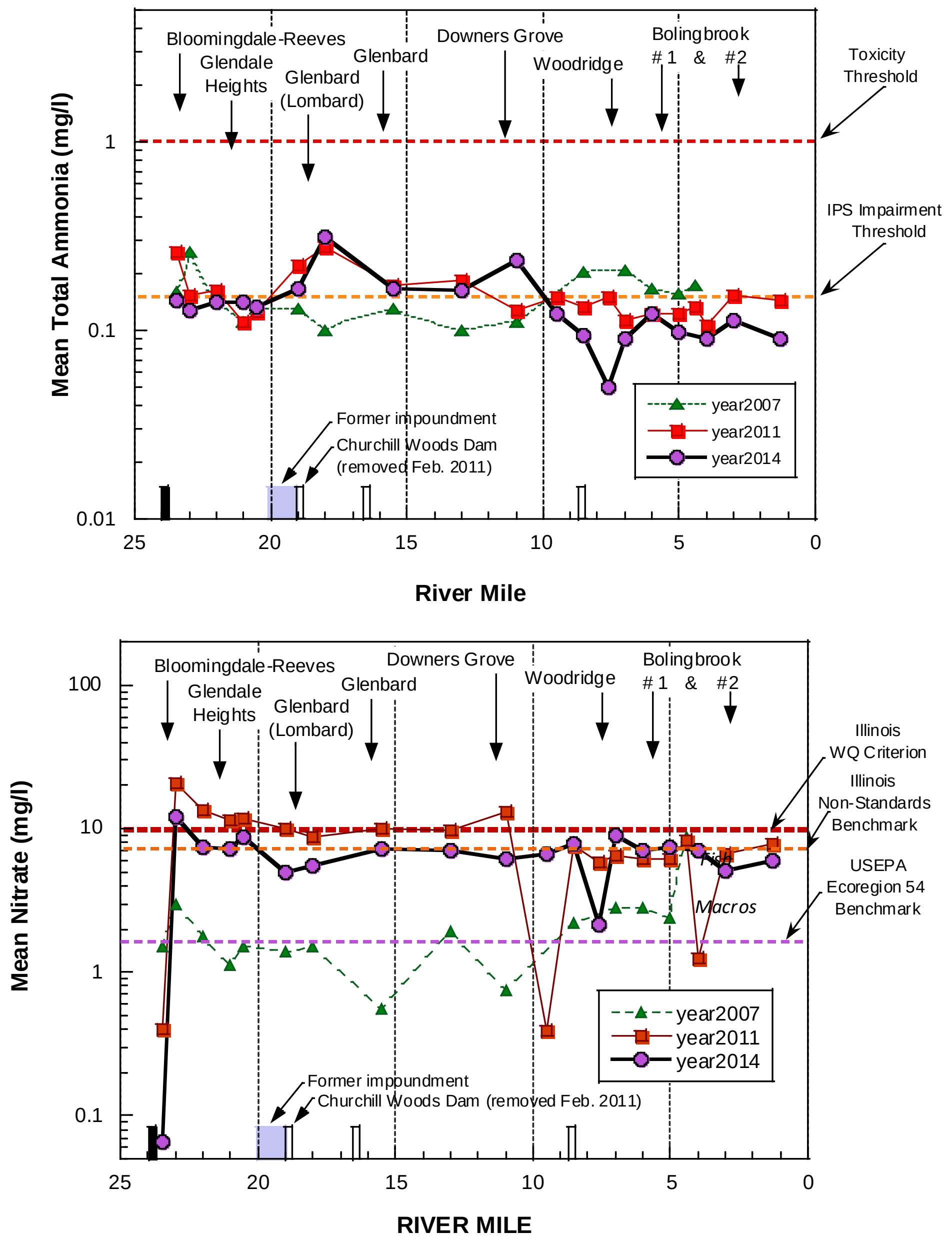

***Figure 12**. Concentrations of ammonia-N (top panel) and nitrate+nitrite-N (lower panel) from E. Branch DuPage River samples in 2007, 2011 and 2014 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (only black bars for dams that impede fish passage). For ammonia-N, the red dashed line (1.0 mg/l) represents a threshold concentration beyond which acute toxicity is likely; the orange dashed line (0.15 mg/l) is correlated with impaired biota in the IPS study. For nitrate+nitrite-N, orange dashed lines represent target concentrations for ecoregion 54 (1.8 mg/l) and the Illinois EPA non-standard based criteria (7.8 mg/l). The red dashed line is the Illinois water quality criterion for public water supplies (10 mg/l).*

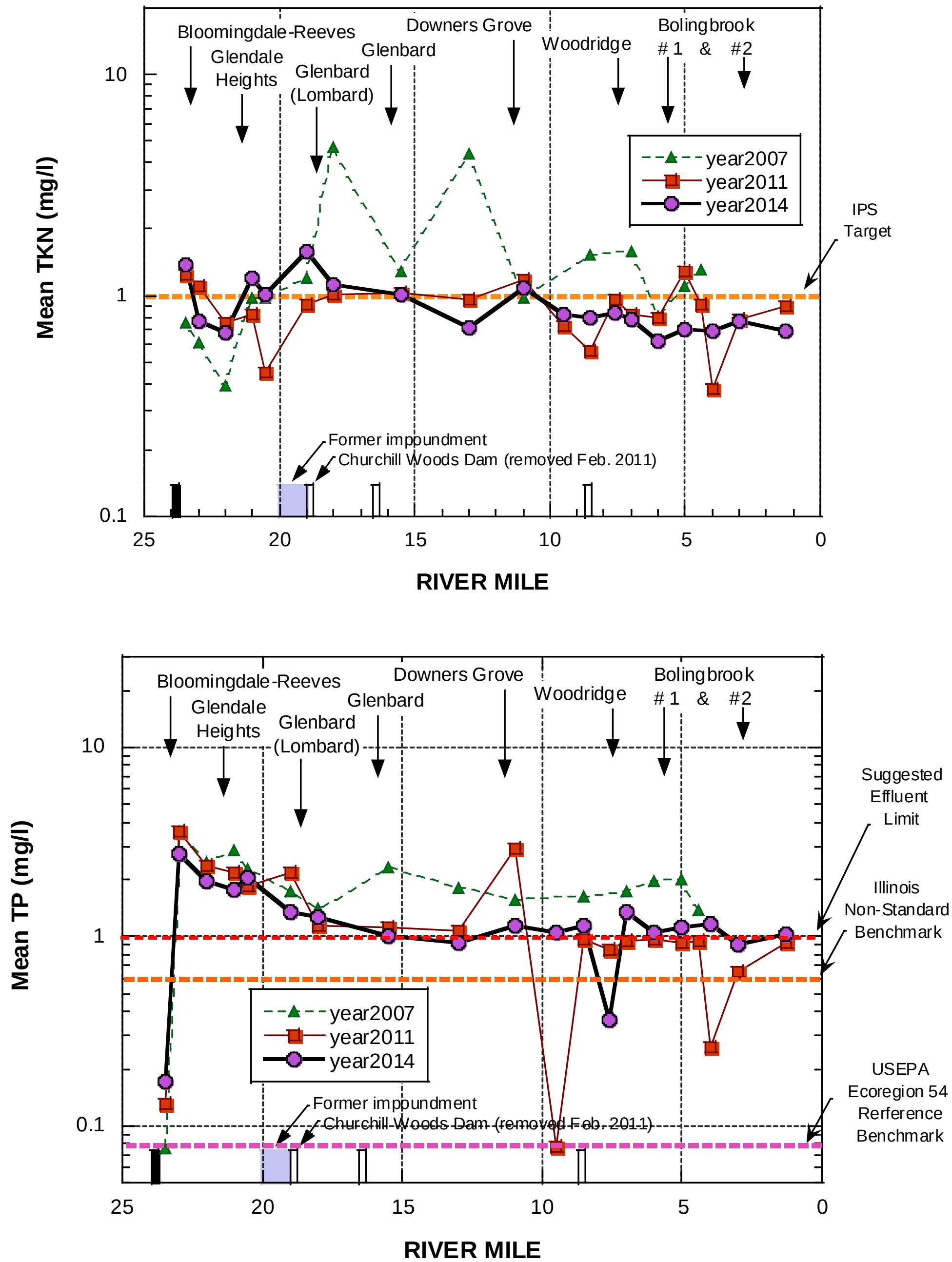

***Figure 13**. Concentrations of total Kjeldahl nitrogen (TKN; top panel) and total phosphorus (lower panel) from E. Branch DuPage River samples in 2007, 2011 and 2014 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). For TKN, the orange dashed line represents the IPS threshold (1.0 mg/l). For phosphorus, orange dashed lines represent target concentrations for ecoregion 54 (0.07 mg/l) and the Illinois EPA non-standard based criterion (0.61 mg/l). The 1.0 mg/l dashed red line is the suggested effluent limit.*

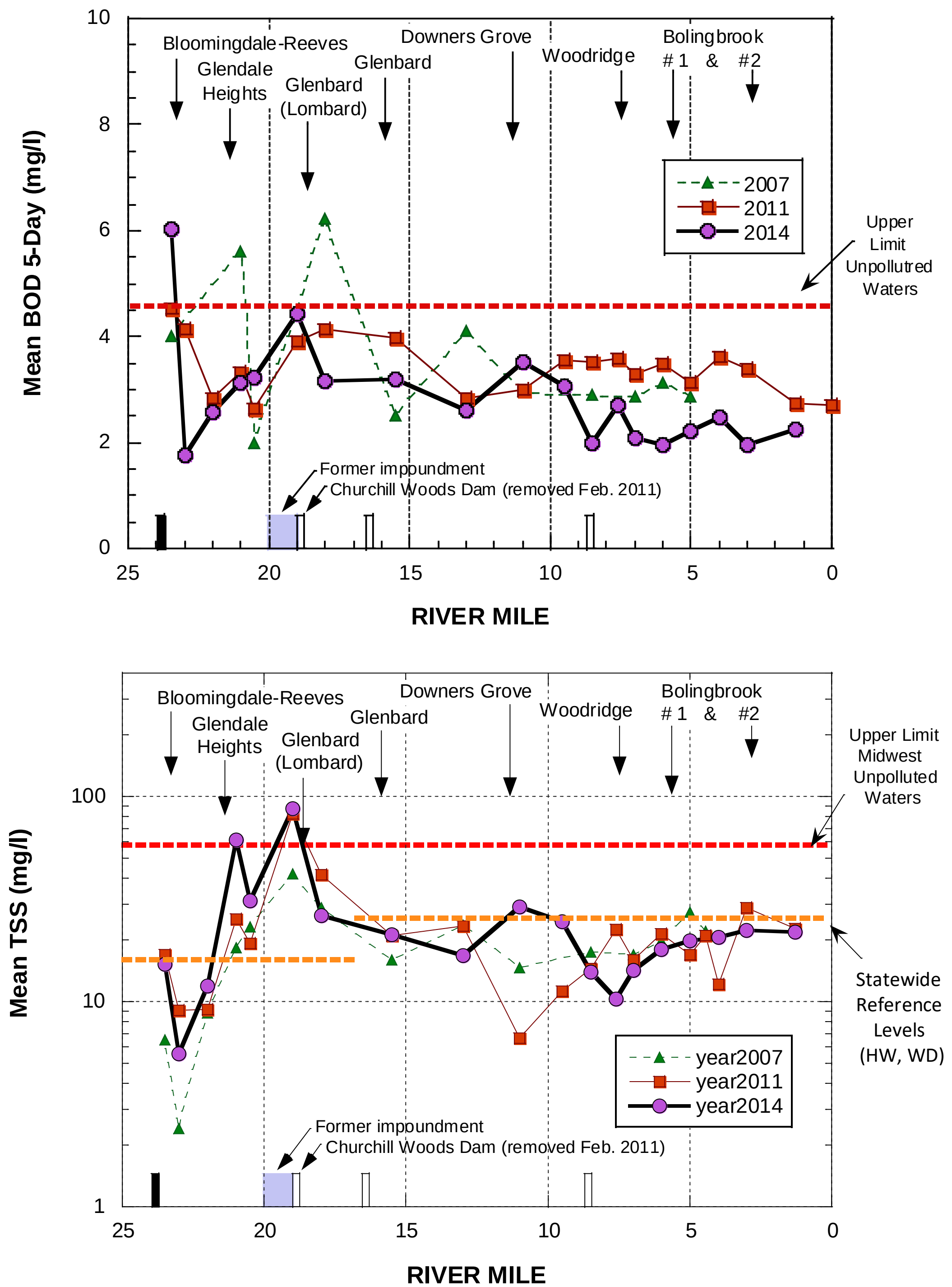

Figure 14*. Concentrations of 5-day biochemical oxygen demand (top panel) and total suspended solids (lower panel) from E. Branch DuPage River samples in 2007, 2011 and 2014 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). Red dashed lines shows the upper limits of concentrations typical for relatively unpolluted waters for BOD_5 (McNeeley et al. 1979) and TSS. Orange dashed line in TSS plot is the Ohio reference threshold for headwater (HW) and wadeable (WD) streams.*

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 between 2012 and 2014. At the five continuous monitoring sites "minimum at any time" exceedances were detected at each station at some point during each sampling year (Table 6); concentrations at the four sites sampled in 2014 are depicted in Figure 14. In addition, exceedances of rolling 7-day averages for both minimum and mean values were measured (Table 6). 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 EBAR) and within the residual Churchill Woods impoundment (station EBCB; Figure 14). The severe D.O. depletion tended to abate with increased distance downstream as minimum concentrations rarely fell below the minimum criterion in the lower ten river miles. 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.

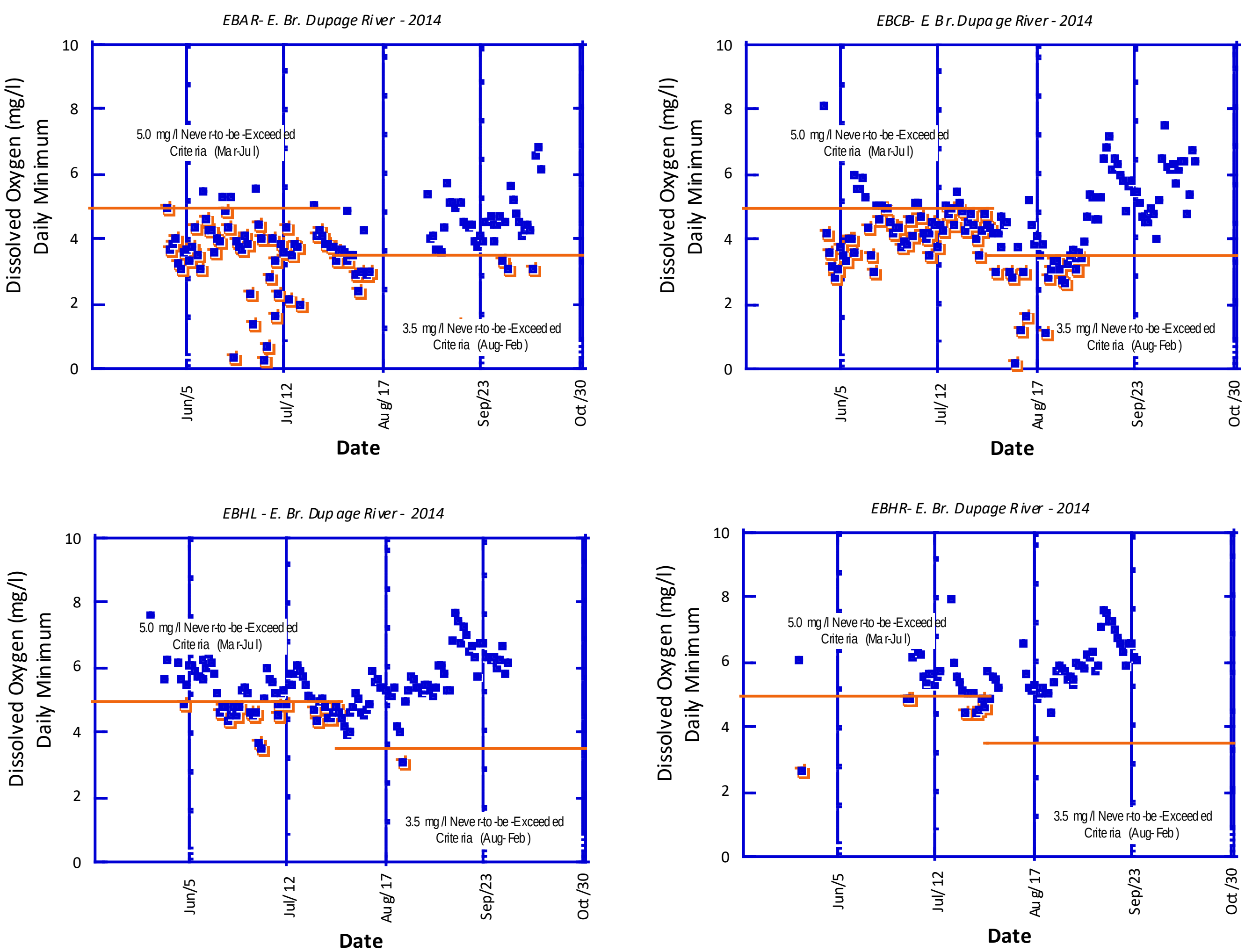

***Figure 15**. Scatter plots of daily minimum D.O. concentrations at four East Br. DuPage River monitoring sites: RMs 23.0 (EBAR), 18.8 (EBCB), 14.0 (EBHL), 8.5 (EBHR) in 2014.*

***Table 6**. Dissolved oxygen concentrations (mg/l) in exceedance of Illinois water quality standards from the East Branch DuPage River, 2012-2014.*

Site ID	Location	Year	Date(s)	Parameter	Criterion	Form
EBAR (RM 23.0)	**East Branch DuPage River**	**2012**	July - 22	D.O.	<5.0 mg/l	Not to exceed
			Aug - 18	D.O.	<3.5 mg/l	Not to exceed
			Sep - 15	D.O.	<3.5 mg/l	Not to exceed
			Oct - 3	D.O.	<3.5 mg/l	Not to exceed
			8/ 1 - 8/23	D.O.	<4.0 mg/l	7-day Minimum
			8/31 - 10/14	D.O.	<4.0 mg/l	7-day Minimum
			7/15 - 7/31	D.O.	<6.0	7-day Average
		2013	June - 12	D.O.	<5.0 mg/l	Not to exceed
			July - 30	D.O.	<5.0 mg/l	Not to exceed
			Aug - 17	D.O.	<3.5 mg/l	Not to exceed
			Sep - 17	D.O.	<3.5 mg/l	Not to exceed
			8/ 2 - 9/25	D.O.	<4.0 mg/l	7-day Minimum
			6/23 - 7/30	D.O.	<6.0	7-day Average
			6/18 - 6/22	D.O.	<6.0	7-day Average
		2014	June - 26	D.O.	<5.0 mg/l	Not to exceed
			July - 25	D.O.	<5.0 mg/l	Not to exceed
			Aug - 6	D.O.	<3.5 mg/l	Not to exceed
			Sep - 1	D.O.	<3.5 mg/l	Not to exceed
			Oct - 3	D.O.	<3.5 mg/l	Not to exceed
			8/ 1 - 9/13	D.O.	<4.0 mg/l	7-day Minimum
			9/15 - 10/ 9	D.O.	<4.0 mg/l	7-day Minimum
			10/11 - 10/14	D.O.	<4.0 mg/l	7-day Minimum
			6/ 3 - 7/31	D.O.	<6.0	7-day Average
EBCB (RM 18.8)	**East Branch DuPage River**	**2012**	June - 21	D.O.	<5.0 mg/l	Not to exceed
			8/ 2 - 8/ 4	D.O.	<4.0 mg/l	7-day Minimum
			5/30 - 6/ 2	D.O.	<6.0	7-day Average
			6/10 - 6/14	D.O.	<6.0	7-day Average
			6/20 - 6/21	D.O.	<6.0	7-day Average
			6/27 - 6/28	D.O.	<6.0	7-day Average
		2013	June - 12	D.O.	<5.0 mg/l	Not to exceed
			July - 24	D.O.	<5.0 mg/l	Not to exceed
			Aug - 5	D.O.	<3.5 mg/l	Not to exceed
			8/ 4 - 8/15	D.O.	<4.0 mg/l	7-day Minimum
			8/21 - 9/15	D.O.	<4.0 mg/l	7-day Minimum
			10/ 5 - 10/ 7	D.O.	<4.0 mg/l	7-day Minimum
			6/26 - 7/ 2	D.O.	<6.0	7-day Average
			7/11 - 7/13	D.O.	<6.0	7-day Average
			7/18 - 7/23	D.O.	<6.0	7-day Average
			7/27 - 7/28	D.O.	<6.0	7-day Average
			7/30 - 7/31	D.O.	<6.0	7-day Average
		2014	June - 22	D.O.	<5.0 mg/l	Not to exceed
			July - 26	D.O.	<5.0 mg/l	Not to exceed

Site ID	Location	Year	Date(s)	Parameter	Criterion	Form
			Aug - 16	D.O.	<3.5 mg/l	Not to exceed
			Sep - 3	D.O.	<3.5 mg/l	Not to exceed
			8/ 1 - 9/ 9	D.O.	<4.0 mg/l	7-day Minimum
			10/ 2 - 10/ 2	D.O.	<4.0 mg/l	7-day Minimum
			6/20 - 7/17	D.O.	<6.0	7-day Average
EBHL (RM 14.0)	**East Branch DuPage River**	**2012**	July - 11	D.O.	<5.0 mg/l	Not to exceed
			7/17 - 7/31	D.O.	<6.0	7-day Average
			7/ 9 - 7/13	D.O.	<6.0	7-day Average
		2013	June - 1	D.O.	<5.0 mg/l	Not to exceed
			July - 18	D.O.	<5.0 mg/l	Not to exceed
			Aug - 1	D.O.	<3.5 mg/l	Not to exceed
			8/ 8 - 8/18	D.O.	<4.0 mg/l	7-day Minimum
			8/20 - 9/ 3	D.O.	<4.0 mg/l	7-day Minimum
			7/21 - 7/27	D.O.	<6.0	7-day Average
		2014	June - 12	D.O.	<5.0 mg/l	Not to exceed
			July - 14	D.O.	<5.0 mg/l	Not to exceed
			Aug - 1	D.O.	<3.5 mg/l	Not to exceed
			8/ 1 - 8/ 8	D.O.	<4.0 mg/l	7-day Minimum
			8/24 - 8/27	D.O.	<4.0 mg/l	7-day Minimum
			6/21 - 7/ 6	D.O.	<6.0	7-day Average
EBHR (RM 8.5)	**East Branch DuPage River**	**2013**	June - 2	D.O.	<5.0 mg/l	Not to exceed
			July - 24	D.O.	<5.0 mg/l	Not to exceed
			Sep - 1	D.O.	<3.5 mg/l	Not to exceed
			9/ 1 - 9/ 6	D.O.	<4.0 mg/l	7-day Minimum
			9/10 - 9/13	D.O.	<4.0 mg/l	7-day Minimum
			7/ 1 - 7/29	D.O.	<6.0	7-day Average
		2014	July - 7	D.O.	<5.0 mg/l	Not to exceed
			7/ 4 - 7/ 6	D.O.	<6.0	7-day Average
EBWL (RM 4.0)	**East Branch DuPage River**	**2012**	June - 17	D.O.	<5.0 mg/l	Not to exceed
			July - 24	D.O.	<5.0 mg/l	Not to exceed
			6/21 - 6/23	D.O.	<6.0	7-day Average
			7/ 2 - 7/31	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 7 lists four nutrient enrichment parameters in relation to various benchmarks that have been 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. 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. The TKN and total ammonia-N thresholds represent change points associated with aquatic assemblage impacts derived by quartile regressions in the 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.

E. Branch DuPage River Mainstem

As was observed in previous surveys, the nutrient enriched condition of the East Branch mainstem continued in 2014 with elevated total P and nitrate-N levels observed along much of its length (Table 7). Mean total phosphorus concentrations were elevated above 1.0 mg/l from river mile 23.0 to 4.0 which coincides with loadings from the series of major WWTPs. Nitrate+nitrite-N followed a similar pattern with all except two locations below the 10 mg/l drinking water criterion - this criterion was exceeded at eight mainstem stations in 2011. The higher river flows in 2014 may have contributed to the decline in very high levels observed between the 2011 and 2014 surveys.

As in previous surveys, no ammonia-N exceedances were detected in grab samples, but mean values sometimes exceeded the aquatic life response derived IPS target of 0.15 mg/l (Miltner et al. 2010; Table 7). However, the number of site exceedances was reduced by 50% between the 2007-11 and 2014 surveys (12 to 6) and nearly all occurred in the upper mainstem.

E. Branch DuPage River Tributaries

The 2014 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 7). In addition, most tributary nutrients (outside of phosphorus) were at lower levels in 2014 compared to the same sites sampled in 2007-11. For example, no exceedances of the 0.15 mg/l ammonia-N IPS threshold were detected at tributary sites in 2014 whereas eight were measured in 2007-11. TKN exceedances at tributary sites declined from nine to two between the former and latter surveys. Zero mean nitrate+nitrite-N exceedances were detected in 2014 compared to four in 2007-11 and with a declining trend between surveys (Figure 15).

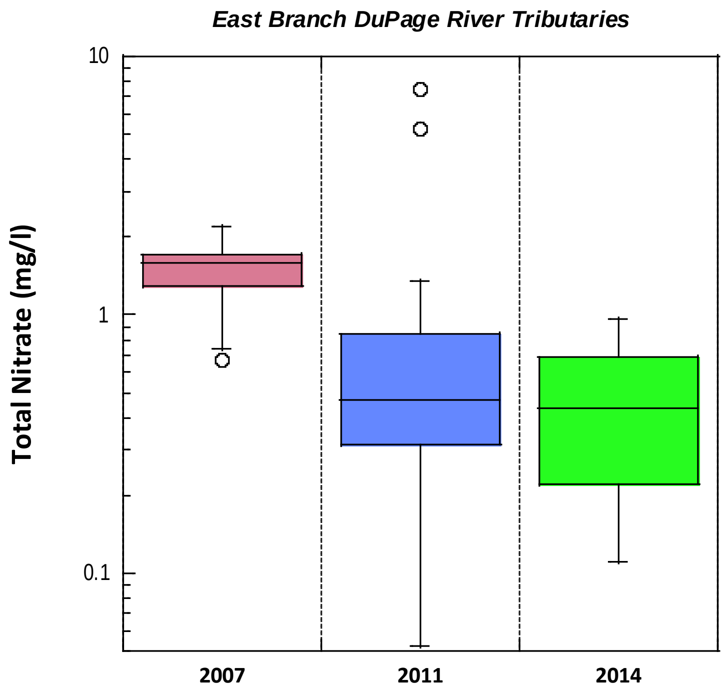

Figure 16. *Nitrate+nitrite-N concentrations from tributary sites in the East Branch DuPage River watershed in 2007, 2011, and 2014.*

Elevated levels of BOD_5, an indicator of organic enrichment, were observed at three tributary sites including EB11 (Willoway Brook), EB17 (22nd St. Trib.), and EB03 (Prentiss Creek RM 1.0). An extremely high reading of 56.4 mg/l was observed at the EB03 site on June 2, 2014. The laboratory analysis was verified as being valid and the source(s) are currently unknown.

***Table 7**. Concentrations of nutrient related parameters including total ammonia-N, nitrate+nitrite-N, TKN, and total phosphorus in the E. Br. DuPage River study area in 2014. Shading represents exceedances of various criteria or thresholds for each parameter (see footnotes).*

Site ID	Basin code	Stream Code	RM	D. Area (sq. mi.)	Ammonia[1] (mg/l)	Nitrate-N[2,3,4] (mg/l)	TKN[5] (mg/l)	Total Phosphorus[6,7,8] (mg/l)
95-980 E. Branch DuPage River								
EB29	95	980	23.5	2	0.05	0.03	1.16	0.17
EB29 Dup.	95	980	23.5	2	0.45	0.12	1.6	0.12
EB25	95	980	23.0	2	0.11	12.85	0.7	3.28
EB23	95	980	22.0	5	0.19	7.94	0.64	1.51
EB26	95	980	21.0	12	0.09	8.44	1	1.81
EB26 Dup.	95	980	21.0	12	0.16	4.3	1.35	1.17
EB21	95	980	20.5	14.2	0.08	8.82	1.03	2.05
EB36	95	980	19.0	16	0.17	4.73	1.47	1.44
EB19	95	980	18.0	18	0.34	5.52	1.23	1.14
EB30	95	980	15.5	27.2	0.13	7.42	1.04	1.04
EB12	95	980	13.0	50	0.05	7.57	0.52	0.96
EB31	95	980	11.0	58	0.08	4.74	0.74	0.92
EB37	95	980	9.5	60.1	0.05	7.69	0.46	1.12
EB32	95	980	8.5	61	0.08	6.24	0.3	0.94
EB32 Dup.	95	980	8.5	61	0.05	13.5	0.3	1.85
EB40	95	980	7.6	63	0.05	0.51	0.74	0.21
EB33	95	980	7.0	64	0.1	8.65	0.56	1.1
EB35	95	980	6.0	76.4	0.08	6.21	0.3	1.01
EB34	95	980	5.0	78	0.08	7.76	0.3	1.0
EB34 Dup.	95	980	5.0	78	0.05	7.9	0.3	1.03
EB34 duplicate	95	980	5.0	78	0.15	5.66	1.34	0.9
EB39	95	980	4.0	78	0.05	6.71	0.53	1.06
EB39 Duplicate	95	980	4.0	78	0.05	5.25	0.3	0.68
EB38	95	980	3.0	81	0.05	5.64	0.94	0.79
EB38 Dup.	95	980	3.0	81	0.11	2.55	0.3	0.44
EB41	95	980	1.3	85	0.05	5.86	0.55	0.8
95-986 Prentiss Creek								
EB04	95	986	3.8	2.3	0.05	0.69	1.04	0.17
EB03	95	986	1.1	6.6	0.05	0.76	0.48	0.1
95-987 - St. Joseph Creek								
EB10	95	987	6.0	1.8	0.12	0.29	0.94	0.2
EB08	95	987	4.0	6	0.12	0.76	0.54	0.15
EB07	95	987	1.0	9.7	0.05	0.96	0.3	0.17
EB07 Dup.	95	987	1.0	9.7	0.05	0.37	0.3	0.17

Site ID	Basin code	Stream Code	RM	D. Area (sq. mi.)	Ammonia[1] (mg/l)	Nitrate-N[2,3,4] (mg/l)	TKN[5] (mg/l)	Total Phosphorus[6,7,8] (mg/l)
95-988 Trib.. to E. Br. DuPage River								
EB01	95	988	0.25	0.7	0.11	0.19	0.78	0.14
95-989 Trib. to E. Br. DuPage River, #6								
EB05	95	989	0.6	1	0.05	0.12	0.3	0.14
95-990 Crabtree Creek								
EB02	95	990	0.2	1.4	0.05	0.58	0.72	0.14
95-951 Army Trail Creek								
EB24	95	951	0.25	0.5	0.05	0.22	0.3	0.07
95-952 Armitage Ditch (trib. to E. Branch DuPage)								
EB22	95	952	0.5	2.2	0.09	0.5	0.63	0.14
95-953 Glencrest Creek								
EB15	95	953	0.5	2.8	0.05	0.66	0.3	0.08
EB15 Dup.	95	953	0.5	0	0.05	0.71	0.3	0.08
95-954 Lacey Creek								
EB14	95	954	2.0	1.8	0.2	0.11	1.36	0.21
EB13	95	954	0.25	4.6	0.05	0.11	0.3	0.16
95-955 Willoway Brook								
EB11	95	955	1.0	4.3	0.11	0.27	0.98	0.13
95-956 22nd St. trib. to E. Branch DuPage River								
EB17	95	956	1.0	0.5	0.08	0.64	0.78	0.17
95-957 Rott Creek								
EB06	95	957	2.0	4.5	0.13	0.26	0.74	0.15

[1]IPS ammonia-N aquatic life threshold (0.15 mg/l).
[2]U.S. EPA Ecoregion 54 reference target for nitrate (1.798 mg/l).
[3]Non-standards based numeric criteria for total nitrate (7.8 mg/l) in water based on the 85th percentile values determined from a statewide dataset from the Ambient Water Quality Monitoring Network, for water years 1978-1996 (Illinois EPA 2011).
[4]Illinois water quality criterion for nitrate-N (10.0 mg/l).
[5]IPS TKN aquatic life threshold (1.0 mg/l).
[6]U.S. EPA Ecoregion 54 reference target for total phosphorus (0.072 mg/l).
[7]Non-standards based numeric criteria for total phosphorus (0.61 mg/l) in water based on the 85th percentile values determined from a statewide set of observations from the Ambient Water Quality Monitoring Network, for water years 1978-1996 (Illinois EPA 2011).
[8]Suggested effluent limit for total phosphorus (1.0 mg/l).

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. Increased concentrations in the East Branch watershed, observed during the 2011 survey, followed several years of high snowfall between 2007 and 2014 (Figure 16); 2013-14 was the 3rd highest on record at 83 inches and snow fighting agencies had the highest number of call outs recorded over that same time period.

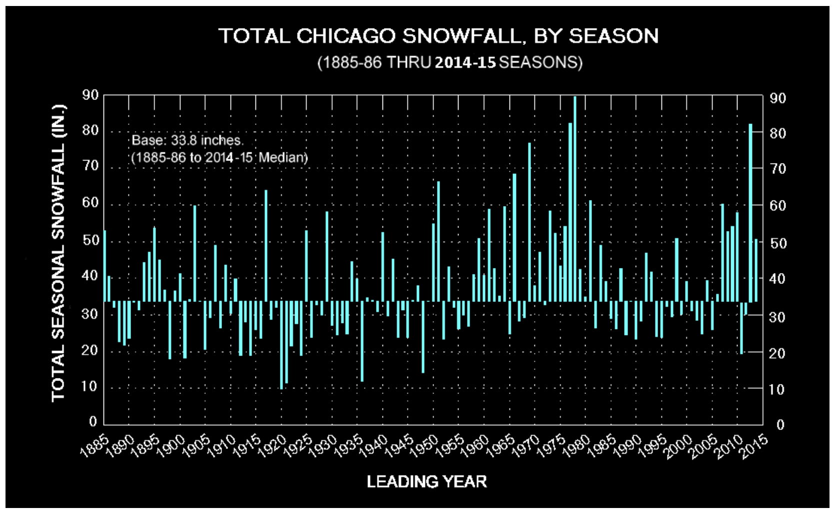

***Figure 17**. Total seasonal snowfall in inches in Chicago by year, 1985-2014. Data from ClimateStations.com:* *http://www.climatestations.com/wp-content/uploads/2013/05/chisnow.gif*

Table 8 shows a group of parameters associated with urban runoff. The highlighted values exceed IPS derived thresholds (total chloride, TKN) or statewide reference levels from similar Ohio waters (conductivity, TDS, TSS, metals; Ohio EPA 1999). For chloride, IPS thresholds for fish and macroinvertebrates (112 and 141 mg/l, respectively) 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 8, Figure 18, and Figure 19) and concentrations increased 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).

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.

To evaluate the fate of residual chloride contributions from nonpoint sources and WWTP discharges in the DuPage watershed, additional chloride sampling was conducted during the summer of 2011 in effluent dominated reaches of the East Branch mainstem. The results showed elevated, but gradually declining concentrations over time (Figure 17). 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. 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 occur (i.e., during the winter months). Actual concentrations that result in adverse effects on fish and invertebrates likely occur during peak

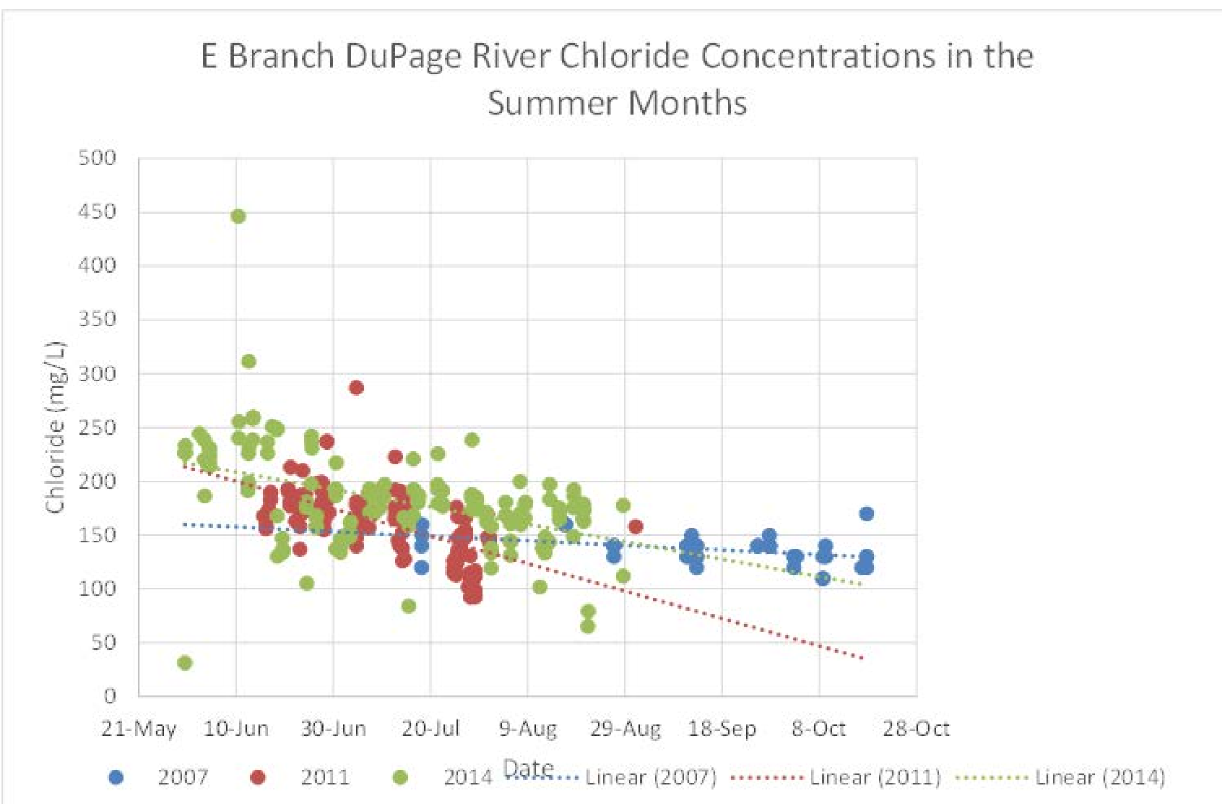

Figure 18. *Chloride concentrations from the East Branch DuPage River during the summers of 2007, 2011, and 2014.*

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.

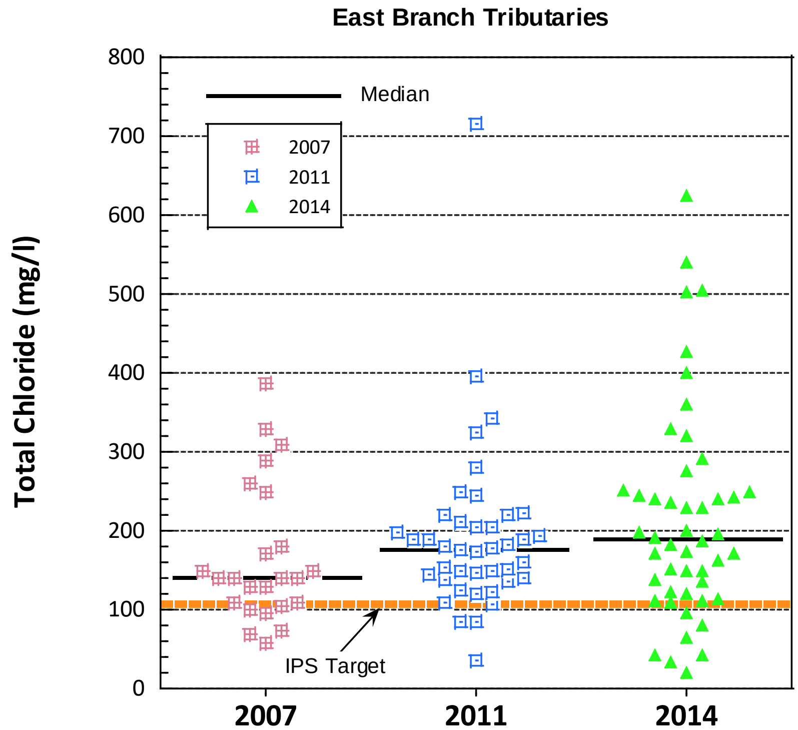

***Figure 19**. Dot plot of summer chloride concentrations in East Branch DuPage River tributary sites in 2007, 2011, and 2014.*

Heavy Metals

No heavy metals exceeded water quality criteria in 2014. To evaluate background metals levels, median copper (Cu) and lead (Pb) concentrations were compared to the Reference Targets in Table 8. Copper levels in the watershed were rarely observed above detection limits and none exceeded the target levels. Lead concentrations were more consistently above detection and were occasionally above targets in the upper mainstem and four tributaries (Armitage Ditch and Army Trail, Rott, and Prentiss Creeks). The tributaries are primarily influenced by urban runoff while mainstem exceedances were restricted to the reach between the Bloomingdale Reeves WWTP and the former Churchill Woods dam. The heavy metals target levels in Table 8 are derived from Ohio EPA data and are associated with good to exceptional (i.e., reference quality) biological assemblages; these locations are outside of the influence of urban and point source influences. For this reason, and given the extensively urbanized landscape in the East Branch watershed, the slightly elevated metals levels found were not considered particularly important. 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.

***Table 8**. Urban parameter results in the E. Branch DuPage River study area, summer 2014. Values that exceeded applicable reference targets are highlighted in yellow.*

Site ID	RM	Conductivity (uS/cm)		TDS (mg/L)		TSS (mg/L)		Chloride (mg/L)		TKN (mg/L)		Total Copper (ug/L)		Total Lead (ug/L)	
		Median	Target[2]	Median	Target[2]	Median	Target[2]	Median	Target[1]	Median	Target[2]	Median	Target[3]	Median	Target[3]
95-951 Army Trail Creek															
EB24	0.25	1089.5	600	832	443	4.7	16	325	112	0.3	1	0.01	0.05	0.04	0.025
95-952 Armitage Ditch (trib. to E. Branch DuPage)															
EB22	0.5	844	600	468	443	24.7	16	168.5	112	0.63	1	0.01	0.05	0.03	0.025
95-953 Glencrest Creek															
EB15	0.5	860	600	486	443	4	16	171	112	0.3	1	-	-	-	-
EB15 Dup.	0.5	846	600	570	443	6.2	16	174	112	0.3	1	-	-	0.01	0.025
95-954 Lacey Creek															
EB14	2	1260	600	1031	443	17.3	16	476.5	112	1.36	1	-	-	0.02	0.025
EB13	0.25	1596	600	885	443	24.75	16	397.5	112	0.3	1	-	-	0.02	0.025
95-955 Willoway Brook															
EB11	1	1164.5	600	667	443	32	16	275.5	112	0.98	1	-	-	0.01	0.025
95-956 22nd St. trib. to E. Branch DuPage River															
EB17	1	1534.5	600	851	443	56.3	16	377.5	112	0.78	1	-	-	0.01	0.025
95-957 Rott Creek															
EB06	2	715	600	425	443	14.9	16	143.5	112	0.74	1	0.02	0.05	0.03	0.025
95-980 E. Branch DuPage River															
EB29	23.5	999.5	600	519	443	16.8	16	192	112	1.16	1	-	-	-	-
EB29 Dup.	23.5	1018	600	580	443	10.7	16	192	112	1.6	1	-	-	0.01	0.025
EB25	23	875	600	453	443	2.9	16	156	112	0.7	1	0.01	0.05	0.03	0.025
EB23	22	863	600	532	443	7	16	146	112	0.64	1	0.01	0.05	0.04	0.025
EB26	21	1059.5	600	583	443	24.55	16	186.5	112	1.00	1	0.01	0.05	0.03	0.025
EB26 Dup.	21	913	600	551	443	164.15	16	193.5	112	1.35	1	-	-	0.02	0.025
EB21	20.5	1001.5	600	555	443	30.4	16	194.5	112	1.03	1	0.01	0.05	0.03	0.025
EB36	19	1089	600	638	443	83.25	16	192.5	112	1.47	1	0.01	0.05	0.04	0.025
EB19	18	1171	600	693	443	27.9	16	188	112	1.23	1	-	-	0.02	0.025
EB30	15.5	954	610	594	463.5	22.8	24.75	175.5	112	1.04	1	0.01	0.05	0.02	0.025
EB12	13	1029.5	610	594	463.5	12.6	24.75	164.5	112	0.52	1	-	-	0.02	0.025
EB31	11	905.5	610	562	463.5	13.7	24.75	176	112	0.74	1	-	-	0.02	0.025
EB37	9.5	1000.5	610	671	463.5	13.5	24.75	189.5	112	0.46	1	-	-	0.02	0.025

Site ID	RM	Conductivity (uS/cm)		TDS (mg/L)		TSS (mg/L)		Chloride (mg/L)		TKN (mg/L)		Total Copper (ug/L)		Total Lead (ug/L)	
		Median	Target[2]	Median	Target[2]	Median	Target[2]	Median	Target[1]	Median	Target[2]	Median	Target[3]	Median	Target[3]
EB32	8.5	1063	610	620	463.5	14	24.75	171.5	112	0.3	1	-	-	0.02	0.025
EB32 Dup.	8.5	1061	610	616	463.5	8.2	24.75	188	112	0.3	1	0.01	0.05	0.02	0.025
EB40	7.6	718.5	610	506	463.5	5.3	24.75	156	112	0.74	1	0.01	0.05	0.01	0.025
EB33	7	1011	610	612	463.5	11.4	24.75	177	112	0.56	1	-	-	0.01	0.025
EB35	6	956	610	626	463.5	15	24.75	172	112	0.3	1	-	-	0.01	0.025
EB34	5	995	610	587	463.5	17.2	24.75	180	112	0.3	1	-	-	0.02	0.025
EB34 Dup.	5	1133	610	582	463.5	20.4	24.75	187	112	0.3	1	-	-	0.01	0.025
EB34 Dup.	5	660	610	482	463.5	23.8	24.75	138	112	1.34	1	-	-	0.02	0.025
EB39	4	1015	610	655	463.5	17.7	24.75	182.5	112	0.53	1	-	-	0.02	0.025
EB39 Dup.	4	1024	610	680	463.5	22.8	24.75	185	112	0.3	1	-	-	0.01	0.025
EB38	3	966.5	610	592	463.5	23.6	24.75	179	112	0.94	1	-	-	0.02	0.025
EB38 Dup.	3	787	610	484	463.5	24.2	24.75	152	112	0.3	1	-	-	0.02	0.025
EB41	1.3	1007	610	596	463.5	22.3	24.75	178.5	112	0.55	1	-	-	0.01	0.025
95-986 Prentiss Creek															
EB04	3.8	334	600	290	443	24.4	16	41.4	112	1.04	1	0.02	0.05	0.03	0.025
EB03	1.1	852	600	516	443	21.8	16	165	112	0.48	1	0.02	0.05	0.03	0.025
95-987 St. Joseph Creek															
EB10	6	406	600	281	443	42.4	16	65.5	112	0.94	1	-	-	0.01	0.025
EB08	4	704.5	600	436	443	8.1	16	128.8	112	0.54	1	-	-	0.01	0.025
EB07	1	1176	600	687	443	4.5	16	237.5	112	0.3	1	-	-	0.01	0.025
EB07 Dup.	1	1273	600	680	443	4.6	16	242	112	0.3	1	-	-	-	-
95-988 Trib. to E. Br. DuPage River															
EB01	0.25	1165.5	600	724	443	6.4	16	328.5	112	0.78	1	-	-	-	-
95-989 Trib. to E. Br. DuPage River, #6															
EB05	0.6	811.5	600	357	443	6.7	16	123.5	112	0.3	1	0.02	0.05	0.03	0.025
95-990 Crabtree Creek															
EB02	0.2	739	600	326	0	26.6	14	176.3	112	0.72	1	-	-	-	-

[1]IPS thresholds (lowest) derived in the IPS study (total chloride)
[2]Median values above statewide reference levels (75th percentiles) from similar Ohio waters (e.g., headwater, wadeable streams).
[3]Single date values above statewide reference levels (75th percentiles) from similar Ohio waters (Cu-5.0; Pb-2.5).

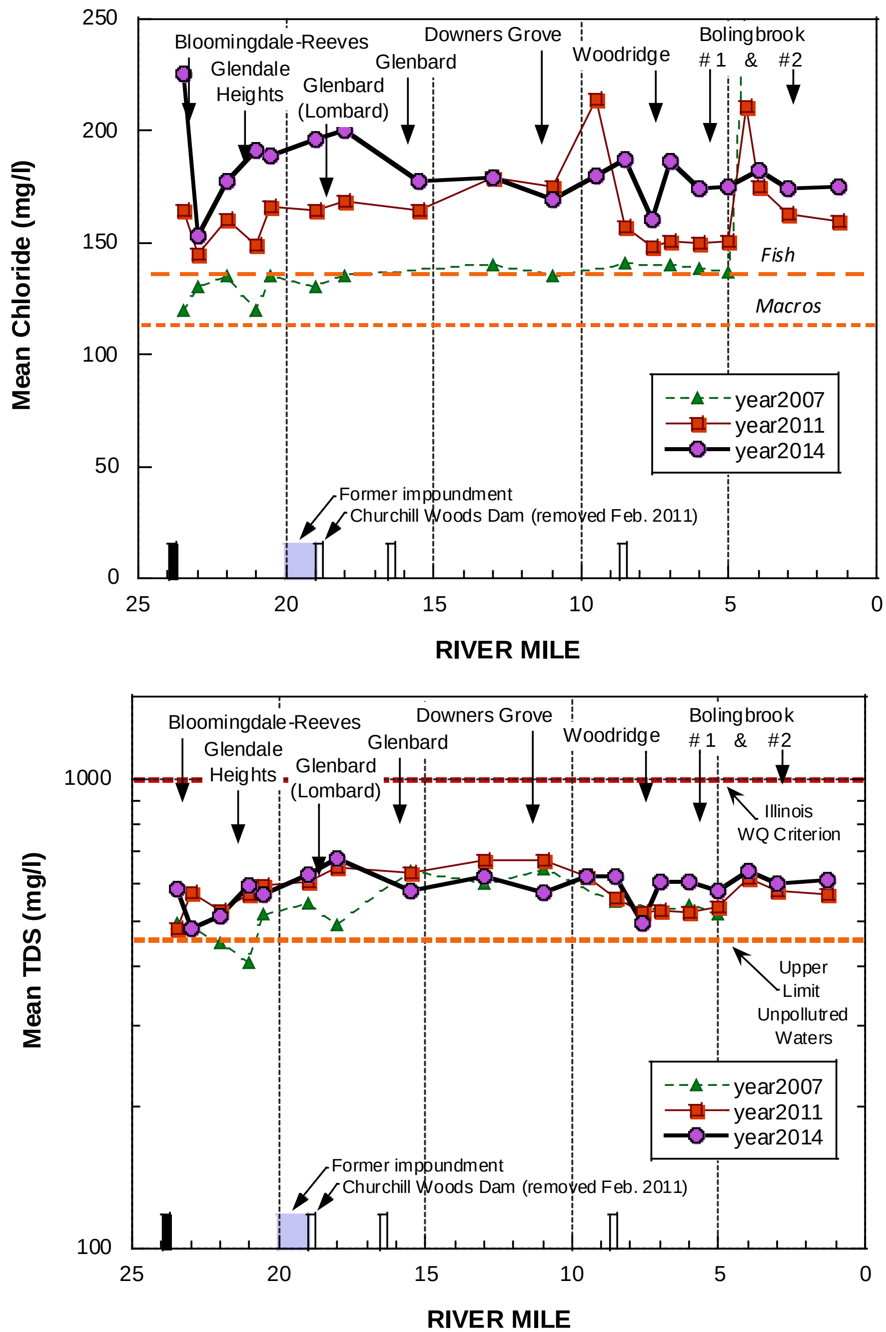

***Figure 20**. Concentrations of total chloride (top panel) and TDS (lower panel) from E. Branch DuPage River samples in 2007, 2011, and 2014. Municipal WWTP discharges are shown by arrows while bars along the x-axis depict mainstem dams or weirs (only black bars impede fish passage). For chloride, the upper red dashed line represents the existing Illinois water quality criterion (500 mg/l, off top panel); the lower orange dashed lines show the IPS thresholds for the fIBI (141 mg/l) and mIBI (112 mg/l). For TDS, the orange dashed line represents the 75th percentile TDS level for small rivers in Ohio and the red dashed line is the existing Illinois water quality criterion (1000 mg/l).*

E. Branch DuPage River Watershed - Sediment Chemistry

Sediment samples were evaluated against 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. Complete sediment sampling results from 2007-14 are summarized by concentration rating and parameter class in Table 9 while 2014 concentrations in excess of TEL and PEL guidelines are listed for heavy metals (Table 10) and organics (Table 11).

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 (Table 9). 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. 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. 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.

The mean number of heavy metal TEL exceedances continued a trend of increase in 2014 (5.2/site) compared to 2011 (3.9) and 2007 (1.5). However, only one 2014 site exceeded the higher PEL threshold compared to four in 2011 and 0 in 2007. The one parameter that exceeded the PEL (iron) in 2014 is a naturally occurring component of stream sediments and is not considered to be threatening to aquatic life. In contrast, PEL exceedances in 2011 were mostly for copper. Excessive levels of heavy metals in urban landscapes are commonly associated with runoff from roads and highways and industrial and municipal sources.

***Table 9**. The number of polycyclic aromatic hydrocarbons (PAHs), metal, polychlorinated biphenyl (PCB), and pesticide concentrations in the E. Branch DuPage River watershed sediment samples from 2007, 2011 (blue shaded), and 2014 (tan shaded) that exceeded threshold effect level (TEL) or probable effect level (PEL) guidelines (McDonald et al. 2000 or Ontario Ministry of Environment 1993).*

			PAHs		Metals		PCBs		Pesticides	
Site ID	**River Mile**	**Year**	**TEL**	**PEL**	**TEL**	**PEL**	**TEL**	**PEL**	**TEL**	**PEL**
E. Branch DuPage River										
EB 29	23.50	2014	6	5	4	0	0	0	0	0
EB 23	22.00	2014	9	0	4	0	0	0	0	0
	22.00	2011	10	1	3	0	0	0	0	0
	22.00	2007	10	6	1	0	0	0	0	0
EB 26	21.00	2014	8	0	3	0	0	0	0	0
	21.00	2007	10	6	1	0	0	0	0	0
EB 21	20.50	2014	5	0	4	0	0	0	0	0
	20.50	2011	9	1	3	0	0	0	0	0
	20.50	2007	10	9	2	0	0	0	0	0
EB 36	19.00	2011	9	0	4	0	0	0	0	0
EB 19	18.00	2014	9	0	6	0	0	0	0	0
	18.00	2011	9	3	5	0	0	0	0	0
EB 30	15.50	2014	4	0	3	1	0	0	0	0
	15.50	2011	9	3	5	1	0	0	0	0
	15.50	2007	10	7	2	0	0	0	1	0
EB 12	13.00	2014	8	0	4	0	0	0	0	0
	13.00	2011	9	2	4	0	0	0	3	2
	13.00	2007	10	6	1	0	0	0	3	1
EB 31	11.00	2014	9	0	7	0	0	0	0	0
	11.00	2011	10	1	4	1	0	0	0	0
	11.00	2007	12	12	1	0	0	0	2	0
EB 37	9.50	2011	10	1	4	1	0	0	0	0
EB 32	8.50	2014	8	0	7	0	0	0	0	0
	8.50	2011	8	2	5	0	0	0	3	0
	8.50	2007	11	11	1	0	0	0	0	0
EB 33	7.00	2014	6	4	6	0	0	0	0	0
	7.00	2011	11	1	4	0	0	0	0	0
	7.00	2007	11	11	2	0	0	0	0	0
EB 35	6.00	2014	7	3	6	0	0	0	0	0
	6.00	2011	10	0	5	0	1	1	0	0
	6.00	2007	12	11	1	0	0	0	0	0
EB 34	5.00	2014	8	0	6	0	0	0	0	0
	5.00	2011	10	1	5	0	0	0	0	0
	5.00	2007	11	11	3	0	0	0	0	0
EB 39	4.00	2014	8	2	6	0	0	0	0	0
	4.00	2011	0	0	5	0	0	0	0	0
	4.00	2007	12	1	0	0	0	0	0	0

Table 9. continued										
EB 38	3.00	2014	9	0	5	0	0	0	0	0
EB 41	1.30	2011	4	0	2	0	0	0	0	0
EB 07	1.00	2014	8	2	7	0	0	0	0	0
St. Joseph Creek										
EB 07	1.00	2011	10	1	5	1	0	0	0	0
	1.00	2007	12	11	2	0	0	0	0	0

***Table 10**. Sediment metal concentrations from the East Branch DuPage River, 2014.*

Site ID	River Mile	Collection Date	Parameters		Parameters >TEL Benchmark (Value, mg/l)	Parameters >PEL Benchmark (Value, mg/l)
			Tested	Detects		
95-980 East Branch DuPage River						
EB29	23.5	09-July	11	11	Cu (42.30); Ni (26.80); Zn (140.00); Fe (20700.00)	
EB23	22.0	09-July	11	10	Cu (48.60); Ni (27.80); Zn (127.00); Fe (24600.00)	
EB26	21.0	16-July	11	11	Cu (49.70); Zn (157.00); Fe (24900.00)	
EB21	20.5	16-July	11	11	Cu (45.20); Ni (24.40); Zn (137.00); Fe (26100.00)	
EB19	18.0	05-Aug	11	11	Cd (1.30); Cu (78.10); Pb (75.40); Ni (28.50); Zn (314.00); Fe (32500.00)	
EB30	15.5	05-Aug	11	11	Cu (43.60); Ni (26.10); Zn (135.00)	Fe (77200.00)
EB12	13.0	30-July	11	11	Cu (58.30); Ni (23.40); Zn (169.00); Fe (26400.00)	
EB31	11.0	29-July	11	11	Cd (1.11); Cu (65.00); Pb (48.90); Mn (829.00); Ni (25.90); Zn (218.00); Fe (30300.00)	
EB32	8.5	29-July	11	11	Cd (1.59); Cu (70.40); Pb (69.40); Mn (536.00); Ni (28.20); Zn (208.00); Fe (24200.00)	
EB33	7.0	23-July	11	11	Cu (61.40); Pb (40.40); Mn (594.00); Ni (25.30); Zn (201.00); Fe (26000.00)	
EB35	6.0	23-July	11	11	Cu (58.40); Pb (40.20); Mn (595.00); Ni (25.20); Zn (194.00); Fe (25000.00)	
EB34	5.0	22-July	11	11	Cu (56.40); Pb (36.00); Mn (518.00); Ni (25.30); Zn (181.00); Fe (24300.00)	
EB39	4.0	22-July	11	11	Cu (60.60); Pb (36.00); Mn (568.00); Ni (23.80); Zn (193.00); Fe (24300.00)	
EB38	3.0	22-July	11	11	Cu (48.20); Mn (540.00); Ni (24.00); Zn (145.00); Fe (21000.00)	
EB07	1.0	30-July	11	11	Cd (1.64); Cu (65.90); Pb (81.10); Mn (652.00); Ni (34.10); Zn (261.00); Fe (26200.00)	

***Table 11**. Number of polycyclic aromatic hydrocarbons (PAHs), metals, polychlorinated biphenyls (PCBs), and pesticide detections in sediment samples from the E. Branch DuPage River and its tributaries in 2014 with concentrations that exceed threshold effect levels (TEL) or probable effect levels (PEL) after McDonald et al. (2000) or Ontario Ministry of Environment (1993).*

Site ID	River Mile	Collect. Date	Parameters		Parameters > TEL Benchmark (Value, mg/l)	Parameters > PEL Benchmark (Value, mg/l)
			Tested	Detects		
95-850 – East Branch DuPage River						
EB29	23.5	09-July	61	12	Anthracene (134.00); Benzo(b)fluoranthene (2610.00); Benzo(k)fluoranthene (875.00); Indeno(1,2,3-cd)pyrene (1450.00); Phenanthrene (1100.00); Benz(a)anthracene (963.00)	Benzo(a)pyrene (1470.00); Chrysene (1860.00); Fluoranthene (3530.00); Pyrene (2590.00); Dibenz(a,h)anthracene (331.00)
EB23	22.0	09-July	61	11	Benzo(b)fluoranthene (778.00); Benzo(k)fluoranthene (258.00); Benzo(a)pyrene (437.00); Chrysene (590.00); Fluoranthene (1150.00); Indeno(1,2,3-cd)pyrene (433.00); Phenanthrene (378.00); Pyrene (820.00); Benz(a)anthracene (296.00)	
EB26	21.0	16-July	61	10	Benzo(b)fluoranthene (520.00); Benzo(a)pyrene (295.00); Chrysene (422.00); Fluoranthene (872.00); Indeno(1,2,3-cd)pyrene (249.00); Phenanthrene (299.00); Pyrene (615.00); Benz(a)anthracene (220.00)	
EB21	20.5	16-Jul	61	7	Benzo(b)fluoranthene (308.00); Benzo(a)pyrene (177.00); Chrysene (278.00); Fluoranthene (551.00); Pyrene (381.00)	
EB19	18.0	05-Aug	61	10	Benzo(b)fluoranthene (684.00); Benzo(k)fluoranthene (255.00); Benzo(a)pyrene (344.00); Chrysene (503.00); Fluoranthene (1050.00); Indeno(1,2,3-cd)pyrene (287.00); Phenanthrene (371.00); Pyrene (870.00); Benz(a)anthracene (225.00)	
EB30	15.5	05-Aug	61	5	Benzo(b)fluoranthene (302.00); Chrysene (239.00); Fluoranthene (469.00); Pyrene (416.00)	
EB12	13.0	30-July	61	10	Benzo(b)fluoranthene (564.00); Benzo(a)pyrene (283.00); Chrysene (370.00); Fluoranthene (780.00); Indeno(1,2,3-cd)pyrene (280.00); Phenanthrene (256.00); Pyrene (615.00); Benz(a)anthracene (221.00)	
EB31	11.0	29-July	61	10	Benzo(b)fluoranthene (827.00); Benzo(k)fluoranthene (295.00); Benzo(a)pyrene (446.00); Chrysene (562.00); Fluoranthene (1080.00); Indeno(1,2,3-cd)pyrene (433.00); Phenanthrene (362.00); Pyrene (854.00); Benz(a)anthracene (344.00)	

Site ID	River Mile	Collect. Date	Parameters		Parameters > TEL Benchmark (Value, mg/l)	Parameters > PEL Benchmark (Value, mg/l)
			Tested	Detects		
EB32	8.5	29-July	61	10	Benzo(b)fluoranthene (586.00); Benzo(a)pyrene (341.00); Chrysene (412.00); Fluoranthene (734.00); Indeno(1,2,3-cd)pyrene (309.00); Phenanthrene (237.00); Pyrene (583.00); Benz(a)anthracene (246.00)	
EB33	7.0	23-July	61	11	Benzo(b)fluoranthene (2060.00); Benzo(k)fluoranthene (590.00); Benzo(a)pyrene (1110.00); Indeno(1,2,3-cd)pyrene (1080.00); Phenanthrene (867.00); Benz(a)anthracene (796.00)	Chrysene (1330.00); Fluoranthene (2610.00); Pyrene (2010.00); Dibenz(a,h)anthracene (228.00)
EB35	6.0	23-July	61	11	Benzo(b)fluoranthene (1920.00); Benzo(k)fluoranthene (519.00); Benzo(a)pyrene (1040.00); Chrysene (1170.00); Indeno(1,2,3-cd)pyrene (974.00); Phenanthrene (739.00); Benz(a)anthracene (733.00)	Fluoranthene (2270.00); Pyrene (1770.00); Dibenz(a,h)anthracene (214.00)
EB34	5.0	22-July	61	10	Benzo(b)fluoranthene (1520.00); Benzo(k)fluoranthene (483.00); Benzo(a)pyrene (771.00); Chrysene (971.00); Fluoranthene (1890.00); Indeno(1,2,3-cd)pyrene (781.00); Phenanthrene (640.00); Pyrene (1490.00); Benz(a)anthracene (562.00)	
EB39	4.0	22-July	61	11	Benzo(b)fluoranthene (1630.00); Benzo(k)fluoranthene (484.00); Benzo(a)pyrene (852.00); Chrysene (1050.00); Fluoranthene (2140.00); Indeno(1,2,3-cd)pyrene (849.00); Phenanthrene (712.00); Benz(a)anthracene (633.00)	Pyrene (1610.00); Dibenz(a,h)anthracene (181.00)
EB38	3.0	22-July	61	10	Benzo(b)fluoranthene (1150.00); Benzo(k)fluoranthene (358.00); Benzo(a)pyrene (601.00); Chrysene (731.00); Fluoranthene (1420.00); Indeno(1,2,3-cd)pyrene (595.00); Phenanthrene (458.00); Pyrene (1100.00); Benz(a)anthracene (430.00)	
EB07	1.0	30-July	61	11	Benzo(b)fluoranthene (1660.00); Benzo(k)fluoranthene (467.00); Benzo(a)pyrene (909.00); Chrysene (1040.00); Fluoranthene (2040.00); Indeno(1,2,3-cd)pyrene (847.00); Phenanthrene (711.00); Benz(a)anthracene (649.00)	Pyrene (1610.00); Dibenz(a,h)anthracene (188.00)

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 12).

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 20, Figure 21). 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 21). 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, 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 scores were very similar to those recorded in in 2007 and slightly higher than in 2011 (Figure 21). Specific reasons for the decline between 2007 and 2011 varied by site, but included silted substrates and variable flow conditions that influenced the habitat features (e.g., shoreline, vegetation). The rebound in 2014 likely illustrates the slight, but inherently variable conditions at the sampling sites from year to year. The lower 18 miles of the East Branch, while largely unimpounded, consists mostly of pools and runs rarely interrupted by riffle habitats. In fact, riffles were absent from 10 of 14 sampling stations in this lower reach in 2011 a reflection of past channelization of the mainstem.

E. Branch DuPage River Tributaries

Habitat ratings from comparable East Branch tributary sites showed a general decline between 2007 and 2011, but scores rebounded somewhat in 2014 (Figure 22). In 2011, an approximate

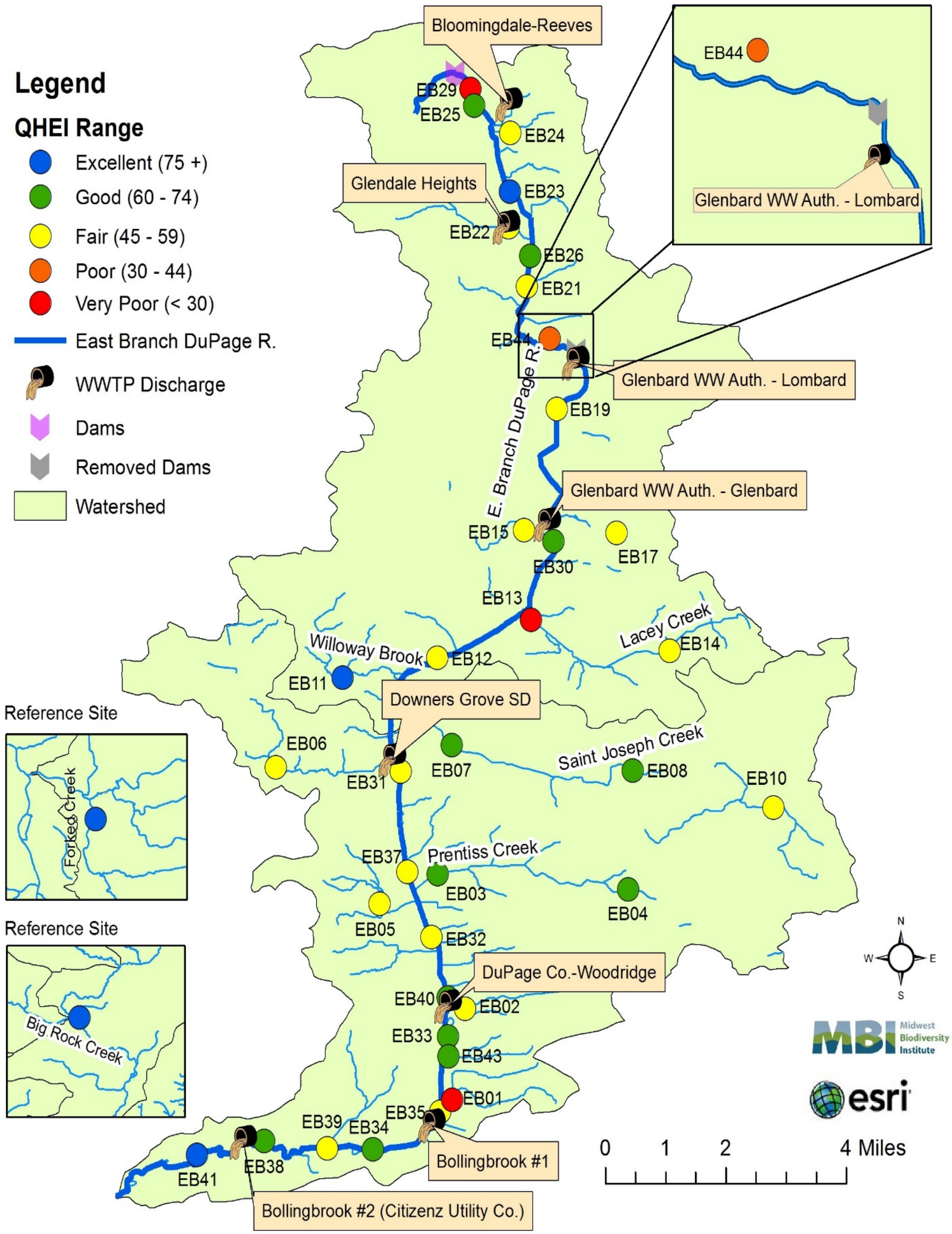

***Figure 21**. East Branch DuPage River watershed QHEI scores, 2014.*

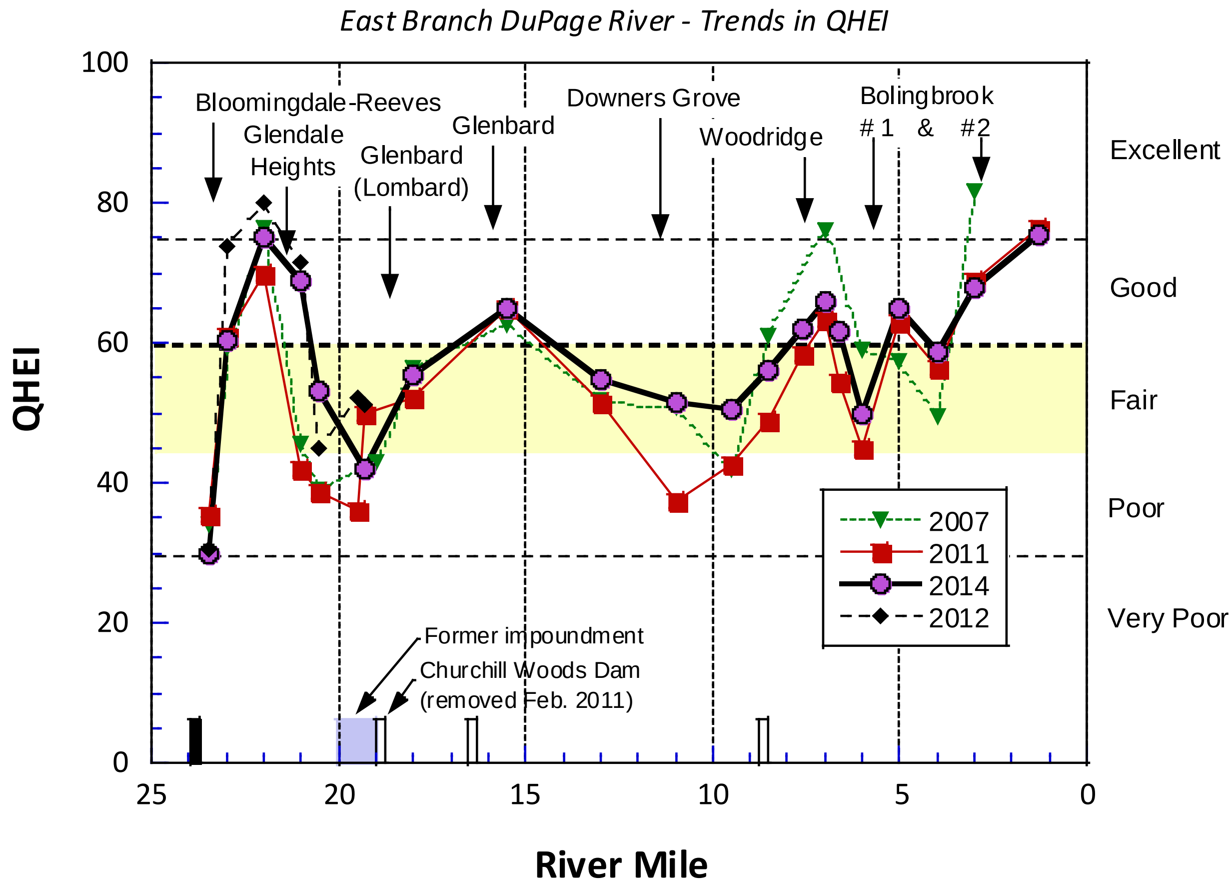

***Figure 22**. Qualitative Habitat Evaluation Index (QHEI) scores for the E. Branch DuPage River in 2007, 2011-12, and 2014 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). The shaded region depicts the range of QHEI scores where habitat quality is marginal and limiting to aquatic life. QHEI scores less than 45 are typical of highly modified habitat.*

The loss of good quality attributes outpaced gains by 3:1 while modified attributes increased by an average of 1.5 per site. Lost good quality attributes were reflective of increased pool embeddedness, riffle embeddedness, and a loss of coarse substrates and deep pools. The 2014 observations followed 2011 as all tributary sites (and all except one mainstem site) had at least one instance of pool or riffle embeddedness recorded.

The greatest change in 2011 tributary QHEIs was a 24 point decline recorded in Armitage Ditch (EB 22) a small, modified channel lined with rock gabions. In 2011, recent channelization, armoring, and riparian removal were the primary reasons for the decline. The 2014 QHEI rebounded and nearly equaled the 2007 score, but the urban stream is still characterized as small, modified, and armored.

Between 2007 and 2011, St. Joseph Creek RM 1.0 (EB07) experienced an almost 20 point decline (from 68.5 to 49.0) which was attributed to poor substrate conditions (increased silt and embeddedness) and poor instream cover. Declines of that magnitude are usually related to upstream silt/sediment loads or direct habitat modifications, but can also be influenced by extremes in flow, which ranged from continuous in 2007 to nearly intermittent in 2011. Under the normal flow conditions in 2014 the habitat score rebounded and nearly equaled 2007.

The 22nd Street Tributary (EB 17) declined by 16.5 points between the 2007 and 2011 surveys, from fully capable of supporting warmwater assemblages (QHEI = 71) to marginally capable (QHEI 54.5). Similar quality was observed in 2014 (QHEI 56.0) which suggests the decline in habitat quality is permanent. Additional investigation into the specific causes is warranted.

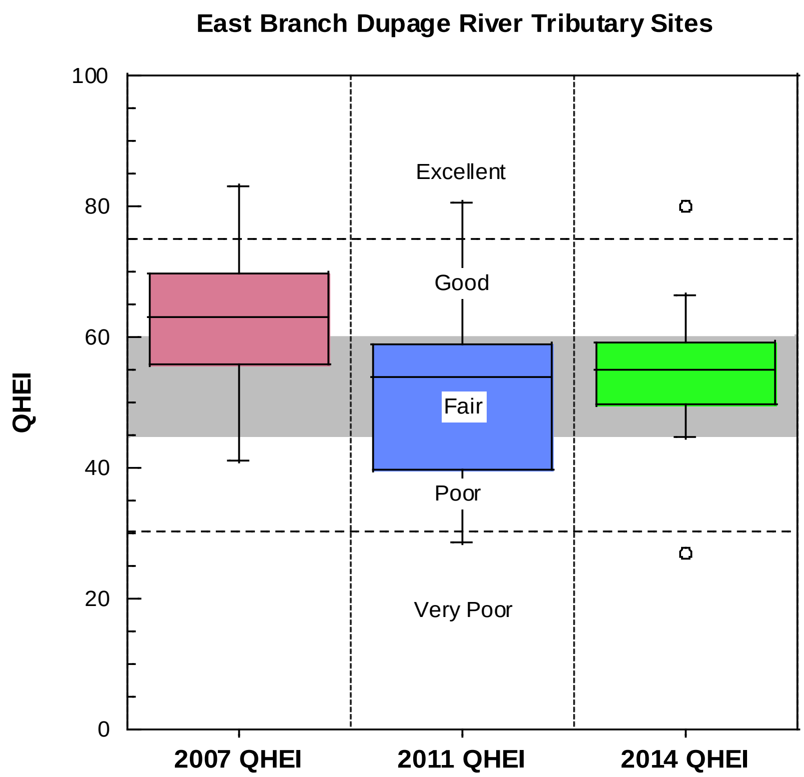

Figure 23. *Box-and-whisker plots of QHEI scores at comparable E. Branch DuPage tributary sites in 2007 (salmon), 2011 (blue), and 2014 (green).*

QHEI scores in Glencrest Creek dropped from excellent (79.3) to good (65.8) to fair (55) during each successive survey 2007-14. Good attributes declined from 9 to 6 to 3 over the same period. Good to excellent quality habitat was maintained in Willoway Brook (the highest quality East Branch tributary), Prentiss Creek (2011-2014 sampling) and, to a lesser degree, Rott Creek and the upper portions of St. Joseph Creek. Based on the overall results, degraded stream habitat with minimal functions beyond water conveyance were observed in Army Trail Creek (EB24), Armitage Ditch (EB22), Lacey Creek (EB13), and the Trib. to E. Br. DuPage River (EB01). The Trib. to E. Br. DuPage River is less than one square mile in drainage and flow was intermittent during the summer.

***Table 12**. Qualitative Habitat Evaluation Index (QHEI) scores showing Good and Modified Habitat attributes at sites in the E. Branch DuPage River study area during 2014. (■- 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

			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
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

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
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 2014 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 23). As in 2011 assemblages throughout the study area were predominated by facultative and tolerant organisms most often associated with elevated nutrients, dissolved solids, and low D.O. Many of the same populations, particularly from low-gradient reaches, are common to sluggish, impounded, or wetland influenced habitats with mucky or silty substrates.

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 only nine. In contrast 16 distinct EPT taxa were found in 2011. EPT taxa are generally considered positive indicators of water quality, but the nine taxa observed in 2014 were almost exclusively facultative or tolerant varieties within the group. No stonefly (Plecoptera) individuals have ever been found in the study area.

EPT taxa were especially lacking in tributaries where 14 of 20 (70%) samples had zero EPT taxa and the remaining sites had only one. Comparatively fewer EPT were also found in 2011 tributaries, but in that survey 33% of the sites had zero EPT (compared to 70% in 2014); 50% of 2011 samples contained multiple (*i.e.*, $\geq$2) EPT taxa compared to none (0%) in 2014. Mainstem EPT richness, while comparatively higher than tributary sites, followed a similar trend. When compared to 2011 mainstem sites with zero EPT taxa occurred only in 2014 and all were restricted to the upper mainstem upstream from Churchill Woods. The same reach coincides with the area of lowest mainstem mIBI scores (Figure 23). D.O. levels were at their lowest levels in this reach (see Table 6).

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 (Table 1). 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 2014 East Branch site where the mIBI also reached the good range.

E. Branch DuPage River Tributaries

As in 2007 and 2011, all 2014 East Branch tributaries had mIBI scores in the poor or fair ranges (Figure 23, Figure 24). While 2011 mIBI scores from comparable sites suggested slightly improved conditions over 2007, the trend was largely reversed in 2014 and scores declined to 2007 levels (as discussed above, elevated flows may have contributed to some of the differences in scores in 2014). An extreme example was Armitage Ditch, a 2.2 sq. mi. drainage that experienced a 20+ point increase in the mIBI from 2007 to 2011, then declined by 9 points in 2014. Since much of the upstream drainage is culverted and urbanized nonpoint source runoff and erratic flow conditions are likely responsible for the variable, but poor quality assemblages. St. Joseph Creek (EB07) near the mouth experienced a 12 point decline in the mIBI, but a specific cause(s) is unknown.

Crabapple Creek (EB02) was sampled for the first time in 2014 and fell in the poor/fair range. While the sample site included riffle/run habitats and contained an abundance of coarse tills, the small tributary was less than 2 square miles in drainage, located in a watershed of extensive suburban development and was culverted for an undetermined distance upstream.

High Water Influences

With few exceptions the 2014 mIBI narrative ratings from the East Branch watershed were not appreciably different compared to previous surveys. However, mIBI scores were consistently lower than in both 2011 and 2007. A more detailed inspection of the tabulated data found almost pervasive, basin wide reductions in what would be considered positive metrics or positive indicator populations including Total Taxa, Ephemeroptera (mayfly), Coleoptera (beetle), and EPT taxa richness, EPT percentage, and mIBI scores (Table 13). These reductions in 2014 were consistent among watershed, tributary, and mainstem sites with only “percent scrapers” values being higher. Percent scrapers is considered a positive metric (i.e., it declines with increased perturbation), but in this instance the trend was attributed to increases in the very tolerant snail genus, *Physella*. For this reason, the scraper increases are somewhat misleading and not considered indicative of an improvement. Mean percentages of scrapers during all sampling years were well below the “best value” of 29.6% for this metric.

This watershed scale trend of decline suggests a broad based influence affecting the results and raises concerns about the sample collection. Most of the sampling in 2014 was conducted 1-2 weeks after a series of high flow events where the flows had only recently declined before sample collection. The results suggest a temporary disruption of macroinvertebrate populations or reduced sampling efficiency shortly after the high water events. For this reason, broad generalizations about the 2014 results should be tempered.

***Table 13**. 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, 2007-14. Values highlighted in yellow are the lowest in each category during the three survey years.*

Sites	Year	No. Samples	Total Taxa	Mayfly Taxa	Coleop. Taxa	Percent EPT	Total EPT	Percent Scrapers	mIBI
Watershed	2007	32	27.8	1.5	1	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
Tributaries	2007	15	25.5	1	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
Upper Mainstem[a]	2007	6	24.8	1	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
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

[a] Upper mainstem = East Branch DuPage Ust. former Churchill Woods dam
[b] Lower mainstem = East Branch DuPage Churchill Woods dam to mouth

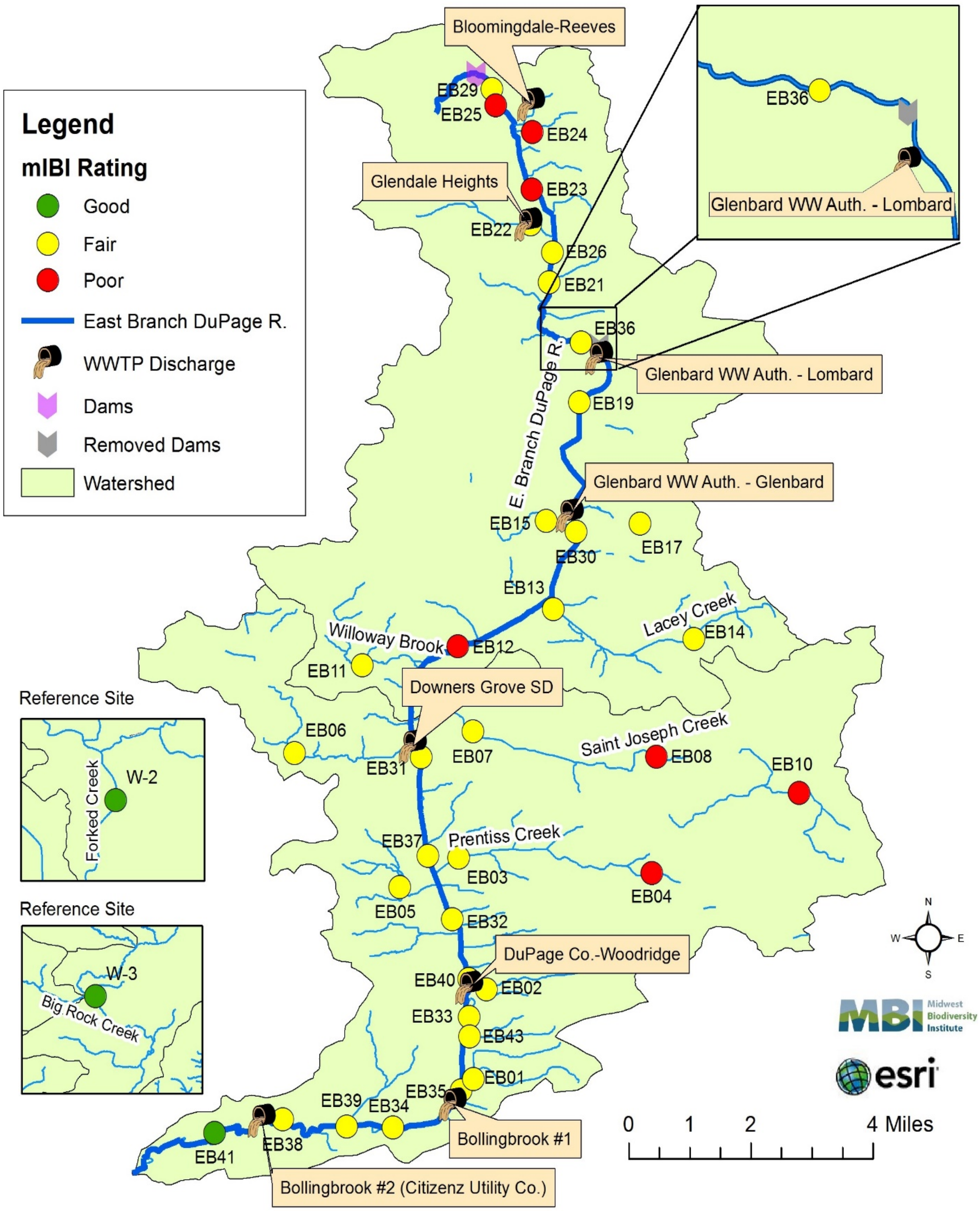

***Figure 24**. Macroinvertebrate IBI (mIBI) scores from 2014 in the E. Branch DuPage River study area rated by Illinois EPA narrative ranges. Chevron symbols denote dams and outfalls denote WWTP locations.*

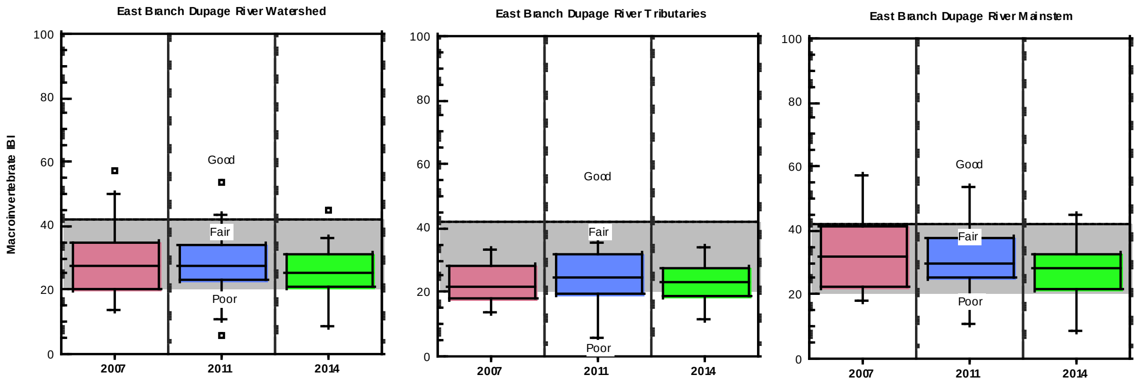

Figure 25. *Box-and-whisker plots of mIBI scores from the E. Branch DuPage River study area in 2007 (salmon), 2011 (blue) and 2014 (green). Scores are displayed by watershed (left), tributaries (middle), and the East Branch mainstem (right).*

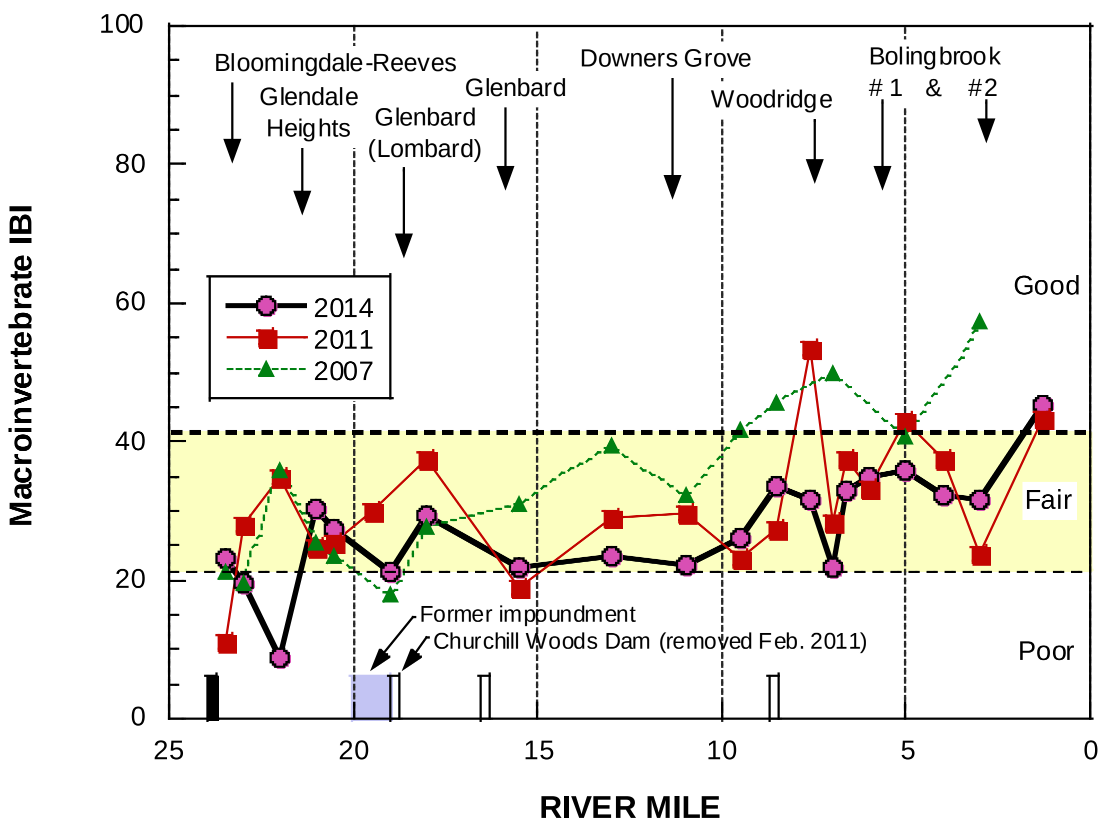

Figure 26. *Macroinvertebrate IBI scores for samples collected from the E. Branch DuPage River, 2014, 2011 and 2007 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (black bars are dams that impede fish passage). The shaded area demarcates the "fair" narrative range.*

E. Branch DuPage River Watershed Biological Assemblages – Fish

Like previous surveys in 2007 and 2011-12 fish assemblage condition throughout the East Branch DuPage River watershed remained in the poor and fair ranges in 2014 (Figure 26, Figure 27). However, mainstem assemblages in particular showed similar quality or modest improvements at nearly all sites compared to 2011 and approached 2007 levels (Figure 28). Tributary assemblages have remained largely in the upper portion of the poor range since 2007, but the 2014 results also reflected slight improvement over 2011.

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 14) 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. The appearance of banded darter, a sensitive species, is a sign of improved quality in the lower nine 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. A small, residual impoundment with heavy deposits of fine muck and peat still exists behind the former dam site and the corresponding fish and habitat quality are among the lowest in the mainstem.

Table 14*. Fish species collected only downstream from the Churchill Woods Dam, species collected upstream from the dam in 2011- 2014 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*	
tadpole madtom	*johnny darter*	
rock bass		
banded darter (2014)		
round goby (2014)		

The fish assemblage gradually improved with increased distance downstream from the Churchill Woods dam site and reflected an improvement compared to 2011 results (Figure 28). The 2014 results suggest a stemming, if not reversal of the declining trend observed between 2007 and 2011. Like previous studies, the improving trend was interrupted in the lower seven river miles extending downstream from the Woodridge and Bolingbrook #1 WWTPs. A decline immediately upstream from the Bolingbrook #1 WWTP at EB35 may be related to fair habitat quality (QHEI 50/fair), but lower fIBI scores persisted downstream from the #1 WWTP despite a subsequent improvement in QHEI score. Following the declining trend in 2011, low D.O. was a suspected, but unverified source of impairment throughout the lower reach. A limited amount of continuous monitor data in 2012 at RM 4.0 shows occasional exceedances, but comparatively fewer than observed in the middle and upper mainstem reaches (see Table 6). 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 were similar to the 2007 and 2011 surveys and continue to reflect mostly poor to marginally fair quality (Figure 27). 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 almost entirely absent.

Lacey Creek site (EB 14).

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. Higher performance levels in 2007 appeared related to augmentation by populations from the East Branch mainstem and a re-occurrence of this phenomenon likely led to a rebound in the fIBI score in 2014.

Prentiss Creek RM 1.0 (EB03) had the lowest fIBI score in 2014 and was among the lowest in the 2011 survey. Despite very good habitat quality (QHEI 67.5), only four tolerant fish species were found in 2014. 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.

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 past surveys, Glencrest Creek (EB15) scored in the poor or marginally fair fIBI range despite good to excellent habitat quality. The 2014 fIBI score (21.5) continues to reflect degraded quality, but now habitat quality is also in decline (see page 51). Additional investigation into both the biological and habitat impacts to Glencrest Creek is warranted.

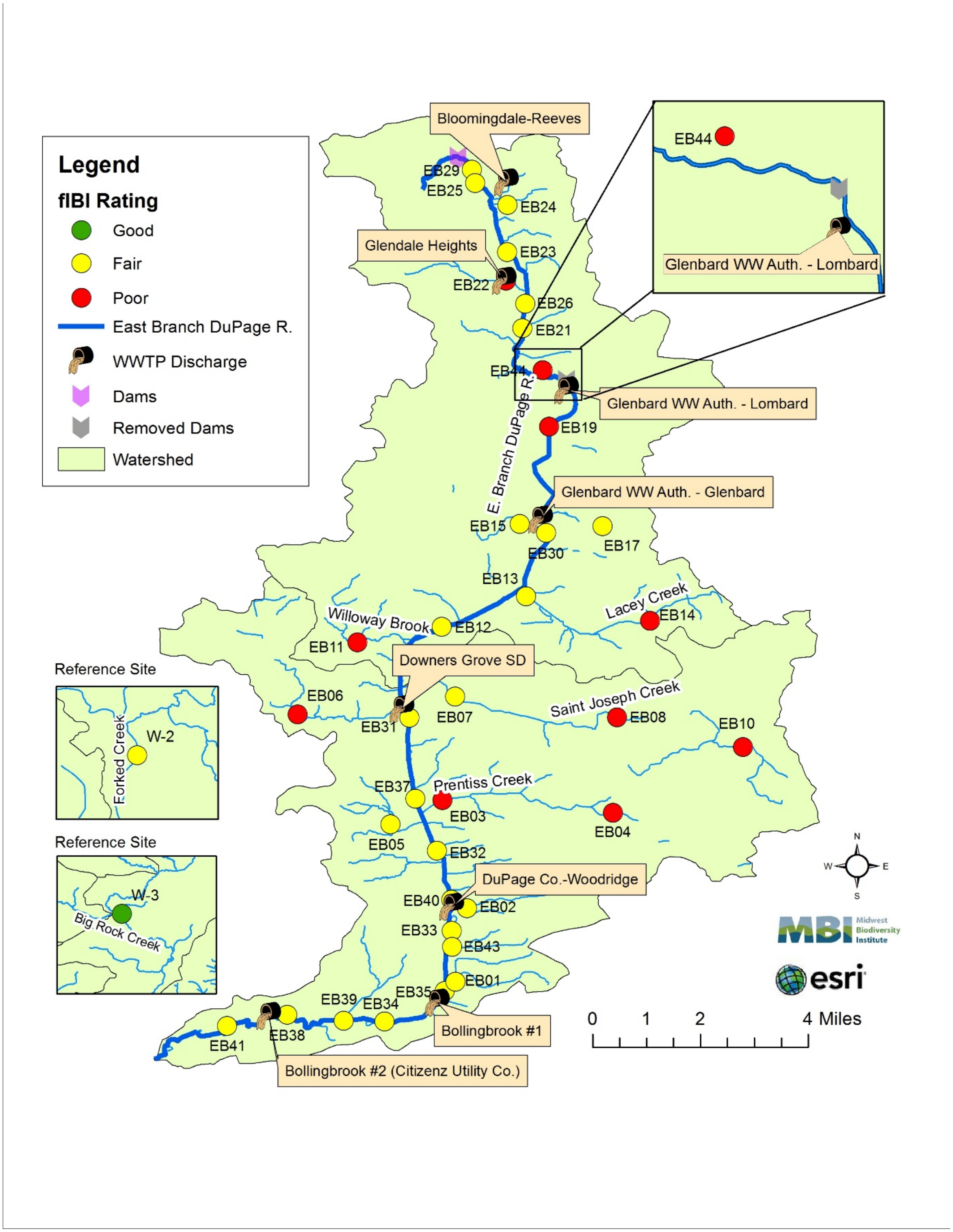

Figure 27. *Fish IBI (fIBI) scores from 2014 in the E. Branch DuPage River study area rated by Illinois EPA narrative ranges. Square symbols denote dams and outfalls denote WWTP locations.*

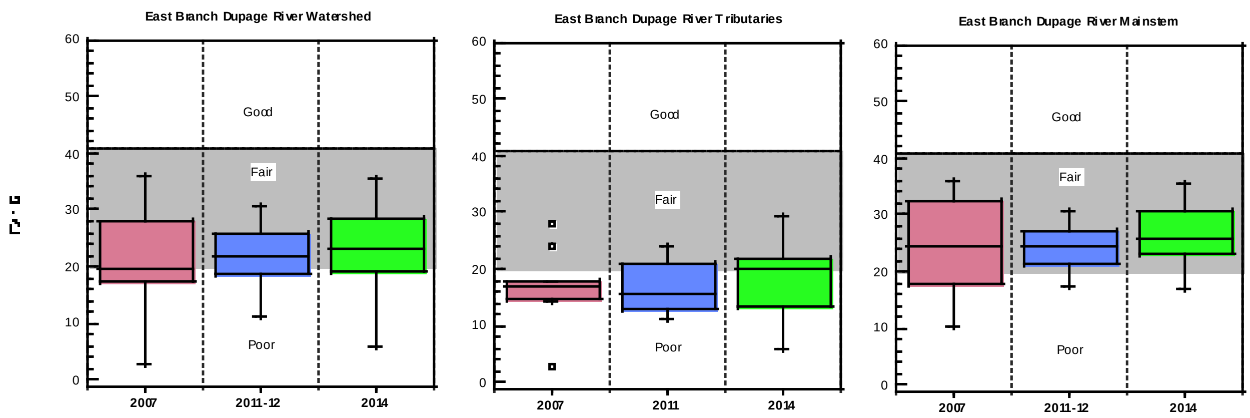

***Figure 28**. Box-and-whisker plots of fIBI scores and trends at comparable sites from the E. Branch DuPage River study area in 2007 (salmon), 2011-12 (blue), and 2014 (green). Scores are displayed by watershed (left), tributaries (middle), and East Branch mainstem (right). Upper mainstem sampling in 2012 (included in middle plot) assessed the removal of the Churchill Woods dam (RM 18.7).*

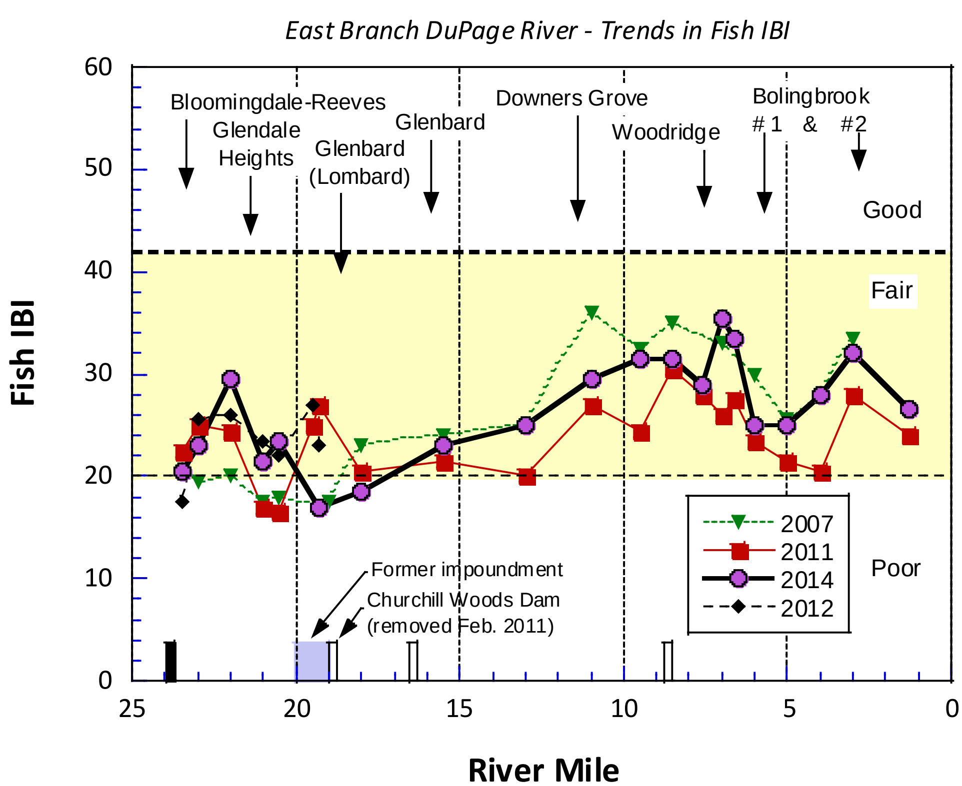

***Figure 29**. Fish IBI scores in the E. Branch DuPage River, 2014, 2011-12 and 2007 in relation to municipal WWTP discharges. Bars along the x-axis depict mainstem dams or weirs (only black bars impede fish passage). The shaded area demarcates the "fair" narrative range.*

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