

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
JANUARY 2009

STAFF REPORT

A BIOLOGICAL SURVEY OF SITES IN THE GALIEN RIVER WATERSHED
BERRIEN COUNTY, MICHIGAN
SEPTEMBER 2007

INTRODUCTION

Staff of the Michigan Department of Environmental Quality (MDEQ) Surface Water Assessment Section conducted a qualitative biological and habitat survey of the Galien River watershed located in Berrien County on September 11 and 12, 2007. Sampling stations were located in wadeable segments of the main stem Galien River and several of its tributaries (Figure 1). The goals of monitoring are to: (1) support the development of water quality-based effluent limits for National Pollutant Discharge Elimination System (NPDES) permits; (2) support the Nonpoint Source Program; (3) determine if waters are attaining Michigan Water Quality Standards (WQS); and (4) determine if the quality of the water body is changing over time. The objective of this survey was to qualitatively characterize the biotic integrity of macroinvertebrate communities with respect to existing habitat conditions at selected sites throughout the Galien River watershed.

Two site selection methods were used to assess the Galien River watershed in 2006: stratified random and targeted. A probabilistic monitoring approach, using stratified random site selection to address statewide and regional questions about water quality, was used to select five stations throughout the Galien River watershed. In addition to probabilistic monitoring, ten sites within the Galien River watershed were selected for targeted monitoring to fulfill specific monitoring requests, assess known or potential areas of concern, collect information and assess attainment of WQS from areas where historic survey information was lacking, or to collect information related to NPDES permits.

Macroinvertebrate community and habitat surveys were performed following Procedure 51 (MDEQ, 1990). Water samples were collected at two locations and were preserved according to MDEQ protocol (Michigan Department of Natural Resources [MDNR], 1994). Water samples were submitted to the MDEQ, Environmental Laboratory, for analysis.

Table 1 lists all sites visited and the type of work done at each site. Survey and site visit locations are presented in Figure 1. Macroinvertebrate community ratings and habitat evaluations are given in Tables 2A and 2B, and Table 3, respectively. Result of water chemistry analyses are presented in Table 4. Figures 2 and 3 demonstrate the relationship between precipitation and stream flow in the Galien River near Sawyer, Michigan.

Watershed Description

The Galien River watershed is located in the Southern Michigan/Northern Indiana Till Plain (SMNITP) ecoregion. The watershed encompasses approximately 180 square miles in portions of La Porte County, Indiana, and Berrien County, Michigan. The Galien River begins at the outlet of Dayton Lake where it flows in a predominantly westerly direction until it enters

southeastern Lake Michigan at New Buffalo, Michigan. Designated coldwater streams in the watershed include: the main stem of the Galien River, east branch Galien River, Blue Jay Creek, south branch Galien River, and a portion of Spring Creek. Agriculture is the dominant land use in the watershed and the majority of the water bodies have been dredged or channelized to facilitate the rapid conveyance of water from the relatively flat landscape.

Two water bodies in the Galien River watershed are listed for not attaining WQS in a report submitted to the United States Environmental Protection Agency, to fulfill the requirements set forth in Section 303(d) of the federal Clean Water Act, and Title 40 of the Code of Federal Regulations, Part 130, Water Quality Planning and Management (LeSage and Smith, 2008). The Galien River, from its confluence with Lake Michigan upstream six miles to the south branch Galien River confluence, is listed as nonattaining because of a fish consumption advisory for carp, which are contaminated with polychlorinated biphenyls and chlordane. Sawyer Creek, from its confluence with Lake Michigan upstream to I-94 in the vicinity of Sawyer, is listed as nonattaining due to nuisance oil product pollution.

Biological surveys conducted in 1997 (Bonnette, 2000) and in 2002 (Walterhouse, 2003) found acceptable biological communities at all of the sampling sites in the watershed which included: Galien River, south branch Galien River, east branch Galien River, Troy Meadow Drain, Squaw Creek, Blood Run, Spring Creek, an unnamed tributary to Spring Creek, and Dowling Creek.

SAMPLING RESULTS

Macroinvertebrate Community Assessment

The qualitative macroinvertebrate community data is rated based on the total score of nine metrics rating from poor (-9 to -5), acceptable (-4 to +4), and excellent (+5 to +9). Macroinvertebrate communities rated acceptable at all stations. No sites rated poor. Total number of taxa for the six stations ranged from 10 to 23 (Table 2a). Metric scores for these sites ranged from -4 to 3 (Table 2b).

It is important to note that the 2007 biosurveys were conducted two weeks after rains had caused the discharge to increase from an average flow of 40 cubic feet per second (cfs) to flows exceeding 700 cfs (Figure 2). High, flashy flows, such as those found in the Galien River watershed, have been found to destroy habitat (Lamberti *et al.*, 1991) and decrease the total density and taxonomic richness of stream macroinvertebrates (Fisher *et al.*, 1982; Palmer *et al.*, 1996). Negishi *et al.* (2002) found that flood events in channelized stream reaches have an even greater impact on macroinvertebrate communities because habitat homogeneity in these reaches reduces the availability of flow refugia critical for the recolonization of the stream. Conversely, low summer flows (Figure 3) may have caused some smaller tributaries to stop flowing or to dry up completely; negatively impacting macroinvertebrate communities and the resultant Procedure 51 assessment scores. Low flows have been found to impact aquatic communities by reducing total useable habitat area, increasing stream temperature, and causing shifts in functional feeding group and habitat guild proportions (Wills *et al.*, 2005).

Stratified Random Sample Results

Although all probabilistic sites scored acceptable, it is estimated that the true proportion of stream miles in the Galien River watershed supporting the other indigenous aquatic life designated use component of Rule 323.1100(1)(e) of Michigan's WQS is between 69 percent

(the lower 95 percent confidence limit) and 100 percent. This estimate is based on the results of sampling only five sites in the Galien River watershed.

Habitat Assessment

Overall stream habitat scores, which consider in-stream habitat as well as the adjacent stream banks and riparian habitat at the 6 sites in the Galien River watershed ranged from 54 (poor) to 106 (good) (Table 3). Glide/pool metrics were used to evaluate habitat at five of the sites and riffle/run metrics were used at the remaining site. Overall, stream habitat at two of the sites was rated as good, three sites were rated as marginal, and one was rated as poor. The sites where habitat scores were better tended to have higher riparian and bank structure scores. Most notable is that the poor and marginal sites scored from one to three (out of ten) on the riparian vegetative zone width metric whereas the good sites scored from eight to ten (Table 3).

Habitat conditions throughout the watershed are highly influenced by flashy flows attributable to channel modification and agricultural land use practices (i.e., field tiling, riparian vegetation removal, etc.). Stream discharge during this assessment cycle was estimated to range between 20 to 55 cfs on the Galien River. A high flow event two weeks prior to our surveys calculated stream flows up to 778 cfs (Figure 3).



Water Chemistry

Water chemistry samples were collected at two locations (see Table 1) and results of the analyses are presented in Table 4. All parameters analyzed were below detection levels. Water samples were collected and analyzed to support future total maximum daily loads in the watershed.

DISCUSSION

In addition to Procedure 51 habitat and biological surveys, visual observations of sites in the Galien River watershed were made in order to document general condition of the watershed and to satisfy external monitoring requests where Procedure 51 was deemed inappropriate.

Many of the streams in this watershed have been channelized for much of their length resulting in flashy flows, reduced floodplain connectivity, decreased riparian zone width and plant community structure, and reduced in-stream habitat complexity; all of which reduce the biologic potential of the streams in this watershed.

Main Branch Galien River

The main branch of the Galien River was visited at five locations (Table 1). Macroinvertebrates and habitat were evaluated at two locations: one upstream of Flynn Road (Station 1) and the other upstream of Pardee Road (Station 2). The macroinvertebrate communities were rated

acceptable at both sites. Habitat was rated marginal at both Flynn Road (100) and Pardee Road (88). The habitat was scored with glide/pool metrics because of the absence of riffle habitat. The greatest impairment of in-stream habitat is due to the flashy flow regime found in the Galien River watershed (see Figures 2 and 3). Our surveys took place only two weeks after water levels had risen five to six feet and discharge had increased from around 50 cfs to over 700 cfs.

Visual reconnaissance at three other locations (Table 1) found conditions similar to those described above. A great deal of the watershed is used for agriculture and, as such, much of the large woody debris has been removed from the straightened channels. The riparian zone of these channelized stretches of the Galien River is extremely narrow, frequently less than 20 feet wide. The channel is deeply incised with the substrate consisting mostly of loose sand. The banks were generally bare and failing in many spots with exposed root mats of surrounding small trees (see photo on page 4).

South Branch Galien River

Two sites on the south branch Galien River were visited (Table 1). The macroinvertebrate community and habitat were evaluated at one location (Station 3) upstream of Forest Lawn Road; downstream of the Forest Lawn Landfill (NPDES permit #MI0048631). The macroinvertebrate community scored acceptable (+3) and the habitat rated good (105). As with the majority of the streams in this watershed, the south branch Galien River suffers from frequent flashy flows and lack of stable habitat suitable for invertebrate colonization. The wooded riparian zone at this station was wide enough and had sufficient connectivity with the stream to serve as a buffer from surrounding land uses and provide a small amount of large woody debris. The addition of large woody debris has provided some habitat heterogeneity in the form of undercuts and large, deep pools. The stable habitat provided by the large woody debris is most likely the reason that the macroinvertebrate community scored much higher here than other sites in the watershed. Despite some in-stream habitat improvements, moving sand bedload still dominates in this area as well as areas of aggradation and bar development.

East Branch Galien River

The macroinvertebrate community and habitat were evaluated at one location (Station 4) on the east branch of the Galien River at Gardner Road. The macroinvertebrate community scored acceptable (-1) and the habitat rated marginal (84). The surrounding land use is dominated by agriculture, and riparian zones are narrow and dominated by shrubs and small trees. The stream channel has been dredged, straightened, and cleared of large woody debris for much of its length.

Deer Creek

The macroinvertebrate community and habitat were evaluated at one location (Station 5) on Deer Creek at Basswood Road. The macroinvertebrate community scored acceptable but tending towards poor (-4) and the habitat rated good (106). Deer Creek at Basswood Road is not a straight channel as it is in upstream sections and has a relatively nice wooded riparian zone. However, the channel has been deeply incised; disconnecting the stream from its flood plain located five to six feet above the stream bed.

Spring Creek

Spring Creek is a coldwater tributary to the South Branch Galien River. It is channelized for most of its length and is maintained as a drain for surrounding agricultural fields. Spring Creek at Avery Road (Station 6) lies about ten feet below the floodplain and was eight feet wide and six inches deep at the time of the biosurvey. The macroinvertebrate community scored acceptable (0) with amphipods making up over 50 percent of all macroinvertebrates collected. Lack of a mature, functional, and connected riparian zone caused the habitat to rate poor (54).

Spring Creek at Kinne Road (Station 13) was visited to investigate a nonpoint source concern upstream of Kinne Road where a steep, sandy bank on a sharp bend is sloughing into the stream. Downstream of this failing bank the substrate is mostly sand with some small gravel. The stream at this location is about 12 feet wide and only a few inches deep. Macroinvertebrates, if sampled, would have likely scored acceptable with patchy habitat in the form of overhanging vegetation, sparse gravel, and undercuts available for colonization. Two large culverts under Kinne Road direct the stream to an old pasture area.

Blood Run

Blood Run is a tributary to the south branch Galien River. Two sites were observed during the summer of 2007. Blood Run's macroinvertebrate community and habitat were last evaluated in 1997 (Procedure 51 assessments were not made in 2007). Results of the 1997 survey found a macroinvertebrate community and habitat ratings that were acceptable but tending toward poor. Low scores in each group of metrics were attributed to poor bank conditions, bottom deposition, and embededness. Conditions of Blood Run do not seem to have improved since then. Sites at Maudlin Road (Station 11) and Wilson Road (Station 12) were visited to satisfy external monitoring requests related to recent road/stream crossing improvements. While the riparian area of these sites is largely forested, gully formation and erosion was observed near road crossings. Both sites had evidence of recent high flows, which appear to be frequent. The flashy hydrology of this stream is responsible for lack of stable habitat and channel widening and aggradation.

Judy Lake Drain

Judy Lake Drain was visited at Boyle Lake Road. Past channelization was evident although it was done in such a way that the floodplain remained intact allowing for the banks and riparian zone to begin to recover. The drain had good flow volume with sand dominated substrate and large amounts of gravel and cobble. Riffle and shallow pool habitats were more dominant here than downstream at Gardner Road.

Sawyer Creek

Sawyer Creek has historically had problems with oil and grease pollution. The stream was accessed across from the truck wash and gas station on Sawyer Road west of I-94. Sawyer Creek was deeply incised (> six feet from the bottom of the stream to the top of the bank), was about five feet wide, and had very little flow. Sediment was to be analyzed at this site but equipment failure precluded sample collection. No evidence of oil or gas products was observed.

Nonpoint Source Summary

The Galien River watershed is beleaguered by poor riparian management and drain maintenance activities. Much of the headwaters of the Galien River and several major tributaries have been channelized and are currently maintained as county drains. Extremes in stream discharge have, and will continue to cause habitat degradation in the form of bank erosion, stream morphology changes (widening, aggradation of sediments, loss of habitat diversity, etc.), increased embeddedness, and reduce indigenous aquatic life metric scores.

A number of external requests for monitoring were made to assess the impacts of road/stream crossing improvements and cattle crossings, as well as requests for macroinvertebrate community status throughout the watershed. Stations 4 and 8 to 14 (see Table 1) were visited to address these requests and are discussed in more detail above.

CONCLUSION

Results of the macroinvertebrate community assessments, habitat assessments, and water chemistry sampling indicate that Michigan's WQS are being met in the Galien River watershed. However, extremes in flow volume and poor riparian management continue to reduce the full biotic potential of the streams in the Galien River watershed.

Report by: Matthew Wesener, Aquatic Biologist
Surface Water Assessment Section
Water Bureau

Fieldwork by: Sarah LeSage and Matthew Wesener
Surface Water Assessment Section
Water Bureau
Michigan Department of Environmental Quality

REFERENCES

- Bonnette, S. 2000. A Biological and Physical Assessment of the Galien River Watershed. Berrien County, Michigan. August 19-25, 1997. Michigan Department of Environmental Quality, Surface Water Quality Division. Report #MI/DEQ/SWQ-99/114.
- Fisher, S.G., L.J. Gray, N.B. Grimm, and D.E. Busch. 1982. Temporal Succession in a Desert Stream Ecosystem Following Flash Flooding. *Ecological Monographs* (51) 93-110.
- Lamberti G.A., S.V. Gregory, L.R. Ashkenas, R.C. Wildman, and K.M.S. Moore. 1991. Stream Ecosystem Recovery Following a Catastrophic Debris Flow. *Canadian Journal of Fisheries and Aquatic Sciences* (48) 196-208.
- LeSage, S. and J. Smith. 2008. Water Quality and Pollution Control in Michigan: 2008 Sections 303(d), 305(b), and 314 Integrated Report. Michigan Department of Environmental Quality, Water Bureau. Report #MI/DEQ/WB-08/007.
- MDEQ. 1990. Surface Water Assessment Section Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers, April 24, 1990. Revised June 1991, August 1996, January 1997, May 2002, and December 2008.
- MDNR. 1994. Quality Assurance Manual for Water, Sediment, and Biological Sampling. Michigan Department of Natural Resources, Surface Water Quality Division.
- Negishi J.N., M. Inoue, and M. Nunokawa. 2002. Effects of Channelization on Stream Habitat in Relation to a Spate and Flow Refugia for Macroinvertebrates in Northern Japan. *Freshwater Biology* (47) 1515-1529.
- Palmer M.A., P. Arensburger, A.P. Martin, and D.W. Denman. 1996. Disturbance and Patch-Specific Responses: The Interactive Effects of Woody Debris and Floods on Lotic Invertebrates. *Oecologia* (105) 247-257.
- Walterhouse, M. 2003. A Biological Survey of Sites in the Galien River Watershed. Berrien County. July 2002. Michigan Department of Environmental Quality, Water Division. Report #MI/DEQ/WD-03/054.
- Wills T.C., E.A. Baker, A.J. Nuhfer, and T.G. Zorn. 2005. Benthic Macroinvertebrate Responses to Reduced Summer Streamflows in a Northern Michigan Stream. Michigan Department of Natural Resources, Fisheries Research Report 2081, Ann Arbor.

Site #	Stream Name	Location	Latitude	Longitude	P-51 Macroinvertebrates	P-51 Habitat	Water Chemistry	Observation Only
1	Galien River	Flynn Rd.	41.8270	-86.5329	X	X		
2	Galien River	Pardee Rd.	41.8275	-86.6557	X	X		
3	South Branch Galien R.	Forest Lawn Rd	41.7767	-86.6637	X	X		
4	East Branch Galien River	Gardner Rd.	41.8731	-86.4745	X	X		
5	Deer Creek	Basswood Rd.	41.7943	-86.6488	X	X		
6	Spring Creek	Avery Rd.	41.7767	-86.5816	X	X		
7	Galien River	City Boat Launch	41.8006	-86.7489			X	
8	Galien River	Minnich Rd.	41.874	-86.5749				X
9	Galien River	Warren Woods	41.8355	-86.6258				X
10	South Branch Galien River	Lakeside Rd.	41.7848	-86.6687				X
11	Blood Run	Maudlin Rd.	41.7852	-86.6916				X
12	Blood Run	Wilson Rd.	41.7700	-86.7047				X
13	Spring Creek	Kinne Rd.	41.7738	-86.5581				X
14	Judy Lake Drain	Boyle Lake Rd.	41.8685	-86.4554				X
15	Sawyer Creek	Sawyer Rd.	41.8853	-86.6042			X	

TABLE 1. 2007 Galien River watershed monitoring locations.

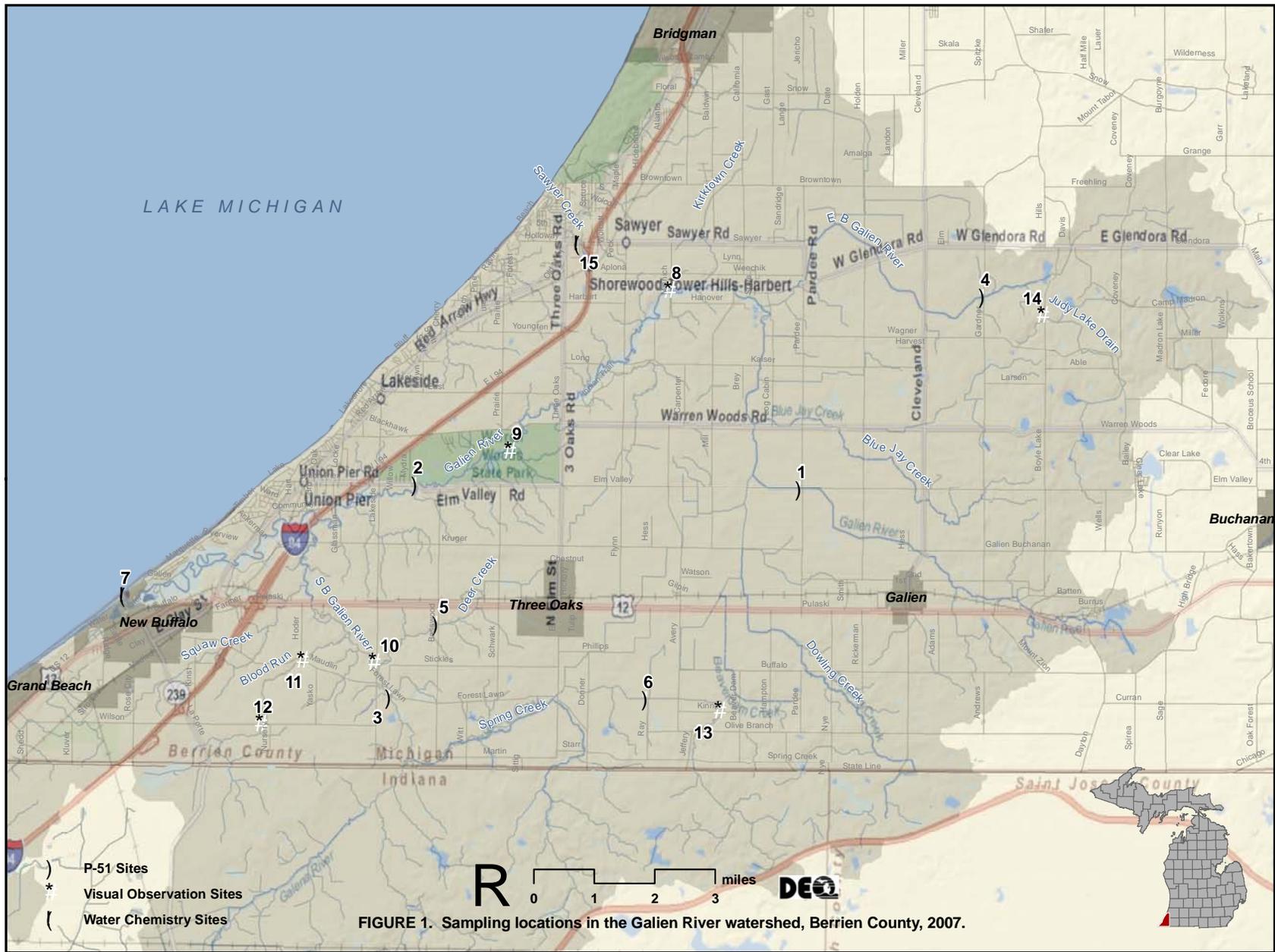


FIGURE 1. Sampling locations in the Galien River watershed, Berrien County, 2007.

FIGURE 1. Sampling locations in the Galien River watershed, Berrien County, 2007.

Table 2A. Qualitative macroinvertebrate sampling results for:

TAXA	Galien River Flynn Rd. 9/12/2007 STATION 1	Galien River Pardee Road 9/11/2007 STATION 2	S. Br. Galien River Forest Lawn Road 9/12/2007 STATION 3	E. Br. Galien River Gardner Road 9/11/2007 STATION 4
PLATYHELMINTHES (flatworms)				
Turbellaria				2
ANNELIDA (segmented worms)				
Hirudinea (leeches)				2
Oligochaeta (worms)	6	6	2	4
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	86	138	43	195
Decapoda (crayfish)	1	2		2
Isopoda (sowbugs)		1	8	
Insecta				
Ephemeroptera (mayflies)				
Baetidae	13	3	3	
Caenidae		1		
Heptageniidae	18	5	12	9
Isonychiidae			1	
Leptophlebiidae	3			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae			5	1
Gomphidae	2		1	
Zygotera (damselflies)				
Calopterygidae	51	28	25	4
Coenagrionidae	9		1	
Plecoptera (stoneflies)				
Perlidae			2	
Hemiptera (true bugs)				
Belostomatidae	2			
Corixidae	14			
Gerridae	1	1		1
Mesoveliidae	4	1		
Megaloptera				
Corydalidae (dobson flies)				
Sialidae (alder flies)	1		1	1
Trichoptera (caddisflies)				
Brachycentridae	2	4	1	
Helicopsychidae				1
Hydropsychidae	12	32	5	3
Leptoceridae			2	
Phryganeidae	1		1	
Psychomyiidae			1	
Coleoptera (beetles)				
Gyrinidae (adults)				
Dryopidae	2		1	
Elmidae		1	2	2
Diptera (flies)				
Chironomidae	20	23	9	13
Simuliidae	1	1	12	
Stratiomyidae	1			
Tabanidae	5			4
Tipulidae	1	2	4	
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)		2		
Physidae		1		
Viviparidae				5
Pelecypoda (bivalves)				
Sphaeriidae (clams)				2
TOTAL INDIVIDUALS	256	252	142	251

Table 2A (cont.). Qualitative macroinvertebrate sampling results for:

TAXA	Deer Creek Basswood Road 9/11/2007 STATION 5	Spring Creek Avery Road 9/11/2007 STATION 6
ANNELIDA (segmented worms)		
Oligochaeta (worms)	24	35
ARTHROPODA		
Crustacea		
Amphipoda (scuds)		160
Decapoda (crayfish)		1
Isopoda (sowbugs)		2
Insecta		
Ephemeroptera (mayflies)		
Baetidae	4	17
Heptageniidae		1
Odonata		
Anisoptera (dragonflies)		
Aeshnidae	2	1
Zygotera (damselflies)		
Calopterygidae	7	4
Hemiptera (true bugs)		
Belostomatidae		1
Gerridae		1
Mesoveliidae		1
Trichoptera (caddisflies)		
Brachycentridae		39
Hydropsychidae	22	3
Limnephilidae		1
Phryganeidae		1
Coleoptera (beetles)		
Gyrinidae (adults)		
Dryopidae		1
Elmidae	34	4
Diptera (flies)		
Ceratopogonidae		2
Chironomidae	85	2
Simuliidae		5
Tabanidae	15	1
Tipulidae	15	1
MOLLUSCA		
Pelecypoda (bivalves)		
Sphaeriidae (clams)	1	
TOTAL INDIVIDUALS	209	285

Table 2B. Macroinvertebrate metric evaluation of:

METRIC	Galien River Flynn Rd. 9/12/2007 STATION 1		Galien River Pardee Road 9/11/2007 STATION 2		S. Br. Galien River Forest Lawn Road 9/12/2007 STATION 3		E. Br. Galien River Gardner Road 9/11/2007 STATION 4		Deer Creek Basswood Road 9/11/2007 STATION 5		Spring Creek Avery Road 9/11/2007 STATION 6	
	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
	TOTAL NUMBER OF TAXA	23	0	18	0	22	0	17	0	10	-1	23
NUMBER OF MAYFLY TAXA	3	0	3	0	3	0	1	0	1	-1	2	0
NUMBER OF CADDISFLY TAXA	3	0	2	0	5	1	2	0	1	-1	4	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	1	1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	13.28	0	3.57	0	11.27	0	3.59	0	1.91	-1	6.32	0
PERCENT CADDISFLY COMP.	5.86	0	14.29	0	7.04	0	1.59	-1	10.53	0	15.44	0
PERCENT DOMINANT TAXON	33.59	0	54.76	-1	30.28	0	77.69	-1	40.67	-1	56.14	-1
PERCENT ISOPOD, SNAIL, LEECH	0.00	1	1.59	1	5.63	0	2.79	1	0.00	1	0.70	1
PERCENT SURF. AIR BREATHERS	9.38	0	0.79	1	0.00	1	0.40	1	0.00	1	1.40	1
TOTAL SCORE	0		0		3		-1		-4		0	
MACROINV. COMMUNITY RATING	ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.	

Parameter	Units	Station 7	Station 15	Parameter	Units	Station 7	Station 15
		Galien River at City Launch Result	Sawyer Creek d/s Sawyer Rd. Result			Galien River at City Launch Result	Sawyer Creek d/s Sawyer Rd. Result
4,4'-DDD	ug/L	Not Detected	Not Detected	1,3,5-Trimethylbenzene	ug/L	Not Detected	Not Detected
4,4'-DDE	ug/L	Not Detected	Not Detected	1,3-Dichlorobenzene	ug/L	Not Detected	Not Detected
4,4'-DDT	ug/L	Not Detected	Not Detected	1,4-Dichlorobenzene	ug/L	Not Detected	Not Detected
a-BHC	ug/L	Not Detected	Not Detected	2-Butanone (MEK)	ug/L	Not Detected	Not Detected
a-Chlordane	ug/L	Not Detected	Not Detected	2-Hexanone	ug/L	Not Detected	Not Detected
Aldrin	ug/L	Not Detected	Not Detected	2-Methylnaphthalene	ug/L	Not Detected	Not Detected
Aroclor 1016	ug/L	Not Detected	Not Detected	2-Propanone (acetone)	ug/L	Not Detected	Not Detected
Aroclor 1221	ug/L	Not Detected	Not Detected	4-Methyl-2-pentanone	ug/L	Not Detected	Not Detected
Aroclor 1232	ug/L	Not Detected	Not Detected	Acrylonitrile	ug/L	Not Detected	Not Detected
Aroclor 1242	ug/L	Not Detected	Not Detected	Benzene	ug/L	Not Detected	Not Detected
Aroclor 1248	ug/L	Not Detected	Not Detected	Bromobenzene	ug/L	Not Detected	Not Detected
Aroclor 1254	ug/L	Not Detected	Not Detected	Bromochloromethane	ug/L	Not Detected	Not Detected
Aroclor 1260	ug/L	Not Detected	Not Detected	Bromodichloromethane	ug/L	Not Detected	Not Detected
Aroclor 1262	ug/L	Not Detected	Not Detected	Bromoform	ug/L	Not Detected	Not Detected
Aroclor 1268	ug/L	Not Detected	Not Detected	Bromomethane	ug/L	Not Detected	Not Detected
b-BHC	ug/L	Not Detected	Not Detected	Carbon disulfide	ug/L	Not Detected	Not Detected
d-BHC	ug/L	Not Detected	Not Detected	Carbon tetrachloride	ug/L	Not Detected	Not Detected
Dieldrin	ug/L	Not Detected	Not Detected	Chlorobenzene	ug/L	Not Detected	Not Detected
Endosulfan I	ug/L	Not Detected	Not Detected	Chloroethane	ug/L	Not Detected	Not Detected
Endosulfan II	ug/L	Not Detected	Not Detected	Chloroform	ug/L	Not Detected	Not Detected
Endosulfan sulfate	ug/L	Not Detected	Not Detected	Chloromethane	ug/L	Not Detected	Not Detected
Endrin	ug/L	Not Detected	Not Detected	cis-1,2-Dichloroethylene	ug/L	Not Detected	Not Detected
Endrin aldehyde	ug/L	Not Detected	Not Detected	cis-1,3-Dichloropropylene	ug/L	Not Detected	Not Detected
Endrin ketone	ug/L	Not Detected	Not Detected	Cyclohexane	ug/L	Not Detected	Not Detected
g-BHC (Lindane)	ug/L	Not Detected	Not Detected	Dibromochloromethane	ug/L	Not Detected	Not Detected
g-Chlordane	ug/L	Not Detected	Not Detected	Dibromomethane	ug/L	Not Detected	Not Detected
Heptachlor	ug/L	Not Detected	Not Detected	Dichlorodifluoromethane	ug/L	Not Detected	Not Detected
Heptachlor epoxide	ug/L	Not Detected	Not Detected	Diethyl ether	ug/L	Not Detected	Not Detected
Hexabromobenzene	ug/L	Not Detected	Not Detected	Diisopropyl Ether	ug/L	Not Detected	Not Detected
Methoxychlor	ug/L	Not Detected	Not Detected	Ethylbenzene	ug/L	Not Detected	Not Detected
Mirex	ug/L	Not Detected	Not Detected	Ethyltertiarybutylether	ug/L	Not Detected	Not Detected
PBB (BP-6)	ug/L	Not Detected	Not Detected	Hexachloroethane	ug/L	Not Detected	Not Detected
Toxaphene	ug/L	Not Detected	Not Detected	Isopropylbenzene	ug/L	Not Detected	Not Detected
1,1,1,2-Tetrachloroethane	ug/L	Not Detected	Not Detected	m & p - Xylene	ug/L	Not Detected	Not Detected
1,1,1-Trichloroethane	ug/L	Not Detected	Not Detected	Methyl iodide	ug/L	Not Detected	Not Detected
1,1,2,2-Tetrachloroethane	ug/L	Not Detected	Not Detected	Methylene chloride	ug/L	Not Detected	Not Detected
1,1,2-Trichloroethane	ug/L	Not Detected	Not Detected	Methyltertiarybutylether	ug/L	Not Detected	Not Detected
1,1-Dichloroethane	ug/L	Not Detected	Not Detected	Naphthalene	ug/L	Not Detected	Not Detected
1,1-Dichloroethylene	ug/L	Not Detected	Not Detected	n-Butylbenzene	ug/L	Not Detected	Not Detected
1,2,3-Trichlorobenzene	ug/L	Not Detected	Not Detected	n-Propylbenzene	ug/L	Not Detected	Not Detected
1,2,3-Trichloropropane	ug/L	Not Detected	Not Detected	o-Xylene	ug/L	Not Detected	Not Detected
1,2,3-Trimethylbenzene	ug/L	Not Detected	Not Detected	p-Isopropyl toluene	ug/L	Not Detected	Not Detected
1,2,4-Trichlorobenzene	ug/L	Not Detected	Not Detected	sec-Butylbenzene	ug/L	Not Detected	Not Detected
1,2,4-Trimethylbenzene	ug/L	Not Detected	Not Detected	Styrene	ug/L	Not Detected	Not Detected
1,2-Dibromo-3-chloropropane	ug/L	Not Detected	Not Detected	tert-Butylbenzene	ug/L	Not Detected	Not Detected
1,2-Dibromoethane	ug/L	Not Detected	Not Detected	tertiary Butyl Alcohol	ug/L	Not Detected	Not Detected
1,2-Dichlorobenzene	ug/L	Not Detected	Not Detected	tertiaryAmylmethylether	ug/L	Not Detected	Not Detected
1,2-Dichloroethane	ug/L	Not Detected	Not Detected	Tetrachloroethylene	ug/L	Not Detected	Not Detected
1,2-Dichloropropane	ug/L	Not Detected	Not Detected	Tetrahydrofuran	ug/L	Not Detected	Not Detected

Table 4. Water chemistry monitoring results from the Galien River (station #7) and Sawyer Creek (station #15).

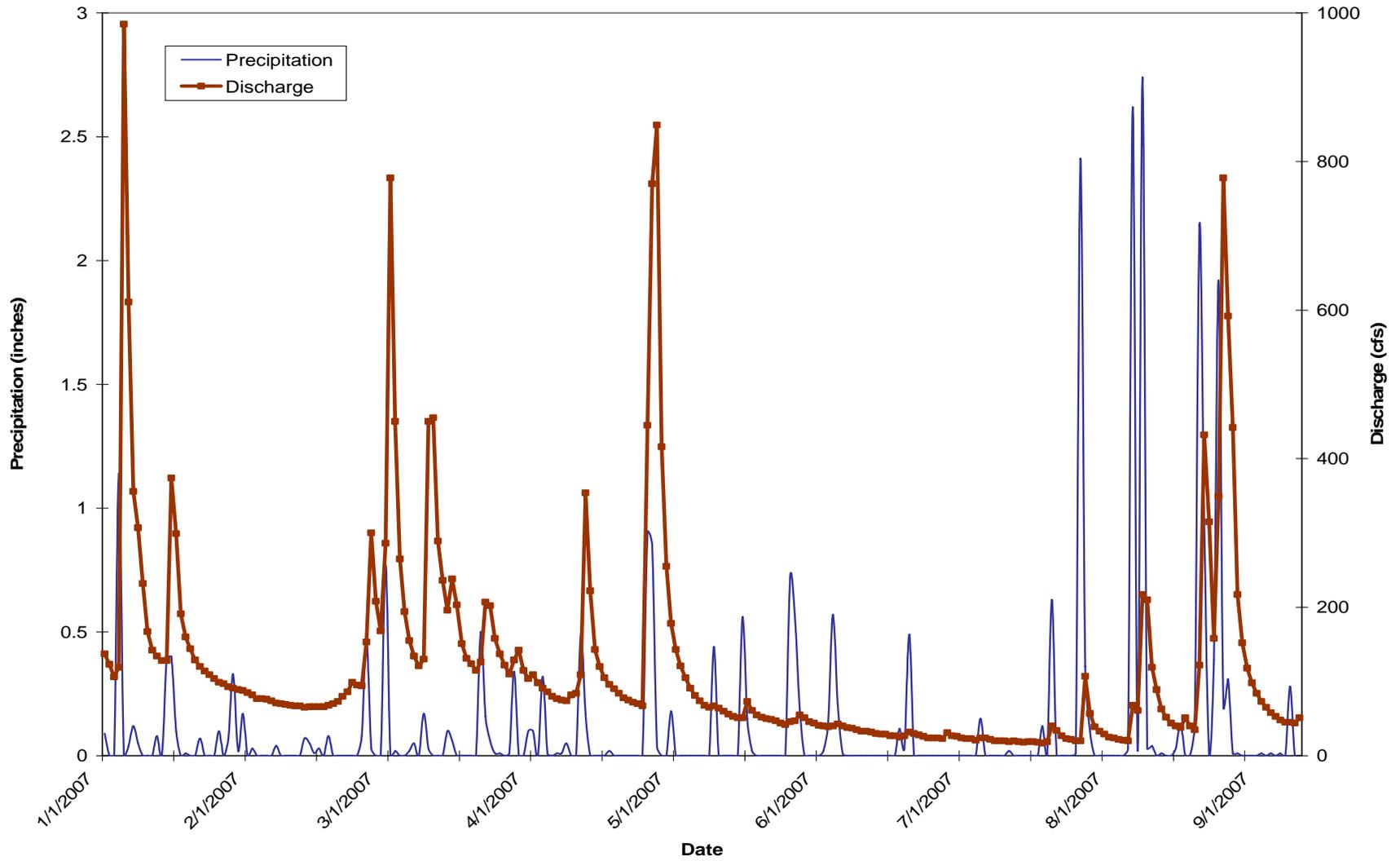


FIGURE 2. USGS discharge measurements and precipitation data for the Galien River near Sawyer, MI. January -September 2007.

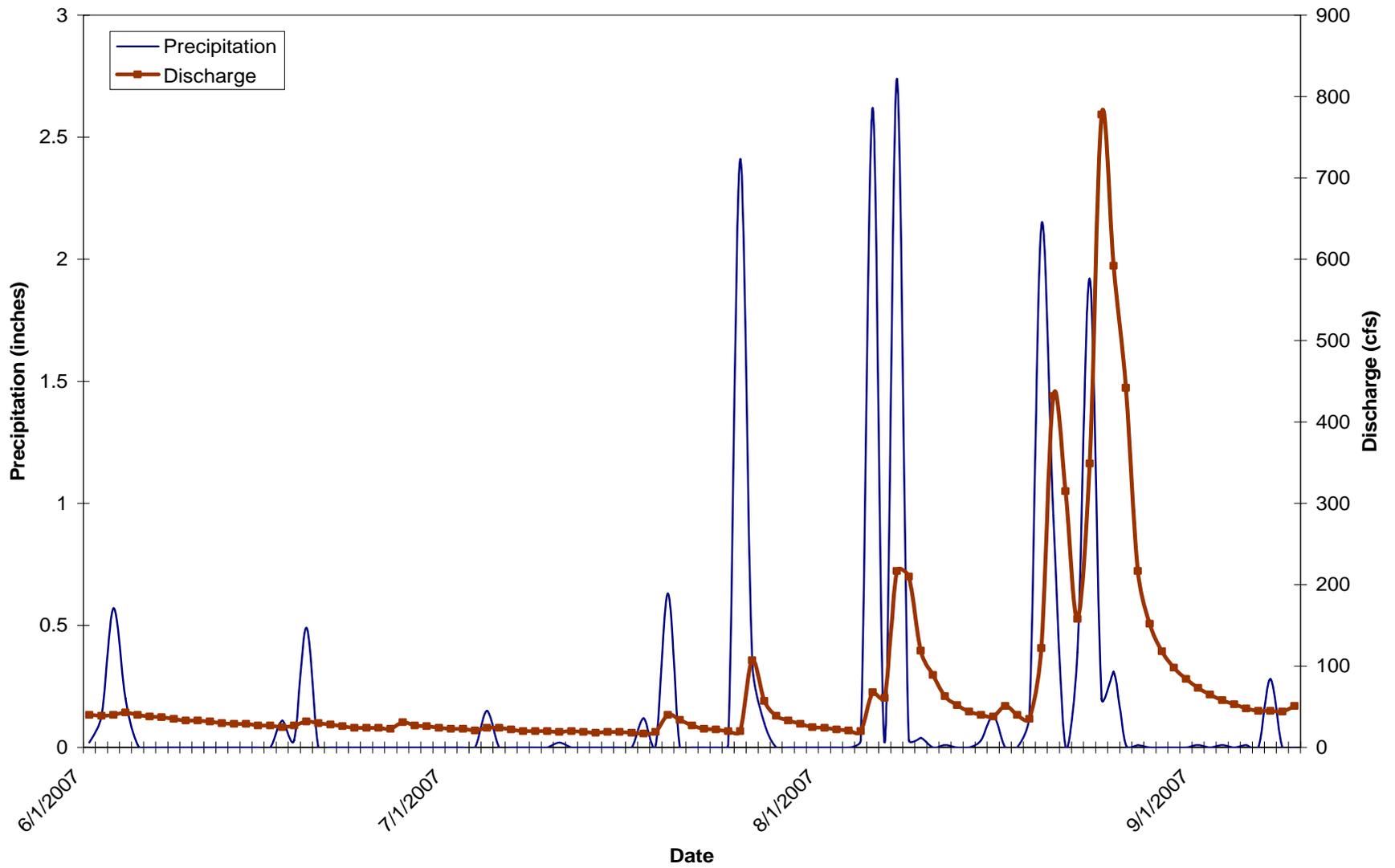


FIGURE 3. USGS discharge measurements and precipitation data for the Galien River near Sawyer, MI. June-September 2007.