Elkhart-South Bend Aquatic Community Monitoring

Annual Report
2011

City of Elkhart
Public Works and Utilities
Dick Moore, Mayor

Clean river Healthy neighborhoods

ELKHART ▪ SOUTH BEND

Cover Photo: Joe King with a walleye from the St. Joseph River upstream of Bristol

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AQUATIC COMMUNITY MONITORING IN ELKHART AND ST. JOSEPH COUNTIES ON THE ST. JOSEPH RIVER AND SELECTED TRIBUTARIES 2011


Ross Carlson with a walleye from Christiana Creek

Prepared by
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INTRODUCTION

For many years, the Cities of South Bend and Elkhart have collected surface water samples from our local rivers to determine pollutant concentrations. In 1998, the City of Elkhart initiated biological community monitoring to compliment chemical and microbial sampling. The City of South Bend joined forces with Elkhart in 2001, and since then both communities have gathered a great deal of information on the health of our local waterways. Since the initiation of monitoring in 1998, chemical and biological data suggest that stream quality is gradually improving. There are some issues that remain, which include unstable drainage practices, sedimentation, stormwater problems, and combined sewer overflows. However, through a series of actions from government entities, watershed organizations, and the general public, the quality of our local waterways should only get better as we move into the future.

In 2011, the Cities of Elkhart and South Bend, through the City of Elkhart's Aquatics Program, continued to monitor local fish populations in area rivers and streams. The information that was gathered has been integrated into an overall water quality program for each City. While the cities measure the chemical and microbial composition of local stream water, having the additional biological data gives a more accurate representation of the overall health of each stream. The way that biological communities are assembled can change as a result of a past or long-term disturbance. Chemical and microbial testing, while very important in pinpointing contaminants, is simply a snapshot of current conditions. In many cases, having both sets of data can help determine the cause and effect of disturbances to our local streams.

During the first six years (1998-2003), Elkhart's Aquatics Program established core fish sampling sites on the St. Joseph River and many of the primary tributaries in the Elkhart area. For three consecutive years, data were collected from these sites and a baseline of information was established for each stream. Baseline data are now used to compare with current monitoring results to determine if impairments or enhancements are taking place in Elkhart area streams.

In 2001, the City of South Bend combined forces with Elkhart's Aquatics staff, establishing a unique biological monitoring partnership between municipalities. As with the Elkhart area, core sampling sites were determined and similar baselines were established for South Bend over a six year period (2001-2006). This year (2011) was the fifth year that the initial sites had been sampled since the baseline period, providing the stakeholders of South Bend with data to determine whether water quality in their area is improving or diminishing.

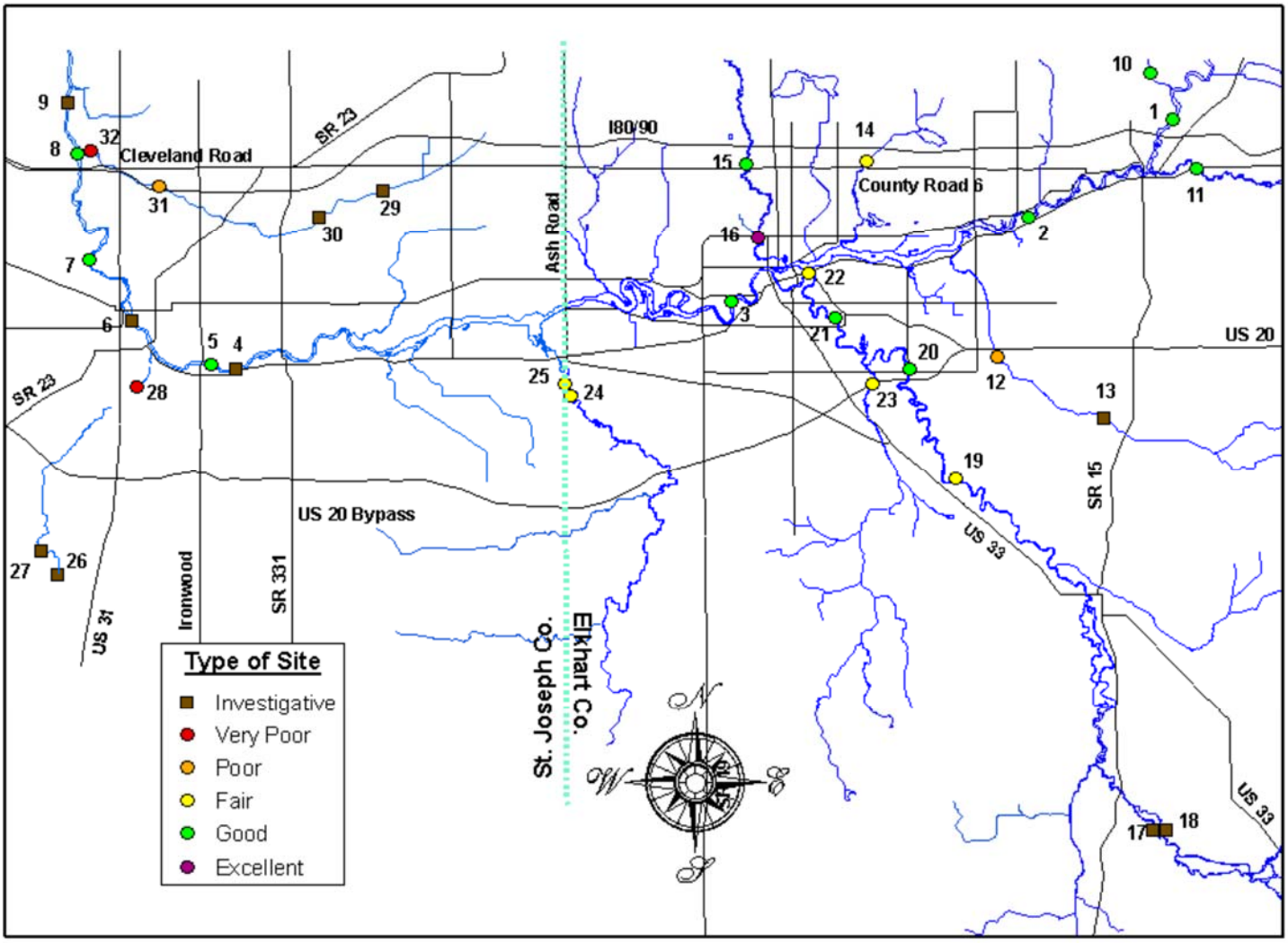
The Aquatics Program consists of more than just traversing through local streams collecting fish data. A considerable portion of the Program is education. The biologist travels to local schools and watershed stakeholder group meetings, giving presentations and demonstrations, in an effort to increase awareness of, and promote conservation for, the bountiful aquatic resources we have in this area.

Indices

The Index of Biotic Integrity (IBI) is the system that is used to assess the local fish communities. The IBI was developed by Dr. James Karr in 1981 as a tool for assessing water/stream quality based on the fish communities that are present. The IBI was modified by Dr. Thomas Simon in 1997 for use in the St. Joseph River Watershed. The IBI is a great tool in that complex biological information can be analyzed to provide measurements of stream quality for non-biologists and members of the general public. The IBI is comprised of three broad categories (species composition, trophic composition, and fish condition) which are broken down into 12 smaller categories, known as metrics (see Appendix A). These metrics are given a score based on their similarity to least impacted (reference) sites. One of three scores can be given for each metric: 1 (not similar to reference conditions), 3 (somewhat similar to reference conditions), or 5 (very similar to reference conditions). In general, the total score for a site will range from 12 to 60, but in an instance where no fish are present at a site, a score of 0 is given. These scores can then be graphed and placed into one of five classifications (very poor, poor, fair, good, or excellent), which describes the overall condition of the fish community being monitored. Biologists recognize that fish community condition is a product of the water quality and the habitat that is available in any given area. Since 2003, the Aquatics Program has been assessing available habitat at all sampling locations using the Qualitative Habitat Evaluation Index (QHEI) (Rankin 1989). This index is similar to the IBI in its structure. It has six broad categories which are broken down into 21 smaller categories or metrics (Appendix A). This index will have a final score of 0 to 100 and the scores will be classified as excellent, good, fair-good, poor, and very poor. This

Figure 1. MBI biologist setting a Hester-Dendy sampler in Bowman Creek

Figure 2: Fish sampling sites in Elkhart and St. Joseph Counties and associated fish community conditions for 2011



assessment will help determine to what extent the IBI scores are being affected by habitat. It may also show specific habitat degradation issues that need to be addressed.

Fish are not the only aquatic organisms that can be monitored to determine overall health of rivers and streams. Through a sub-contract with the Midwest Biodiversity Institute (Figure 1) (MBI, Columbus, Ohio), the Aquatics Program is also monitoring benthic (bottom dwelling) macroinvertebrates (visible animals without backbones). Fourteen (14) sites were sampled in 2011 and results were compared to their respective baseline values. The macroinvertebrate communities are assessed with the Invertebrate Community Index (ICI) developed by the Ohio Environmental Protection Agency (EPA) (Ohio EPA 1987). This index is broken down into 10 metrics (Appendix A). Like the IBI metrics, the ICI metrics are given a score based on their similarity to relatively undisturbed sites; 6 (comparable to exceptional community), 4 (comparable to typical community), 2 (slightly different from the typical community), or 1 (very different from the typical community). The site scores range from 0 to 60 and are classified similar to IBI scores. This combination of fish, habitat, and macroinvertebrate monitoring provides the cities of Elkhart and South Bend with the most comprehensive view of the health of our streams.

The Indiana Department of Environmental Management (IDEM) has established guidelines to determine if a body of water is impaired or if its condition is supportive of aquatic life (IDEM 2010) for the IBI and QHEI. The ICI is not an index used by IDEM, however, similar guidelines have been established by OHIO EPA for a nearby region, and those values are being used with the Elkhart and St. Joseph County data. Values of 36 or higher for IBI and ICI scores are indicators of a stream with the ability to support aquatic life. QHEI scores of 51 or greater indicate enough quality habitat is available to support aquatic communities.

In addition to performing water quality monitoring in the St. Joseph River basin, fish collections are conducted to determine the overall species diversity throughout the watershed. Walleye (*Sander*

Table 1: Fish sampling sites in Elkhart and St. Joseph Counties, 2011

Stream	Site	Site Number	Type of Site	County	Method	IBI Scores	ICI Scores	QHEI Scores
						2011	2011	2011
St. Joseph River	Toll Road (Bristol)	1	Index	Elkhart	Boat	54		83
	Six-Span (CR17)	2	Index	Elkhart	Boat	51	40	81
	Bridge Street	3	Index	Elkhart	Boat	51	42	77
	Ironwood (Above)	4	Investigative	St. Joseph	Boat			75
	Ironwood Drive	5	Index	St. Joseph	Boat	49	30	74
	Howard Park	6	Investigative	St. Joseph	Boat			62
	Angela Blvd	7	Index	St. Joseph	Boat	51	Good	86
	Darden Road	8	Index	St. Joseph	Boat	49	38	83
	Auten Road (Above)	9	Investigative	St. Joseph	Boat			81
Trout Creek	County Road 2	10	Index	Elkhart	Tote Barge	47		66
Little Elkhart River*	State Road 120	11	Index	Elkhart	Tote Barge	53	52	92
Pine Creek*	US 20 Bypass	12	Index	Elkhart	Tote Barge	28		69
	County Road 20	13	Investigative	Elkhart	Tote Barge			55
Puterbaugh Creek*	Reedy Drive	14	Index	Elkhart	Tote Barge	39		70
Christiana Creek	County Road 6	15	Index	Elkhart	Tote Barge	52	48	84
	Willowdale Park	16	Index	Elkhart	Tote Barge	56		78
Elkhart River	Baintertown Diversion Channel	17	Investigative	Elkhart	Tote Barge			87
	Baintertown Dam Below	18	Investigative	Elkhart	Tote Barge			59
	Oxbow Park (A)	19	Index	Elkhart	Boat	44		83
	Hively Ave. (CR18)	20	Index	Elkhart	Boat	46	50	82
	Studebaker Park (A)	21	Index	Elkhart	Boat	48		79
	American Park	22	Index	Elkhart	Boat	45	50	64
Yellow Creek	US 20 Bypass	23	Index	Elkhart	Boat	36	48	77
Baugo Creek	Restoration Site	24	Index	Elkhart	Tote Barge	43	48	76
	Restoration (Below)	25	Index	Elkhart	Tote Barge	45		81
Auten Ditch (East Branch)	Roosevelt Road	26	Investigative	St. Joseph	Back Pack			41
	Locust Road (S)	27	Investigative	St. Joseph	Back Pack			34
Bowman Creek	Studebaker Golf Course	28	Index	St. Joseph	Back Pack	16	36	38

*** denotes a cool/cold water stream**

Underlined values are indicative of impaired aquatic communities

Table 1: Fish sampling sites in Elkhart and St. Joseph Counties, 2011 (continued)

Stream	Site	Site Number	Type of Site	County	Method	IBI Scores 2011	ICI Scores 2011	QHEI Scores 2011
Juday Creek*	Capital Avenue	29	Investigative	St. Joseph	Tote Barge			31
	Holy Cross Pkwy	30	Investigative	St. Joseph	Tote Barge			56
	Kintz	31	Index	St. Joseph	Tote Barge	30	58	70
	Izaak Walton League	32	Index	St. Joseph	Tote Barge	22	40	81

vitreus) and smallmouth bass (*Micropterus dolomieu*) populations are monitored from previous tagging events in cooperation with the Indiana Department of Natural Resources (IDNR). Tissue from six fish species was collected and analyzed for mercury and polychlorinated biphenyl (PCB) content. The current Indiana Fish Consumption Advisory (FCA) (Table 11) displays many species from the Indiana portion of the St. Joseph River Watershed. The cities involved in the Program believe it is vital to continually provide local citizens with the most updated information on fish consumption.

Methods

For the past 14 years, the Aquatics staff has used two collection protocols (investigative sampling and index sampling) to quickly catalog the major fish species and to quantify water quality in the St. Joseph River watershed. Investigative sites are sampled once during the season and the fish collected at these sites are identified to species, the largest and smallest specimens are measured to the nearest millimeter (mm), and all fish are counted and then released. Index sites are sampled twice during the season, with a minimum five week "rest" period between sampling events. Individual species maximum and minimum lengths are recorded, all fish are counted, and game fish are weighed and measured individually, while non-game fish are mass weighed.

The length of stream sampled at an index site is dependent on the wetted width of the stream. The length of sites is 15 times this width, with a minimum of 50 meters and a maximum of 500 meters. Differences in sampling and processing (Foy 2004) have allowed multiple investigative sites to be sampled in a day versus one or two index sites. Every species collected at each site is verified either by retaining and preserving a small specimen for the Public Works & Utilities voucher museum or by photographing a large specimen. This practice allows for the verification of the field and lab identifications if needed.

In 2011, six index and seven investigative sites were sampled in St. Joseph County and 14 index and three investigative sites were sampled in Elkhart County. Two index sites on Baugo Creek were located right on the Elkhart/St. Joe County border. (Figure 2 and Table 1). IBI scores were calculated for each of the index sites and an average from the two visits was obtained to give the final score (Table 1).

Fish were collected from all sites using either boat mounted, tote barge, or backpack electrofishing equipment. The type of gear used depended on the size of the stream. The St. Joseph and Elkhart Rivers were sampled with the boat. Smaller, wadeable streams were sampled with the tote barge, unless the stream was extremely small and shallow, in which case, the backpack was used. Power output from the three devices differed. The boat output was 8-16 amperes, the tote barge was 4-6 amperes, and the backpack was 0.5-1.5 amperes.

At each fish sampling event stream habitat information was methodically collected using the QHEI as developed by Ohio EPA (Rankin 1989). Given that each index site was sampled twice, scores were averaged to give a final score (Table 1).

In early July 2011, MBI personnel placed Hester-Dendy samplers (artificial substrates used to collect small aquatic organisms) (Figure 3) at 14 sites that were also sampled for fish (Table 2 and Figure 4) following Ohio EPA macroinvertebrate sampling procedures (Ohio EPA 1987, 1989). Thirteen (13) of the 14 samplers were successfully retrieved approximately seven weeks after being set and their contents were preserved in alcohol for later identification. The data gathered from the samplers is considered a quantitative sample where species are identified and specimens are counted. This information was then used to calculate ICI scores for each site. Qualitative sampling also took place at each site with the use of a kick net through all available habitat near the location of the sampler. This extra sampling is used to capture additional species as well as provide information to make an estimate of stream health in the case where an ICI score can not be calculated due to the loss or vandalism of a sampler.

Fish tissue in the form of fillets was collected from channel catfish (*Ictaluras punctatus*), common

carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), quillback (*Carpiodes cyprinus*), smallmouth bass (*Micropterus dolomieu*), and walleye (*Sander vitreus).* Table 3 and Figure 5 display the locations of tissue sample collection. Each tissue sample sent in for laboratory analysis (Pace Analytical, Green Bay, WI) was a composite of fillets from three fish of the same species from the sample reach. The shortest specimen was within 90% of the length of the longest specimen. The samples were collected following the procedures in Appendix B (this report) and Appendix III in "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory" (1993).

Results and Discussion

During the summer of 2011, a total of 14,864 fish, representing 15 families and 63 species, were collected in Elkhart County. The two sites along Baugo Creek accounted for 3,968 of the fish that were collected, most of which were small minnow species. In St. Joseph County 4,352 fish, representing 14 families and 55 species, were collected. (See Appendix C for more detailed information). In total, 69 different species were captured from the two counties. Bluntnose minnows (*Pimephales notatus*), bluegill (*Lepomis macrochirus*), and white suckers (*Catostomus commersonii*) were the most abundant species collected in Elkhart County, while longear sunfish (*Lepomis megalotis*), creek chubs (*Semotilus atromaculatus)*, and rock bass (*Ambloplites rupterus*) were the most abun-

Figure 3: Hester-Dendy sampler placed into the stream bed.

Table 2: Macroinvertebrate Sampling Sites, 2011

Site Number	Stream	Location	Site Number	Stream	Location
1	St. Joseph River	Six-Span	8	Elkhart River	Hively Ave (CR18)
2	St. Joseph River	Bridge Street	9	Elkhart River	American Park
3	St. Joseph River	Ironwood Dr	10	Yellow Creek	US 20 Bypass
4	St. Joseph River	Angela Blvd	11	Baugo Creek	Restoration
5	St. Joseph River	Darden Road	12	Bowman Creek	Studebaker GC
6	Little Elkhart River	State Road 120	13	Juday Creek	Kintz Avenue
7	Christiana Creek	County Road 6	14	Juday Creek	Izaak Walton League

Figure 4: Location of macroinvertebrate sampling sites for 2011

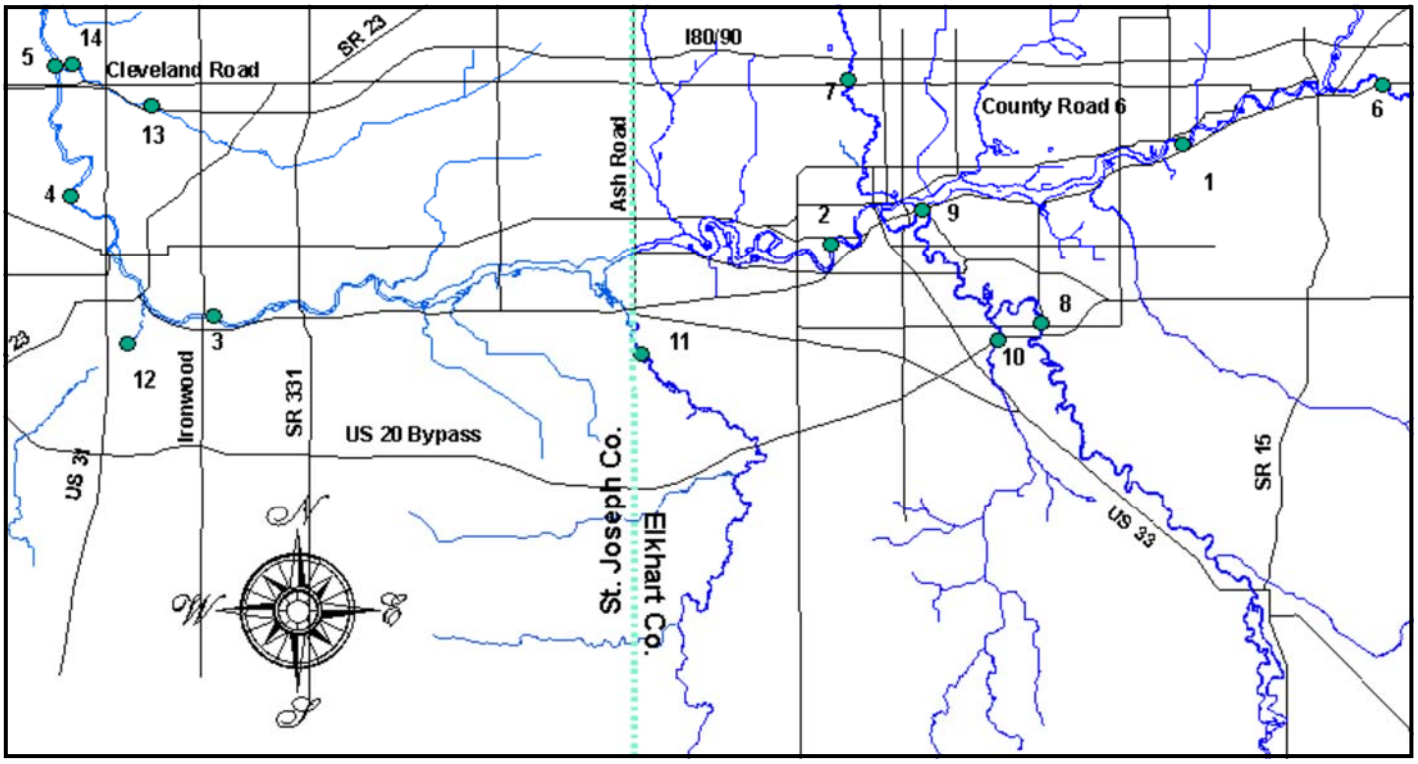
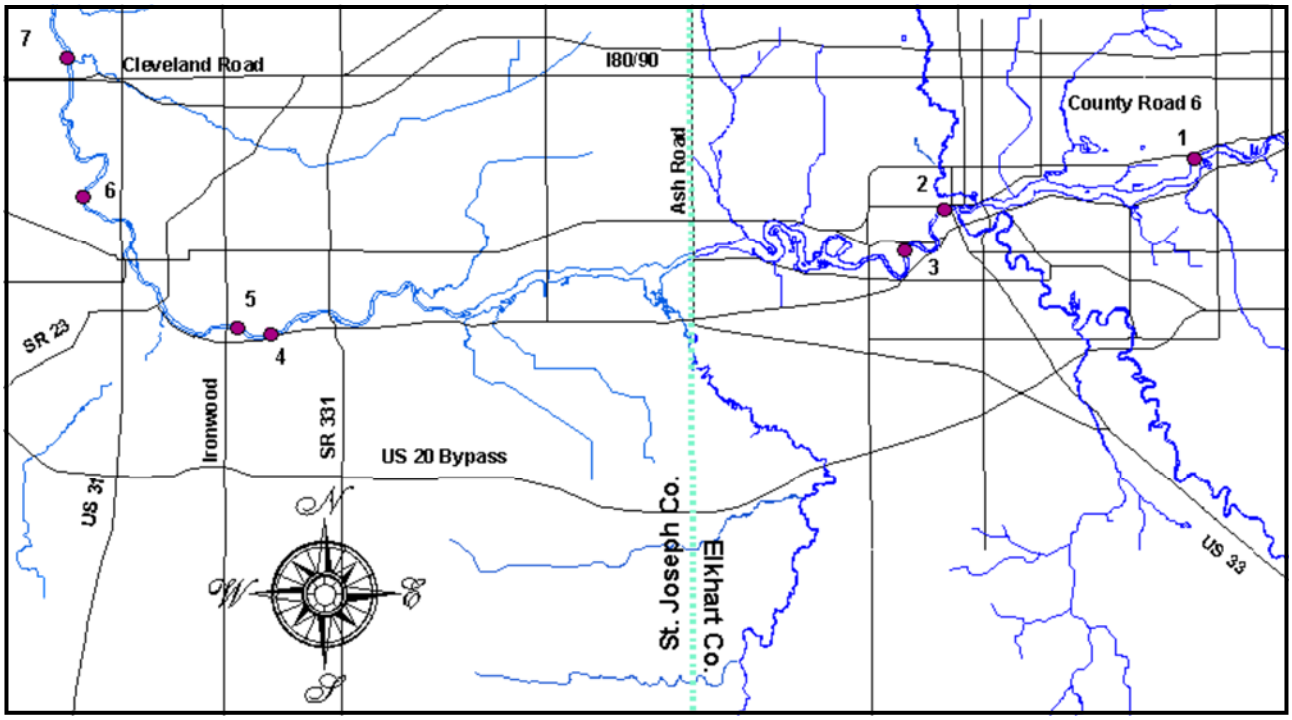


Figure 5: Location of fish tissue collection sites for 2011



dant in St. Joseph County.

Indices

Fish community conditions at the index sites ranged from very poor (16) at Studebaker Park on Bowman Creek to excellent (56) at Willowdale Park on Christiana Creek. Macroinvertebrate community scores ranged from fair (30) at Ironwood Drive on the St. Joseph River to excellent (58) at Kintz Avenue on Juday Creek. Habitat quality ranged from poor (31) at Capital Avenue on Juday Creek to excellent (92) at State Road 120 on the Little Elkhart River.

The longitudinal trends in fish community condition for the entire Indiana portion of the St. Joseph River are displayed in Figure 6. Fish, Macroinvertebrate, and habitat index scores are presented in Table 4. The Elkhart County portion of the river continues to support good fish communities. All three Elkhart County sites scored 2 points lower in 2011 compared to 2008, while maintaining scores above the baseline for the third consecutive time since the completion of baseline monitoring. The IBI score at the Toll Road site (54) was the most impressive and remained well above the baseline value of 50.

The Six-Span and Bridge Street sites were the two St. Joseph River Elkhart County sites where macroinvertebrate communities were assessed in 2011. While the Bridge Street site had a similar ICI score to 2008, the score at the Six-Span site dropped significantly from 52 in 2008 to 40 in 2011. This is somewhat surprising since the fish

Table 3: Location of fish tissue collection sites for 2011

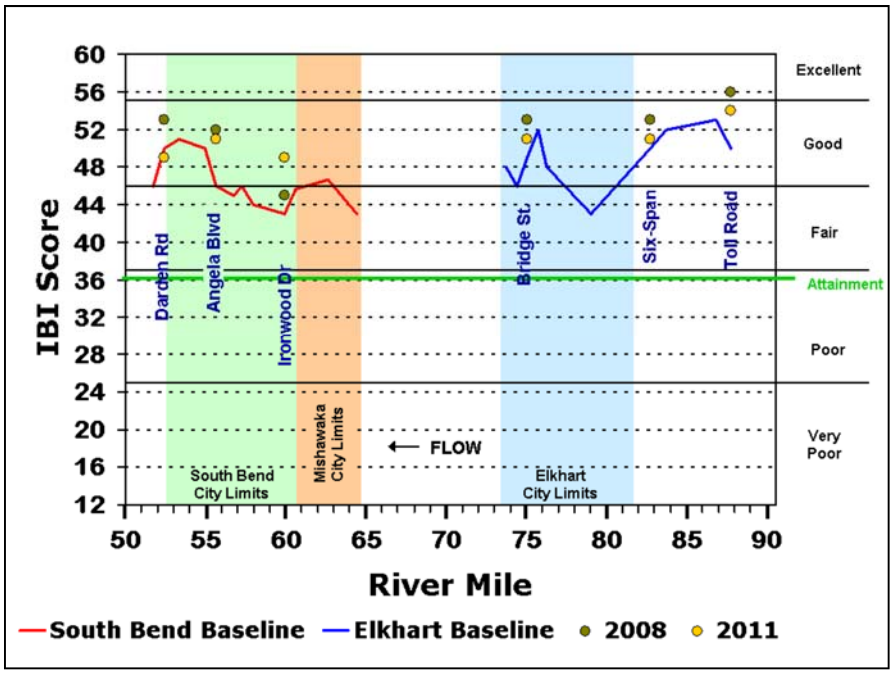
Site Number	Stream	Location
1	St. Joseph River	Six-Span (B)
2	St. Joseph River	Downtown Elkhart
3	St. Joseph River	Sherman Street
4	St. Joseph River	Ironwood (A)
5	St. Joseph River	Ironwood
6	St. Joseph River	Angela Blvd
7	Elkhart River	Darden

community has remained stable since 2008, although it is not unusual for instances like this to occur given the differences in fish and macroinvertebrate communities and how they react to stressors (Deegan, 2010). Habitat scores at the Elkhart County sites all fell in the excellent range. The lowest QHEI score was seen at the Bridge Street site, which is characterized by an exceptional riffle area, but is located in an urban section of Elkhart with minimal riparian habitat.

IBI scores for the St. Joseph River in the South Bend area were impressive at two of the three sites that were monitored in 2011. Increases, well above baselines values, were observed at the Ironwood Drive and Angela Boulevard sites. The IBI score at the Darden Road site (49) was slightly less than the baseline score and significantly lower than when the site was last sampled in 2008. It should also be noted that in 2010, a score slightly lower than the baseline was also observed at the

Pinhook (B) site, which is located less than 1 mile upstream of Darden Road. While these results are not alarming, they are interesting considering that improvements were observed in upstream sections of the river in 2010 and 2011. The Aquatics Program will closely monitor scores from this section of the river in upcoming years. The ICI scores in the South Bend section of the river were disappointing in 2011. The sampler was lost at the Angela Blvd, although qualitative results showed it to be in the good range. This site had an ICI score of 36 when it was last sampled in 2008, which is more or less equivalent to a good qualitative rating. The score at Darden Road dropped from 42 in 2008 to 38 2011. It could be that reduced scores along the St. Joseph River in 2011 are attributed to sediment loading and movement. Spikes in sediment concentrations were up in 2011 compared to previous years (see Surface Water Chemical Data & River Discharge on Page 16 for additional information). The ICI score at Ironwood Drive was very low (30) in 2011. This score is indicative of an impaired macroinvertebrate community. However, it should be noted, that the sampler at this site was collected in a location that had poor flow, and the impoundment characteristics of this site make it difficult to meaningfully analyze the macroinvertebrate community.

Figure 6: IBI scores for the St. Joseph River, Elkhart and St. Joseph Counties



Habitat continues to score in the excellent range at the Angela Boulevard site and the Darden Road site, while falling in the good range at the Ironwood Drive site. Habitat availability at the Ironwood Drive site is more limited for two reasons: 1) It is located above the South Bend dam which has caused deeper, less natural impoundment-like qualities, 2) it is located in a heavily urbanized section of the river.

IBI scores for the two Elkhart River sites within Elkhart City limits were consistent with baseline values (Figure 7). The ICI score of 50 at American Park was significantly higher in 2011 that the last time it was sampled in 2008. The score is considered exceptional, which is good news for this section of river that generally supports less diverse fish communities. The IBI score at Hively Avenue, just upstream of Elkhart, was significantly lower than the baseline and all other times the site has been sampled (Table 5). Wet weather resulting in unstable flows and difficult sampling conditions in the month of June may have contrib-

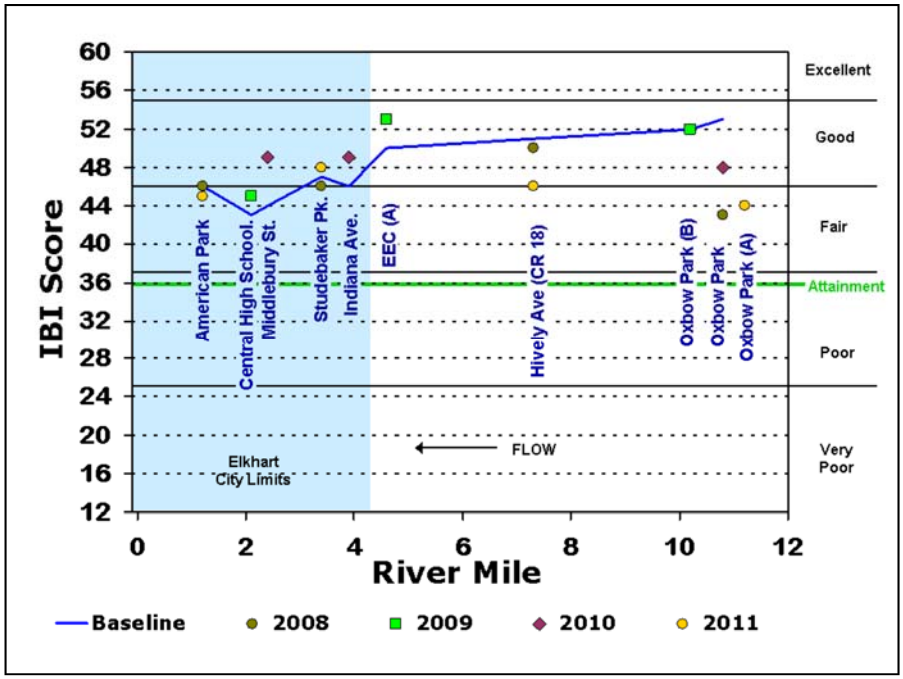
Table 4. Index scores for St. Joseph River sites, Elkhart and St. Joseph Counties

Station	County	River Mile	Fish IBI Scores				2011 Habitat Scores	(ICI) Macroinvertebrate Scores	
			Baseline	2005	2008	**2011**		2008	**2011**
Toll Road (Bristol)	Elkhart	87.7	50	51	56	**54**	83		
Six-Span	Elkhart	82.7	50	51	53	**51**	81	52	**40**
Bridge St.	Elkhart	75	49	52	53	**51**	77	40	**42**
Ironwood Drive	St. Joseph	59.9	43		45	**49**	74	NA	**30**
Angela Boulevard	St. Joseph	55.6	46		52	**51**	86	36	**Good**
Darden Road	St. Joseph	52.4	50		53	**49**	83	42	**38**

uted to this decrease. In yet another contrast to the fish IBI score, the macroinvertebrate community scored in the exceptional range in 2011 and was up significantly from the last time this site was sampled. It will be interesting to see how the fish community scores when it is sampled again in 2014.

The section of the Elkhart River adjacent to Oxbow Park has seen some significantly reduced IBI scores in recent years (Figure 7). The Aquatics Program monitors two sites in the Oxbow Park area: Oxbow Park and Oxbow Park (B). While the most upstream of these two sites appears to have been impacted, the IBI scores at the downstream site, Oxbow Park (B), have remained consistent with the baseline. Given this information, we have speculated in previous years that the reduced scores observed at Oxbow Park are being caused (or were caused) by upstream sources and impacts do not continue downstream. Therefore, to determine the extent of upstream impacts, a site [Oxbow Park (A)] located approximately 0.5 miles upstream, was sampled in 2011. The IBI score for Oxbow Park (A) was 44, which is considered fair, but is significantly lower than baseline IBI values for the Oxbow Park sites. The habitat score at this site was the best of all Elkhart River sites sampled in 2011, while the IBI score was the lowest, suggesting water quality issues. The Aquatics Program may continue to move upstream of Oxbow Park in coming years to determine the extent of the problem.

Figure 7: IBI scores for the Elkhart River, Elkhart



In 2011, the Aquatics Program also performed two investigative surveys on the Elkhart River below the Baintertown dam. In recent years the levee above the dam has failed which has created a diversion channel around the dam. One of the surveys was performed immediately below the dam, and the other was performed in the diversion channel. The premise behind the surveys was to determine if fish are migrating upstream in the diversion channel and to what degree the dam is inhibiting fish migration. A total of 19 species were collected in the diversion channel and 25 species were collected immediately below the dam. The current velocity within the diversion channel was very fast, almost making it difficult to sample, and while it was good to see close to 20 species of fish in the channel, it is likely that not all species can migrate through the channel due to high velocity. Finding more species immediately below the dam supports this theory.

While it is important to monitor the main stem of the St. Joseph and Elkhart Rivers, it is also important to monitor their tributaries. Assessing the

Table 5. Index scores for Elkhart River sites, Elkhart County

Station	River Mile	Fish IBI Scores				2011 Habitat Scores	(ICI) Macroinvertebrate Scores	
		Baseline	2005	2008	**2011**		2008	**2011**
Oxbow Park (A)	11.2	53*			**44**	83		
Hively Ave. (CR18)	7.3	51	52	50	**46**	82	42	**50**
Studebaker Park (A)	3.4	47	42	46	**48**	79		
American Park	1.2	46	44	49	**45**	64	42	**50**

*** Baseline data were not gathered for the Oxbow Park (A) site. This value is for a site located 0.5 miles downstream of the Oxbow Park (A) site.**

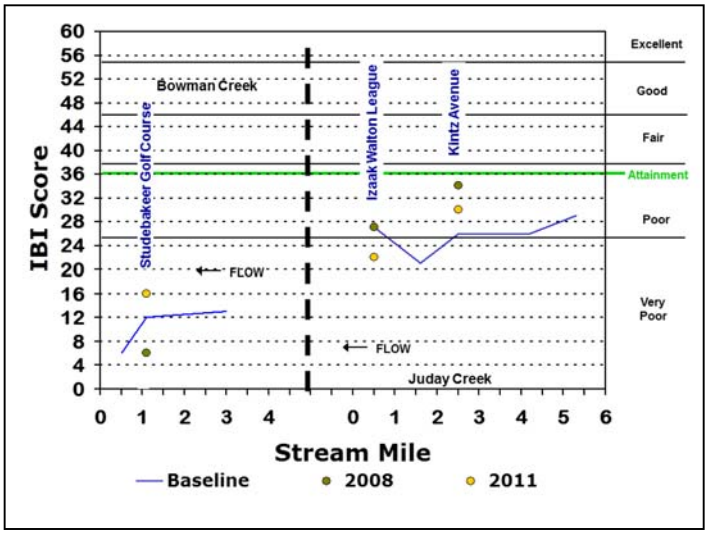
tributaries provides more information on the observed conditions within the larger streams. Similar longitudinal views are presented for area tributaries and current results can be compared against past conditions.

Juday Creek and Bowman Creek are two tributaries of the St. Joseph River that flow through areas of South Bend. Both tributaries are heavily impacted by urban influences, but they are quite different from an ecological standpoint. Juday Creek is a cool/cold water stream that is capable of supporting trout, whereas Bowman Creek is much warmer with historically impaired biological communities.

The IBI score for Bowman Creek at Studebaker Golf Course (16) was up from the baseline value of 12 and significantly higher than the last time it was sampled in 2008 (Figure 8). There have been several times in the past that no fish have been collected at this site. In 2011, four fish were collected during the first round of sampling and 302 fish were collected during the second round. Of the 302 fish collected during the second sampling pass, 12 were young of the year largemouth bass, while the remaining fish were juvenile creek chubs. Although the collection of so many fish may appear to be encouraging for this site, the lack of diversity in species and age groups is indicative of a very impaired fish community as reflected in the IBI score. The abundance of creek chubs was likely promoted by relatively high water flows in the spring and summer of 2011. The macroinvertebrate community, which was sampled for the first time in 2011 provided the biggest surprise of the year. The ICI score at Studebaker Golf Course was 36 which is considered to be attaining and reflects a "Good" macroinvertebrate community according to ICI criteria. Overall 39 different types of macroinvertebrates were collected from this site, with seven of them being considered moderately intolerant. Given that Bowman Creek can run dry during hot and dry summers, the continuous flow of water in 2011 is likely the reason for seeing a diverse community of macroinvertebrates. These results also speak to the vigorous ability of streams to reestablish ecologically following disturbance. If Bowman Creek could sustain flow for several years, it is likely that the fish community would also start to rebound and become more diverse.

The IBI score for Juday Creek at Kintz Avenue (30) was up significantly from the baseline (26) but significantly less than the last time it was sampled in 2008 (Figure 8). The ICI score of 58 for this site was astonishingly high in 2011 and up significantly from the last time it was sampled (Table 6). This ICI score was also the highest recorded in by the Aquatics Program in 2011. What is interesting about this result is the fact that the fish community is impaired. Similar findings were also observed at the State Road 23 location in 2010. The Izaak Walton League site had a very

Figure 8: IBI scores for Bowman Creek and Juday Creek, St. Joseph County



disappointing score of 22 in 2011, which is significantly lower than the baseline (27) and considered very poor (Figure 8). The ICI score for this site, however, was 40 which is indicative of a "Good" macroinvertebrate community. As discussed previously we recognize that differences between macroinvertebrate and fish community scores are expected because the 2 different types of organisms react differently to stressors. However, the differences in Juday Creek, particularly at Kintz Avenue seem inflated by the very low fish community scores. These results are likely an artifact of the current fish data analysis methodology, the Northern Indiana Till Plain IBI, which is not calibrated for the coolwater conditions of Juday Creek. Using the Coolwater IBI that was developed by the Indiana Biological Survey in 2007, IBI scores for Izaak Walton League are significantly higher and fall above the attainment line. Results at Kintz Avenue are slightly lower, but the use of the Coolwater IBI reflects superior overall stream quality for Juday Creek (the Coolwater IBI sets attainment at 32 as opposed to 36 with the regular IBI: Figure 9). Following an in-depth analysis of both IBI types for Juday Creek fish assemblage data, it appears that the Coolwater IBI is more appropriate for use in Juday Creek (see Appendix F for details). Unfortunately, there are some problems with the Coolwater IBI (Deegan, 2011), which have caused it to not be formally recognized by IDEM. Until that time, the Aquatics Program will report results generated from both IBI types. Detailed information on this topic is located in Appendix F.

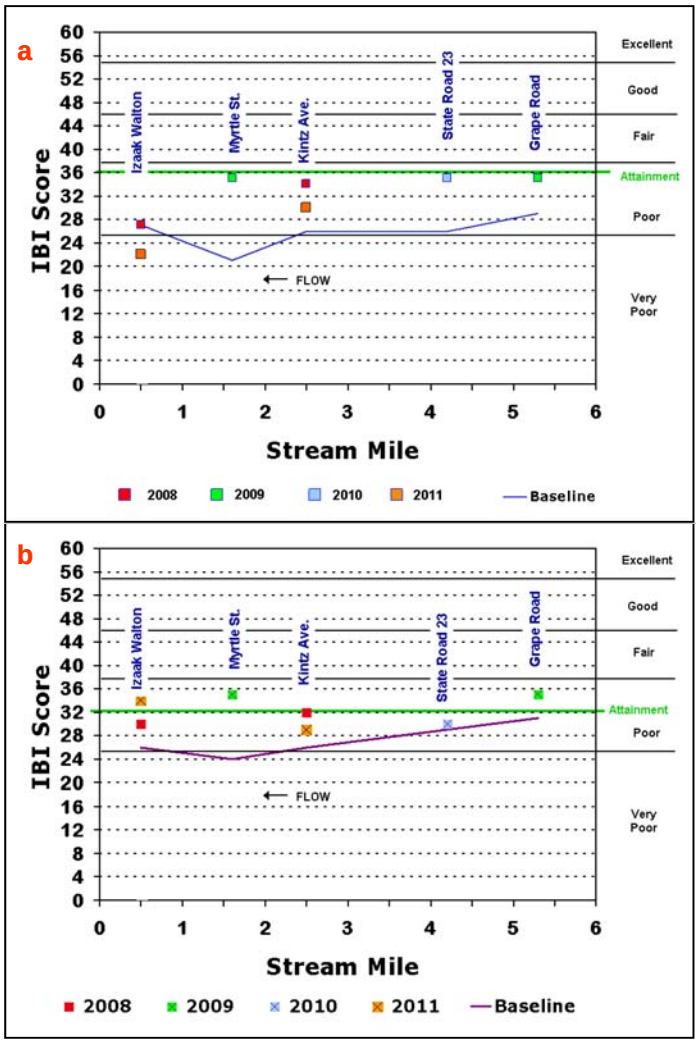
Pine Creek at the US 20 Bypass had an IBI score of 28 which was lower than the baseline score of 31. IBI scores for this site have fluctuated throughout the years (Table 7), which is not surprising given that Pine Creek has been highly modified for drainage purposes and has unstable flows. In 2011, a significant amount of bank erosion and downed trees were observed at this site. While the habitat at the US 20 Bypass falls in the

good range due to a wide wooded riparian zone on both sides of the site, limitations to the fish community include those described previously which are sourced from upper reaches of the creek in intensively farmed areas. Pine Creek is another small Elkhart County coolwater stream that could potentially benefit from the use of a Coolwater IBI.

The IBI score at the U.S. 20 Bypass on Yellow Creek (36) was below the baseline score of 39 (Figure 10) and was significantly lower than the last time it was sampled when it had a score of 42. This site has seen its share of problems and underwent major modifications for drainage purposes in 2003. The high score of 42 in 2008, hinted at a recovery of this site (Kring, 2009), but the results from 2011 suggest that it still suffers from stream quality issues. Interestingly, the habitat score for this site was 77 in 2011, which is considered excellent, and the ICI score for the site was 48 in 2011, up from 42 in 2008. There is promise for Yellow Creek, but its flashy drainage patterns and associated pollutant intake need to be controlled.

The 2011 IBI score for Christiana Creek at County Road 6 was slightly higher than the baseline value (Figure 11, Table 8). This site is one of the best stream sites in Elkhart County, hosting a diverse community of fish. The macroinvertebrate community also continues to thrive, boasting an ICI score of 48 in 2011. The site at Willowdale Park had a remarkable IBI score of 56 in 2011, which was almost 20 points above the baseline (Figure 11). This score is considered excellent overall and was the highest of all sites sampled in 2011. Since the inception of the Aquatics Program, a score increase of such magnitude has not been observed. It is possible that natural variables played a role in this high score and that conditions were optimal in this section of the stream in 2011 to promote such a healthy fish community. Several large trees have fallen into stream at Willowdale Park and have altered the instream habitat by scouring and shifting substrate. It is possible that these trees have promoted fish habitat at Willowdale Park, but it is unlikely that they are the sole reason for such a significant enhancement in the fish community. Future monitoring results will help determine if the fish community has rebounded at Willowdale Park.

Figure 9: Comparison of Northern Indiana Till Plain IBI scores (Figure a) and Coolwater IBI Scores (Figure b) for Juday Creek. Note that the attainment line is set at 32 using the coolwater methodology.



The Little Elkhart River at State Road 120 scored right at the baseline value of 53 in 2011 which was down slightly from 56 when it was last sampled in 2008 (Figure 11, Table 8). In addition, the ICI for this site was 52 in 2011, up significantly from 2008 when it was 42. This site continues to

Table 6: Index scores for Bowman Creek and Juday Creek sites, St. Joseph County

Stream	Station	River Mile	Fish IBI Scores (Coolwater IBI Scores)			2011 Habitat Scores	(ICI) Macroinvertebrate Scores	
			Baseline	2008	**2011**		2008	**2011**
Bowman Creek	Studebaker Golf Course	1.1	12	6	**16**	38		**36**
Juday Creek	Kintz Ave	2.5	26 (26)	34 (32)	**30 (29)**	70	42	**58**
Juday Creek	Izaak Walton	0.5	27 (26)	27 (30)	**22 (34)**	81	40	**40**

Figure 10: IBI scores for Pine Creek and Yellow Creek, Elkhart County

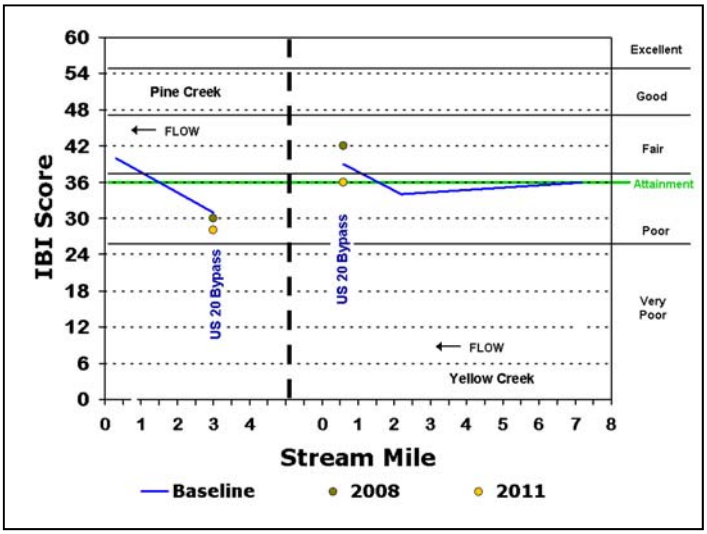
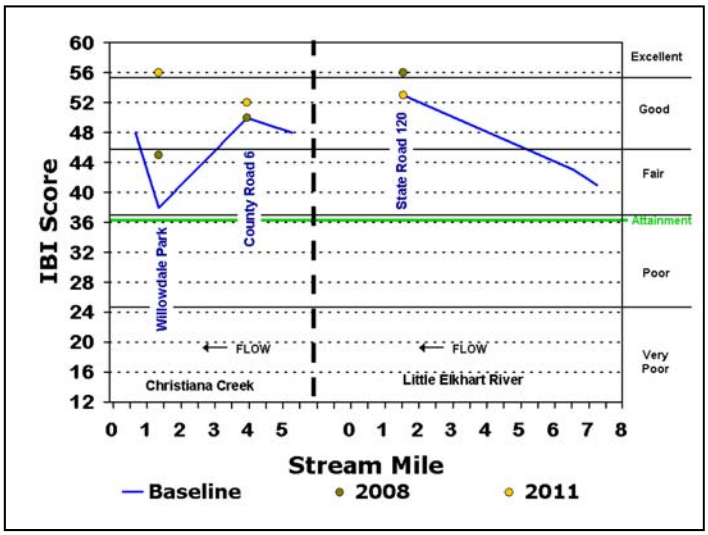


Figure 11: IBI scores for Christiana Creek and the Little Elkhart River, Elkhart County



host the most superior coolwater biological community in Elkhart County. It is also comprised of an exceptional complex of riffles, runs, and pools which is reflected in its very high habitat score of 92.

Trout Creek at County Road 2 had an IBI score of 47 in 2011, which is significantly lower than the baseline value of 51 (Figure 12, Table 9). When this site was last sampled in 2008, the IBI score was even worse at 44. Kring, 2009 noted that this site is highly influenced by nearby lakes that it drains. These lakes supply large numbers of sunfish to this site. In 2008 and 2011, over 66% of the fish collected were bluegill sunfish, which negatively effected several IBI metrics. Despite the overabundance of sunfish, fish diversity and abundance of other species appears to be very good at this site. While the in-stream habitat is relatively good at this site, the stream channel has been modified and straightened significantly; this is reflected by a relatively weak QHEI score for this site.

Puterbaugh Creek at Reedy Drive had an IBI score of 39 in 2011, which was up slightly from the baseline value of 37 and slightly lower than the last time it was time it was sampled (Figure 12, Table 9). Puterbaugh Creek is another Elkhart County stream that has significant groundwater infiltration giving it coolwater characteristics. It has an interesting fish community that has similar species to many of the other area coolwater streams, but it is also highly influenced by nearby Heaton Lake which supplies an abundance of bass and sunfish.

In 2010, the Aquatics team initiated index sampling at two new sites on Baugo Creek. The Elkhart County Drainage Board has implemented stream restoration practices along several stretches of Baugo Creek. The two new sites that were chosen by the Aquatics Program were within and downstream of the most significant restoration project, which is located right at the St. Joseph County line. The impetus for monitoring these sites is to determine the impact this restoration work has on the biological communities within the stream.

The 2011 IBI scores for both sites were almost identical to 2010 scores (Figure 13, Table 10). Scores at each site dropped by one in 2011, which indicates that much did not change in the fish community since restoration activities were implemented. However, it will likely take a few years until improvements are observed in the fish communities. A Hester Dendy sampler was set at the Restoration site, which yielded an ICI score of 48.

Table 7: Index scores for Yellow Creek and Pine Creek, Elkhart County

Stream	Station	River Mile	Fish IBI Scores								2011 Habitat Scores	(ICI) Macroinvertebrate Scores	
			Baseline	2001	2002	2003	2004	2005	2008	**2011**		2008	**2011**
Yellow Creek	US 20 Bypass	0.6	39	28	38	31	37	34	42	**36**	77	42	**48**
Pine Creek	US 20 Bypass	3.0	31				26		30	**28**	69		

Table 8: Index scores for Christiana Creek and the Little Elkhart River, Elkhart County

Stream	Station	River Mile	Fish IBI Scores				2011 Habitat Scores	(ICI) Macroinvertebrate Scores	
			Baseline	2005	2008	**2011**		2008	**2011**
Christiana Creek	County Road 6	4	50	47	50	**52**	84	Excellent	**48**
Christiana Creek	Willowdale Park	1.4	38	31	45	**56**	78		
Little Elkhart River	State Road 120	1.6	53	49	56	**53**	92	42	**52**

This score was up significantly from 2010 when the ICI score was 36. These findings are promising and suggest that restoration activities might already be benefiting the biological communities at this site.

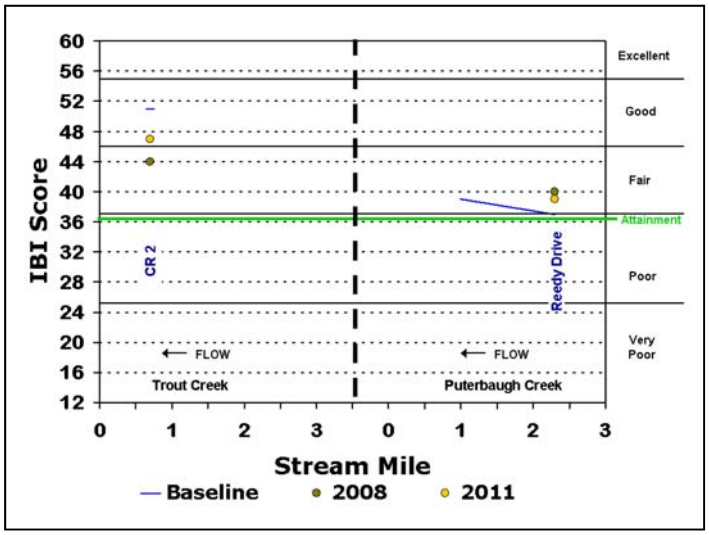
Fish Tissue

In 2011, tissue was collected from fish in both Elkhart and St. Joseph Counties. Collections were based on the current Indiana Fish Consumption Advisory (FCA) for area streams and potential data gaps within the FCA. The FCA provides guidance on the rate of consumption of local wild fishes (Table 11). Based on PCB or mercury concentrations, fish species within a certain size range will be placed within an FCA Grouping. Table 12 summarizes each grouping and the associated guidance. It should be noted that the State FCA has more restrictive guidance for individuals that are considered to be part of the "sensitive population." Women who are pregnant or are breast-feeding, women who plan to have children, or children under the age of 15 are considered to be part of the sensitive population. For more information on local fish consumption, the State FCA should be reviewed.

It should be noted that many variables play a role in contaminant concentrations in fish. Our results have shown varying contaminant concentrations from year to year and among different sizes of fish. However, concentrations do not tend to vary that significantly and an understanding of contaminant concentrations can be determined by gathering data multiple times. In general, larger fish will tend to have higher concentrations of contaminants in their tissue. The following narrative describes results from the Aqautics Programs fish tissue collections from Elkhart and St. Joseph Counties in 2011:

Common carp (31.3-31.7 inches long) were collected for fish tissue analysis at County Road 17 on the St. Joseph River. This species was last collected in this section of the river in 1998 and 1999. Tissue concentrations of mercury and PCBs in 2011 were similar to those in 1998 and 1999 with common carp falling in Group 2 for mercury and Group 3 for PCBs. The FCA currently lists all 25 inch or greater carp in Elkhart County in Group 4 for PCBs.

Figure 12: IBI scores for Trout Creek and Puterbaugh Creek, Elkhart County



Two size ranges of channel catfish were collected on the St. Joseph River downstream of the Johnson Street dam. Catfish ranging from 19.9 to

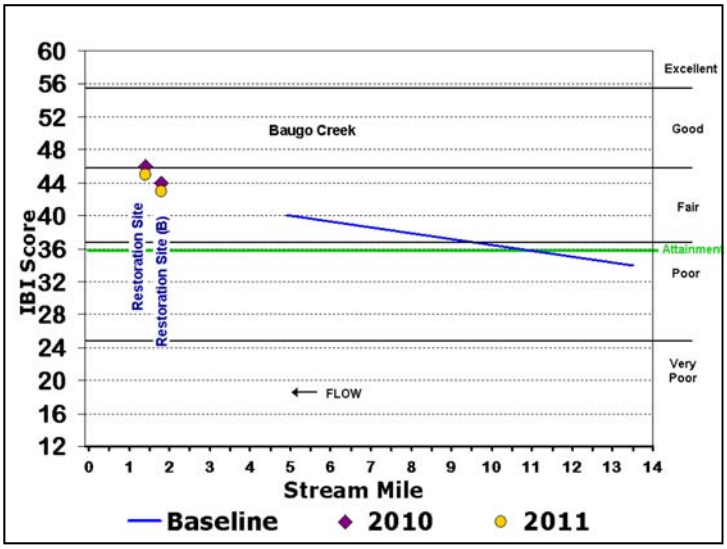
Table 9: Index scores for Trout Creek and Puterbaugh Creek sites, Elkhart County

Stream	Station	River Mile	Fish IBI Scores				2011 Habitat Scores
			Baseline	2005	2008	**2011**	
Trout Creek	County Road 2	0.7	51	51	44	**47**	66
Puterbaugh Creek	Reedy Drive	2.3	37	39	40	**39**	70

20.3 inches were collected at the mouth of the Elkhart river and slightly upstream to Jackson Blvd. Catfish in the 16.7 to 17.7 inch size range were collected farther downstream in the section of River from McNaughton Park to Sherman Street. Concentrations in both size ranges fell in Group 1 for mercury and Group 3 for PCBs. These results were interesting since it was expected that the larger group of fish would contain significantly higher concentrations of contaminants. However, the results correspond with the FCA, which places channels catfish of all size ranges in Group 3 for PCBs.

Walleye were collected for the second straight year in the Elkhart area. In 2010, walleye in the 15.0 to 15.4 inch size range were collected downstream of McNaughton Park and fell in Group 1 for both contaminants. In 2011, fish in the 15.4 to 16.2 inch range were collected at Main Street in downtown Elkhart. These walleye fell in Group 2 for mercury and Group 1 for PCBs. The rise in mercury concentrations may be attributed to slightly bigger fish being collected in 2011. The FCA reports walleye 25 inches or greater in Group 3 for PCBs.

Figure 13: IBI scores for Baugo Creek, Elkhart and St. Joseph Counties



In 2011, quilback were collected in two different sections of the St. Joseph River in the South Bend area. Quilback (17.5-19.1 inches) were collected at Ironwood Drive while fish in the 19.3-19.7 inch range were collected at Darden Road. At Ironwood Drive, concentrations fell in Group 2 for both contaminants, while at Darden Road concentrations fell in Group 2 for mercury and Group 3 for PCBs. The FCA reports that Quilback up to 19 inches fall in Group 4, while those bigger than 19 inches fall n Group 5.

Largemouth bass (13 to 13.7 inches) were collected upstream of Ironwood Drive at the edge of South Bend City limits. Concentrations fell in Group 2 for mercury and Group 1 for PCBs indicating that smaller keeper size largemouth bass are relatively safe to eat in the South Bend area. The FCA currently does not list largemouth bass in the South Bend area. The Aquatics Program will likely collected another sample of similar size largemouth bass in 2012 to corroborate these results

Smallmouth bass were also collected in South Bend in 2011, but downstream of the South Bend Dam between Darden Road and Angela Blvd. Two size ranges were collected for analysis: 11.7 to 12.1 inch fish and 13 to 13.7 inch fish. Similar to channel catfish that were collected in the Elkhart area, two different size ranges were collected to determine if contaminant concentrations varied significantly based on fish size. For both size ranges, mercury concentrations fell in Group 1. However, concentrations of PCBs were in Group 2 for the 11.7 to 12.1 inch fish and in Group 3 for the larger group. In 2010, smallmouth bass in the 12 to 13 inch size range were collected above Michigan Street in South Bend and fell in Group 2 for Mercury and Group 3 for PCBs. The FCA currently lists smallmouth bass up to 16 inches in length in Group 2 for both contaminants.

Surface Water Chemical Data & River Discharge

The City of South Bend has been collecting water samples from the St. Joseph River for many years. Samples have been collected at three bridge crossings: Colfax Avenue, Angela Boulevard, and Auten Road. General chemical parameters have been analyzed from these samples including dissolved oxygen, *E. coli*, and total suspended solids. Total suspended solids (TSS) data were reviewed

Table 10: Index scores for Baugo Creek, Elkhart and St. Joseph County

Stream	Station	River Mile	Fish IBI Scores		2011 Habitat Scores	ICI Macroinvertebrate Scores	
			2010	**2011**		2010	**2011**
Baugo Creek	Restoration	1.8	44	**43**	76	36	**48**
Baugo Creek	Restoration (B)	1.4	46	**45**	81		

Table 11: Fish consumption information taken from the 2010 Indiana Fish Consumption Advisory

Location	Species	Fish Size (inches)	Contaminant	Group
Elkhart River *Elkhart County (Goshen to CR 18 in Elkhart)*	Golden Redhorse	Up to 17		1
	Rock Bass	Up to 7		1
	White Sucker	Up to 16		1
Elkhart River *Elkhart County (CR 18 to downtown Elkhart)*	Rock Bass	9+	PCBs	3
	Smallmouth Bass	17+	PCBs	3
	White Sucker	16+	PCBs	3
Christiana Creek *Elkhart County*	Northern Hogsucker	Up to 14		1
	Rock Bass	Up to 7		1
	Yellow Bullhead	Up to 9		1
St. Joseph River *Elkhart County*	Bluegill	Up to 8		1
	Channel Catfish	All	PCBs	3
	Common Carp	Up to 25	PCBs	3
		25+	PCBs	4
	Northern Hogsucker	15+	PCBs	3
	Rock Bass	Up to 7		1
	Redhorse Species	17+	PCBs	3
	Walleye	25+	PCBs	3
	White Sucker	Up to 14		1
St. Joseph River *St. Joseph County (Baugo Bay Area to Petro Park)*	Bluegill	Up to 8		1
	Channel Catfish	Up to 22	PCBs	3
		22+	PCBs	4
	Largemouth Bass	Up to 13		1
	Rock Bass	Up to 8		1
	Spotted Sucker	Up to 17		1
	White Sucker	Up to 14		1
St. Joseph River *St. Joseph County (Petro Park to Indiana State Line)*	Bluegill	7+	PCBs	4
	Channel Catfish	All	PCBs	4
	Common Carp	15-20	PCBs	3
		20-25	PCBs	4
		25+	PCBs	**5**
	Chinook Salmon	28+	PCBs	4
	Carpsucker species (Quilback)	Up to 19	PCBs	4
		19+	PCBs	**5**
	Rock Bass	Up to 7	PCBs	2
	Smallmouth Bass	Up to 16	PCBs & Mercury	2
	Steelhead Trout	30+	PCBs	4
	Yellow Bullhead	Up to 10	PCBs	2
Juday Creek	White Sucker	17+	PCBs	3

Table 12: Indiana State Fish Consumption Advisory (FCA)Groupings

FCA Grouping	Guidance
Group 1	Unrestricted consumption
Group 2	Limit consumption to 1 meal per week
Group 3	Limit consumption to 1 meal every month
Group 4	Restrict consumption to 1 meal every 2 months
Group 5	DO NOT EAT

for this report to determine if sediment concentrations are reducing in the South Bend area since the completion of baseline fish community monitoring in 2006.

Total suspended solids (TSS) is a measure of the amount of particles in water. In the St. Joseph River Basin, most of the solids are made up of sediment from erosion activity and unstable hydrology related to stormwater events. Although sediment is an inert material, it can have significant impacts on aquatic organisms when present in heavy loads. For example, sediment can cover fish nests and spawning substrate, it can impair an aquatic animals ability to find food, and it can carry pollutants that are bound to it. Due to the relationship between stormwater runoff and sedimentation, TSS concentrations are usually reflective of most other common pollutant types, and when TSS concentrations are high, many other pollutants are also typically high. Figure 14 displays the relationship between TSS concentrations and the amount of water that is being discharged in the St. Joseph River.

A review of suspended solids data for the three South Bend stream crossings was interesting. Concentrations of TSS were very similar at each location from 2001 to 2011 and did not show any statistical differences (statistical analysis of TSS data is presented in Appendix G). However concentrations have been significantly lower in the St. Joseph River since the completion of baseline fish community monitoring in 2006. Figure 15 depicts the difference in TSS concentrations between the baseline fish community monitoring period (2001-2006) and the post baseline monitoring period (2007-2011). Recent trends in fish community data suggest stream quality is improving in the South Bend area, which corresponds with suspended solid concentrations from the past decade. The 2010 Annual Report also presented water quality from the Elkhart section of the St. Joseph River, where concentrations of suspended solids and phosphorus have also decreased since baseline monitoring (Deegan, 2011).

Another interesting change that has occurred since baseline monitoring is the amount of water being discharged in the St. Joseph River. While suspended solid concentrations may have decreased significantly, the quantity of water being discharged at the Elkhart gauge station on the St. Joseph River has increased significantly (Figure 16). This increased discharge is attributed to wet weather conditions and flooding events in the watershed in recent years. It is surprising, however, that suspended solid concentrations have decreased since river discharge and suspended solid concentrations are very strongly correlated as illustrated in Figure 14. These findings suggest that improvements in the St. Joseph River could be attributed to reduced TSS and other pollutants concentrations, or from increased discharge/water levels, or from a combination of both factors.

Although overall suspended solids concentrations have reduced in recent years, TSS concentrations did increase in 2011. Figure 17 depicts TSS concentrations at Angela Boulevard from 2001 to 2011. While the mean value in 2011 was very high and indicates large spikes in TSS concentrations, median values did remain relatively low and similar to concentrations in 2008 and 2009. It will be interesting to see if higher mean values of TSS in 2011 will have an impact on the biological communities in upcoming years. Biological community scores at Darden Road in South Bend, particularly for macroinvertebrates, did sag a little in 2011, which could have been attributed high mean TSS concentrations.

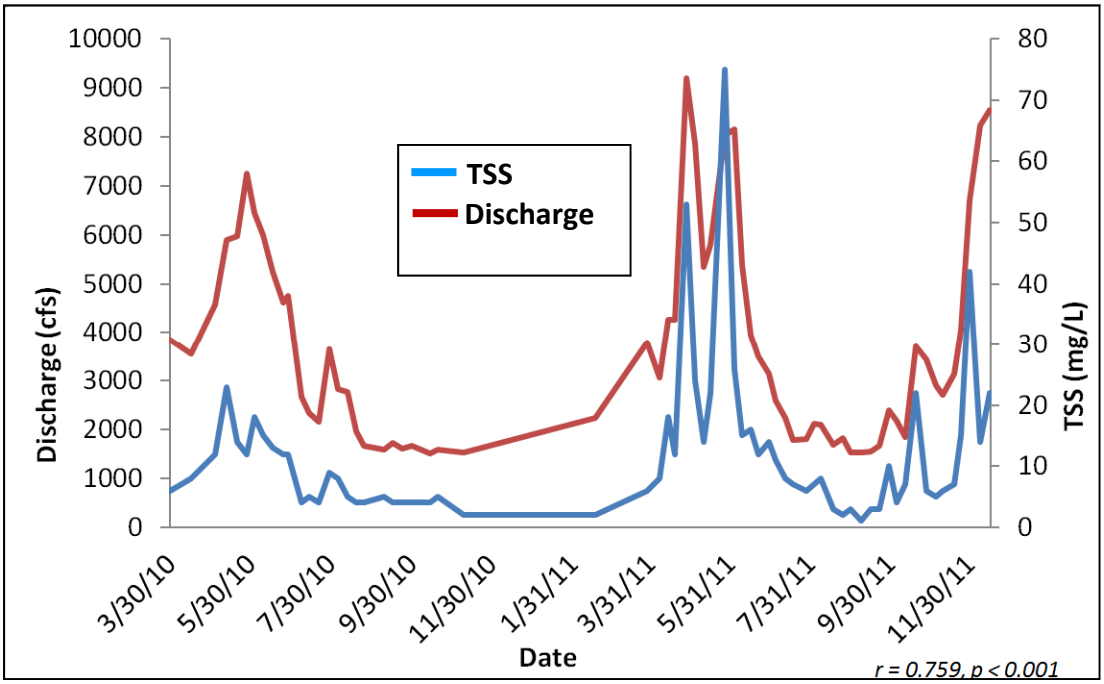
Additional information on TSS concentrations, St. Joseph River discharge data, statistical analysis, and a description of how to interpret boxplot graphs is presented in Appendix G.

Conclusion

Long-term biological monitoring in the Indiana portion of the St. Joseph River watershed continues to provide us with valuable information on the condition of the aquatic communities inhabiting area waterways.

Current trends in the biological and chemical conditions in the St. Joseph River and most of its tributaries suggest that water quality is improving. It is possible that the condition of local streams naturally fluctuates, and that the past several years have just been good stream quality years. 2011 hinted at this notion, as contaminant concentrations were up slightly in the St. Joseph River and fish and macroinvertebrate index scores were down from previous years at several sites. Weather patterns could also be playing a role, as wet weather over the past several years has promoted increased discharge/water levels potentially causing a multitude of effects to the dynamic eco-

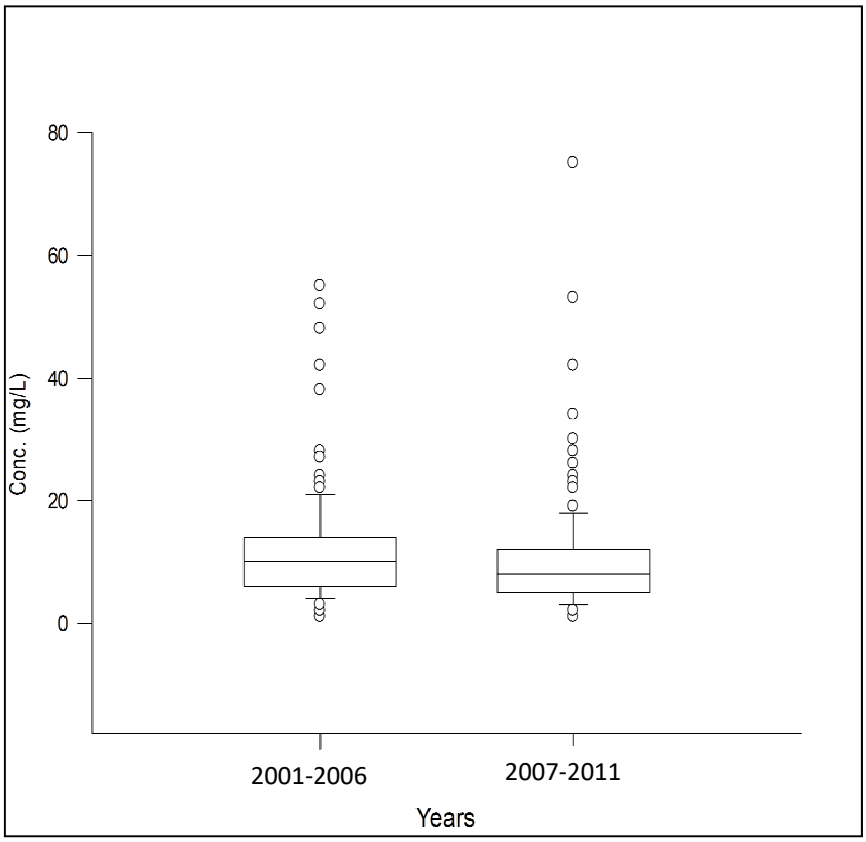
Figure 14: Suspended solids concentrations at Auten Road and discharge levels in the St. Joseph River in 2010 and 2011.



logical relationships in the St. Joseph River. As the Aquatics Program gathers more chemical and biological data in the coming years, it will become easier to determine which factors are responsible for improved conditions.

It is common knowledge that one of the biggest hurdles facing our local waterways is unstable hydrology, caused by drainage practices that promote getting water off urban and agricultural lands as quickly as possible. These drainage practices promote the movement and deposition of pollutants, erosion activity, and sedimentation. While data do suggest improvements to the St. Joseph River and several of its tributaries, streams that have been ditched for drainage continue to demonstrate poor stream quality. The good news is that government agencies and watershed groups have been, and currently are, working to improve stream quality. The Cities of Elkhart and South Bend have also committed to Long-Term Control Plans for combined sewer overflows, and are actively working to reduce wastewater discharges into our waterways. As our local communities continue to make these positive steps, the Aquatics Program will document the water quality improvements along the way.

Figure 15: Boxplot graph depicting the difference between TSS concentrations during (2001-2006) and after (2007-2011) baseline fish community monitoring.



Acknowledgements

Thanks to the 2011 field crew of Joseph King, Rumya Sundaram, and Ross Carlson for their efforts during the fish sampling season. Thanks also to the staff of Elkhart Public Works and Utilities and their counterparts at the City of South Bend for their continued support of the Aquatics Program. Recognition is also extended to local groups such as the Michiana Walleye Association, Elkhart River Restoration Association, RRA, Friends of the St. Joe River, and many others that support the work of the Aquatics Program and the improvement of the St. Joseph River Watershed.

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Figure 16: Boxplot graph depicting the difference between discharge levels during (2001-2006) and after (2007-2011) baseline fish community monitoring in South Bend.

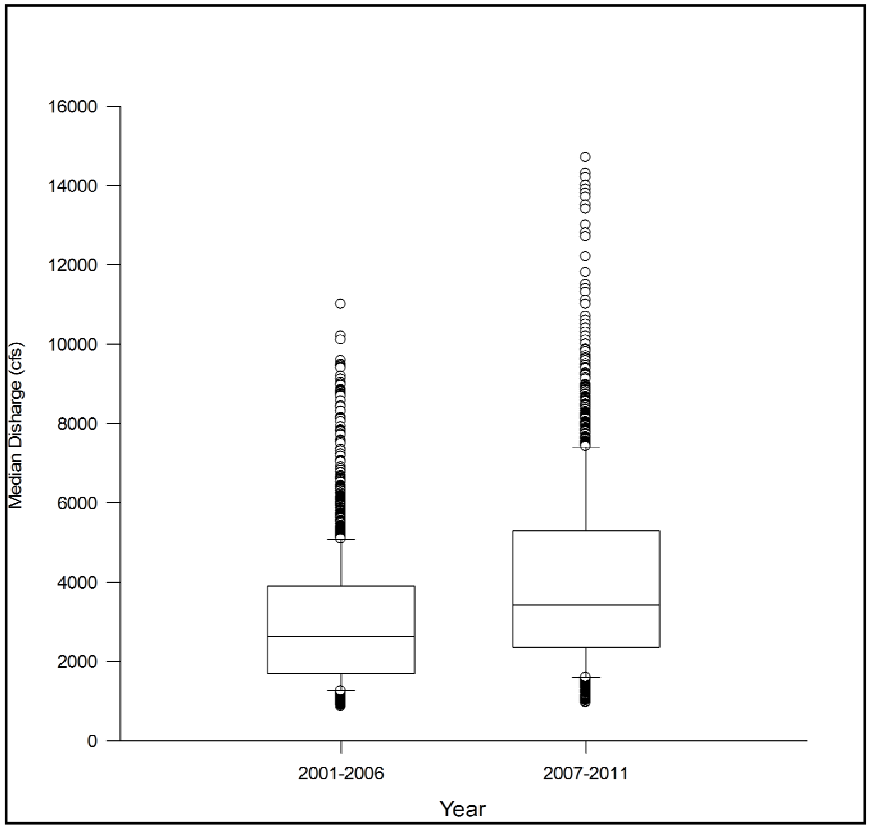

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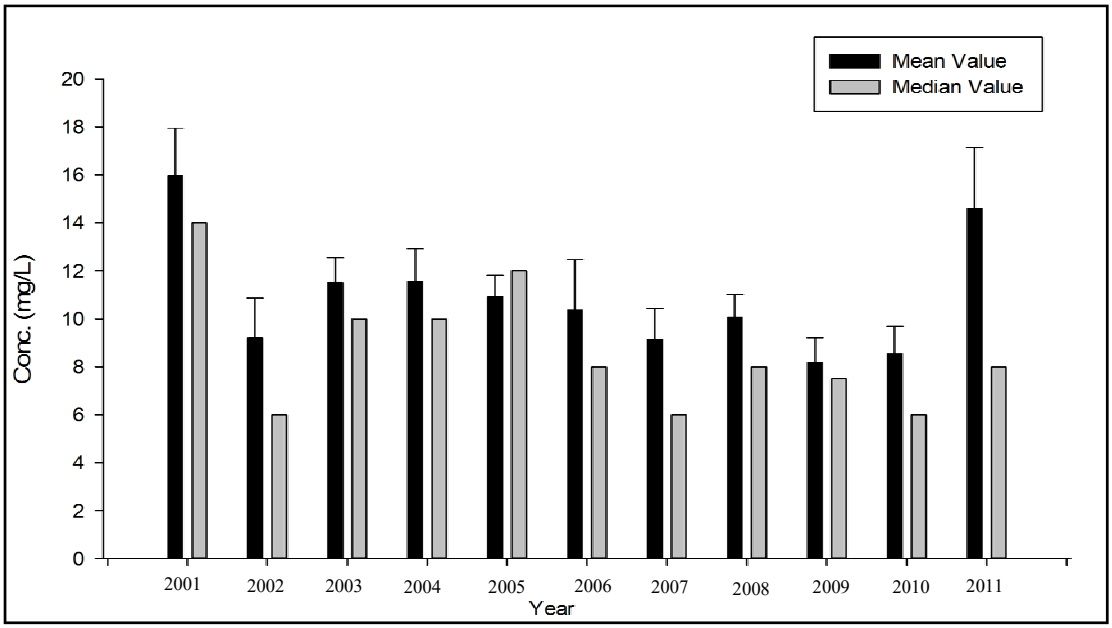
Figure 17: Mean and median concentrations of total suspended solids from Angela Boulevard



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SUMMER 2011

Ross with a greater redhorse at Howard Park in South Bend

A 6" mottled sculpin from Juday Creek

Daragh with a Common Carp at Ironwood Dr. South Bend

Ross with a nice walleye at Darden Road

Joe with a big Muskie at Darden Road

Ross with a Spotted Gar at Nibbyville

Rumya with an Angela Blvd. channel cat

Daragh with 2 Sherman Street bass

APPENDICES

Appendix A
Index of Biotic Integrity metrics

The Northern Indiana Till Plain Index of Biotic Integrity metrics used to evaluate headwater stream (<20 square miles drainage area) sites in the St. Joseph River drainage:

1. Total number of species
2. Number of darter/madtom/sculpin species
3. Percent headwater species
4. Number of minnow species
5. Number of sensitive species
6. Percent tolerant
7. Percent omnivores
8. Percent insectivores
9. Percent pioneer species (individuals)
10. Number of fish collected
11. Percent simple lithophils
12. Percent DELT anomalies

The Northern Indiana Till Plain Index of Biotic Integrity metrics used to evaluate wadeable stream (>20-<1,000 square miles drainage area) sites in the St. Joseph River drainage:

1. Total number of species
2. Number of darter species
3. Number of sunfish species
4. Number of sucker species
5. Number of sensitive species
6. Percent tolerant
7. Percent omnivores
8. Percent insectivores
9. Percent carnivores
10. Number of fish collected
11. Percent simple lithophils
12. Percent DELT anomalies

Invertebrate Community Index categories and metrics used to evaluate sites in the St. Joseph River drainage:

1. Total number of taxa
2. Total number of mayfly taxa
3. Total number of caddisfly taxa
4. Total number of dipteran taxa
5. Percent mayfly composition
6. Percent caddisfly composition
7. Percent tribe Tanytarsini midge composition
8. Percent other dipteran and non-insect composition
9. Percent tolerant organisms
10. Total number of qualitative EPT (mayflies, stoneflies and caddisflies) taxa

Qualitative Habitat Evaluation Index categories and metrics used to evaluate sites in the St. Joseph River drainage:

1. Substrate
    - type
    - number of types present
    - origin
    - silt cover
    - extent of embeddedness

2. Instream Cover
    - type
    - amount

3. Channel Morphology
    - sinuosity
    - development
    - channelization
    - stability

4. Riparian Zone and Bank Erosion
    - riparian width
    - floodplain quality
    - bank erosion

5. Pool/Glide and Riffle/Run Quality
    - maximum pool depth
    - pool/riffle morphology
    - pool/riffle/run current velocity
    - riffle/run depth
    - riffle/run substrate
    - riffle/run embeddedness

6. Gradient

The Coolwater Index of Biotic Integrity metrics used to evaluate sites in Indiana with less than or equal to 100 square miles drainage area:

1. Number of Native Species
2. Number of darter/madtom/sculpin species
3. Percent headwater species
4. Percent coolwater species
5. Percent sensitive and intolerant Species
6. Percent tolerant
7. Percent detritivore
8. Percent invertivore
9. Percent pioneer species
10. Number of fish collected (minus tolerant individuals)
11. Percent simple lithophils
12. Percent DELT anomalies

The Coolwater Index of Biotic Integrity metrics used to evaluate sites in Indiana with greater than 100 square miles drainage area:

1. Number of Native Species
2. Number of darter/madtom/sculpin species
3. Percent catostomidae (sucker family)
4. Percent coolwater species
5. Percent sensitive and intolerant Species
6. Percent tolerant
7. Percent detritivore
8. Percent invertivore
9. Percent carnivore
10. Number of fish collected (minus tolerant individuals)
11. Percent simple lithophils
12. Percent DELT anomalies

Appendix B

Fish tissue preparation and results

Materials needed:

- Reynolds aluminum foil
- freezer wrap
- deionized (DI) water
- 1/2 gallon, 1 gallon, and jumbo size freezer bags w/write-on labels
- skinners
- stainless steel fillet knives
- knife sharpener
- scalers
- ice
- cooler

A group of three fish per species was selected based on size. The smallest fish in each group was greater than or equal to 90% of the length of the largest fish in that group. The largest fish or fish that fell into a length range for species on the advisory were selected. The fish were kept as close in size as possible within a group because the tissue from the three fish in each group was composited (mixed together) before the analyses were completed.

All of the tissue was in the form of boneless fillets taken from the fish. All of the fish had skin-on fillets taken. Before the tissue was removed, the fillet knives, scalers and skinners were cleaned and rinsed with DI water, and freezer wrap was placed where the fish were to be processed. The knives, scalers and skinners were washed in river water and rinsed with DI water after each species was processed and new freezer wrap was placed before another species was processed. For skin-on samples, the scales were removed before the fillet was taken. It was important to be consistent with where the cut of the fillet ended and to not include any of the body cavity or viscera. Once the fillets were removed, they were rinsed in river water and then rinsed with DI water before being placed on aluminum foil. The foil was large enough to hold the three fillets for each species at a site. When all three fillets were placed on the foil, it was then wrapped and placed in a labeled freezer bag and placed on ice in a cooler. The fish tissue was placed in a freezer upon returning to the lab, and kept frozen until sent to the contract lab for analyses.

Fish Tissue Results

Station (s)	Species	Length Range (inches)	Advisory Length Range (inches)	Hg Advisory Group (PW)	Hg Advisory Group (state)	PCB Advisory Group (PW)	PCB Advisory Group (State)
St. Joseph River County Road 17	Common Carp	31.3-31.7	25+	2	-	3	4
Elkhart River Jackson	Channel Catfish	19.9-20.3	All	1	-	3	3
St. Joseph River Bridge Sreet McNaughton Park Sherman Street	Channel Catfish	16.7-17.7	All	1	-	3	3
St. Joseph River Main Street	Walleye	15.4-16.2	25+	2	-	1	3
St. Joseph River Ironwood (A)	Largemouth Bass	13-13.7	NA	2	-	1	-
St. Joseph River Ironwood Drive	Quilback	17.5-19.1	Up to 19	2	-	2	4
St. Joseph River Darden Road	Quilback	19.3-19.7	19+	2	-	3	5
St. Joseph River Angela Blvd Darden Road	Smallmouth Bass	11.7-12.1	Up to 16	1	2	2	2
St. Joseph River Angela Blvd Darden Road	Smallmouth Bass	13-13.7	Up to 16	1	-	3	-

Appendix C

Summary of fish collected by county, 2011

Summary of species captured at index sites in Elkhart County, 2011

Common Name	Total Number	% by Number	Total Weight (g)	Total Weight (lbs)	% by Weight
Bluntnose Minnow	1,876	13.13	3,254	7.17	0.31
Bluegill	1,545	10.81	32,683	72.05	3.16
Rock Bass	841	5.89	65,585	144.59	6.35
White Sucker	801	5.61	106,057	233.82	10.27
Mimic Shiner	798	5.58	1,324	2.92	0.13
Sand Shiner	771	5.40	842	1.86	0.08
Striped Shiner	701	4.91	9,452	20.84	0.91
Common Shiner	584	4.09	4,258	9.39	0.41
Smallmouth Bass	539	3.77	70,943	156.40	6.87
Hornyhead Chub	517	3.62	8,810	19.42	0.85
Spotfin Shiner	512	3.58	1,656	3.65	0.16
Logperch	475	3.32	4,327	9.54	0.42
Rainbow Darter	339	2.37	533	1.18	0.05
Northern Hog Sucker	338	2.37	80,765	178.06	7.82
Golden Redhorse	326	2.28	180,562	398.07	17.48
Johnny Darter	318	2.23	420	0.93	0.04
Blacknose Dace	311	2.18	726	1.60	0.07
Longear Sunfish	301	2.11	10,965	24.17	1.06
Shorthead Redhorse	277	1.94	119,907	264.35	11.61
Creek Chub	229	1.60	3,688	8.13	0.36
Stoneroller, Central	195	1.36	1,505	3.32	0.15
Largemouth Bass	172	1.20	16,178	35.67	1.57
Mottled Sculpin	144	1.01	693	1.53	0.07
Silverjaw Minnow	135	0.94	203	0.45	0.02
Steelcolor Shiner	132	0.92	296	0.65	0.03
Blackside Darter	122	0.85	392	0.86	0.04
Rosyface Shiner	102	0.71	184	0.41	0.02
Orangethroat Darter	102	0.71	150	0.33	0.01
Greater Redhorse	86	0.60	32,141	70.86	3.11
Green Sunfish	84	0.59	1,147	2.53	0.11
Redear Sunfish	65	0.45	2,283	5.03	0.22
Chestnut Lamprey	57	0.40	565	1.25	0.05
Longnose Dace	51	0.36	296	0.65	0.03
Central Mudminnow	41	0.29	153	0.34	0.01
Yellow Bullhead	37	0.26	3,020	6.66	0.29
Yellow Perch	37	0.26	826	1.82	0.08
Grass Pickerel	36	0.25	741	1.63	0.07
Silver Redhorse	34	0.24	55,736	122.88	5.40
River Chub	30	0.21	607	1.34	0.06
Common Carp	26	0.18	104,420	230.21	10.11
Spotted Sucker	20	0.14	4,038	8.90	0.39
River Redhorse	19	0.13	66,350	146.28	6.42
American Brook Lamprey	19	0.13	145	0.32	0.01
Northern Pike	12	0.08	5,428	11.97	0.53
Rainbow Trout	10	0.07	3,606	7.95	0.35
Quillback	10	0.07	2,118	4.67	0.21
Pumpkinseed	10	0.07	226	0.50	0.02

Summary of species captured at index sites in Elkhart County, 2011 (continued)

Common Name	Total Number	% by Number	Total Weight (g)	Total Weight (lbs)	% by Weight
Banded Killifish	10	0.07	31	0.07	0.003
Brown Trout	9	0.06	1,779	3.92	0.17
Black Crappie	9	0.06	525	1.16	0.05
Hybrid Sunfish	9	0.06	357	0.79	0.03
Greenside Darter	9	0.06	21	0.05	0.002
Longnose Gar	8	0.06	2,349	5.18	0.23
Bowfin	7	0.05	6,911	15.24	0.67
Brook Silverside	7	0.05	18	0.04	0.00
Walleye	6	0.04	4,212	9.29	0.41
YOY Suckers (Unid.)	6	0.04	74	0.16	0.01
Stonecat	5	0.03	127	0.28	0.01
Pirate Perch	5	0.03	47	0.10	0.005
Warmouth	4	0.03	110	0.24	0.01
Channel Catfish	3	0.02	3,030	6.68	0.29
Black Redhorse	3	0.02	2,550	5.62	0.25
Spotted Gar	1	0.01	726	1.60	0.07
Blackstripe Topminnow	1	0.01	5	0.01	0.0005
Total	**14,289**	**100**	**1,033,076**	**2,277.54**	**100.00**

Summary of species captured at investigative sites in Elkhart County, 2011

Common Name	Total Number	% by Number
Bluntnose Minnow	126	21.91
Hornyhead Chub	67	11.65
Creek Chub	60	10.43
White Sucker	52	9.04
Common Shiner	51	8.87
Sand Shiner	45	7.83
Johnny Darter	25	4.35
Mottled Sculpin	19	3.30
Striped Shiner	18	3.13
Grass Pickerel	18	3.13
Rosyface Shiner	11	1.91
Bluegill	11	1.91
Spotfin Shiner	9	1.57
Silverjaw Minnow	9	1.57
Green Sunfish	7	1.22
Blackside Darter	6	1.04
Blacknose Dace	6	1.04
Pirate Perch	5	0.87
Longear Sunfish	5	0.87
Rainbow Darter	5	0.87
Northern Hog Sucker	4	0.70
Largemouth Bass	3	0.52
Rock Bass	3	0.52
Central Mudminnow	2	0.35
Smallmouth Bass	2	0.35
Stoneroller, Central	2	0.35
Northern Pike	2	0.35
Pumpkinseed	1	0.17
Steelcolor Shiner	1	0.17
Total	**575**	**100**

Index Sites	14,289
Investigative Sites	575
Elkhart County Total	14,864

Summary of species captured at index sites in St. Joseph County, 2011

Common Name	Total Number	% by Number	Total Weight (g)	Total Weight (lbs)	% by Weight
Creek Chub	564	17.97	6,679	14.72	0.94
Longear Sunfish	346	11.03	12,022	26.50	1.69
Bluegill	291	9.27	8,183	18.04	1.15
Mimic Shiner	272	8.67	426	0.94	0.06
Rock Bass	247	7.87	19,648	43.32	2.77
Smallmouth Bass	238	7.58	30,523	67.29	4.30
Golden Redhorse	226	7.20	154,734	341.13	21.79
Mottled Sculpin	145	4.62	812	1.79	0.11
Shorthead Redhorse	90	2.87	71,789	158.27	10.11
White Sucker	57	1.82	14,848	32.73	2.09
Black Redhorse	53	1.69	38,250	84.33	5.39
Green Sunfish	53	1.69	1,598	3.52	0.23
Blacknose Dace	53	1.69	380	0.84	0.05
Logperch	43	1.37	678	1.49	0.10
Quillback	42	1.34	58,570	129.12	8.25
Spotfin Shiner	39	1.24	170	0.37	0.02
Northern Hog Sucker	37	1.18	14,104	31.09	1.99
Rainbow Trout	33	1.05	23,206	51.16	3.27
Redear Sunfish	33	1.05	1,495	3.30	0.21
Bluntnose Minnow	31	0.99	74	0.16	0.01
Spotted Sucker	29	0.92	7,788	17.17	1.10
Common Carp	28	0.89	176,843	389.87	24.91
Pumpkinseed	28	0.89	1204	2.65	0.17
Largemouth Bass	27	0.86	5,980	13.18	0.84
Hornyhead Chub	13	0.41	286	0.63	0.04
Rainbow Darter	13	0.41	22	0.05	0.003
Striped Shiner	12	0.38	280	0.62	0.04
Chestnut Lamprey	12	0.38	138	0.30	0.02
Walleye	9	0.29	6,548	14.44	0.92
Steelcolor Shiner	9	0.29	51	0.11	0.01
Silver Redhorse	8	0.25	12,356	27.24	1.74
Johnny Darter	8	0.25	11	0.02	0.002
Blackside Darter	6	0.19	16	0.04	0.002
Sand Shiner	6	0.19	5	0.01	0.001
Gizzard Shad	4	0.13	3,229	7.12	0.45
Brown Bullhead	4	0.13	2,330	5.14	0.33
Hybrid Sunfish	4	0.13	339	0.75	0.05
Yellow Bullhead	3	0.10	564	1.24	0.08
Black Crappie	3	0.10	537	1.18	0.08
Brown Trout	3	0.10	136	0.30	0.02
Common Shiner	3	0.10	120	0.26	0.02
River Redhorse	2	0.06	7,850	17.31	1.11
Northern Pike	2	0.06	1,178	2.60	0.17
Muskellunge	1	0.03	9,500	20.94	1.34
Channel Catfish	1	0.03	6,000	13.23	0.85
Chinook Salmon	1	0.03	5,000	11.02	0.70
Greater Redhorse	1	0.03	2,200	4.85	0.31
Bowfin	1	0.03	1,289	2.84	0.18

Summary of species captured at index sites in St. Joseph County, 2011

Common Name	Total Number	% by Number	Total Weight (g)	Total Weight (lbs)	% by Weight
Warmouth	1	0.03	36	0.08	0.01
Greenside Darter	1	0.03	6	0.01	0.001
Longnose Gar	1	0.03	5	0.01	0.001
Spottail Shiner	1	0.03	1	0.002	0.0001
	3,138	100	710,037	1,565.36	100

Summary of species captured at investigative sites in St. Joseph County, 2011

Common Name	Total Number	% by Number
Longear Sunfish	238	19.60
Rock Bass	196	16.14
Smallmouth Bass	183	15.07
Golden Redhorse	130	10.71
Bluegill	70	5.77
Spotfin Shiner	58	4.78
White Sucker	55	4.53
Mottled Sculpin	36	2.97
Central Mudminnow	33	2.72
Mimic Shiner	21	1.73
Black Redhorse	17	1.40
Creek Chub	17	1.40
Green Sunfish	17	1.40
Logperch	16	1.32
Spotted Sucker	15	1.24
Blacknose Dace	11	0.91
Common Carp	11	0.91
Bluntnose Minnow	10	0.82
Yellow Bullhead	8	0.66
Shorthead Redhorse	8	0.66
Largemouth Bass	8	0.66
Brown Trout	7	0.58
Quillback	7	0.58
Northern Hog Sucker	5	0.41
Pumpkinseed	5	0.41
Sand Shiner	5	0.41
Redear Sunfish	5	0.41
Blackside Darter	4	0.33
Brook Silverside	2	0.16
Steelcolor Shiner	2	0.16
Gizzard Shad	2	0.16
Hybrid Sunfish	2	0.16
Silver Redhorse	2	0.16
River Redhorse	2	0.16
Greater Redhorse	2	0.16
Fathead Minnow	1	0.08
Johnny Darter	1	0.08
Walleye	1	0.08
Rainbow Darter	1	0.08
Total	1,214	100

Index Sites	3,138
Investigative Sites	1,214
St. Joseph County Total	4,352

Appendix D

Summary of fish collected by site, 2011
(Reference Table 1 for site numbers and locations)

Stream	St. Joseph River, Elkhart County 2011					
Site	Toll Road		Six Span		Bridge Street	
	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass
~American Brook Lamprey			X			
Black Crappie				X	X	
~Black Redhorse				X		X
Blackside Darter	X	X	X	X	X	X
Bluegill	X	X	X	X	X	X
#Bluntnose Minnow	X	X	X	X	X	X
Bowfin	X					
~Brook Silverside	X	X	X			
#Channel Catfish					X	
Chestnut Lamprey	X	X	X	X	X	
#Common Carp	X		X		X	X
~Golden Redhorse	X	X	X	X	X	X
Grass Pickerel	X			X	X	
~Greater Redhorse					X	
Green Sunfish					X	X
~Greenside Darter		X				
~Hornyhead Chub	X	X		X		
Johnny Darter	X	X			X	
Largemouth Bass	X	X	X	X	X	X
~Logperch	X	X		X		X
~Longear Sunfish	X	X	X	X	X	X
#Longnose Gar	X			X	X	X
~Mimic Shiner	X	X	X	X	X	X
~Northern Hog Sucker	X	X	X	X		X
Northern Pike	X				X	X
Pumpkinseed	X			X		X
#Quillback					X	X
~Rainbow Darter	X	X	X	X		
Redear Sunfish	X	X	X			
~River Redhorse		X	X	X	X	X
~Rock Bass	X	X	X	X	X	X
~Rosyface Shiner	X	X				
~Sand Shiner				X		
~Shorthead Redhorse	X	X	X	X	X	X
~Silver Redhorse		X	X	X	X	X
~Smallmouth Bass	X	X	X	X	X	X
Spotfin Shiner	X	X	X	X	X	X
#Spotted Gar				X		
Spotted Sucker	X	X	X	X	X	
Steelcolor Shiner		X				X
Striped Shiner	X	X	X	X		

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Stream	St. Joseph River, Elkhart County 2011 (continued)					
Site	Toll Road		Six Span		Bridge Street	
	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass
Walleye		X			X	
Warmouth						X
#White Sucker		X			X	X
#Yellow Bullhead	X	X		X		
Yellow Perch	X	X		X		

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Stream	St. Joseph River, St. Joseph County 2011								
Site	Ironwood (A)	Ironwood		Howard Park	Angela Boulevard		Darden Road		Auten Road
		1st Pass	2nd Pass		1st Pass	2nd Pass	1st Pass	2nd Pass	
Black Crappie						X			
~Black Redhorse				X	X	X	X	X	X
Blackside Darter	X		X		X			X	X
Bluegill	X	X	X	X	X	X	X	X	X
#Bluntnose Minnow	X	X	X	X	X	X		X	
Bowfin			X						
~Brook Silverside				X					
#Brown Bullhead		X	X						
#Channel Catfish						X			
Chestnut Lamprey		X	X		X		X	X	
#Common Carp	X	X	X	X	X	X			
#Gizzard Shad			X	X	X				
~Golden Redhorse	X	X	X	X	X	X	X	X	X
~Greater Redhorse	X	X		X					
#Green Sunfish	X	X	X	X			X		
~Greenside Darter						X			
~Hornyhead Chub		X							
Hybrid Sunfish	X		X	X		X	X		
Johnny Darter									X
Largemouth Bass	X	X		X	X	X	X	X	X
~Logperch	X		X			X		X	X
~Longear Sunfish	X	X	X	X	X	X	X	X	X
#Longnose Gar			X						
~Mimic Shiner	X	X	X		X	X	X	X	X
Muskellunge							X		
~Northern Hog Sucker	X		X		X	X		X	X
Northern Pike							X	X	
Pumpkinseed	X	X	X	X	X				
#Quillback	X	X	X		X	X	X	X	X
~Rainbow Darter			X	X	X	X		X	
Rainbow Trout							X	X	
Redear Sunfish					X	X	X	X	X
~River Redhorse					X	X			X
~Rock Bass	X	X	X	X	X	X	X	X	X
~Sand Shiner			X						
~Shorthead Redhorse	X	X	X		X	X	X	X	X
~Silver Redhorse					X	X	X	X	X
~Smallmouth Bass	X	X	X	X	X	X	X	X	X
Spotfin Shiner	X	X	X		X	X			X
Spottail Shiner								X	
Spotted Sucker	X	X	X	X		X	X	X	X

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# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Stream	St. Joseph River, St. Joseph County 2011 (continued)								
Site	Ironwood (A)	Ironwood		Howard Park	Angela Boulevard		Darden Road		Auten Road
		1st Pass	2nd Pass		1st Pass	2nd Pass	1st Pass	2nd Pass	
Steelcolor Shiner	X	X			X	X	X		
Walleye			X		X			X	X
Warmouth							X		
#White Sucker			X	X			X	X	
#Yellow Bullhead	X			X				X	

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Tributaries of St. Joseph River, Elkhart County 2011									
Stream	Trout Creek		Little Elkhart River		Pine Creek			Puterbaugh Creek	
Site	CR 2		SR 120		CR 20	US 20		Reedy Drive	
	1st Pass	2nd Pass	1st Pass	2nd Pass		1st Pass	2nd Pass	1st pass	2nd Pass
~Am. Brook Lamprey	X	X	X	X					
#Blacknose Dace					X	X	X		
Blackside Darter		X	X	X					
Bluegill	X	X	X	X	X	X	X	X	X
#Bluntnose Minnow	X	X	X						
Bowfin	X	X							
Brown Trout	X		X	X					
#Central Mudminnow			X	X	X	X	X	X	X
Chestnut Lamprey				X					
Common Shiner	X	X							
#Creek Chub		X		X	X	X	X		
~Golden Redhorse	X								
Grass Pickerel			X	X	X	X	X	X	X
#Green Sunfish			X	X	X	X	X		
~Greenside Darter	X	X							
~Hornyhead Chub	X	X						X	
Hybrid Sunfish	X	X							
Johnny Darter		X		X	X			X	X
Largemouth Bass	X	X		X			X		X
~Logperch	X	X	X	X				X	
~Longear Sunfish	X								
Mottled Sculpin			X	X	X	X	X	X	X
~Northern Hog Sucker	X		X	X					
Pirate Perch								X	
~Rainbow Darter	X	X	X	X				X	
Rainbow Trout			X	X					
Redear Sunfish	X	X						X	X
~Rock Bass	X	X	X	X					
~Rosyface Shiner			X	X					
~Shorthead Redhorse			X	X					
~Silver Redhorse			X						
~Smallmouth Bass	X	X	X	X					X
Spotfin Shiner	X								
Spotted Sucker		X							
~Stonecat		X							
Striped Shiner	X		X						
Warmouth								X	

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# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Tributaries of St. Joseph River, Elkhart County 2011									
Stream	Trout Creek		Little Elkhart River		Pine Creek			Puterbaugh Creek	
Site	CR 2		SR 120		CR 20	US 20		Reedy Drive	
	1st Pass	2nd Pass	1st Pass	2nd Pass		1st Pass	2nd Pass	1st pass	2nd Pass
#White Sucker		X	X	X	X	X	X	X	X
#Yellow Bullhead		X						X	X
Yellow Perch	X	X						X	X
YOY Suckers (Unid.)			X						

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Tributaries of St. Joseph River , Elkhart County 2011										
Stream	Christiana Creek				Yellow Creek		Baugo Creek			
Site	CR6		Willowdale Park		US 20 Bypass		Restoration		Restoration (B)	
	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass
~American Brook Lamprey	X									
#Banded Killifish									X	X
Black Crappie						X				
#Blacknose Dace					X	X	X	X	X	X
Blackside Darter				X		X	X	X	X	X
Bluegill	X	X	X	X	X	X	X	X	X	X
#Bluntnose Minnow	X	X	X	X	X	X	X	X	X	X
Brown Trout	X									
#Central Mudminnow					X					X
#Channel Catfish		X								
Chestnut Lamprey	X		X			X			X	
#Common Carp	X		X	X						
Common Shiner					X	X				X
#Creek Chub				X	X	X	X	X	X	X
~Golden Redhorse	X	X	X	X				X		X
Grass Pickerel		X	X	X						
#Green Sunfish	X				X	X	X	X		X
~Greenside Darter									X	
~Hornyhead Chub	X	X	X	X	X	X				
Hybrid Sunfish		X	X							
Johnny Darter			X		X	X	X	X	X	X
Largemouth Bass		X		X	X	X	X	X	X	X
~Logperch		X	X	X			X	X	X	X
~Longear Sunfish									X	X
#Longnose Gar	X					X	X	X	X	X
~Mimic Shiner							X	X	X	
Mottled Sculpin										
~Northern Hog Sucker	X	X	X	X	X					
Northern Pike						X				
Orangethroat Darter	X				X	X	X	X	X	
Pirate Perch							X			X
Pumpkinseed				X						
#Quillback										X
~Rainbow Darter	X	X	X	X		X	X	X	X	X
~River Chub	X	X								
~Rock Bass	X	X	X	X			X	X		X
~Rosyface Shiner										X
~Sand Shiner							X	X		X
~Shorthead Redhorse	X		X	X			X	X	X	X
~Silver Redhorse	X		X						X	
Silverjaw Minnow					X	X	X	X	X	X
~Smallmouth Bass	X	X	X	X		X	X	X	X	X
Spotfin Shiner		X	X	X			X	X	X	X

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Tributaries of St. Joseph River , Elkhart County 2011 (continued)										
Stream	Christiana Creek				Yellow Creek		Baugo Creek			
Site	CR6		Willowdale Park		US 20 Bypass		Restoration		Restoration (B)	
	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass
Steelcolor Shiner		X		X			X	X		X
~Stonecat	X									
Central Stoneroller						X	X	X	X	X
Striped Shiner	X	X	X	X	X	X	X	X	X	X
Walleye		X					X	X		
#White Sucker	X	X	X	X	X	X	X	X	X	X
#Yellow Bullhead	X	X	X	X			X			X

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Stream	Elkhart River, Elkhart County 2011									
Site	Baintertown		Oxbow (A)		Hively Avenue		Studebaker Park		American Park	
	Below	Divergence	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass	1st Pass	2nd Pass
~American Brook Lamprey			X	X	X		X		X	X
Black Crappie				X		X	X		X	
#Blacknose Dace		X								
Blackside Darter	X	X								
Blackstripe Topminnow					X					
Bluegill	X	X	X	X	X	X	X	X	X	X
#Bluntnose Minnow	X	X					X		X	
#Central Mudminnow	X									
Chestnut Lamprey			X		X	X	X		X	
#Common Carp							X			
Common Shiner	X	X				X			X	
#Creek Chub	X	X			X					
~Golden Redhorse			X	X	X	X	X	X	X	X
Grass Pickerel	X	X							X	X
~Greater Redhorse									X	
#Green Sunfish	X		X	X	X	X	X	X	X	X
~Hornyhead Chub	X	X	X	X	X	X	X	X		
Johnny Darter	X	X								
Largemouth Bass	X	X		X	X	X	X	X	X	X
~Longear Sunfish	X		X	X	X	X	X	X	X	X
~Northern Hog Sucker		X	X	X	X	X	X	X		X
Northern Pike	X			X	X				X	
Pirate Perch	X	X	X			X				
Pumpkinseed	X			X		X				
~Rainbow Darter	X	X	X			X		X		
Redear Sunfish						X		X		X
~River Redhorse					X				X	
~Rock Bass	X	X	X	X	X	X	X	X	X	X
~Rosyface Shiner	X	X	X	X	X		X		X	X
~Sand Shiner	X	X					X			
Silverjaw Minnow	X						X			
~Smallmouth Bass		X	X	X	X	X	X	X	X	X
Spotfin Shiner	X	X						X		X
Spotted Sucker						X		X		X
Steelcolor Shiner	X			X	X		X		X	
~Stonecat				X		X				
Central Stoneroller	X									
Striped Shiner	X		X	X	X	X	X	X	X	
Warmouth					X			X		
#White Sucker	X	X	X	X	X	X	X	X	X	X
#Yellow Bullhead				X						
Yellow Perch								X		X

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Tributaries to St. Jospeh River, St. Joseph County 2011										
Stream	Juday Creek						Auten Ditch East Branch		Bowman Creek	
Site	Capital Avenue	Holy Cross Pkwy	Kintz Avenue		Isaac Walton League		Roosevelt Road	Locust Road (S)	Studebaker Golf Course	
			1st Pass	2nd Pass	1st Pass	2nd Pass			1st Pass	2nd Pass
#Blacknose Dace	X	X	X	X	X	X				
Bluegill	X	X	X	X						
Brown Trout		X	X	X						
#Central Mudminnow							X	X		
#Creek Chub		X	X	X	X	X	X	X	X	X
#Fathead Minnow							X			
#Green Sunfish		X	X	X				X		
Hybrid Sunfish			X							
Johnny Darter			X	X						
Largemouth Bass										X
Mottled Sculpin	X	X	X	X	X	X				
~Rainbow Darter					X	X				
Rainbow Trout			X	X	X	X				
~Rock Bass			X	X						
#White Sucker	X	X	X	X	X	X				

~ - denotes a species that is SENSITIVE to environmental disturbances such as degraded water quality or habitat
# - denotes a species that is TOLERANT of environmental disturbances such as degraded water quality or habitat

Appendix E

Summary of macroinvertebrates (insects) collected by site, 2011

Macroinvertebrates were collected in two ways to calculate the Invertebrate Community Index (ICI). The first method employed a sampling device known as a Hester-Dendy multi-plate sampler (HD sampler). Macroinvertebrates collected using this method were identified and counted (Quantitative column in the following tables). The second method was a sweep with a net of all the available habitat types in the area of the Hester-Dendy in an effort to identify other macroinvertebrates in the stream that may not colonize the HD samplers. Macroinvertebrates collected in this way were identified and simply counted as being present (Qualitative column).

Site: St. Joseph River (Six Span)

Collection Date: 8/11/11

Site Number: 1

Taxa Name	Quantitative	Qualitative	Tolerance
Turbellaria	109		F
Oligochaeta	16	+	T
Hyalella azteca	6	+	F
Gammarus sp	44		F
Gammarus fasciatus	0	+	F
Acentrella sp	0	+	I
Plauditus dubius or P. virilis	0	+	I
Baetis intercalaris	9	+	F
Pseudocloeon propinquum	0	+	I
Plauditus punctiventris	0	+	MI
Centroptilum sp (w/o hindwing	4		MI
Procloeon sp (w/o hindwing	9	+	MI
Isonychia sp	0	+	MI
Leucrocuta sp	7		I
Stenacron sp	128	+	F
Stenonema exiguum	409	+	I
Stenonema mediopunctatum	1		I
Stenonema mexicanum in-	9		MI
Stenonema pulchellum	169		MI
Stenonema terminatum	44		MI
Serratella sp	20	+	I
Tricorythodes sp	662		MI
Caenis sp	20		F
Coenagrionidae	0	+	MT
Acroneuria internata	5	+	MI
Neoperla clymene complex	1	+	I
Trichocorixa sp	0	+	F
Neureclipsis sp	12	+	MI
Polycentropus sp	1	+	MI
Cheumatopsyche sp	21	+	F
Ceratopsyche sparna	2		MI
Hydropsyche phalerata	15	+	MI
Hydropsyche valanis	2		F
Macrostemum zebratum	2	+	I
Agraylea sp	19		F
Hydroptila sp	32		F
Ochrotrichia sp	21		MI
Brachycentrus numerosus	1	+	MI
Pycnopsyche sp	0	+	MI
Oecetis avara	1	+	I
Oecetis persimilis	0	+	MI
Dineutus sp	5	+	F
Psephenus herricki	0	+	MI
Macronychus glabratus	48	+	MI
Stenelmis sp	5	+	F
Ablabesmyia janta	78		F
Hayesomyia senata or Thiene-	12		F
Labrundinia sp	10		F
Nilotanypus fimbriatus	4	+	MI
Pentaneura inconspicua	39		F
Corynoneura sp	10		MI
Corynoneura lobata	4		MI
Cricotopus (C.) sp	39		F
Cricotopus (C.) bicinctus	39		MT
Nanocladius (N.) crassicornus or	10		F
Thienemanniella xena	8		F
Dicrotendipes neomodestus	481	+	F
Polypedilum (Uresipedilum) fla-	246		F
Polypedilum (P.) illinoense	20	+	T
Polypedilum (Tripodura)	12		F
Tanytarsus sepp	10		MI
Hemerodromia sp	8		F
Physella sp	9	+	T
Corbicula fluminea	0	+	MI
Sphaerium sp	0	+	F

No. Quantitative Taxa: 52 Number of Organisms: 2898

No. Qualitative Taxa: 36 Qual EPT: 21

Total Taxa: 65 **ICI: 40**

Tolerance MT = Moderately Tolerant

F = Facultative T = Tolerant

I = Intolerant VT = Very Tolerant

MI = Moderately Intolerant

Site: St. Joseph River (Bridge Street)

Collection Date: Site Number: 2

Taxa Name	Quantitative	Qualitative	Tolerance	Taxa Name	Quantitative	Qualitative	Tolerance
Spongillidae	0	+	MI	Helicopsyche borealis	0	+	MI
Turbellaria	97	+	F	Nectopsyche sp	0	+	MI
Nemertea	8		F	Nectopsyche exquisita	0	+	MI
Nematoda	16			Oecetis sp	1	+	MI
Fredericella sp	3		MI	Petrophila sp	20		I
Oligochaeta	8		T	Macronychus glabratus	12	+	MI
Caecidotea sp	0	+	MT	Stenelmis sp	8	+	F
Gammarus sp	1	+	F	Antocha sp	8		MI
Acentrella sp	28		I	Simulium sp	4		F
Plauditus sp	68		MI	Tanypodinae	0	+	
Plauditus dubius	5		MI	Ablabesmyia janta	0	+	F
Pseudocloeon sp	0	+	I	Hayesomyia senata or Thieneman-	10	+	F
Baetis intercalaris	37	+	F	Nilotanypus fimbriatus	4	+	MI
Plauditus punctiventris	18		MI	Cricotopus (C.) sp	95		F
Isonychia sp	116	+	MI	Cricotopus (C.) bicinctus	85	+	MT
Leucrocuta sp	9	+	I	Nanocladius (N.) crassicornus or N.	10		F
Stenacron sp	2	+	F	Nanocladius (N.) spiniplenus	0	+	MI
Stenonema exiguum	228	+	I	Tvetenia discoloripes group	10		I
Stenonema mediopuncta-	1		I	Dicrotendipes neomodestus	161	+	F
Stenonema pulchellum	196	+	MI	Polypedilum (Uresipedilum) flavum	217	+	F
Stenonema terminatum	13	+	MI	Polypedilum (P.) illinoense	10		T
Serratella sp	64	+	I	Tribelos fuscicorne	0	+	F
Tricorythodes sp	49	+	MI	Tribelos jucundum	0	+	F
Caenis sp	0	+	F	Rheotanytarsus pellucidus	10		MI
Anthopotamus sp	0	+	MI	Rheotanytarsus sp	150	+	MI
Corydalus cornutus	1		MI	Sublettea coffmani	10		I
Polycentropus sp	8	+	MI	Hemerodromia sp	24	+	F
Cheumatopsyche sp	600	+	F	Elimia sp	0	+	MI
Hydropsyche aerata	0	+	MI	Lampsilis radiata luteola	0	+	MI
Hydropsyche phalerata	34	+	MI				
Hydropsyche simulans	12		MI				
Macrostemum zebratum	163	+	I				
Hydroptilidae	0	+	F				
Hydroptila sp	33		F				
Ochrotrichia sp	58		MI				
Brachycentrus numerosus	21	+	MI				
Neophylax sp	0	+	I				
Pycnopsyche sp	0	+	MI				

No. Quantitative Taxa: 48 Number of Organisms: 2746

No. Qualitative Taxa: 45 Qual EPT: 25

Total Taxa: 67 **ICI: 42**

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Site: St. Joseph River (Ironwood Drive)

Collection Date: Site Number: 3

Taxa Name	Quantitative	Qualitative	Tolerance
Porifera	0	+	
Hydra sp	5		F
Turbellaria	15	+	F
Ectoprocta	3		
Urnatella gracilis	37		F
Oligochaeta	1	+	T
Helobdella triserialis	1		T
Caecidotea sp	0	+	MT
Crangonyx sp	0	+	MT
Gammarus sp	32	+	F
Leucrocuta sp	2		I
Stenacron sp	107	+	F
Stenonema exiguum	2	+	I
Stenonema mexicanum in-	1		MI
Tricorythodes sp	3	+	MI
Brachycercus sp	0	+	I
Caenis sp	1	+	F
Coenagrionidae	0	+	MT
Argia sp	0	+	F
Polycentropus sp	3	+	MI
Cheumatopsyche sp	2		F
Macrostemum zebratum	0	+	I
Hydroptila sp	0	+	F
Oxyethira sp	0	+	F
Brachycentrus numerosus	0	+	MI
Macronychus glabratus	4	+	MI
Stenelmis sp	0	+	F
Ablabesmyia janta	6	+	F
Ablabesmyia mallochi	6	+	F
Labrundinia pilosella	4		MI
Procladius (Holotanypus) sp	0	+	MT
Corynoneura n.sp 8	4		
Cricotopus (C.) sp	2		F
Cryptotendipes pseudotener	0	+	MI
Dicrotendipes sp	6		F
Dicrotendipes neomodestus	115		F
Endochironomus sp	8		F
Glyptotendipes (G.) sp	13		MT
Parachironomus carinatus	2		F
Phaenopsectra flavipes	2		F
Polypedilum (P.) illinoense	38		T
Polypedilum (Tripodura) halterale	0	+	F
Stenochironomus sp	2		F
Tribelos fuscicorne	10	+	F
Tanytarsus sp	2	+	MI
Hemerodromia sp	1		F
Elimia sp	1	+	MI
Physella sp	1	+	T
Ferrissia sp	10		F
Corbicula fluminea	0	+	MI

No. Quantitative Taxa:	35
No. Qualitative Taxa:	30
Total Taxa:	50
Number of Organisms:	452
Qual EPT:	10
ICI:	**30**

Tolerance

F = Facultative	MT = Moderately Tolerant
I = Intolerant	T = Tolerant
MI = Moderately Intolerant	VT = Very Tolerant

Site: St. Joseph River (Angela Blvd)

Collection Date: Site Number: 4

Taxa Name	Quantitative	Qualitative	Tolerance
Nemertea		+	F
Oligochaeta		+	T
Gammarus fasciatus		+	F
Plauditus sp		+	MI
Plauditus dubius		+	MI
Baetis flavistriga		+	F
Baetis intercalaris		+	F
Isonychia sp		+	MI
Stenacron sp		+	F
Stenonema exiguum		+	I
Stenonema femoratum		+	F
Stenonema pulchellum		+	MI
Serratella sp		+	I
Tricorythodes sp		+	MI
Polycentropus sp		+	MI
Cheumatopsyche sp		+	F
Hydropsyche phalerata		+	MI
Macrostemum zebratum		+	I
Protoptila sp		+	I
Hydroptila sp		+	F
Ochrotrichia sp		+	MI
Brachycentrus numerosus		+	MI
Macronychus glabratus		+	MI
Simulium sp		+	F
Procladius (Holotanypus) sp		+	MT
Cricotopus (C.) bicinctus		+	MT
Tvetenia discoloripes group		+	I
Chironomus (C.) decorus group		+	T
Cryptochironomus sp		+	F
Polypedilum (Uresipedilum) flavum		+	F
Polypedilum (P.) illinoense		+	T
Rheotanytarsus pellucidus		+	MI
Rheotanytarsus sp		+	MI
Elimia sp		+	MI
Physella sp		+	T
Ferrissia sp		+	F
Corbicula fluminea		+	MI

No Quantitative Taxa:	0*
No. Qualitative Taxa:	37
Total Taxa:	37
Number of Organisms:	0
Qual EPT:	19
ICI:	**Good**

Tolerance

F = Facultative	MT = Moderately Tolerant
I = Intolerant	T = Tolerant
MI = Moderately Intolerant	VT = Very Tolerant

* Quantitative data were not gathered due

Site: St. Joseph River (Darden Road)

Collection Date: Site Number: 5

Taxa Name	Quantitative	Qualitative	Tolerance
Porifera	1		
Turbellaria	8		F
Nemertea	2		F
Paludicella articulata	1		MI
Oligochaeta	17		T
Caecidotea sp	0	+	MT
Hyalella azteca	0	+	F
Crangonyx sp	0	+	MT
Baetis sp	5		F
Baetis flavistriga	5	+	F
Baetis intercalaris	110	+	F
Isonychia sp	10	+	MI
Stenacron sp	94	+	F
Stenonema exiguum	34	+	I
Stenonema mediopunctatum	1		I
Stenonema pulchellum	29	+	MI
Serratella sp	1		I
Tricorythodes sp	4	+	MI
Calopterygidae	4		
Argia sp	20	+	F
Boyeria vinosa	0	+	F
Macromia sp	1		F
Chimarra obscura	0	+	MI
Polycentropodidae	0	+	
Neureclipsis sp	4		MI
Nyctiophylax sp	1		MI
Cheumatopsyche sp	64	+	F
Hydropsyche phalerata	1	+	MI
Macrostemum zebratum	2	+	I
Protoptila sp	12	+	I
Hydroptila sp	2		F
Brachycentrus numerosus	4	+	MI
Mystacides sepulchralis	0	+	MI
Nectopsyche sp	0	+	MI
Oecetis persimilis	6		MI
Hydrocanthus sp	0	+	
Berosus sp	0	+	MT
Psephenus herricki	0	+	MI
Macronychus glabratus	68	+	MI
Simulium sp	2	+	F
Tanypodinae	1		
Ablabesmyia sp	1		
Nilotanypus fimbriatus	0	+	MI
Pentaneura sp	1		F
Thienemanniella xena	7		F
Chironomus sp	0	+	T
Cryptochironomus sp	0	+	F
Dicrotendipes sp	1		F
Polypedilum sp	2		
Polypedilum (Uresipedilum) fla-	20	+	F
Polypedilum (P.) fallax group	4		F
Polypedilum (P.) illinoense	39	+	T
Polypedilum (P.) laetum group	1		MI
Stenochironomus sp	2		F
Tribelos fuscicorne	6		F
Hemerodromia sp	5		F
Elimia sp	18	+	MI
Fossaria sp	2		F
Physella sp	5	+	T
Planorbella sp	0	+	T
Ferrissia sp	23	+	F
Corbicula fluminea	0	+	MI

No. Quantitative Taxa:	46
No. Qualitative Taxa:	36
Total Taxa:	62
Number of Organisms:	651
Qual EPT:	16
ICI:	**38**

Tolerance

F = Facultative	MT = Moderately Tolerant
I = Intolerant	T = Tolerant
MI = Moderately Intolerant	VT = Very Tolerant

Site: Little Elkhart River (State Road 120)

Collection Date: Site Number: 6

Taxa Name	Quantitative	Qualitative	Tolerance	Taxa Name	Quantitative	Qualitative	Tolerance
Hydra sp	2		F	Conchapelopia sp	1		F
Turbellaria	0	+	F	Nilotanypus fimbriatus	3		MI
Plumatella sp	1		F	Procladius sp	0	+	MT
Glossiphoniidae	0	+	F	Thienemannimyia group	1		F
Caecidotea sp	0	+	MT	Brillia flavifrons group	1		F
Crangonyx sp	0	+	MT	Corynoneura lobata	1		MI
Orconectes sp	0	+	F	Orthocladius (O.) sp	3	+	F
Baetis flavistriga	92	+	F	Parametriocnemus sp	3		MI
Baetis intercalaris	7		F	Rheocricotopus (Psilocricotopus)	2	+	MI
Pseudocloeon propinquum	0	+	I	Thienemanniella taurocapita	4		I
Procloeon sp	1	+	MI	Tvetenia bavarica group	35	+	MI
Isonychia sp	1	+	MI	Chironomus (C.) riparius group	0	+	VT
Stenacron sp	1	+	F	Dicrotendipes sp	1		F
Stenonema exiguum	30	+	I	Microtendipes "caelum"	1		MI
Stenonema terminatum	78	+	MI	Polypedilum (Uresipedilum) fla-	2		F
Hetaerina sp	1	+	F	Polypedilum (P.) fallax group	2		F
Pteronarcys sp	0	+	I	Tribelos jucundum	1		F
Paragnetina sp	3		I	Rheotanytarsus sp	29	+	MI
Trichocorixa sp	0	+	F	Tanytarsus glabrescens group sp	0	+	MI
Sialis sp	0	+	F	Chelifera sp	4	+	MI
Lype diversa	2		MI	Hemerodromia sp	1		F
Polycentropus sp	0	+	MI	Elimia sp	0	+	MI
Cheumatopsyche sp	26	+	F	Fossaria sp	1		F
Ceratopsyche morosa group	7	+	MI	Physella sp	0	+	T
Ceratopsyche sparna	101	+	MI	Ferrissia sp	3		F
Hydropsyche depravata	2		F	Corbicula fluminea	0	+	MI
Brachycentrus numerosus	11	+	MI	Sphaerium sp	0	+	F
Peltodytes sp	0	+	MT				
Scirtidae	0	+	F				
Macronychus glabratus	8	+	MI				
Stenelmis sp	0	+	F				
Antocha sp	4		MI				
Tipula sp	1		F				
Dixella sp	0	+	F				
Simulium sp	2		F				
Ablabesmyia mallochi	0	+	F				
Clinotanypus pinguis	0	+	T				

No. Quantitative Taxa: 41 Number of Organisms: 480

No. Qualitative Taxa: 40 Qual EPT: 13

Total Taxa: 64 **ICI: 52**

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Site: Christiana Creek (County Road 6)

Collection Date: 8/12/11 Site Number: 7

Taxa Name	Quantitative	Qualitative	Tolerance
Turbellaria	15	+	F
Oligochaeta	0	+	T
Caecidotea sp	0	+	MT
Hyalella azteca	0	+	F
Gammarus sp	41	+	F
Orconectes rusticus x sanbornii	0	+	F
Hydracarina	0	+	F
Baetis flavistriga	32	+	F
Pseudocloeon frondale	0	+	I
Baetis intercalaris	304	+	F
Plauditus punctiventris	15	+	MI
Heterocloeon curiosum	7		I
Procloeon irrubrum	0	+	MI
Stenacron sp	7	+	F
Stenonema exiguum	172	+	I
Stenonema mediopunctatum	3	+	I
Stenonema mexicanum integrum	0	+	MI
Stenonema pulchellum	72	+	MI
Stenonema terminatum	6		MI
Serratella sp	60	+	I
Tricorythodes sp	5	+	MI
Calopterygidae	1	+	
Hetaerina sp	0	+	F
Coenagrionidae	2		MT
Stylurus sp	0	+	MI
Acroneuria internata	0	+	MI
Corydalus cornutus	3	+	MI
Chimarra obscura	1		MI
Neureclipsis sp	1	+	MI
Cheumatopsyche sp	35	+	F
Ceratopsyche morosa	0	+	MI
Ceratopsyche sparna	26	+	MI
Hydropsyche phalerata	21	+	MI
Protoptila sp	0	+	I
Hydroptila sp	3		F
Brachycentrus numerosus	8	+	MI
Lepidostoma sp	0	+	MI
Helicopsyche borealis	4	+	MI
Nectopsyche sp	0	+	MI
Petrophila sp	2		I
Dineutus sp	0	+	F
Ectopria sp	1	+	MI
Macronychus glabratus	33	+	MI
Optioservus sp	0	+	MI
Stenelmis sp	7	+	F
Diptera	4		
Simuliidae	0	+	
Simulium sp	5	+	F
Conchapelopia sp	1		F
Hayesomyia senata or Thienemannimyia	1		F
Nilotanypus fimbriatus	1		MI
Pentaneura inconspicua	1		F
Cardiocladius albiplumus	0	+	F
Cricotopus (C.) sp	0	+	F
Eukiefferiella brehmi group	0	+	MI
Rheocricotopus (Psilocricotopus) robacki	2		MI
Thienemanniella taurocapita	8		I
Thienemanniella xena	10	+	F
Tvetenia discoloripes group	14		I
Microtendipes "caelum" (sensu Simpson	3		MI
Microtendipes pedellus group	3	+	MI
Polypedilum (Uresipedilum) flavum	14	+	F
Polypedilum (P.) fallax group	1		F
Polypedilum (Tripodura) scalaenum	1		F
Tribelos jucundum	0	+	F
Rheotanytarsus pellucidus	1		MI
Rheotanytarsus sp	21		MI
Hemerodromia sp	11		F
Elimia sp	5	+	MI
Physella sp	0	+	T
Ferrissia sp	105		F
Sphaeriidae	4		

No. Quantitative Taxa:	49
No. Qualitative Taxa:	50
Total Taxa:	72
Number of Organisms:	1103
Qual EPT:	23
ICI:	**48**

Tolerance

F = Facultative	MT = Moderately Toler-
I = Intolerant	T = Tolerant
MI = Moderately Intolerant	VT = Very Tolerant

Site: Elkhart River (Hively Ave - CR18)

Collection Date: 8/12/11 Site Number: 8

Taxa Name	Quantitative	Qualitative	Tolerance
Spongillidae	0	+	MI
Turbellaria	20		F
Oligochaeta	4		T
Caecidotea sp	0	+	MT
Gammarus sp	9	+	F
Orconectes rusticus x sanbornii	0	+	F
Hydracarina	0	+	F
Baetis flavistriga	21	+	F
Pseudocloeon frondale	6	+	I
Baetis intercalaris	12		F
Plauditus punctiventris	4	+	MI
Isonychia sp	220	+	MI
Leucrocuta sp	9	+	I
Stenacron sp	107	+	F
Stenonema exiguum	282	+	I
Stenonema pulchellum	104	+	MI
Stenonema terminatum	26	+	MI
Serratella sp	4		I
Tricorythodes sp	103	+	MI
Caenis sp	0	+	F
Calopteryx sp	0	+	F
Hetaerina sp	2	+	F
Argia sp	8		F
Pteronarcys sp	1		I
Agnetina capitata complex	24		I
Corydalus cornutus	1		MI
Polycentropodidae	0	+	
Nyctiophylax sp	1		MI
Polycentropus sp	3	+	MI
Cheumatopsyche sp	72	+	F
Ceratopsyche morosa group	2		MI
Hydropsyche depravata group	2		F
Hydropsyche phalerata	4	+	MI
Hydroptila sp	10		F
Brachycentrus numerosus	9		MI
Neophylax sp	0	+	I
Pycnopsyche sp	0	+	MI
Lepidostoma sp	0	+	MI
Helicopsyche borealis	1	+	MI
Ancyronyx variegata	8		MI
Macronychus glabratus	16	+	MI
Antocha sp	6		MI
Simulium sp	0	+	F
Ceratopogonidae	4		F
Tanypodinae	3		
Ablabesmyia mallochi	6	+	F
Ablabesmyia rhamphe group	3		MT
Hayesomyia senatam or Thienemannimyia norena	6	+	F
Nilotanypus fimbriatus	4		MI
Pentaneura inconspicua	3		F
Procladius (Holotanypus) sp	0	+	MT
Rheopelopia paramaculipennis	11		MI
Corynoneura "celeripes"	3		I
Corynoneura lobata	8		MI
Cricotopus (C.) sp	3		F
Cricotopus (C.) bicinctus	3		MT
Cricotopus (C.) tremulus group	3		F
Thienemanniella similis	2		I
Tvetenia discoloripes group	6		I
Cryptotendipes pseudotener	0	+	MI
Dicrotendipes neomodestus	99	+	F
Microtendipes "caelum"	14	+	MI
Paratendipes albimanus or P. duplicatus	0	+	MI
Phaenopsectra obediens group	3		F
Polypedilum (Uresipedilum) flavum	42	+	F
Polypedilum (P.) fallax group	3		F
Polypedilum (P.) laetum group	3		MI
Polypedilum (Tripodura) halterale group	3		F
Polypedilum (Tripodura) scalaenum group	3		F
Rheotanytarsus pellucidus	0	+	MI
Rheotanytarsus sp	20		MI
Tanytarsus sp	0	+	MI
Tanytarsus sepp	6		MI
Chrysops sp	0	+	F
Elimia sp	50	+	MI
Physella sp	0	+	T
Planorbella (Pierosoma) pilsbryi	0	+	T
Ferrissia sp	10	+	F
Corbicula fluminea	0	+	MI
Sphaerium sp	0	+	

No. Quantitative Taxa: 59 Number of Organisms: 1425

No. Qualitative Taxa: 45 Qual EPT: 19

Total Taxa: 80 **ICI: 50**

Tolerance

F = Facultative MT = Moderately Tolerant

I = Intolerant T = Tolerant

MI = Moderately Intolerant VT = Very Tolerant

Site: Elkhart River (American Park)

Collection Date: 8/11/11 Site Number: 9

Taxa Name	Quantitative	Qualitative	Tolerance
Hydra sp	2	F	F
Gammarus sp	1	F	F
Plauditus dubius	1	MI	F
Baetis flavistriga	21	F	T
Baetis intercalaris	138	F	T
Plauditus punctiventris	1	MI	MT
Procloeon irrubrum	4	MI	F
Isonychia sp	350	MI	MI
Leucrocuta sp	3	I	F
Stenacron sp	26	F	F
Stenonema exiguum	384	I	F
Stenonema mediopunctatum	1	I	MI
Stenonema mexicanum integrum	1	MI	I
Stenonema pulchellum	136	MI	MI
Stenonema terminatum	48	MI	F
Serratella sp	9	I	F
Tricorythodes sp	22	MI	
Caenis sp	0	F	F
Nasiaeschna pentacantha	0	F	MI
Gomphus sp	0	F	MI
Stylurus sp	0	MI	F
Pteronarcys sp	0	I	MI
Acroneuria internata	1	MI	F
Paragnetina sp	5	I	MI
Agnetina capitata complex	9	I	MI
Corydalus cornutus	1	MI	MI
Polycentropus sp	3	MI	F
Cheumatopsyche sp	53	F	MI
Hydropsyche depravata group	0	F	F
Hydropsyche phalerata	6	MI	F
Brachycentrus numerosus	12	MI	MI
Nectopsyche sp	0	MI	F
Helichus sp	0	MI	F
Dubiraphia vittata group	0	F	I
Macronychus glabratus	10	MI	MI
Stenelmis sp	0	F	MT
Simulium sp	1	F	F
Tanypodinae	1		F
Ablabesmyia sp	2		MI
Ablabesmyia mallochi	1	F	F
Clinotanypus pinguis	0	T	MI
Nilotanypus fimbriatus	12	MI	T
Orthocladiinae	1		F
Corynoneura lobata	2	MI	F
Cricotopus (C.) sp	2	F	MI
Cricotopus (C.) tremulus group	1	F	F
Rheocricotopus (Psilocricotopus)	1	MI	F
Thienemanniella xena	1	F	F
Dicrotendipes neomodestus	3	F	T
Microtendipes pedellus group	1	MI	F
Paratendipes albimanus or P. dupli-	1	MI	F
Phaenopsectra obediens group	1	F	MI
Polypedilum (Uresipedilum) flavum	42	F	MI
Polypedilum (P.) illinoense	3	T	F
Polypedilum (P.) laetum group	1	MI	T
Polypedilum (Tripodura) scalaenum	2	F	F
Tribelos fuscicorne	5	F	
Tribelos jucundum	1	F	
Rheotanytarsus sp	24	MI	
Tanytarsus sepp	5	MI	
Elimia sp	0	MI	
Physella sp	0	T	

No. Quantitative Taxa:	49
No. Qualitative Taxa:	34
Total Taxa:	62
Number of Organisms:	1362
Qual EPT:	17
ICI:	**50**

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Site: Yellow Creek (US 20 Bypass)

Collection Date: 8/12/11 Site Number: 10

Taxa Name	Quantitative	Qualitative	Tolerance
Hydra sp	2		F
Turbellaria	24	+	F
Plumatella sp	2	+	F
Oligochaeta	6	+	T
Erpobdella punctata punctata	0	+	T
Caecidotea sp	4	+	MT
Hydracarina	6	+	F
Baetis tricaudatus	2		MI
Baetis flavistriga	468	+	F
Baetis intercalaris	42	+	F
Stenacron sp	26	+	F
Stenonema terminatum	2		MI
Serratella sp	4		I
Tricorythodes sp	0	+	MI
Hetaerina sp	2	+	F
Boyeria vinosa	0	+	F
Polycentropodidae	1		
Cheumatopsyche sp	99	+	F
Ceratopsyche morosa group	277	+	MI
Ceratopsyche sparna	179	+	MI
Hydropsyche depravata group	1060	+	F
Psephenus herricki	0	+	MI
Scirtidae	0	+	F
Ancyronyx variegata	2	+	MI
Macronychus glabratus	18	+	MI
Optioservus sp	2		MI
Stenelmis sp	0	+	F
Antocha sp	4		MI
Tipula sp	6		F
Simulium sp	12	+	F
Nilotanypus fimbriatus	5	+	MI
Pentaneura sp	6		F
Thienemannimyia group	11		F
Corynoneura "celeripes" (sensu Simp-	27		I
Corynoneura lobata	11		MI
Cricotopus (C.) bicinctus	11		MT
Cricotopus (C.) tremulus group	54		F
Orthocladius (O.) sp	74	+	F
Rheocricotopus (Psilocricotopus)	11		MI
Thienemanniella sp	11		F
Tvetenia bavarica group	35	+	MI
Chironomus sp	0	+	T
Dicrotendipes sp	6	+	F
Dicrotendipes fumidus	0	+	F
Microtendipes "caelum" (sensu	13	+	MI
Phaenopsectra obediens group	0	+	F
Polypedilum (Uresipedilum) flavum	432	+	F
Polypedilum (P.) fallax group	6	+	F
Polypedilum (P.) illinoense	0	+	T
Polypedilum (Tripodura) scalaenum	0	+	F
Stenochironomus sp	6		F
Rheotanytarsus sp	321	+	MI
Tanytarsus glabrescens group sp 7	38	+	MI
Hemerodromia sp	2		F
Physella sp	4		T
Ferrissia sp	10	+	F

No. Quantitative Taxa:	45
No. Qualitative Taxa:	37
Total Taxa:	56
Number of Organisms:	3344
Qual EPT:	8
ICI:	**48**

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Site: Baugo Creek Restoration

Collection Date: 8/12/11 Site Number: 11

Taxa Name	Quantitative	Qualitative	Tolerance
Turbellaria	8		F
Fredericella sp	2		MI
Oligochaeta	24		T
Erpobdella punctata punctata	0	+	T
Baetis flavistriga	1		F
Baetis intercalaris	392	+	F
Stenacron sp	1	+	F
Stenonema exiguum	5	+	I
Stenonema pulchellum	1		MI
Stenonema terminatum	8	+	MI
Calopterygidae	8		
Calopteryx sp	0	+	F
Neureclipsis sp	1	+	MI
Cheumatopsyche sp	259	+	F
Ceratopsyche morosa	947	+	MI
Ceratopsyche sparna	71	+	MI
Hydropsyche depravata group	58	+	F
Hydroptila sp	8		F
Oecetis persimilis	0	+	MI
Ancyronyx variegata	4	+	MI
Macronychus glabratus	0	+	MI
Antocha sp	8		MI
Simulium sp	153	+	F
Ablabesmyia mallochi	22		F
Hayesomyia senata or Thiene-	130		F
Nilotanypus fimbriatus	42		MI
Trissopelopia ogemawi	22		MI
Corynoneura lobata	94		MI
Cricotopus (C.) sp	130		F
Cricotopus (C.) tremulus group	87		F
Nanocladius (N.) crassicornus	22		F
Nanocladius (N.) spiniplenus	22		MI
Paratrichocladius sp	65		MI
Rheocricotopus	195	+	MI
Thienemanniella taurocapita	27		I
Cryptochironomus sp	0	+	F
Dicrotendipes neomodestus	109		F
Dicrotendipes simpsoni	43		T
Endochironomus nigricans	22		F
Glyptotendipes (G.) sp	43		MT
Microtendipes pedellus group	0	+	MI
Paratendipes albimanus or P. duplicatus	0	+	MI
Phaenopsectra punctipes	22		F
Phaenopsectra flavipes	22		F
Polypedilum (Uresipedilum) flavum	259	+	F
Polypedilum (P.) fallax group	22		F
Polypedilum (Tripodura) scalaenum group	0	+	F
Paratanytarsus sp	130		F
Rheotanytarsus pellucidus	43		MI
Rheotanytarsus sp	109	+	MI
Tanytarsus sp	109		MI
Tanytarsus glabrescens group sp 7	152		MI
Tanytarsus sepp	303		MI
Hemerodromia sp	52		F
Physella sp	16	+	T
Ferrissia sp	21	+	F

No. Quantitative Taxa: 48 Number of Organisms: 4294

No. Qualitative Taxa: 24 Qual EPT: 10

Total Taxa: 56 **ICI: 48**

Tolerance

F = Facultative MT = Moderately Tolerant

I = Intolerant T = Tolerant

MI = Moderately Intolerant VT = Very Tolerant

Site: Bowman Creek (Studebaker Golf Course)

Collection Date: 8/11/11 Site Number: 12

Taxa Name	Quantitative	Qualitative	Tolerance
Eunapius fragilis	0	+	F
Turbellaria	5		F
Nematoda	2		
Fredericella sp	2		MI
Oligochaeta	24		T
Erpobdella punctata punctata	2	+	T
Caecidotea sp	1		MT
Gammarus sp	11	+	F
Orconectes (Gremicambarus) immunis	1		MT
Baetis flavistriga	510	+	F
Baetis intercalaris	1		F
Cheumatopsyche sp	63	+	F
Hydropsyche depravata group	52		F
Ochrotrichia sp	2	+	MI
Macronychus glabratus	6		MI
Stenelmis sp	44	+	F
Tanypodinae	6		
Conchapelopia sp	291		F
Hayesomyia senata or Thienemannimyia	6		F
Nilotanypus fimbriatus	7		MI
Pentaneura inconspicua	6		F
Corynoneura lobata	54		MI
Parametriocnemus sp	17		MI
Thienemanniella xena	9	+	F
Dicrotendipes neomodestus	24		F
Microtendipes "caelum"	17		MI
Microtendipes pedellus group	226		MI
Paratendipes albimanus or P. duplicatus	35		MI
Polypedilum (Uresipedilum) flavum	117	+	F
Polypedilum (P.) fallax group	11		F
Polypedilum (P.) illinoense	0	+	T
Paratanytarsus sp	11		F
Rheotanytarsus sp	0	+	MI
Tanytarsus glabrescens group sp 7	6		MI
Tanytarsus sepp	17		MI
Hemerodromia sp	4		F
Physella sp	22	+	T
Ferrissia sp	22		F
Sphaerium sp	4		F

No Quantitative Taxa:	36
No. Qualitative Taxa:	12
Total Taxa:	39
Number of Organisms:	1638
Qual EPT:	3
ICI:	**36**

Tolerance

F = Facultative	MT = Moderately Tolerant
I = Intolerant	T = Tolerant
MI = Moderately Intolerant	VT = Very Tolerant

Site: Juday Creek (Kintz Ave.)

Collection Date: 8/12/11 Site Number: 13

Taxa Name	Quantitative	Qualitative	Tolerance
Turbellaria	34	+	F
Nemertea	4		F
Nematoda	4		
Plumatella sp	1		F
Oligochaeta	0	+	T
Gammarus sp	2	+	F
Orconectes sp	1		F
Hydracarina	0	+	F
Plauditus sp	0	+	MI
Baetis tricaudatus	27		MI
Baetis flavistriga	443	+	F
Leucrocuta sp	57		I
Stenacron sp	183	+	F
Stenonema exiguum	335	+	I
Stenonema pulchellum	24	+	MI
Stenonema terminatum	99	+	MI
Stenonema vicarium	1	+	MI
Ranatra sp	0	+	F
Chimarra obscura	13	+	MI
Cheumatopsyche sp	513	+	F
Ceratopsyche morosa	103	+	MI
Ceratopsyche sparna	313	+	MI
Hydropsyche depravata group	1		F
Hydroptila sp	19		F
Brachycentrus numerosus	3	+	MI
Lepidostoma sp	1		MI
Nectopsyche diarina	1	+	MI
Oecetis sp	4		MI
Oecetis persimilis	3	+	MI
Ancyronyx variegata	0	+	MI
Macronychus glabratus	94	+	MI
Stenelmis sp	19	+	F
Antocha sp	32		MI
Tanypodinae	20		
Hayesomyia senata or Thieneman-	57		F
Helopelopia sp	20		F
Nilotanypus fimbriatus	4		MI
Pagastia orthogonia	20	+	MI
Corynoneura n.sp 1	13		MI
Corynoneura lobata	20		MI
Cricotopus (C.) sp	20	+	F
Cricotopus (C.) bicinctus	20		MT
Cricotopus (C.) tremulus group	20		F
Nanocladius (N.) crassicornus or N.	0	+	F
Parametriocnemus sp	207	+	MI
Paratrichocladius sp	0	+	MI
Rheocricotopus (Psilocricotopus) robacki	37		MI
Thienemanniella xena	21	+	F
Tvetenia bavarica group	90	+	MI
Tvetenia discoloripes group	86	+	I
Microtendipes "caelum"	37		MI
Polypedilum (Uresipedilum) flavum	20		F
Polypedilum (P.) laetum group	20		MI
Rheotanytarsus pellucidus	74	+	MI
Rheotanytarsus sp	1201	+	MI
Chelifera sp	86		MI
Ferrissia sp	29		F

No. Quantitative Taxa:	50
No. Qualitative Taxa:	32
Total Taxa:	57
Number of Organisms:	4456
Qual EPT:	14
ICI:	**58**

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Site: Juday Creek (Izaak Walton League)
Collection Date: 8/12/11 Site Number: 14

Taxa Name	Quantitative	Qualitative	Tolerance
Hydra sp	8		F
Turbellaria	30	+	F
Nemertea	12		F
Oligochaeta	0	+	T
Baetis flavistriga	42	+	F
Baetis intercalaris	4		F
Stenacron sp	1		F
Stenonema exiguum	38	+	I
Stenonema pulchellum	46	+	MI
Stenonema terminatum	23		MI
Boyeria vinosa	0	+	F
Chimarra obscura	2		MI
Lype diversa	9		MI
Cheumatopsyche sp	305	+	F
Ceratopsyche sparna	349	+	MI
Brachycentrus numerosus	4	+	MI
Neophylax sp	0	+	I
Lepidostoma sp	1		MI
Oecetis persimilis	1		MI
Macronychus glabratus	8	+	MI
Optioservus sp	24		MI
Stenelmis sp	36	+	F
Simulium sp	12		F
Conchapelopia sp	56		F
Hayesomyia senata or Thieneman-	14		F
Helopelopia sp	14		F
Nilotanypus fimbriatus	16		MI
Corynoneura lobata	24		MI
Cricotopus (C.) sp	0	+	F
Parametriocnemus sp	418	+	MI
Thienemanniella xena	16		F
Tvetenia bavarica group	28		MI
Polypedilum (Uresipedilum) aviceps	14		MI
Polypedilum (P.) fallax group	70		F
Rheotanytarsus sp	501	+	MI
Chelifera sp	21		MI

Taxa Name	Quantitative	Qualitative	Tolerance
No. Quantitative Taxa:	32		
No. Qualitative Taxa:	15		
Total Taxa:	36		
Number of Organisms:	2147		
Qual EPT:	7		
ICI:	**40**		

Tolerance

F = Facultative

I = Intolerant

MI = Moderately Intolerant

MT = Moderately Tolerant

T = Tolerant

VT = Very Tolerant

Appendix F

Analysis and Comparison of the Northern Indiana Till Plain IBI and the Coolwater IBI data from Juday Creek

Biological communities in coolwater streams are assembled quite differently than warmwater streams and unfortunately, the current system, the Northern Indiana Till Plain IBI, does not account for these differences. Given the number of coolwater streams in the Indiana portion of the St. Joseph River watershed, the Aquatics Program has long felt the need to incorporate a more appropriate analysis of fish communities for coolwater environments. In 2010, the Aquatics Program investigated Indiana's Coolwater IBI for use within the St. Joseph River Watershed. Although the investigation revealed some problems, it was determined that the Coolwater IBI offers very similar results to the Northern Indiana Till Plain IBI for Juday Creek (see Figures F–4, F-5, F-6). Based on the similarities in scores in 2010, and the fact that the Coolwater IBI has not been formally accepted for use by IDEM, it was decided that the Aquatics Program would continue to use the Northern Indiana Till Plain IBI for analyzing the fish communities of Juday Creek.

In 2011, however, results for the Izaak Walton League site on Juday Creek suggest that switching to the Coolwater IBI may be more appropriate. In 2011, the IBI score was 22, which is significantly lower than the baseline score of 27. This site also scored 27 in 2008, while all other sites along Juday Creek have scored well above their respective baseline values since 2007 (see Figure F-1). Therefore, according to the Northern Indiana Till Plain IBI, Juday Creek appears to be improving in the upper portions of the watershed, but diminishing closer to the confluence of the St. Joseph River at the Izaak Walton League. This notion is problematic, however, as the Izaak Walton League offers the best instream and riparian habitat in the Juday Creek Watershed. Furthermore, it is expected that if the biological communities are reacting positively to a water quality improvement in upper reaches of the watershed, a positive reaction would also be observed downstream.

A comparison of Coolwater and Northern Indiana Till Plain IBI scores at the Izaak Walton League shows almost the opposite results in 2008 and 2011 (Figure F-2), while results of both IBI types from 2002 to 2004 are almost identical. In addition, results for both IBI types are almost identical at Grape Road, Kintz Avenue, and Myrtle Street for all the years that these sites have been assessed (Figures F-4, F-5, F-6). The only site where IBI scores are completely different is at State Road 23 (Figure F-3) where significant fluctuations in scores occur with the Northern Indiana Till Plain IBI.

Figure F-2: A comparison of coolwater and N. Indiana Till Plain IBI scores for Juday Creek at the Izaak Walton League

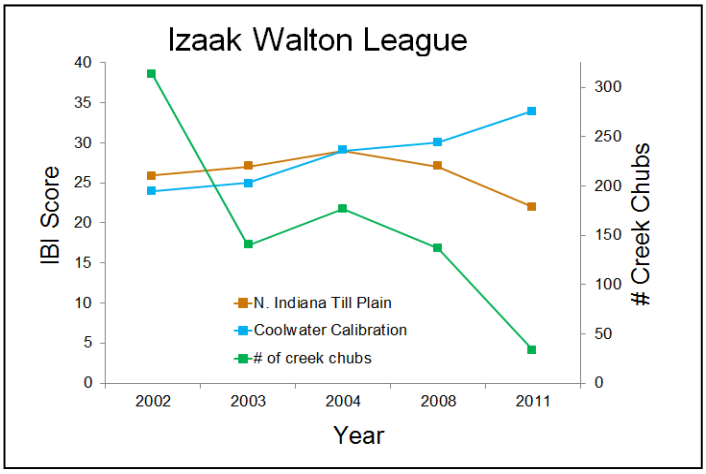
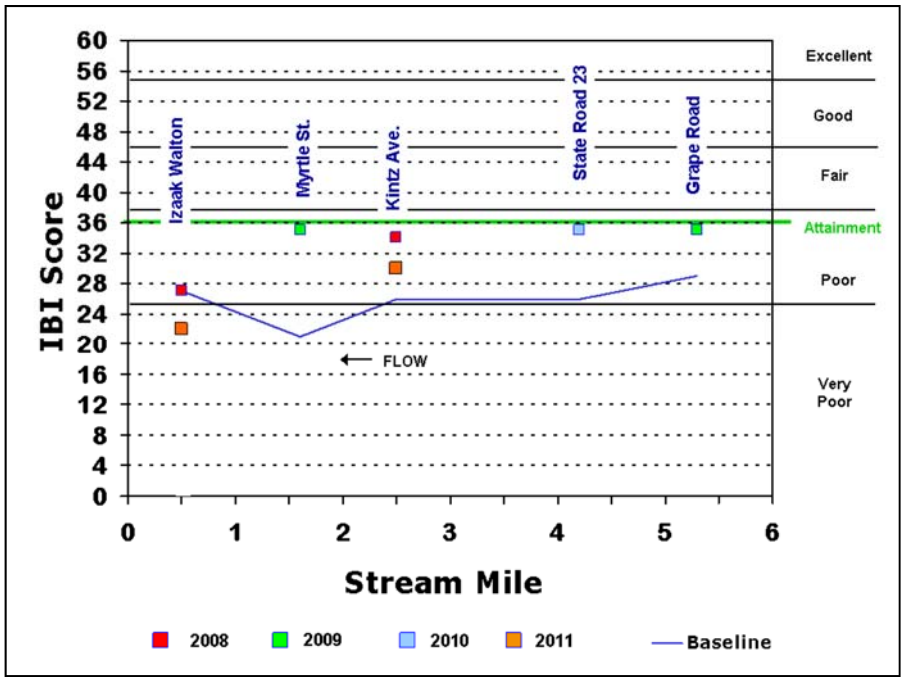


Figure F-1: IBI scores for sites along Juday Creek (2008 to 2011) using the Northern Indiana Till Plain IBI



In an effort to evaluate the variability described above, an in-depth analysis of individual metrics, species, and fish assemblage data was performed. Analysis of sites with similar results (Grape Road, Kintz Avenue, & Myrtle Street) are interesting given that the Coolwater IBI and Northern Indiana Till Plain IBI have many different metrics (See Appendix A for IBI Metrics). In fact, in many cases, similar yearly fluctuations in IBI scores between the two IBI types resulted for the opposite reasons. For example, at Kintz Avenue when more fish were collected during a sampling event it would positively affect the IBI score using the Northern Indiana Till Plain system, but negative-

ly affect the IBI score using the Coolwater system. Interestingly, while the number of fish caught caused the opposite effect, other characteristics of the fish communities would affect different metrics and balance things out to provide similar scores.

An analysis of fish community data at the Izaak Walton League revealed some issues with the Northern Indiana Till Plain IBI suggesting that it is less applicable than the Coolwater IBI for Juday Creek. From 2002 to 2004, the fish communities underwent very few changes and scores between both IBI types were very similar. However, from 2008 to 2011, the fish communities underwent significant changes. From 2002 to 2004, creek chubs dominated the fish community, with an average of 209 creek chubs being collected. However, in 2008 that number began to drop with an average of 137 creek chubs being collected from the two sampling events that year. In 2011, that number dropped even further to an average of 33 creek chubs. While the number of creek chubs dropped in 2008 and 2011 the diversity and abundance of all other species stayed relatively the same. Consequently, metrics within the Northern Indiana Till Plain IBI were negatively affected and the scores dropped, but metrics within the Coolwater IBI were positively affected and the scores increased. So what does this tell us? Creek chubs are considered a very tolerant pioneering species and when a stream is dominated by this species it suggests a stream quality issue. The fact that the Northern Indiana Till Plain reacts negatively to a drop in dominance of this species is problematic. The Coolwater IBI, on the other hand, reacted positively to the reduction of creek chubs, as would be expected.

Results at the State Road 23 site further demonstrates the superiority of the Coolwater IBI for Juday Creek (Figure F-3). The higher scores that occurred in 2002, 2007, and 2010 with the Northern Indiana Till Plain IBI were caused by an increase in abundance of creek chubs or green sunfish (another tolerant species). The Coolwater IBI scores remain farily consistent throughout the years and it does not react inappropriately to an

Figure F-3: A comparison of coolwater and N. Indiana Till Plain IBI scores for Juday Creek at State Road 23

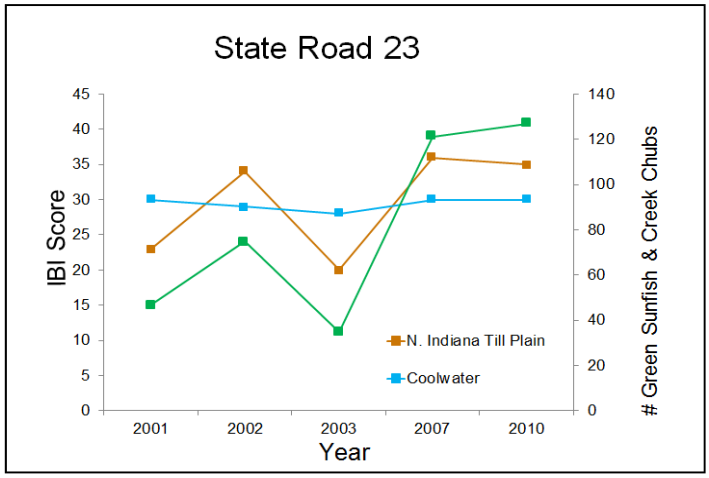
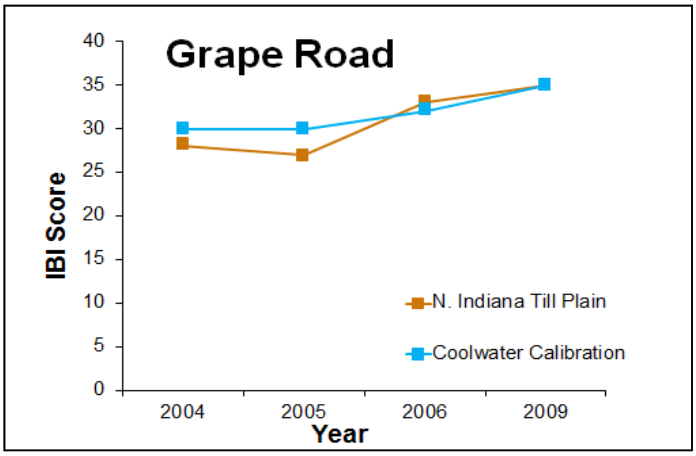
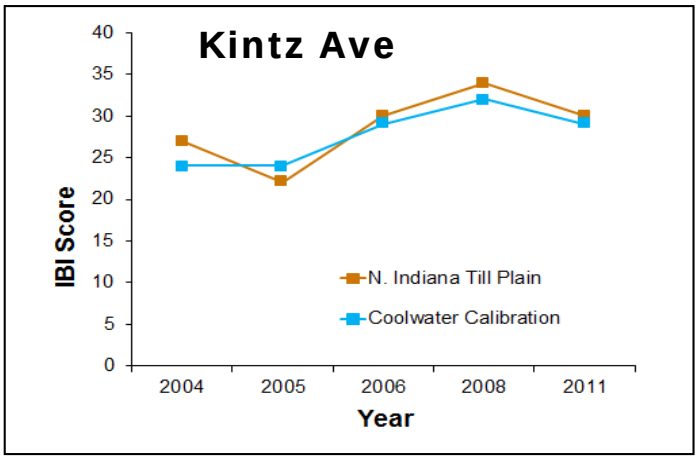
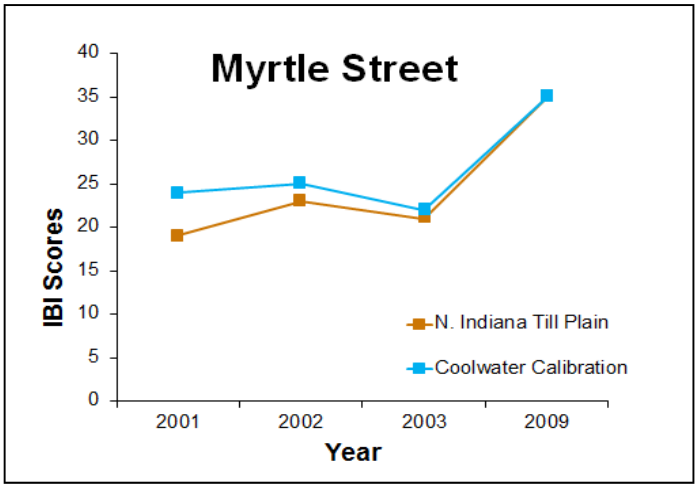


Figure F-4, F-5. F-6: A comparison of coolwater and N. Indiana Till Plain IBI scores for Juday Creek at Grape Road, Kintz Ave, and Myrtle Street





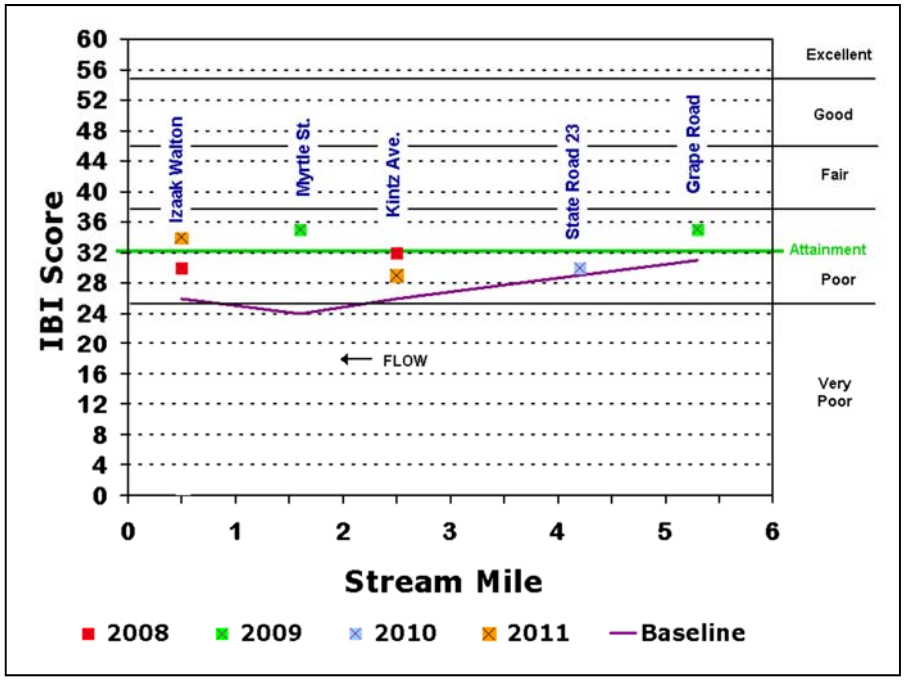


increase in tolerant species.

Figure F-7 displays scores for Juday Creek using the Coolwater IBI. Overall the baseline for the Coolwater IBI is relatively similar to the Northern Indiana Till Plain IBI (Figure F-1). In addition several of the scores from 2008 to 2011 are very similar. The only major differences are the IBI scores for Izaak Walton League. Using the Coolwater system, the Izaak Walton League was meeting water quality criteria for the first time in 2011 (note that in the Coolwater system attainment is met with a score of 32 as opposed to 36 with the Northern Indiana Till Plain). In addition, the Coolwater IBI also brings the other sites along Juday Creek closer to attainment.

While neither IBI system might be ideal for evaluating the fish communities of Juday Creek, the Coolwater calibration appears to more accurately reflect their condition.

Figure F-7: IBI scores for sites along Juday Creek (2008 to 2011) using the Northern Indiana Till Plain IBI



Appendix G

Statistical Analysis of Total Suspended Solid Data and St. Joseph River Discharge Data

The following graphs summarize surface water total suspended solids (TSS) concentrations in the St. Joseph River in South Bend and discharge data from the St. Joseph River in Elkhart. Data were analyzed statistically and graphed using SigmaPlot ® software. Data analysis was performed using the non-parametric Kruskil-Wallis One Way Analysis of Variance (ANOVA) test when comparing several groups or the Mann-Whitney Rank Sum test when only comparing two groups. Rather than performing conventional ANOVA or t-tests, these non-parametric equivalents were performed due to violations of normality or heteroscedacity among data sets. The relationship between TSS concentrations and river discharge was also analyzed using Pearson's Correlation test.

Interpreting Boxplot Graphs

Boxplots, also called box-whisker plots, are an effective way of depicting groups of data for interpretation. The box represents 50% of the data (25th to 75th percentile). The lower whisker depicts the minimum value to the 25th percentile, and the upper whisker represents the 75th to 100th percentile. The line in the middle of the box is the median value, and circles represent outliers.

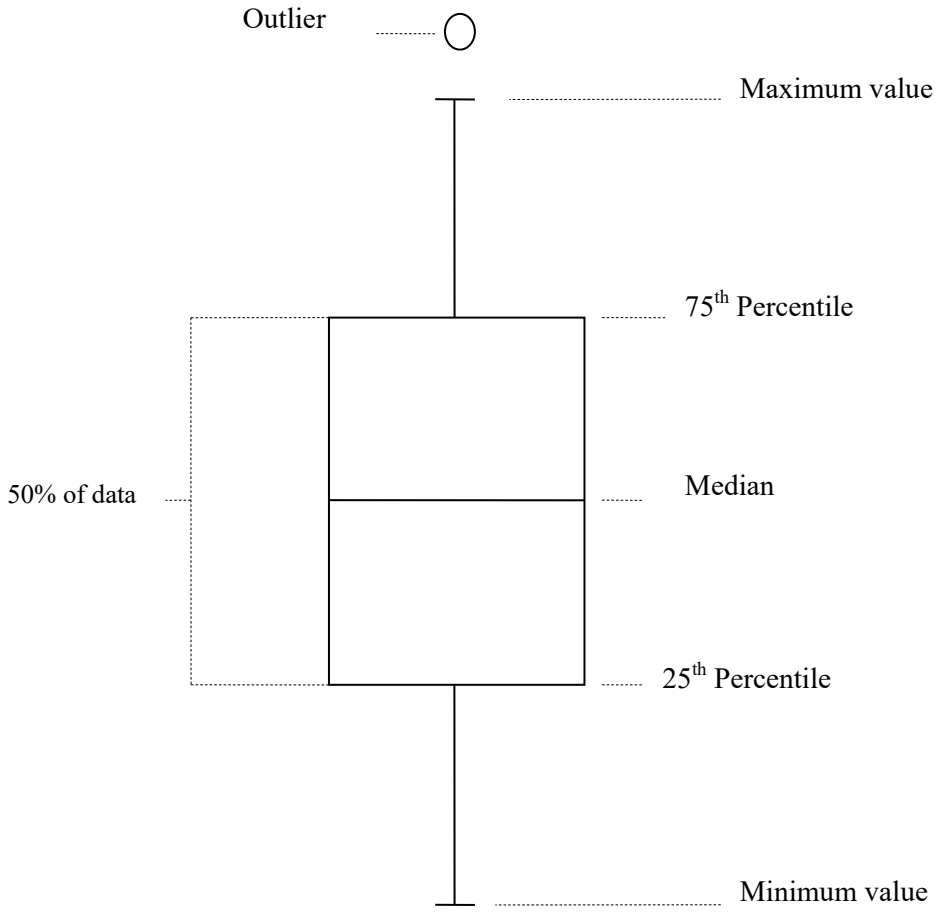


Figure G1: Boxplot graphs comparing TSS concentrations during baseline fish community monitoring (2001-2006) to post baseline monitoring (2007 to 2011) at Colfax Avenue. Concentrations of TSS were significantly higher during the baseline period (*P = 0.001*)

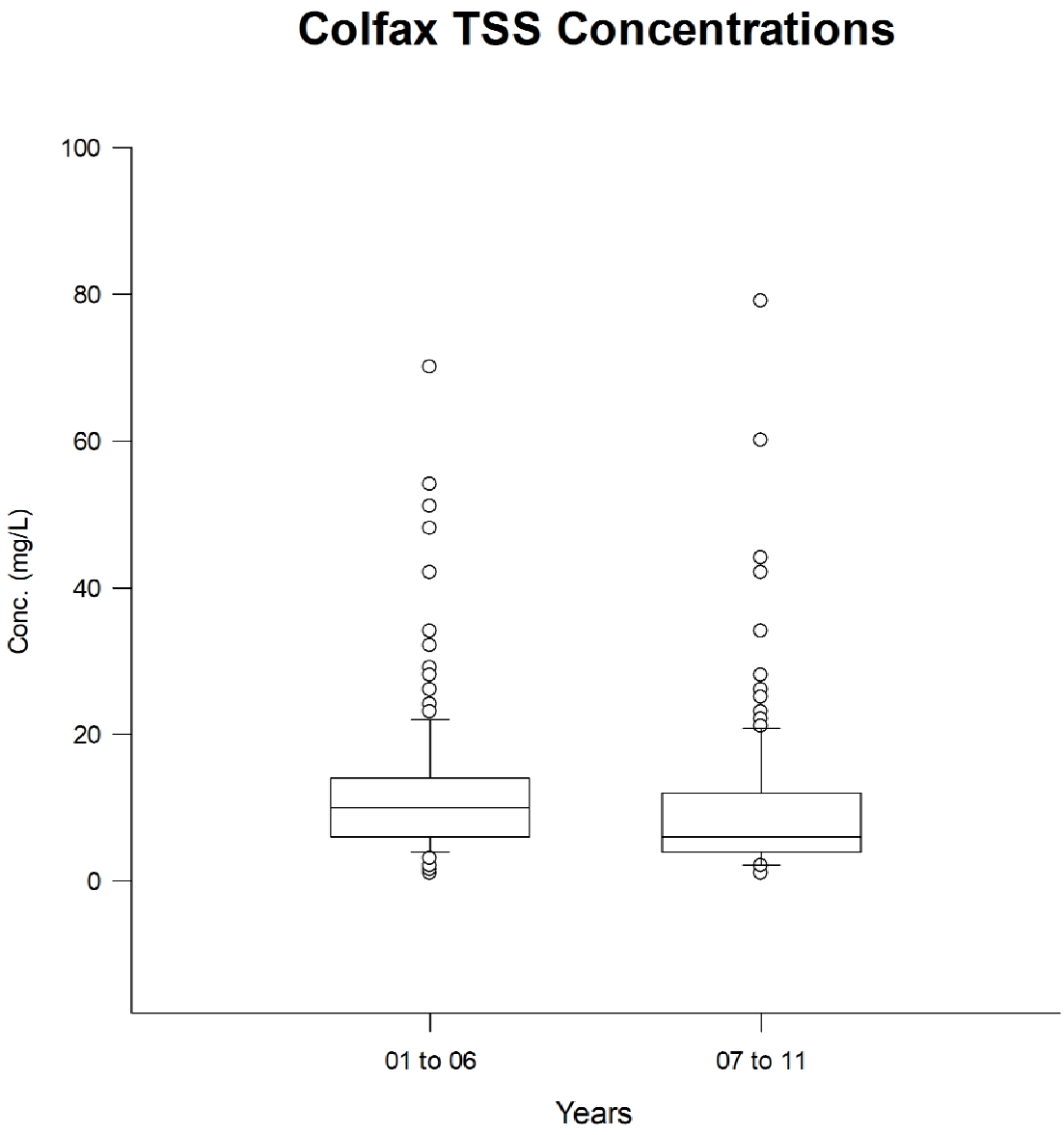


Figure G2: Boxplot graphs comparing TSS concentrations during baseline fish community monitoring (2001-2006) to post baseline monitoring (2007 to 2011) at Angela Boulevard. Concentrations of TSS were significantly higher during the baseline period (*P = 0.013*)

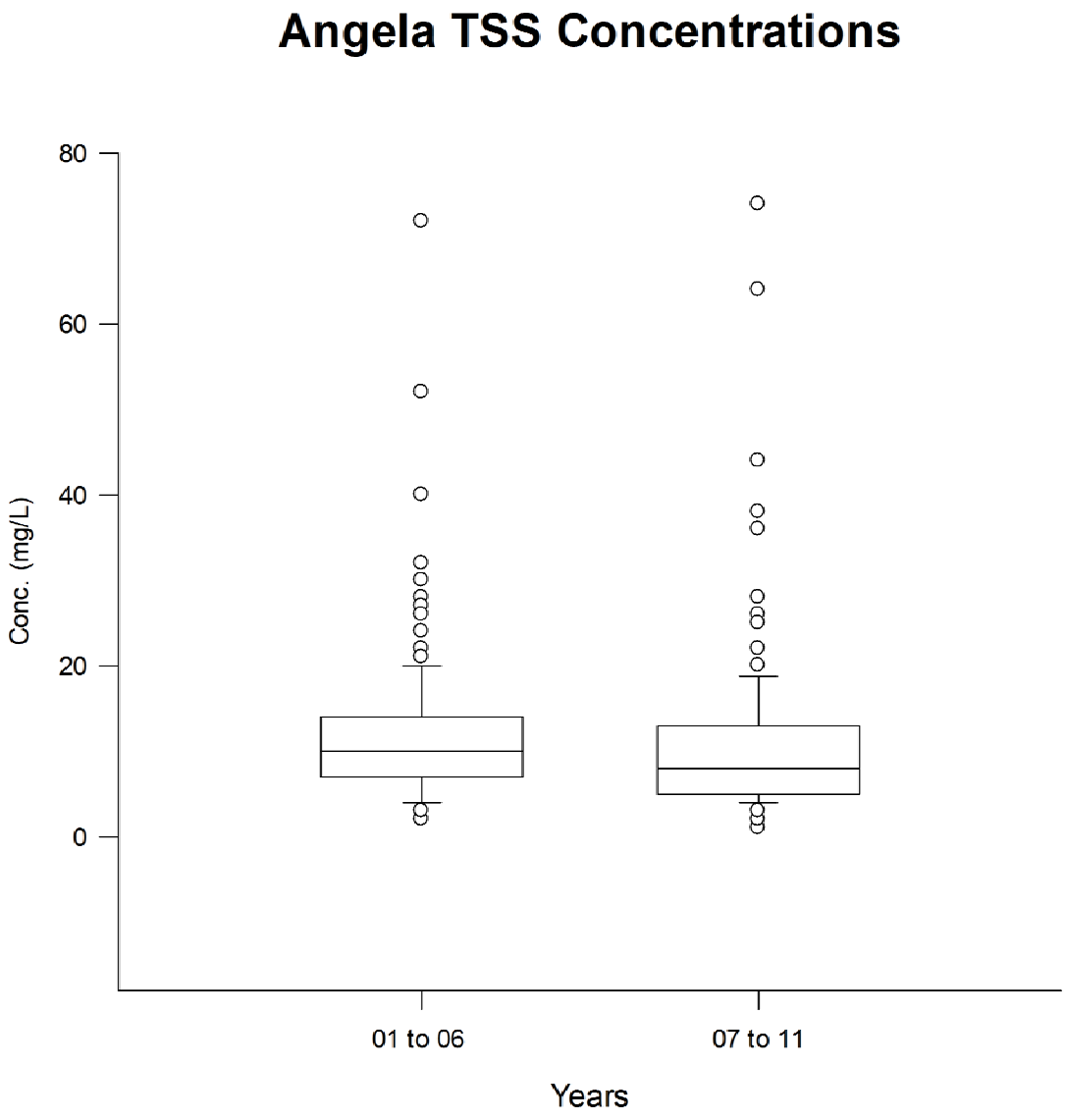


Figure G3: Boxplot graph comparing TSS concentrations during baseline fish community monitoring (2001-2006) to post baseline monitoring (2007 to 2011) at Auten Road. Concentrations of TSS were significantly higher during the baseline period (*P = 0.026*)

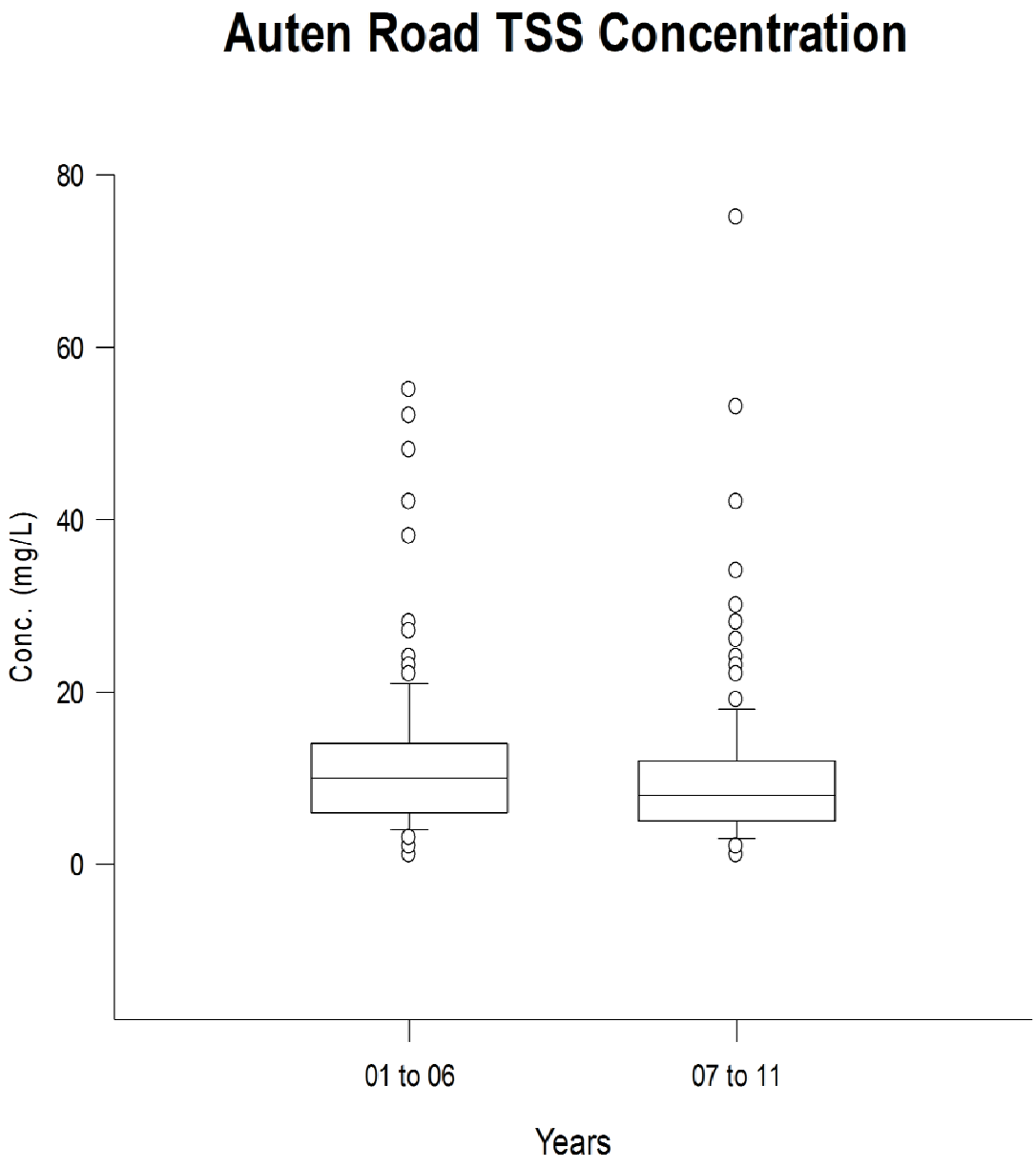


Figure G4: Boxplot graph comparing annual TSS concentrations. Data are pooled from all 3 sites: Colfax Avenue, Angela Boulevard, and Auten Road. Differences among years are significant ($p < 0.001$). Boxplots with a non-corresponding letter(s) differ significantly.

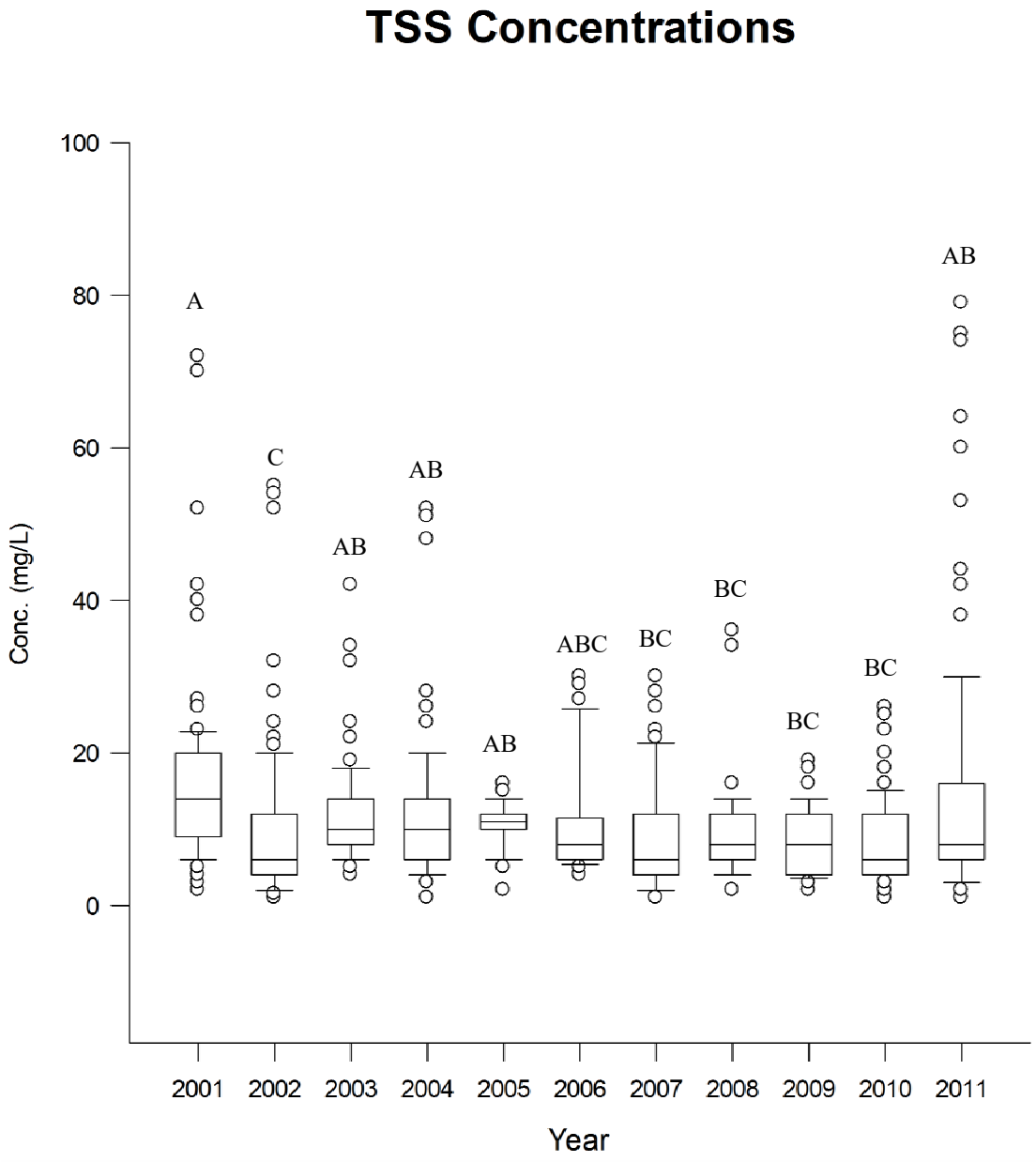
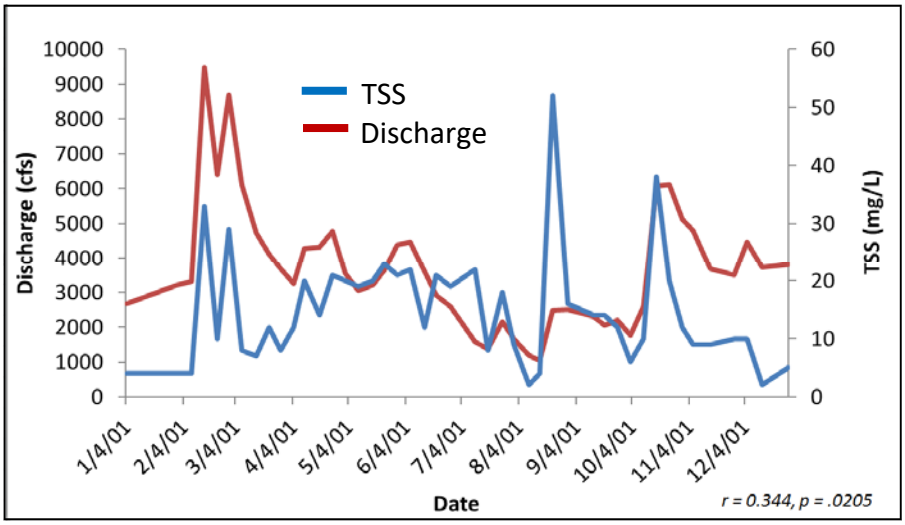
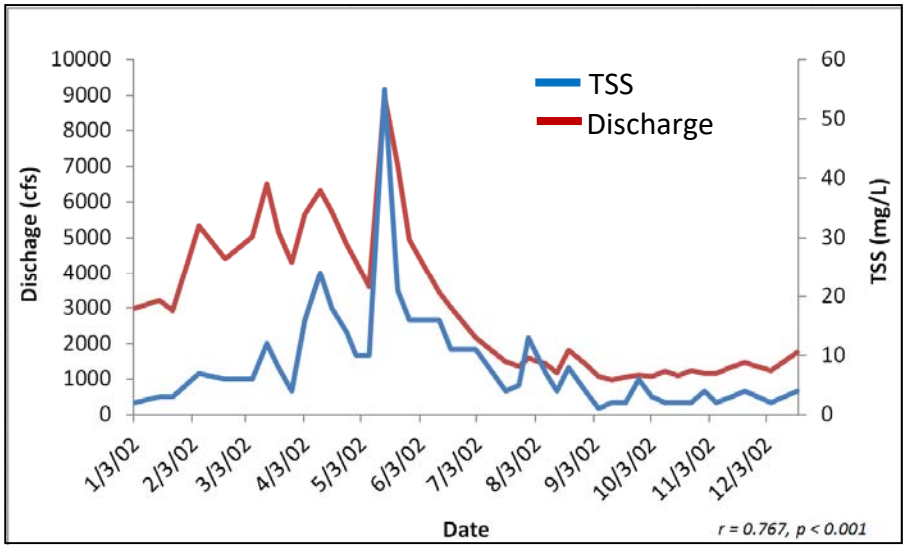


Figure G5—G8: Suspended solid concentrations at Auten Road on the St. Joseph River and river discharge data from the gauge station in Elkhart from 2001 to 2003. The relationship between TSS and discharge was significant for all years. r and p values are displayed in the bottom right hand corner of each graph.





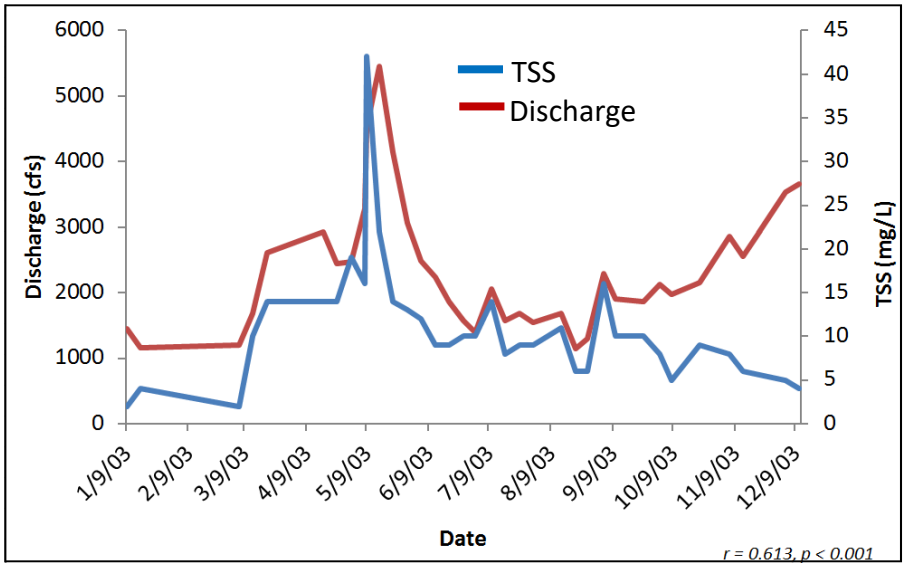
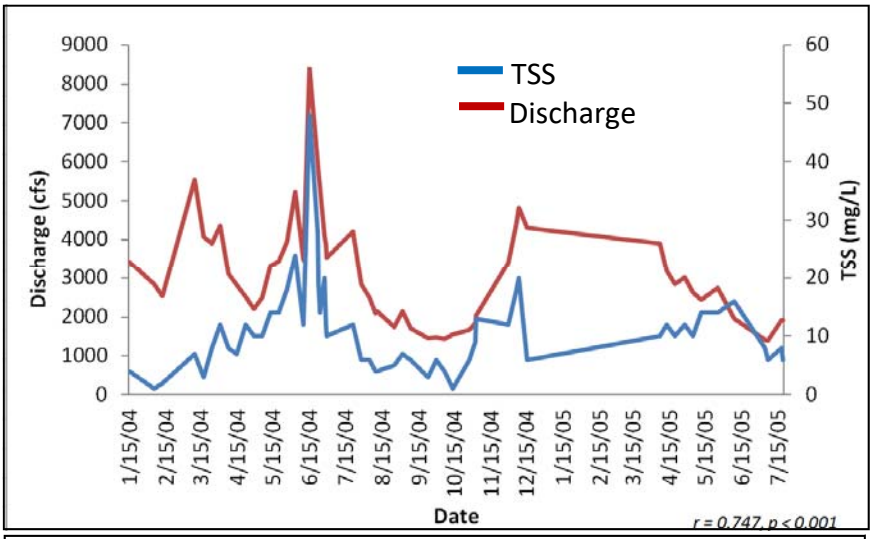
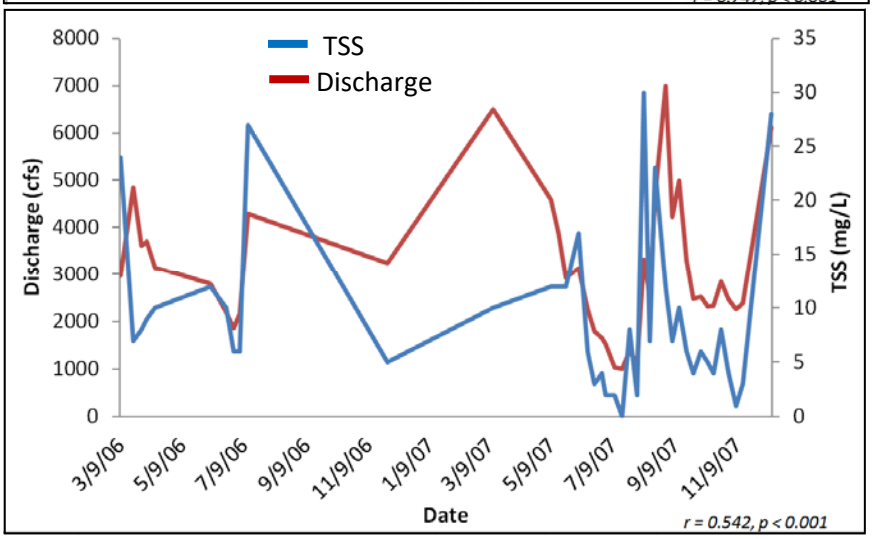


Figure G9—G11: Suspended solid concentrations at Auten Road on the St. Joseph River and river discharge data from the gauge station in Elkhart from 2004 to 2008. The relationship between TSS and discharge was significant for all years. r and p values are displayed in the bottom right hand corner of each graph.





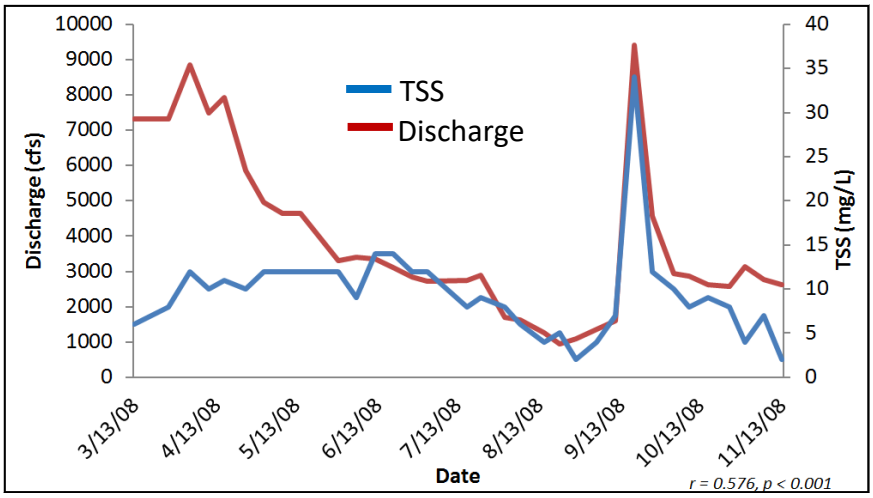


Figure G12—G14: Suspended solid concentrations at Auten Road on the St. Joseph River and river discharge data from the gauge station in Elkhart from 2009 to 2011. The relationship between TSS and discharge was significant for all years. r and p values are displayed in the bottom right hand corner of each graph.

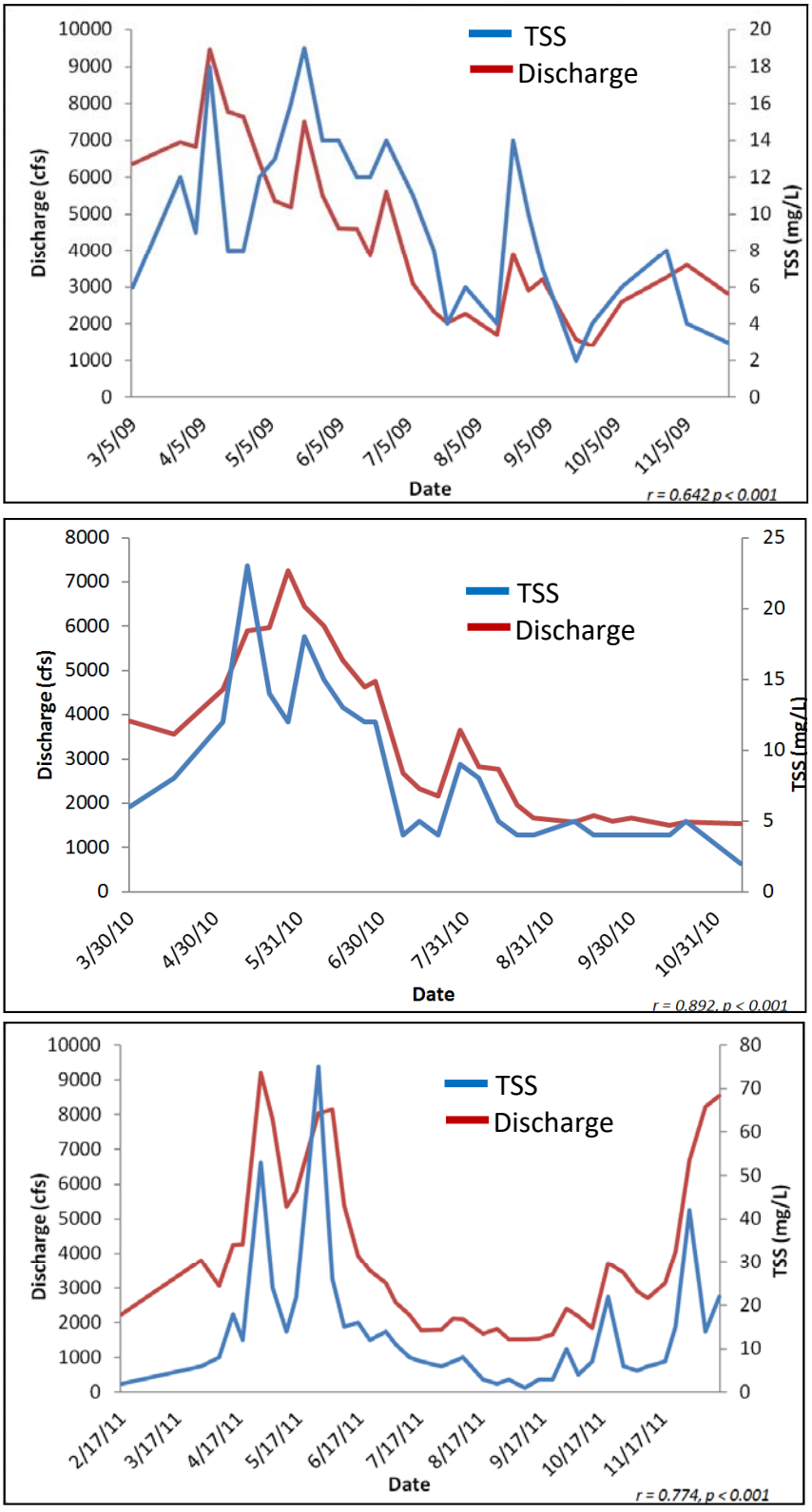
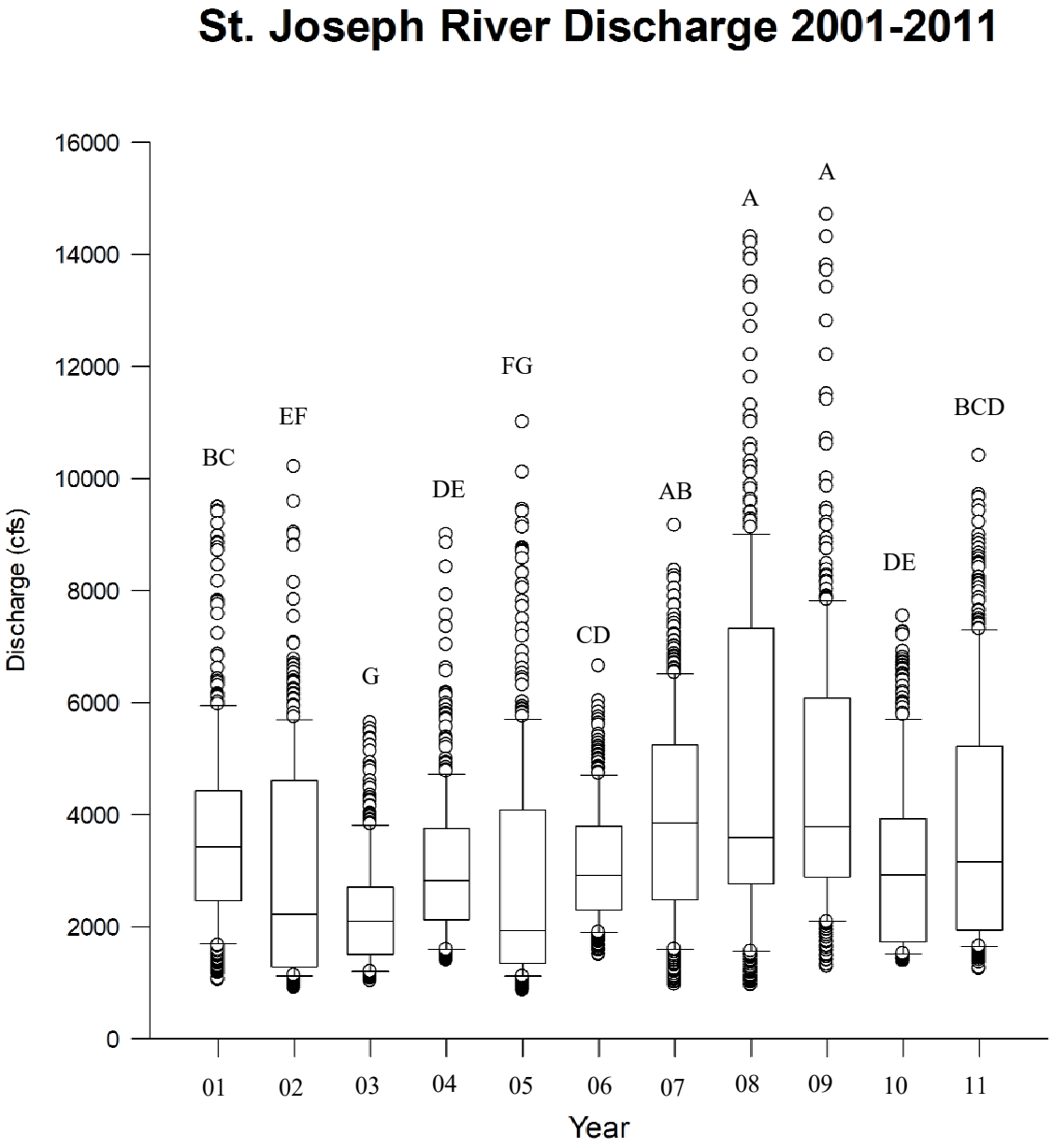


Figure G15: Boxplot graph comparing annual discharge data from the Elkhart gauge station of the St. Joseph River. Differences among years were significant ($p < 0.001$). Boxplots with a non-corresponding letter(s) differ significantly.



Appendix H
Aerial Site Location Maps

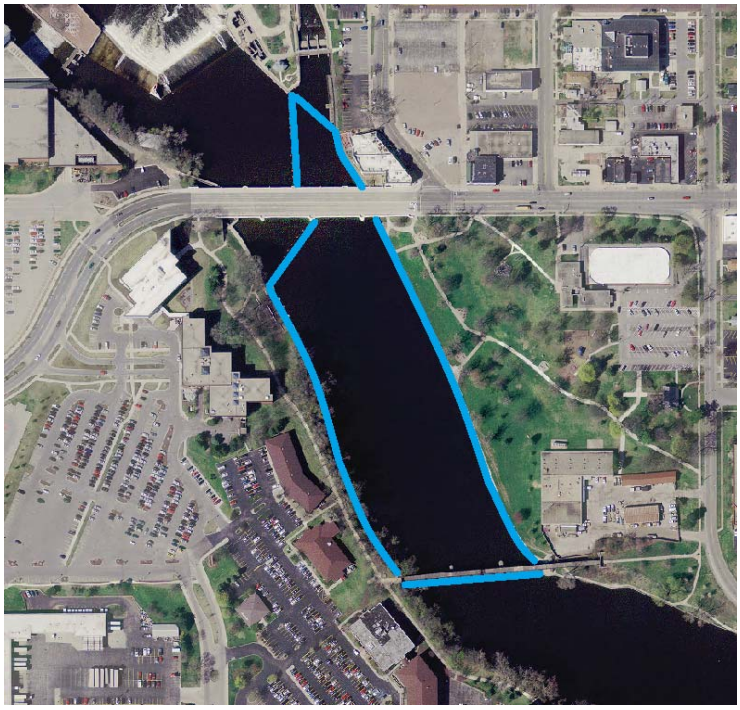
Site #1: St. Joseph River Toll Road (Bristol)

Site #2: St. Joseph River Six Span (CR 17)

Site #3: St. Joseph River Bridge Street

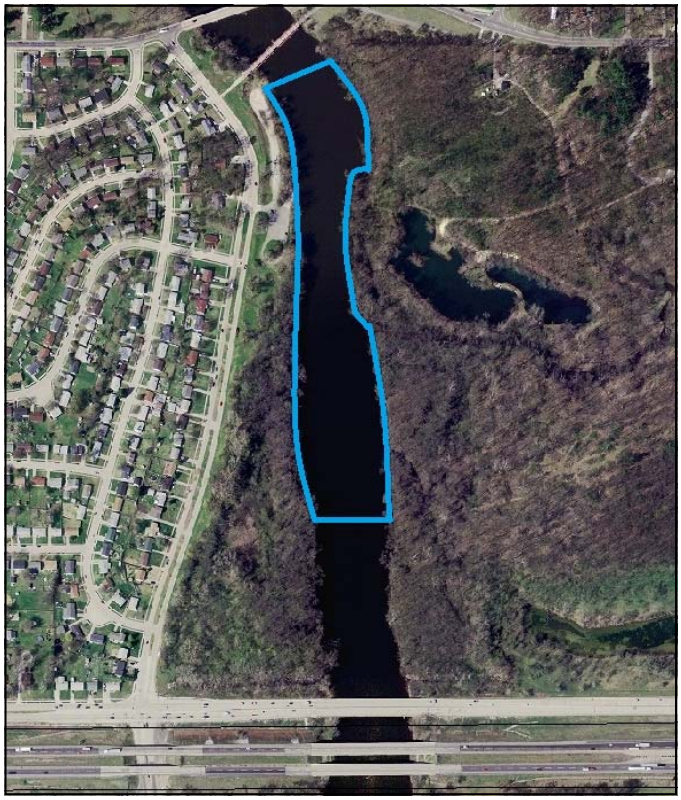
Site #4: St. Joseph River Ironwood (A)

Site #5: St. Joseph River Ironwood Drive

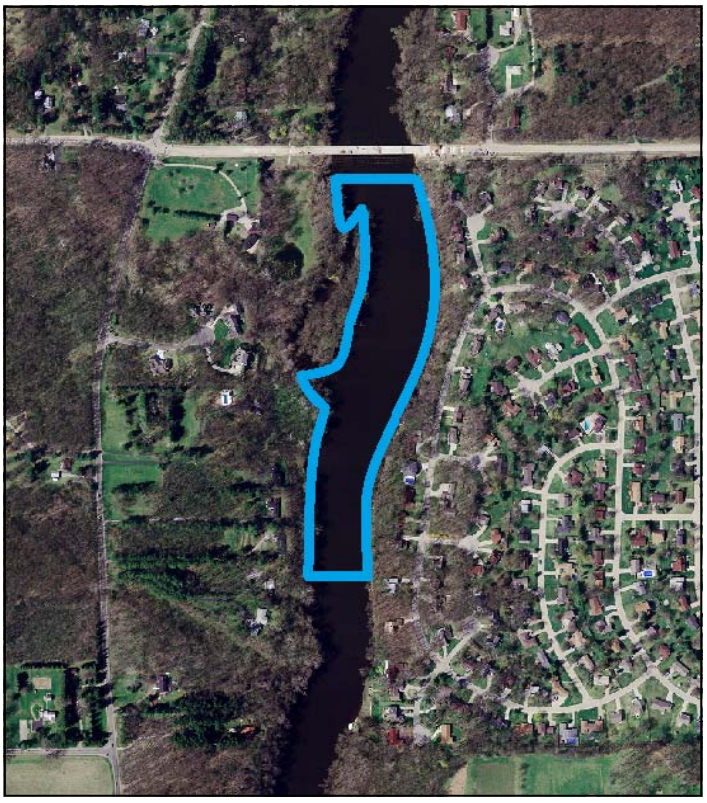


Site #6: St. Joseph River Howard Park

Site #7: St. Joseph River Angela Blvd.



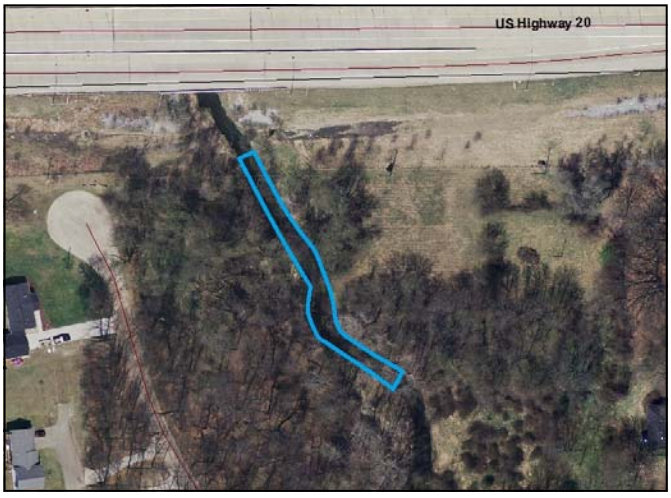
Site #8: St. Joseph River Darden



Site #9: SJR Auten (A)

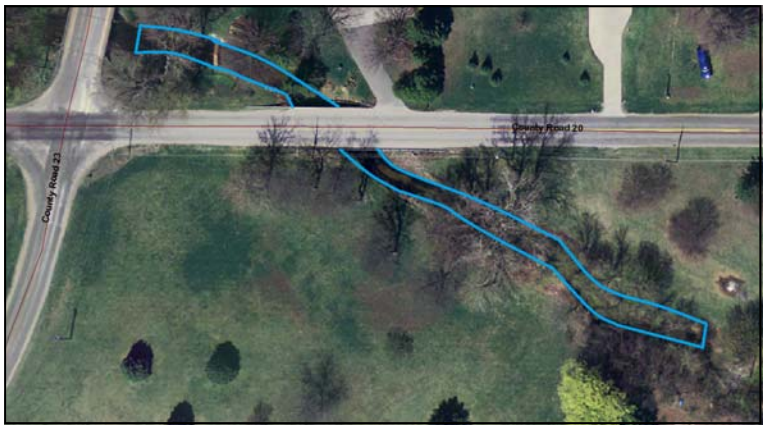
Site #11: Little Elkhart River SR 120

Site #10: Trout Creek CR 2



Site #12: Pine Creek US 20 Bypass

Site #14: Puterbaugh Creek Reedy

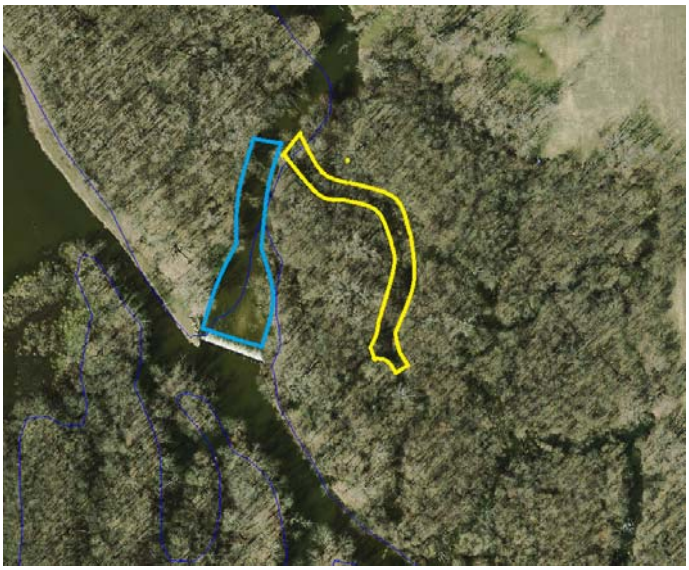


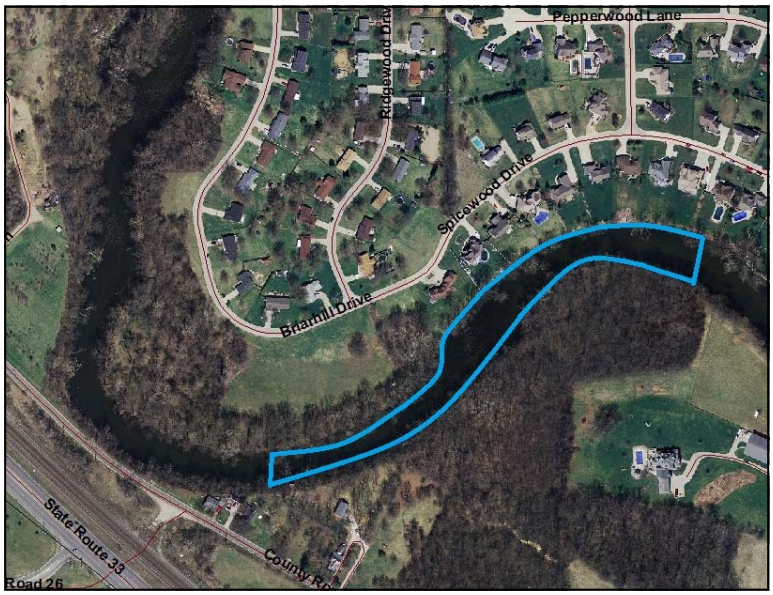
Site #13: Pine Creek CR 20

Site #15: Christiana Creek CR 6

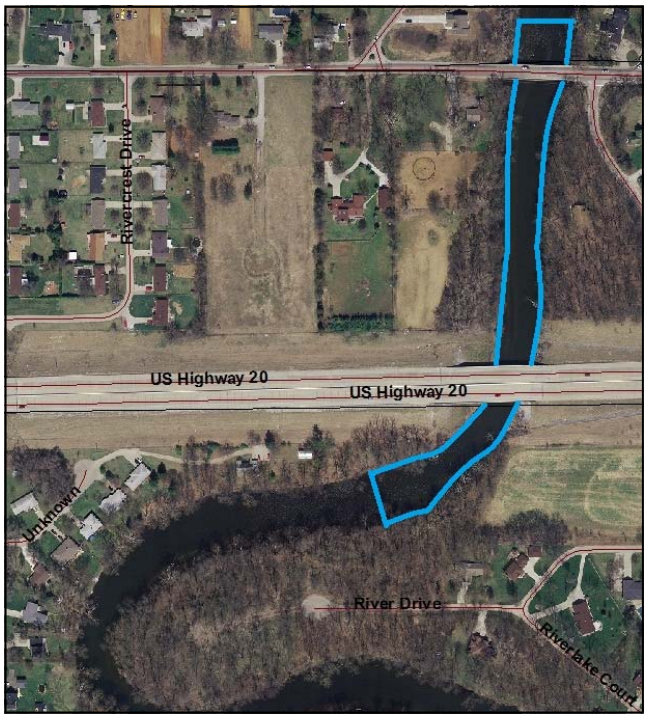
Site #16: Christiana Creek Willowdale

Site #17: Elkhart River Baintertown Diversion Channel (Yellow Line)
Site #18: Elkhart River Baintertown Dam Below (Blue Line)

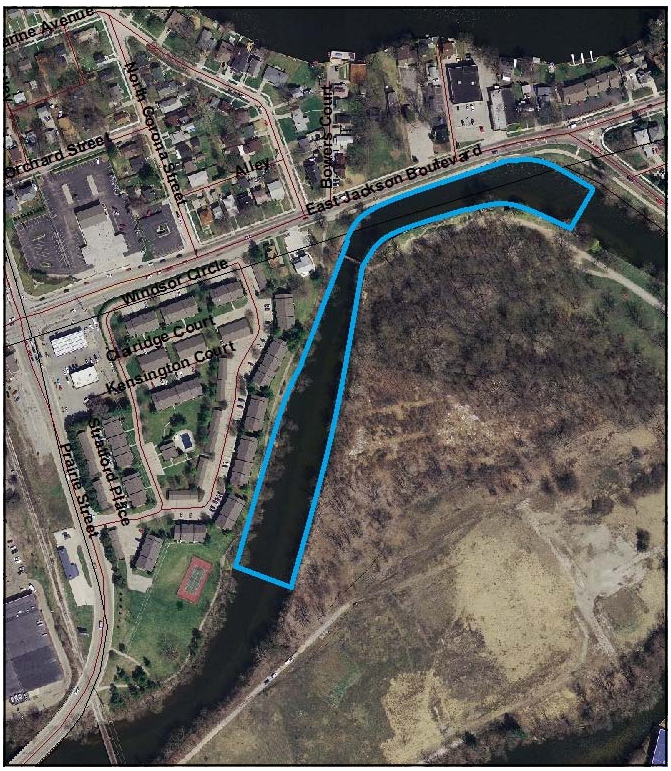




Site #19: Elkhart River Oxbow (A)



Site #20: Elkhart River Hively Avenue

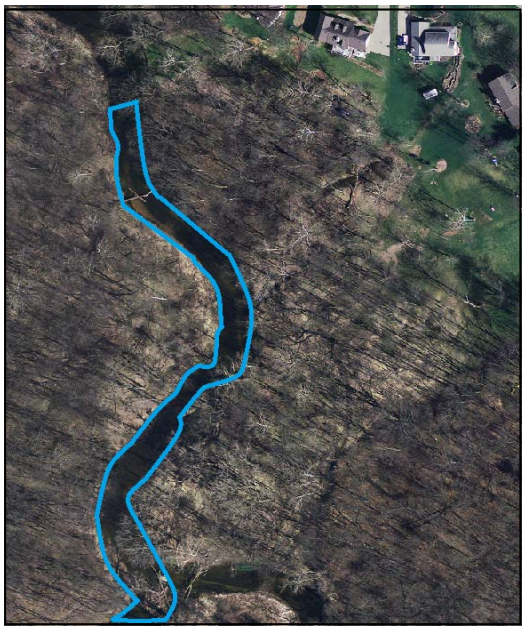


Site #19: Elkhart River American Park

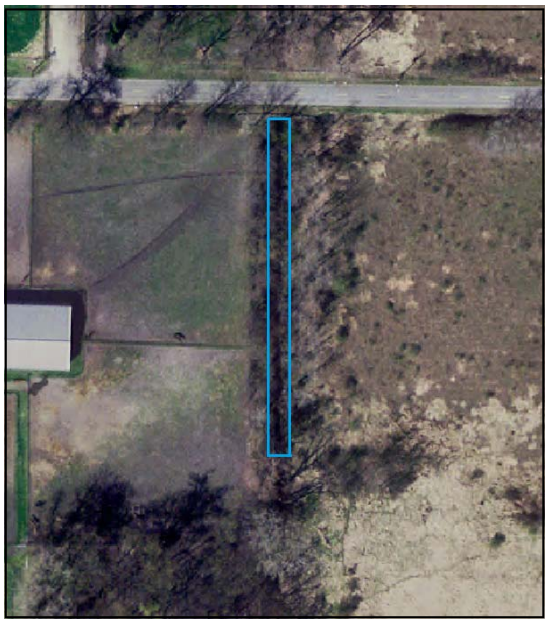
Site #20: Elkhart River Studebaker Park (A)

Site #23: Yellow Creek US 20 Bypass

Site #24 Baugo Creek Restoration



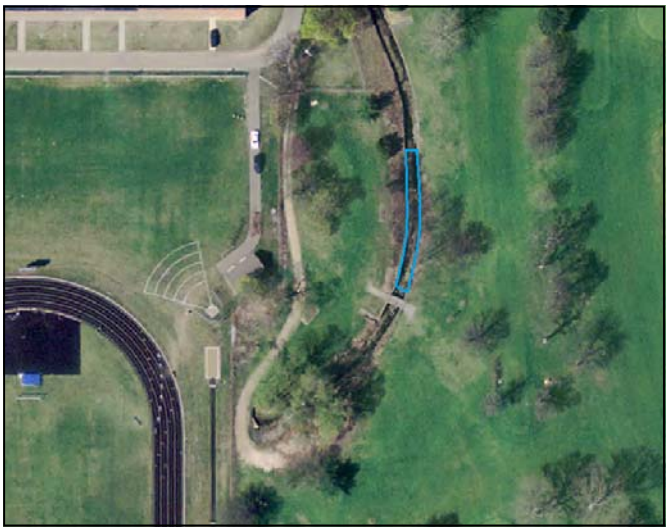
Site #25: Baugo Creek Restoration (Below)

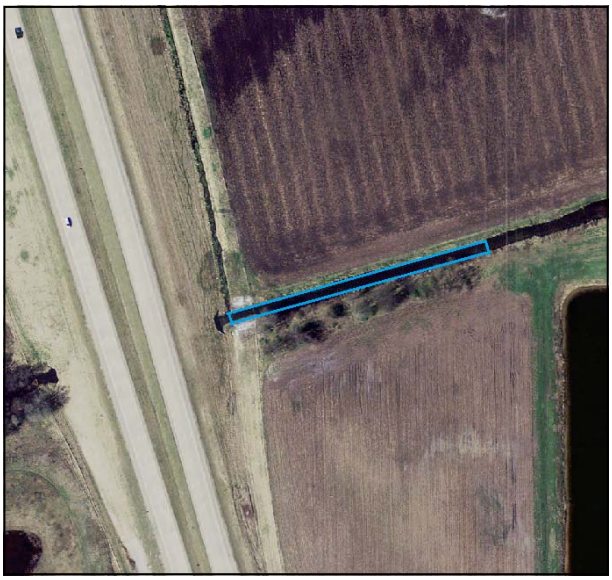


Site #26: Auten Ditch (East Branch) Roosevelt Road

Site #27: Auten Ditch (East Branch) Locust Road South

Site #28: Bowman Creek Studebaker Golf Course





Site #29: Juday Creek Capital Avenue

Site #30: Juday Creek Holy Cross Pkwy.

Site #32: Juday Creek Izaak Walton League

Site #31: Juday Creek Kintz Ave.