2018 Biotic Index Evaluation of the Main Stem of Bassett Creek

Between 1980 and 2018, the Bassett Creek Watershed Management Commission (BCWMC) has collected benthic macroinvertebrates (bottom-dwelling organisms) from the Main Stem of Bassett Creek on 11 occasions. The purpose of the sampling was to evaluate water quality and detect changes over time.

In 2018, the BCWMC monitored the Main Stem of Bassett Creek east of Brookridge Avenue and at Rhode Island Avenue and the Metropolitan Council Environmental Services monitored the Main Stem at Irving Avenue (Figure 1, page 2) for:

- Macroinvertebrates.
- Flow and water quality measurements.
- Habitat.

Three biotic indices were used to assess the macroinvertebrate data:

- **Hilsenhoff Biotic Index (HBI)—**Assessed long-term oxygen content of the stream.
- **Invertebrate Community Index (ICI)—** Determined the average tolerance of the macroinvertebrate community to a wide range of pollutants.
- **Macroinvertebrate Index of Biotic Integrity (M-IBI)—**Assessed the health of the macroinvertebrate communities. The Minnesota Pollution Control Agency (MPCA) developed the M-IBI and added it to Minnesota's water quality standards to help identify biologically impaired rivers and streams.

At a glance: 2018 results

HBI and ICI summary

In 2018, a statistically significant trend toward improving HBI scores (indicating improving oxygen conditions), was documented at the Main Stem Irving Avenue location. The improved HBI score at this location appears to have resulted from a Main Stem stream restoration project which stabilized the stream and reduced sediment: CIP project #1, from Golden Valley Road to Glenwood Avenue, completed in 2015 (Figure 1, Table 1). Sediment contains organic matter, which consumes oxygen during degradation, lowering oxygen levels in the stream. The significant improvement in HBI score documents the improved quality due to the sediment reductions in the stream following completion of the project.

The 2018 ICI score from the Main Stem at Irving Avenue and the 2018 HBI and ICI scores from all other Main Stem sampling locations were consistent with past scores.

M-IBI summary

Improved M-IBI scores were documented at all Main Stem locations in 2018 (Figure 6). Consistently improving M-IBI scores were documented at the east of Brookridge location since 2012 and at the Irving Avenue location since 2008. The long-term improvements appear to show the positive impacts of multiple stream restoration projects completed from 2012 through 2018 (Figure 1, Table 1).

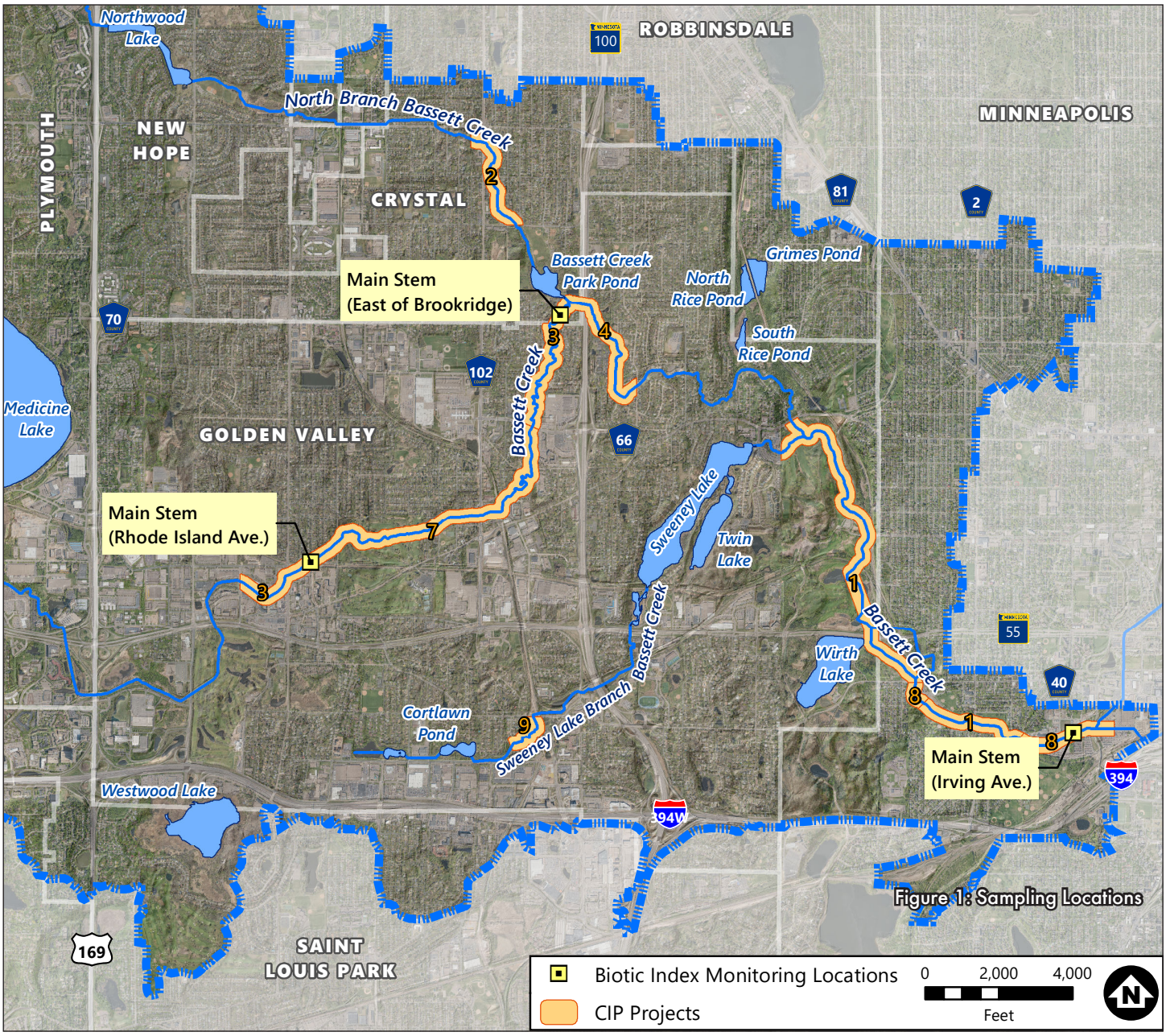


Figure 1: Sampling Locations

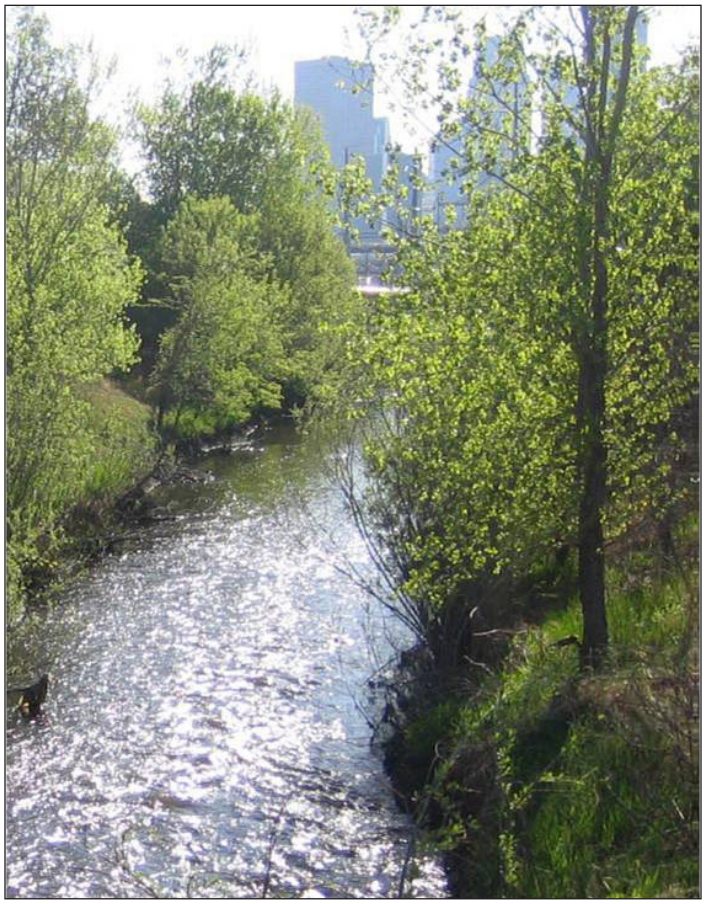
Table 1: Capital Improvement Projects (Stream Restoration) along Bassett Creek

#	Project Name	Status	Location
1	Main Stem Restoration Project, Golden Valley Rd. to Glenwood Ave.	Construction began Oct. 2014; substantial completion spring 2015; project acceptance Nov. 2015	Golden Valley
2	North Branch Bassett Creek Restoration Project, 200 Feet Upstream of Douglas Dr. to 32nd Ave. N.	Construction began fall 2012; construction completed fall 2013	Crystal
3	Main Stem Restoration Project, Wisconsin Ave. to 10th Ave. and Duluth St. to the Crystal Border	Construction began Dec. 2012; substantial completion March 2013; project acceptance Nov. 2013	Crystal
4	Main Stem Restoration Project Golden Valley-Crystal Border to Regent Ave.	Construction completed winter of 2010-2011; final construction tasks and plantings in summer 2012	Golden Valley
7	Bassett Creek Main Stem Stream Restoration Project, 10th Ave. to Duluth St.	Construction began winter 2015-2016; construction completed in 2016; establishment of native vegetation began in 2016 and continued through 2018	Golden Valley
8	Main Stem Channel Restoration, Cedar Lake Rd. to Dupont Ave. N/2nd Ave. N, plus Fruen Mill Area	Anticipated construction start 2020	Minneapolis
9	Sweeney Lake Branch Channel Restoration, Cortlawn Pond to Turner's Crossroad	Construction began/completed spring 2008	Golden Valley

Better M-IBI scores in 2018 resulted from improvement in seven of the 10 metrics that collectively determine the score:

- Increased numbers of taxa known as climbers (i.e., taxa requiring habitat such as overhanging vegetation that provides opportunities to climb); this is an indication of improved habitat.
- An increased percentage of taxa known as clingers (i.e., taxa that cling to rocks and other substrate to avoid being washed away by the stream); this is an indication of lower sediment in the stream (sediment causes surfaces to be more slippery and makes it harder to cling to the substrate).
- A greater diversity and more even distribution of organisms so that the dominant five taxa comprised a lower percentage of the total sample.
- A reduced percentage of tolerant taxa in the stream.
- A higher HBI_MN score, resulting from a lower percentage of tolerant taxa in the stream.
- Increased numbers of Odonata taxa (i.e., dragonflies and damselflies).
- Increased numbers of taxa known as predators (i.e., taxa that feed on other organisms in the stream).

Unfortunately, despite the improving scores, none of the Main Stem locations monitored from 2006 through 2018 met the MPCA M-IBI impairment standard. Thus, Bassett Creek would be considered biologically impaired.



Recommendations

Because Bassett Creek is biologically impaired, it is recommended that BCWMC continue to:

- **Assess Bassett Creek** to identify and implement additional habitat and/or water quality improvement projects to further improve the macroinvertebrate community with a goal of meeting the M-IBI impairment threshold for the stream.
- **Monitor the macroinvertebrates of Bassett Creek** periodically to assess the health of the community and determine whether the M-IBI impairment standard has been met
- **Monitor habitat, flow, and water quality** when biological samples are collected to identify changes over time and identify stressors to the macroinvertebrate community.

Main Stem Bassett Creek habitat

The BCWMC completed habitat surveys of the Main Stem at Rhode Island Avenue and east of Brookridge in 2015 and 2018 using the MPCA quantitative habitat survey methods. The survey results are summarized in Table 2. Flows and water depths were higher in 2018 than 2015 (Table 2, Figures 2 through 5). The habitat survey results indicate the Main Stem stream restoration project from 10th Avenue to Duluth Street improved habitat at the Rhode Island Avenue and east of Brookridge locations. Project construction began in the winter of 2015 and concluded in 2018 with the establishment of native vegetation along the restored stream banks. Habitat improvements at Rhode Island Avenue documented by the 2018 survey include the following:

- A decrease in the average depth of fine sediment
- A decrease (to none) in percent of transects with left-bank erosion
- A decrease in percent of transects with right-bank erosion
- A decrease in the average length of bank erosion per transect for both the left bank and right bank
- An increase in the average amount of algae
- An increase in the average number of aquatic plants
- An increase in the amount of overhanging vegetation and submergent vegetation (as represented by the "percent length of transect over at least 10 cm of water with overhanging vegetation and submergent vegetation" metrics).

Habitat improvements east of Brookridge documented by the 2018 survey include:

- A decrease in the average embeddedness of coarse sediment
- A decrease in the percent of transects with right-bank erosion
- A decrease in the average length of bank erosion per transect for the left bank
- An increase in the amount of overhanging vegetation (as represented by the "percent length of transect over at least 10 cm of water with overhanging vegetation" metric).
- An increase in the amount of woody debris (as represented by the "percent of transect over at least 10 cm of water with woody debris" metric).

Metropolitan Council Environmental Services (MCES) used the MPCA qualitative habitat survey—the MPCA Stream Habitat Assessment (MSHA)—to monitor habitat at the Main Stem at Irving Avenue in 2017 and 2018. A stream restoration project from Golden Valley Road to Glenwood Avenue was completed in 2015. The 2017 and 2018 habitat surveys provided a post-project assessment of habitat at Irving Avenue.

Habitat was relatively stable between the two years with a slight improvement in 2018. On a scale of 0 to 100, with higher scores indicating a better habitat, the overall habitat score for this location was 66.1 in 2017 and 68.6 in 2018. A comparison of the two surveys shows the following changes:

- Siltation increased from a "normal" rating in 2017 to a "moderate" rating in 2018. Water quality monitoring by MCES documented an increase in total suspended solids concentrations from 2017 to 2018, which is the likely cause of the increased siltation.
- Channel stability increased from "moderate" in 2017 to "moderate/high" in 2018.
- Floating leaf plants were observed in 2018 but not 2017.
- Pool width was equal to riffle width in 2018, but less than riffle width in 2017.

HBI and ICI

From 1980 through 2018, the BCWMC assessed macroinvertebrates using biotic indices to evaluate the water quality of the Main Stem of Bassett Creek. The Hilsenhoff Biotic Index (HBI) was used to assess the long-term oxygen content of the stream from 1980 through 2018. HBI assesses stream oxygen by determining the average tolerance of the macroinvertebrate community to low oxygen conditions. Sediment added to streams by stormwater runoff or streambank erosion contains organic matter that consumes oxygen during degradation, lowering oxygen levels in the stream. The HBI assessment of oxygen conditions documents water quality changes related to changes in sediment from stormwater runoff.

Table 2: 2015 and 2018 Bassett Creek Main Stem habitat comparison: Rhode Island Avenue and east of Brookridge

Parameter	Rhode Island Avenue		East of Brookridge	
	2015	2018	2015	2018
Discharge (flow), cubic feet per second (cfs)	4.3	40.3	3.4	40.8
Average depth of water (cm)	18	39	19	34
Average depth of fine sediment (cm)	2.0	0.3	0.4	2.3
Average embeddedness of coarse substrates (nearest 25%)	50	50	50	42
Percent of transects with left-bank erosion	92	0	54	77
Percent of transects with right-bank erosion	77	0	62	39
Average length of bank erosion per transect: left bank (m)	1.1	0	0.5	0.4
Average length of bank erosion per transect: right bank (m)	0.6	0	0.6	0.7
Average amount of algae (filamentous or attached) observed on quadrate[1] (%)	0.0	2.9	8.0	1.8
Average number of aquatic plants observed on quadrate[1] (%)	0.0	5.8	0.0	0.0
Percent length of transect over at least 10 cm of water depth with overhanding vegetation	0.0	1.0	0.0	0.4
Percent length of transect over at least 10 cm of water depth with submergent vegetation	0.0	9.0	0.0	0.0
Percent length of transect over at least 10 cm of water depth with emergent vegetation	0.0	0.0	0.0	0.0
Percent length of transect over at least 10 cm of water depth with woody debris	2.7	0.0	0.0	0.4
Percent length of transect over at least 10 cm of water depth with boulders	0.0	6.0	6.7	4.2

[1] Each transect is divided into four equal parts (a quadrate); each quadrate is evaluated.

Figure 2: Main Stem of Bassett Creek east of Brookridge in 2015

Figure 3: Main Stem of Bassett Creek east of Brookridge in 2018

Figure 4: Main Stem of Bassett Creek at Rhode Island Ave. in 2015

Figure 5: Main Stem of Bassett Creek at Rhode Island Ave. in 2018

A second index, the Invertebrate Community Index (ICI), provided a broader view of the stream's water quality by determining the average tolerance of the macroinvertebrate community to a wide range of pollutants from 1995 through 2018.

To determine whether any trends could be detected, HBI scores from 2018 were compared to scores from 1980 through 2015, and ICI scores from 2018 were compared to scores from 1995 through 2015. A trend toward decreasing HBI scores (improving oxygen conditions) was documented on the Main Stem at the Irving Avenue location. The trend was statistically significant (i.e., there was a 5 percent or less probability that the change was due to chance). The improved HBI score at this location appears to be the result of the Main Stem stream restoration project from Golden Valley Road to Glenwood Avenue, completed in 2015 (Figure 1 and Table 1). The project stabilized the stream bank and was expected to reduce total suspended solids.

The 2018 ICI score from the Main Stem at Irving Avenue and the 2018 HBI and ICI scores from the other Main Stem sampling locations were consistent with past scores. The results of trend analyses at these locations indicate there were no statistically significant changes (i.e., there is more than a 5 percent probability that changes were due to chance).

M-IBI biological metrics

The MPCA has established biological water quality standards for all Minnesota streams and rivers, including Bassett Creek. A macroinvertebrate index of biotic integrity (M-IBI) and a fish index of biotic integrity (F-IBI) were added to Minnesota standards and approved by the United States Environmental Protection Agency on June 26, 2018.

The M-IBI helps identify biologically impaired rivers and streams by assessing the health of their macroinvertebrate communities. The BCWMC used the M-IBI to assess the Main Stem of Bassett Creek from 2006 through 2018 to determine whether it met the MPCA standard for macroinvertebrates (Figure 6).

The M-IBI score is the sum of the scores from 10 individual metrics (Table 3). Each metric assesses an attribute of the macroinvertebrate community; collectively, the metrics assess the overall health of the community.

Each M-IBI metric has a scale of 0 to 10; the lowest possible score is 0 and the highest is 10. Increasing scores indicate improving conditions. Because 10 metrics are summed to attain the M-IBI score and each metric has a maximum score of 10, the maximum possible score is 100. To meet the MPCA macroinvertebrate standard, the sum of the scores from the 10 individual metrics must equal or exceed the impairment threshold—a score of at least 37 for Bassett Creek. On average, a score of at least 3.7 for each metric would be needed to attain the impairment threshold.

As shown in Figure 6, none of the Main Stem locations monitored from 2006 through 2018 met the MPCA M-IBI impairment standard. Thus, Bassett Creek would be considered biologically impaired. However, improved M-IBI scores were documented at all Main Stem locations in 2018 (Figure 6). Improving M-IBI scores were documented consistently at the east of Brookridge location since 2012 and at the Irving Avenue location since 2008. The long-term improvements appear to reflect the positive impacts of multiple stream restoration projects completed from 2012 through 2018 (Figure 1 and Table 1):

- **CIP project #4—**Crystal border to Regent Avenue (completed 2012)
- **CIP project #3—**Wisconsin Avenue to 10th Avenue and Duluth Street to the Crystal border (completed 2013)
- **CIP project #1—**Golden Valley Road to Irving Avenue (completed in 2015)
- **CIP project #7—**10th Avenue to Duluth Street (construction completed in 2016; establishment of native vegetation began in 2016 and continued through 2018)

The 10 individual metrics of the M-IBI were assessed to determine changes since 2006. The scores were also compared to the individual metric score required to attain the impairment threshold score of 37 (an average of 3.7). Improved scores for seven of the 10 metrics were documented in the Main Stem of Bassett Creek during 2018. The improvements are discussed in the following paragraphs.

Table 3: M-IBI Metrics

Metric Name	Metric Description
ClimberCh	The number of different types of macroinvertebrates that are climbers (climb on vegetation or woody debris) determines the score. Higher numbers result in a better score.
ClingerChTxPct	Relative percentage of the types of macroinvertebrates adapted to cling to a substrate, such as a rock, in swift-flowing water determines the score. Higher numbers result in a better score.
DomFiveChPct	The percent of the dominant five types of macroinvertebrates determines the score. A lower percent results in a better score because a diverse community is healthier than a community primarily comprising a few species.
HBI_MN	This is a measure of pollution based on tolerance values assigned to each individual type (e.g., genus or species) of macroinvertebrate. A tolerance value indicates how tolerant each type of organism is to disturbance that alters habitat and/or pollution. The score is based on the average tolerance value computed for the community. Lower tolerance values result in a better score because they indicate the stream comprises sensitive organisms that would be eliminated by disturbance and/or pollution.
InsectTxPct	The percent of macroinvertebrates collected from the stream that are insects determines the score. Higher numbers result in a better score because a higher percentage of insects is associated with a healthier stream.
Odonata	The number of different types of macroinvertebrates in the Odonata group, which includes dragonflies and damselflies, determines the score. Higher numbers result in a better score.
Plecoptera	The number of different types of macroinvertebrates in the Plecoptera group, which includes stoneflies, determines the score. Higher numbers result in a better score.
Predator	The number of different types of macroinvertebrates that are predators (i.e., eat other macroinvertebrates) determines the score. Higher numbers result in a better score.
Tolerant2ChTxPct	The percent of the types of macroinvertebrates that have a Minnesota tolerance value equal to or greater than 6 determines the score. Tolerance values range from 1 to 10 and values from 6 to 10 indicate organisms more tolerant of disturbed habitat and/or pollution than 1 to 5.
Trichoptera	The number of different types of macroinvertebrates in the Trichoptera group, which includes caddisflies, determines the score. Higher numbers result in a better score.

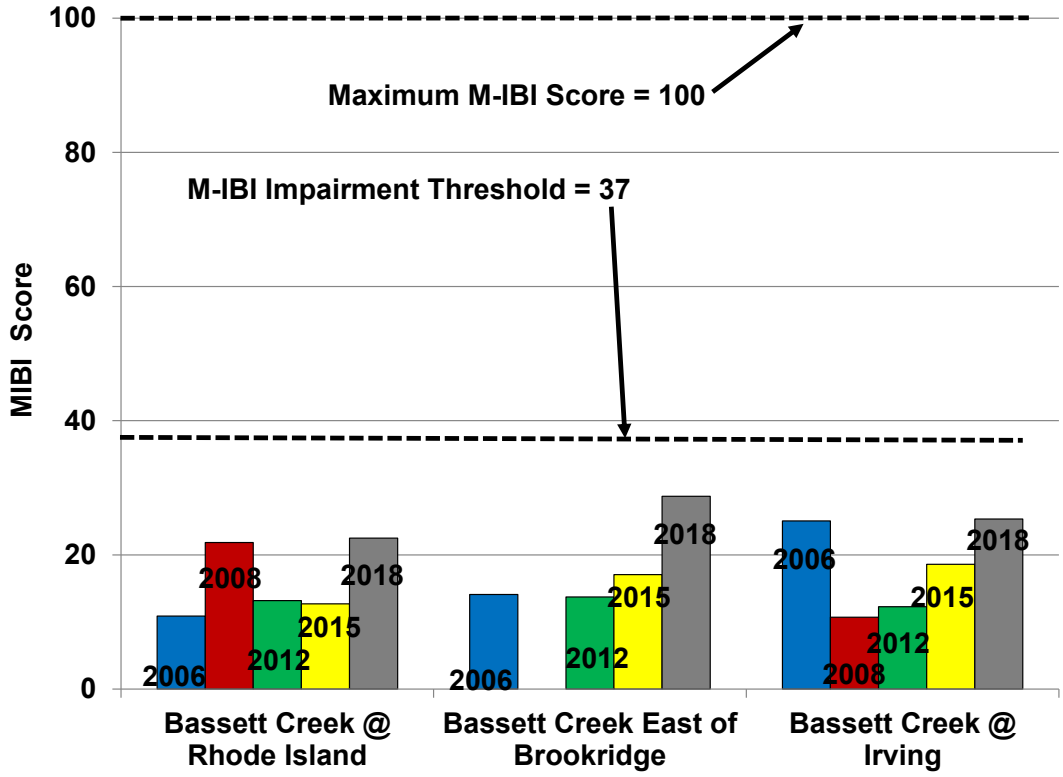


Figure 6: 2006–2018 MIBI scores from Main Stem Bassett Creek

Climber Ch

ClimberCh is a metric that assesses the number of different types of macroinvertebrates in a stream that are climbers. Climbers are macroinvertebrates, such as damselfly larvae, that live on plants, algae, plant debris, logs, or roots found in a stream or on vegetation overhanging the stream. The score for the metric ClimberCh is determined from the number of different climber taxa (genus/species) found at a sample location. A score of 0 is assigned when two or fewer climber taxa are found, and a score of 10 is assigned when 12 or more climber taxa are found. Scores from 1 to 9 are assigned when three to 11 climber taxa are found. To support the presence of climbers, the stream must contain habitat that provides opportunities for these taxa to climb, such as live plants, algae, plant debris, logs, roots, or overhanging vegetation.

Habitat data, shown in Table 2, indicate stream restoration projects on the Main Stem of Bassett Creek improved habitat for climbers and increased the number of climber taxa at all Main Stem locations in 2018. Improved habitat includes:

- Increased overhanging vegetation at both the east of Brookridge Avenue and Rhode Island Avenue (Figure 7) locations.
- Increased algae, aquatic plants, submerged vegetation, and woody debris at the Rhode Island Avenue location (Figure 7).

Main Stem locations east of Brookridge and at Irving Avenue had one or two climber taxa in 2012 and 2015 (a score of 0 for both years). An increase to four climber taxa at both locations in 2018 improved the score to 1.4 (Figure 8).

The Rhode Island Avenue location has consistently supported climber taxa. However, the number of climbers decreased from five in 2008 to three in 2012. A stream restoration project from Wisconsin Avenue to 10th Avenue from December 2012 through November 2013 (#3 on Figure 1) and from 10th Avenue to Duluth Street from winter 2015–2016 through 2018 (#7 on Figure 1) improved habitat and appeared to result in an increase in the number of climber taxa at the Rhode Island location. After completion of the projects, the number increased to four in 2015 and seven in 2018, resulting in a score of 5.4 (Figure 8). This is the only time during the period examined that the score exceeded the impairment threshold of 3.7 (Figure 8).

Figure 7: In addition to increased overhanging vegetation, the Rhode Island Avenue location had increased algae, submerged vegetation, and woody debris—all conducive to Climbers.

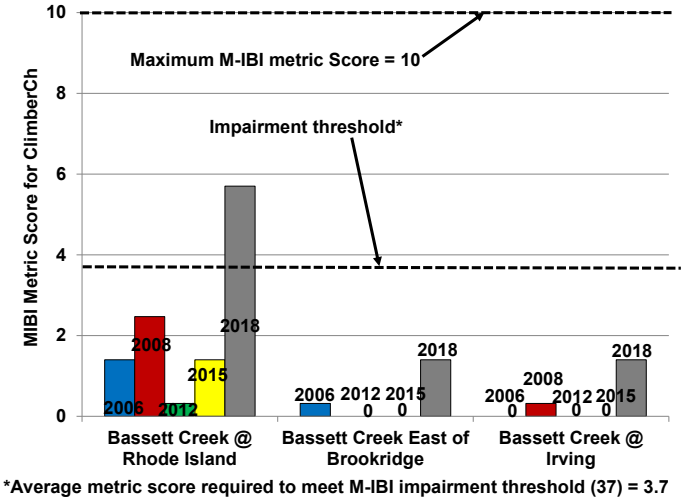


Figure 8: Above: ClimberCh scores from three monitoring stations. Scores at two of the three locations failed to meet the M-IBI impairment threshold (3.7). Left: The climber Belostoma (giant waterbug)

ClingerTxPct

The ClingerTxPct metric score is based on the relative percentage of taxa adapted to cling to substrates in swift-flowing water. The number of macroinvertebrates in the "clinger" group can provide an indication of how flow regimes and hydrologic conditions may be impacting macroinvertebrates in a stream. The clinger group is best suited for high-flow or "flashy" environments, with physiological and morphological adaptions which allow them to attach to fixed, coarse substrates (gravel, cobble, or boulders) and avoid being carried downstream. Clingers maintain a relatively fixed position on firm, clean substrates in current. Sediment deposited on the substrate causes surfaces to become slippery and makes it difficult for them to attach firmly and avoid being carried downstream. For this reason, clingers would not be expected to thrive in streams with high quantities of sediment. Hence, a relatively high percentage of clinger taxa in a stream indicates a low quantity of sediment. When 20 percent or less of the sample comprises clingers, a score of 0 is assigned. When 46 percent or more of the sample comprises clingers, a score of 10 is assigned. Scores of 1 to 9 are assigned when the percent of clingers in the sample is between 20 percent and 46 percent.

During the period examined, the Main Stem of Bassett Creek generally supported a healthy number of clinger taxa. All scores for this metric have been better than the impairment threshold at the east of Brookridge location since 2006 and at the Irving Avenue location in 2006 and from 2012 to 2018 (Figure 9). Scores at the Rhode Island Avenue location were better than the impairment threshold in 2006 and 2008, but declined in 2012. Scores improved in 2015 and 2018 indicating stream restoration projects from Wisconsin Avenue to 10th Avenue and 10th Avenue to Duluth Street (# 3 and # 7 on Figure 1) improved habitat for clingers at this location. The 2018 score of 3.5 was close to the impairment threshold of 3.7 (Figure 9.) Improved habitat and sediment reductions from the stream restoration project completed at Rhode Island Avenue in 2018 are expected to increase future scores.

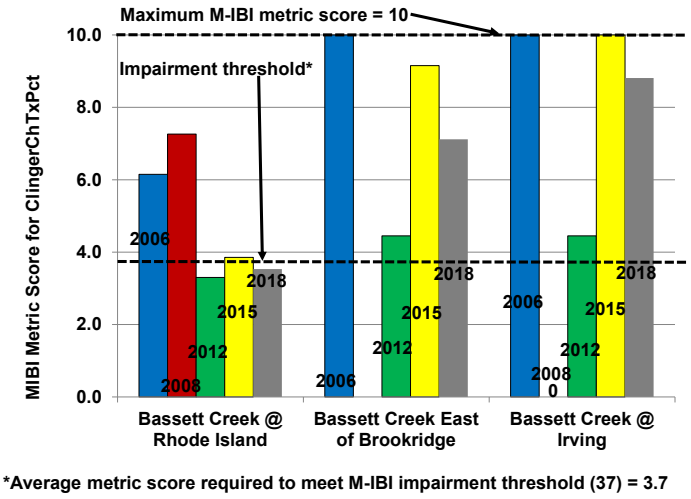
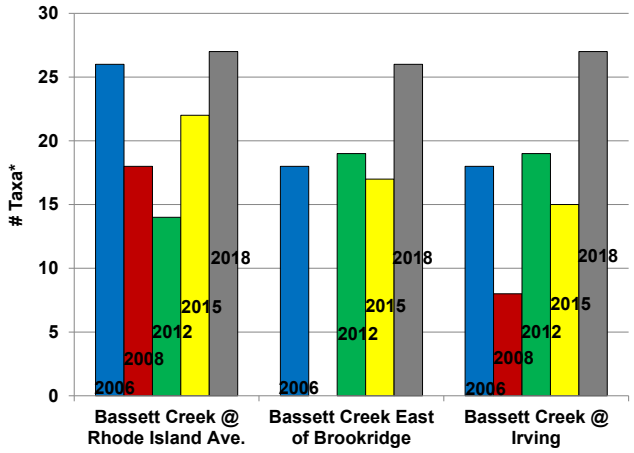


Figure 9: Above: ClingerTxPct scores from three monitoring stations. Scores at one of the three locations failed to meet the M-IBI impairment threshold (3.7) in 2018. All three locations had reduced scores in 2018. Left: The clinger Baetis flavistriga (mayfly nymph)

DomFiveChPct

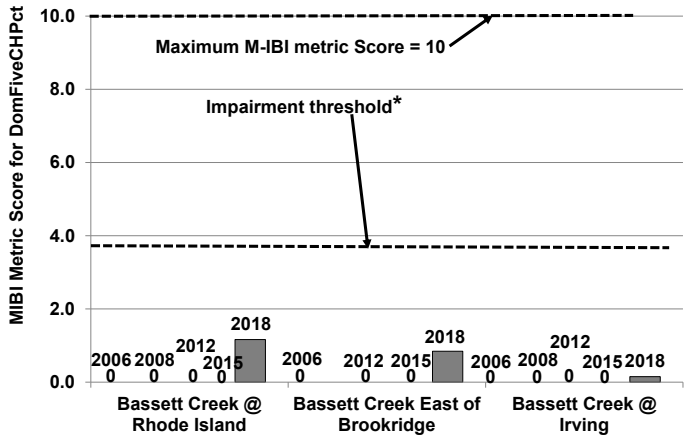
Healthy and stable streams are characterized by a greater diversity and more even distribution of organisms among taxa rather than dominance by a few. The DomFiveChPct uses the percentage of the macroinvertebrate community comprised by the dominant five taxa to assess stream health. For this metric, a higher percentage indicates a less even distribution among taxa and is indicative of stream degradation. Conversely, a lower percentage is indicative of a more even distribution and a healthier stream. A score of 0 is assigned when the dominant five taxa comprise 78 percent or more of the sample, and a score of 10 is assigned when they comprise 38 percent or less. Intermediary scores are assigned when they comprise between 38 and 78 percent of the sample.

Main Stem stream restoration projects (#1, #3, #4, and #7 on Figure 1 and Table 1) appear to have increased the number of taxa at Main Stem locations and improved distribution. The number of taxa at all Main Stem locations in 2018 was the highest to date (Figure 10). 2018 was also the first time that a score greater than zero was observed for the DomFiveChPct metric at any of the Main Stem locations (Figure 11).



*#Taxa is the # of different family, genus, and species found in each sample.

Figure 10: Number of taxa at three Main Stem locations



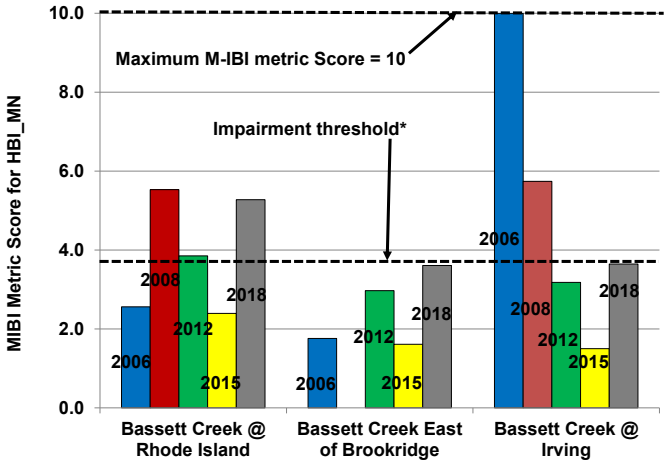
*Average metric score required to meet M-IBI impairment threshold (37) = 3.7

Figure 11: Above: DomFiveChPct scores from three monitoring stations. Scores at all three locations failed to meet the M-IBI impairment threshold (3.7). Left: One of the five dominant taxa, Baetis Gammarus (amphipod crustacean)

HBI_MN

The HBI_MN, developed by the MPCA, is a measure of pollution, based on tolerance values assigned to each individual taxon. The MPCA-assigned tolerance values are based on analysis of six disturbance variables: human disturbance score (a land-use-based stressor score), Minnesota Stream Habitat Assessment score, total phosphorus, total suspended solids, ammonia, and nitrate/nitrite. Dissolved oxygen is not directly used to determine tolerance values because both very high and very low dissolved oxygen values correlate with stress on the macroinvertebrate community. However, the generalized stressors used to develop tolerance values for the HBI_MN often correlate with dissolved oxygen stress. The HBI_MN metric score is based on the average tolerance value of the sample. A score of zero is assigned when the average tolerance value is 8.3 to 10, and a value of 10 is assigned when the average is 0 to 4.9. Intermediary values are assigned when the average tolerance value is between 4.9 and 8.3.

The overall work of the BCWMC and member cities to reduce pollution and improve water quality (including BCWMC CIP projects, city projects, development requirements, education, and non-structural BMPs) may have contributed to improvements to HBI_MN, with scores at all three locations more than doubling in 2018. The 2018 score of 5.3 at Rhode Island Avenue was better than the impairment threshold of 3.7, while scores of 3.6 east of Brookridge and at Irving Avenue were only slightly below the impairment threshold (Figure 12).



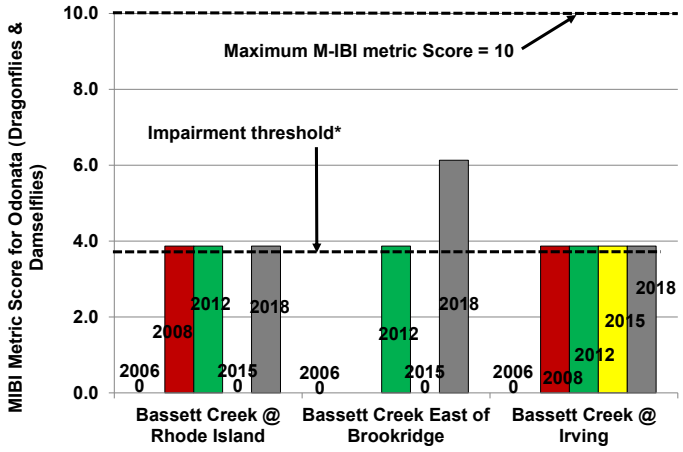
*Average metric score required to meet M-IBI impairment threshold (37) = 3.7

Figure 12: Above: HBI_MN scores from three monitoring stations. Scores increased in 2018, but failed to meet the M-IBI impairment threshold (3.7) at two locations. Left: Sphaerium (fingernail clam)

Odonata (dragonflies and damselflies)

Odonata, which include dragonflies and damselflies, are a diverse group of organisms that have a wide array of sensitivities and life histories. They exploit most aquatic microhabitats, and their diversity is considered a good indicator of aquatic health. The score for this metric is determined by the number of Odonata taxa (e.g., genus or species). A score of zero is assigned when no Odonata taxa are present, and a score of 10 is assigned when five taxa are present. Intermediary scores are assigned when one to four taxa are present.

In 2018, scores at all three Main Stem locations were better than the impairment threshold (Figure 13). Rhode Island Avenue and east of Brookridge locations have generally supported Odonata since 2008; however, in 2015 both locations had scores of 0. After completion of a stream restoration project from 10th Avenue to Duluth Street from the winter of 2015–2016 through 2018 (#7 on Figure 1 and Table 1) scores increased to 3.9 at the Rhode Island location and 6.1 at the east of Brookridge Avenue location (Figure 13). Scores at Irving Avenue have been stable (3.9) and better than the impairment threshold since 2008 (Figure 13).



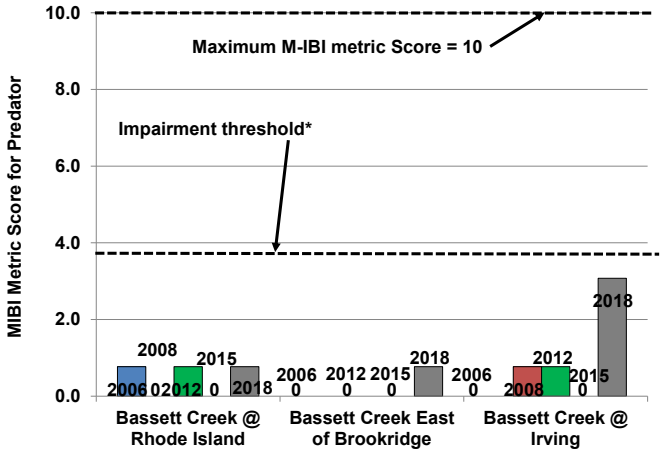
*Average metric score required to meet M-IBI impairment threshold (37) = 3.7

Figure 13: Above: Odonata scores from three monitoring stations. Scores at all three locations met the M-IBI impairment threshold (3.7). Left: Odonata Calopteryx (damselfly larvae)

Predator

Predators, such as damselflies, beetles, water bugs, leeches, and water striders, feed on living animals (e.g., insects). Water quality or habitat degradation reduces the number of predator taxa. The score for this metric is determined by the number of predator taxa. A score of zero is assigned when three or fewer predator taxa are found, and a score of 10 is assigned when 16 or more are found. Intermediary values are assigned when four to 15 predator taxa are found.

Although scores for the Predator metric were less than the impairment threshold in 2018, scores at all three locations improved from a 2015 score of zero. This improvement appears to be a positive result of Main Stem stream restoration projects #1 and #7, (Figure 1 and Table 1). The 2018 score of 0.8 at the east of Brookridge location was the only predator metric score greater than zero at this location during the entire period examined (Figure 14). The 2018 score of 3.1 at Irving Avenue was more than three times greater than all previous scores for this metric (Figure 14), and the score of 0.8 at Rhode Island Avenue was greater than the score of 0 in 2015 and similar to scores in 2006 and 2012 (Figure 14).



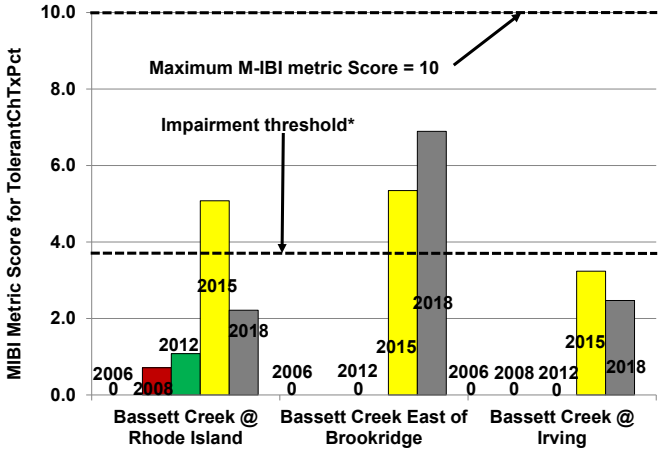
*Average metric score required to meet M-IBI impairment threshold (37) = 3.7

Figure 14: Above: Predator scores from three monitoring stations. Scores at all three locations failed to meet the M-IBI impairment threshold (3.7). Left: The predator Liodessus (beetle)

Tolerant2ChTxPct

The MPCA has developed tolerance values (TVs) for macroinvertebrate taxa collected in Minnesota (MN TVs). Tolerance values range from 0 to 10, with increasing TVs indicating stream degradation. The Tolerant2ChTxPct metric uses the relative percentage of taxa with TVs greater than or equal to 6 to assess the percentage of taxa that are tolerant to stream degradation. A score of 0 is assigned when taxa with TVs greater than or equal to 6 comprise 94 percent or more of the sample, and a score of 10 is assigned when they comprise 47 percent or less of the sample. Intermediary scores are assigned when they comprise between 47 and 94 percent of the sample.

Main Stem stream restoration projects (#1, #3, #4, and #7 on Figure 1 and Table 1) appear to have reduced the relative percentage of tolerant taxa in the stream by creating conditions favorable for less-tolerant taxa. Scores of 5.3 and 6.9 were observed at the east of Brookridge location in 2015 and 2018, both better than the impairment threshold of 3.7 and the first scores above zero at these locations during the period examined (Figure 15). Scores of 3.2 (2015) and 2.5 (2018) at the Irving Avenue location were the first scores above zero at this location during the period examined (Figure 15). Scores of 5.1 (2015) and 2.2 (2018) at the Rhode Island location were the highest scores at this location during the period examined (Figure 15).



*Average metric score required to meet M-IBI impairment threshold (37) = 3.7

Figure 15: Above: Tolerant2ChTxPct scores from three monitoring stations. Scores at two of the three locations failed to meet the M-IBI impairment threshold (3.7). Left: Simulium (blackfly larvae)