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Aquatic Invertebrate Monitoring at Herbert Hoover National Historic Site, 2008

Natural Resource Data Series NPS/HTLN/NRDS—2010/053

ON THE COVER
Hoover Creek, Herbert Hoover National Historic Site, Iowa.
Photo from the Heartland Inventory & Monitoring Network files.

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Abstract

An unnamed tributary, known unofficially as Hoover Creek, of the west branch of Wapsinonoc Creek runs through the Herbert Hoover National Historic Site (HEHO) in eastern Iowa. The Hoover Creek watershed has historically been dominated by agricultural land use. However, in recent years, agricultural land use has declined as the city of West Branch expands west into the watershed. Such land use changes have dramatically altered the water quality and stream hydrology throughout the watershed by creating more dynamic surface water flow regimes resulting in periodic flash-flooding. The creek flows through an 81-acre restored tallgrass prairie at HEHO, but it also drains the impervious cover within the historic site. Historic structures and many cultural resources are in the flood plain. Stream-side vegetation in the Historic Site consists largely of a manicured lawn up to the stream edge. A native vegetation community is lacking which exacerbates flooding. The altered hydrological regime has caused substantial stream bank erosion in the historic site. Hoover Creek also has degraded water quality attributed to point and non-point agricultural and urban impacts in the watershed. The creek is listed by the Iowa Department of Natural Resources as an impaired stream under Section 303(d) of the Clean Water Act.

The Heartland Inventory and Monitoring Network (HTLN) of the National Park Service (NPS) began monitoring water quality and aquatic invertebrate community structure in Hoover Creek, HEHO in 2008 as a gage of stream ecological integrity. Aquatic invertebrates are an important biological tool for understanding and detecting changes in stream ecosystem integrity and can be used to reflect cumulative impacts that cannot otherwise be detected through traditional water quality monitoring. The objectives of this monitoring are: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics, and 2) relate the invertebrate community to overall water quality through quantification of metrics related to species richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat condition.

The invertebrate community data collected during this initial study suggests that Hoover Creek is impaired. Total taxa richness and Ephemeroptera, Plecoptera, Trichoptera (EPT) richness for Hoover Creek were roughly one-third that expected for regional reference streams, and the dominant EPT taxa represented were all tolerant genera. EPT taxa are, in general, sensitive to poor water quality conditions. Overall, the invertebrate fauna in Hoover Creek is judged to be tolerant of the various disturbances that affect this stream.

Future invertebrate sampling events at Hoover Creek should include a composited multihabitat sample in order to allow investigators to calculate the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods. This will allow site managers to evaluate the invertebrate community structure relative to Iowa reference streams in addition to assessing long-term trend in this resource.

There are few available options to park management for mitigating water quality impairment of Hoover Creek flowing through HEHO because some of the impacts to water quality and

associated effects on the invertebrate communities originate upstream of the park boundaries. The impacts of urbanization and agricultural practices often are so pervasive that mitigation strategies are rarely effective. However, widening and maintaining of riparian buffer zones along these streams within the park will aid in protecting aquatic life as well as in-stream habitat from local chemical runoff and sedimentation. Riparian buffers can be improved by restoring native grasses to areas where they occurred historically. Improved buffer zones will reduce bank erosion within HEHO by reducing stream velocity and the amount of water entering the creek. A reduction in impervious surfaces (sidewalks, trails and parking lots) within the Historic Site, minimizing mowing in the riparian buffers, and rerouting or eliminating tile drains flowing into the Hoover Creek would also help to stabilize the riparian zone and in-stream habitat. All of these actions are necessary for completing the goals for stream restoration and stabilization described in the Historic Site's Prairie Management Plan, General Management Plan, and Stream Management Plan.

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Introduction

An unnamed tributary, known unofficially as Hoover Creek, of the west branch of Wapsinonoc Creek runs through the Herbert Hoover National Historic Site (HEHO) in eastern Iowa. Hoover Creek drains about 1,752 acres of agricultural, rural residential, and urban land. The Hoover Creek watershed has been dominated by agricultural land use since the mid-1800s. Agricultural land in the watershed is tiled (drained with underground pipes) and development has pressed close to the stream banks during the last century. Approximately 250 meters of the upstream portion of the creek flows adjacent to an 81-acre restored tallgrass prairie, but the downstream portion of the creek drains the impervious cover and managed lawn within the historic site. In recent years, agricultural land use has declined as the city of West Branch expands into the watershed creating a more urban landscape in the vicinity of HEHO. Such land use changes have dramatically altered the water quality and stream hydrology throughout the watershed by creating more dynamic surface water flow regimes. This encourages the creek to flash flood during peak flows and poses a threat to historic structures and many cultural resources in the flood plain. Flashy flows or a rapid stream rise following modest rainfall can have dramatic effects on channel morphology and biological integrity by increasing erosion within the stream and decreasing the stability, quality, quantity, and diversity of microhabitats. The banks of Hoover Creek in HEHO are largely eroded due to the frequent flash floods that occur there.

Hoover Creek also has degraded water quality from both point and non-point pollution sources (Foreman 2007). There are several tile lines that drain into the creek within the jurisdictional boundaries of the historic site. Water quality parameters for Hoover Creek that have violated state and/or federal standards include nitrate + nitrite nitrogen, total Kjeldhahl nitrogen, turbidity, dissolved oxygen, and bacteria. Periodic sampling of Hoover Creek indicates that the creek previously violated state standards for bacteria and nitrate-nitrogen with bacteria levels of 39,000 colony forming units (CFU) /100 ml and nitrate-nitrogen concentrations that exceed 20 mg/L. Foreman (2007) reported the primary source of the fecal contamination comes from leaking septic systems or gray-water lines within the Historic Site. Hoover Creek is listed as an impaired stream under Section 303(d) of the Clean Water Act (Iowa Department of Natural Resources 2010).

Aquatic invertebrates are an important biological assessment tool for understanding and detecting changes in stream ecosystem integrity, and they can be used to reflect cumulative impacts that cannot otherwise be detected through traditional water quality monitoring. The Heartland Inventory and Monitoring Network (HTLN) of the National Park Service (NPS) began monitoring water quality and invertebrate community structure in Hoover Creek in 2008 (Bowles et al. 2008). The monitoring objectives of this study, as described by DeBacker et al. (2005), are: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics, and 2) relate the invertebrate community to overall water quality through quantification of metrics related to species richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat condition. The purpose of this report is to summarize baseline aquatic invertebrate monitoring data collected during July 2008 under the framework of the monitoring protocol.

Methods

Methods and procedures used in this report follow Bowles et al. (2008), Monitoring Protocol for Aquatic Invertebrates of Small Streams in the Heartland Inventory & Monitoring Network. Samples were collected at one reach of Hoover Creek on July 7, 2008 (Figure 1).

Three successive riffles were sampled with three benthic invertebrate samples collected at each riffle, resulting in nine samples. A Surber stream bottom sampler (500 μm mesh, 0.09 m^2) was used to collect the samples. Samples were sorted in the laboratory following a subsampling routine described in Bowles et al. (2008). Taxa were identified to the lowest practical taxonomic level (usually genus) and counted. Metrics calculated for each sample included genus richness, Shannon diversity index, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, EPT ratio (EPT density/(EPT density + Chironomidae density), genus evenness (where 0 = minimum evenness, 1 = maximum evenness), and Hilsenhoff biotic index (HBI) (Bowles et al. 2008). For details on calculating and interpreting metrics used in this report refer to Bowles et al. (2008). High values are preferred for all metrics, except for HBI, where smaller values are the desired response. An increase in HBI values over time is undesired, because that would reflect the community's increasing tolerance to disturbance.

For each sample, current velocity (meters/second) and depth (cm) were recorded directly in front of the sampling net frame. Qualitative habitat variables (embeddedness, periphyton, filamentous algae, aquatic vegetation, deposition, and organic material) were estimated within the sampling net frame as percentage categories (0, <10, 10-40, 40-75, >75). Habitat data were analyzed as midpoints of each category. Dominant substrate size from the area within the sampling net frame was visually assessed using the Wentworth scale (Wentworth 1922). Daily mean discharge for Hoover Creek was obtained from the United States Geological Survey Water Resources database (http://waterdata.usgs.gov/nwis). Water quality readings were recorded hourly using a calibrated YSI 6920 data logger. The water quality and habitat data presented in this report represent only a snap-shot of the broad temporal range of conditions and should be cautiously interpreted. They are intended to describe the prevailing conditions that influence the structure of invertebrate communities, and they may help explain variability between samples, but they should not be used as an analytical tool in the strictest sense (Bowles et al. 2008). Due to the limitations of using water quality data obtained with data loggers, the invertebrate community is used here as a surrogate of the long-term water quality condition of Hoover Creek.

A rain event occurred on the evening after invertebrate samples were collected resulting in a modest rise in stream flow. While this rain event did not influence invertebrate collections, it did have an influence on water quality parameters measured during that period.

The intent of this study is to monitor community condition within a site over time and not make comparisons within the site (Bowles et al. 2008). Because sample size presently is small (n=1 year), a rigorous statistical analysis of the data cannot be accomplished and only summary statistics are presented in this report.

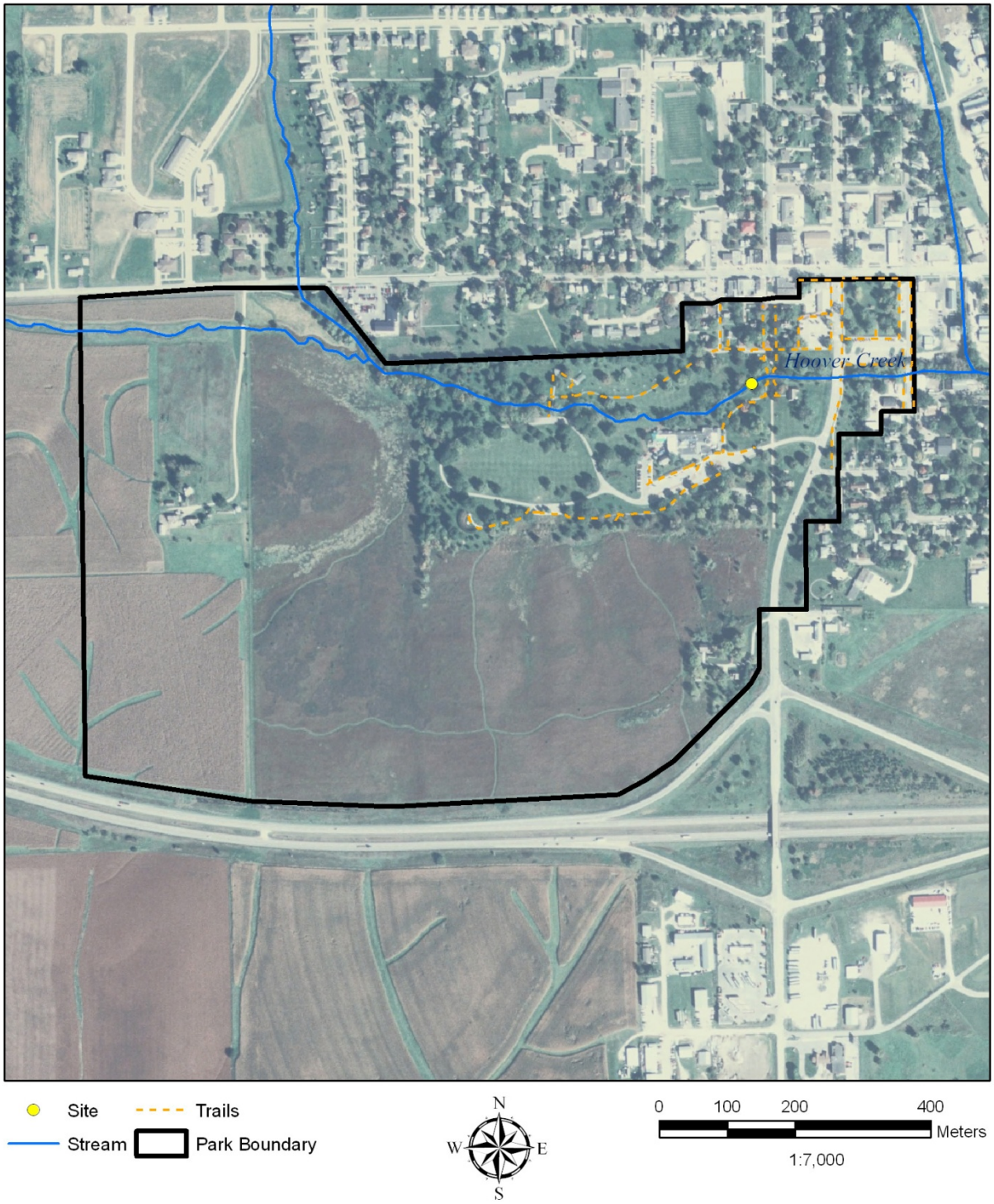

Figure 1. Map showing the approximate lower sampling reach boundary (yellow dot) for Hoover Creek, Herbert Hoover National Historic Site.

Results

Genus and EPT richness values for Hoover Creek were roughly one-third those expected for regional reference streams (Wilton 2004). Mean genus richness across riffles was 14 (range=12.7-15.0) and one third of those taxa were EPT. The low EPT ratio for Hoover Creek indicates that the dipteran family Chironomidae represented a substantial portion of the benthic community among samples. The percentage composition of Chironomidae in the total benthic community ranged from 14%-70% (mean=47%). Shannon index among samples ranged from 1.18 to 2.10 (mean=1.67). Genus evenness ranged from 0.47-0.79 (mean=0.63). HBI was moderately high for all samples ranging from 6.32-5.62 (mean=5.99). Most taxa in samples were tolerant of disturbance with tolerance values ranging from 1.4-8.7 (mean 5.7, median 6.0). The dominant EPT in samples were moderately intolerant taxa, including the caddisfly (Trichoptera) genera *Cheumatopsyche* (Hydropsychidae) and *Hydroptila* (Hydroptilidae) (tolerance values 6.6 and 6.0, respectively), and the mayfly family Baetidae (tolerance value 4.0). Only *Ceratopsyche* (Trichoptera: Hydropsychidae) and *Optioservus* (Coleoptera: Elmidae) had tolerance values less than four and they were poorly represented in samples. The top three dominant taxa comprised the majority of benthic densities for all samples (range 52.1-93.3%, mean=73.6). In most cases, the three dominant taxa included tolerant Oligochaeta, Chironomidae, *Cheumatopsyche*, and the black fly genus *Simulium* (Diptera: Simuliidae). The tolerant isopod genus *Lirceus* and the riffle beetle *Stenelmis* (Elmidae) were secondarily dominant.

Some water quality parameters measured in this study compared favorably to Iowa surface water standards and to regional reference streams while others did not (Tables 2 and 3). The data in Table 1 are arranged based on readings taken before and after the rain event that occurred during data logging in order to avoid presenting water quality conditions that are not reflective of the creek during non-flood conditions. The mean water temperature reported here was slightly above the 75th percentile for Iowa reference streams. Higher water temperatures are considered deleterious for aquatic life. Mean dissolved oxygen fell near the 25th percentile for state reference streams, and lower dissolved oxygen levels generally reflect poor conditions for aquatic life. The Iowa surface water quality standard for dissolved oxygen is that the minimum dissolved oxygen levels shall not be less than 5.0 mg/l during any 24-hour period (IDNR 2010). This minimum standard was not met for Hoover Creek where the minimum value recorded was 4.7 mg/l. Specific conductance was at an acceptable level for the region, as was mean pH. Although mean turbidity measured in this study was below the 50th percentile for reference streams, it greatly exceeded the maximum for state reference streams following the rain event and corresponding stream rise that increased turbidity. Stream discharge was 0.07 m^3 (2.4 ft^3) on July 7, 2008 at the time of invertebrate sampling, but increased to 0.17 m^3cubic meter (5.9 ft^3) when the datalogger was retrieved on July 8, 2008 (USGS 2008).

Habitat among riffles was uniform (Table 4). Riffles were shallow (mean= 11.33 cm) with relatively slow current velocity (mean=0.22 m/sec). Mean substrate at all three riffles ranged from 13-15 (22.6-64 mm, small-large pebble) on the Wentworth scale (Bowles et al. 2008). Embeddedness and deposition were relatively high (means= 48% and 74%, respectively). Periphyton was consistently 25% among samples, and no aquatic vegetation was present in samples. Percent organic material in samples was moderate (36%).

Table 1. Summary statistics for invertebrate samples collected from Hoover Creek, Herbert Hoover National Historic Site, 2008.

Statistic	Genus Richness	Shannon	EPT Richness	EPT Ratio	Genus Evenness	HBI
Mean	14.00	1.67	4.67	0.36	0.63	5.99
Standard Error	0.69	0.27	0.19	0.15	0.09	0.20
Minimum	12.67	1.18	4.33	0.11	0.47	5.62
Maximum	15.00	2.10	5.00	0.62	0.79	6.32
N	9	9	9	9	9	9

Table 2. Water quality data for Hoover Creek, Herbert Hoover National Historic Site, 2008. Data were collected hourly with calibrated data loggers.

N	Statistic	Temperature (^{o}C)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/liter)	pH	Turbidity (NTU)
Prior to Rain Event						
6	Mean	23.53	392.50	8.43	7.99	6.87
	Standard Deviation	0.49	4.09	0.59	0.06	1.36
	Minimum	22.70	385.00	7.73	7.91	5.30
	Maximum	24.04	396.00	9.30	8.05	9.10
Following Rain Event						
10	Mean	20.25	250.5	7.67	7.52	242.60
	Standard Deviation	1.60	35.32	0.22	0.20	135.31
	Minimum	18.11	179.00	7.30	7.38	99.90
	Maximum	22.89	297.00	7.94	7.92	497.40

Table 3. Statistical ranges of water quality parameters sampled at 98 candidate reference sites from 1994-1998 (from Wilton 2004).

Parameter	Minimum	25th Percentile	50th Percentile	75th Percentile	Maximum
Temperature (^{o}C)	8	14.6	18.6	21	26.8
Dissolved Oxygen (mg/l)	4.7	7.7	8.4	9.5	12.6
pH	6.5	7.4	7.7	8	8.6
Conductivity (µS/cm)	340	518	625	733	1200
Dissolved solids (mg/l)	210	280	340	400	610
Turbidity (NTU)	1	8	16	26	80

Table 4. Summary statistics for habitat variables associated with benthic samples collected from Hoover Creek, Herbert Hoover National Historic Site, 2008.

Habitat Parameter	Mean	Standard Error	Minimum	Maximum	N
Depth (cm)	11.33	3.18	6.00	17.00	9
Current Velocity (m/sec)	0.22	0.06	0.14	0.34	9
Substrate (Wentworth Scale)	13.78	0.22	13.33	14.00	9
Embeddedness (%)	48.47	4.78	41.25	57.50	9
Vegetation (%)	0	0	0	0	9
Filamentous Algae (%)	26.25	8.33	12.50	41.25	9
Periphyton (%)	25.00	0	25.00	25.00	9
Deposition (%)	74.17	1.67	72.50	77.50	9
Organics (%)	35.83	5.42	25.00	41.25	9

Discussion

The water quality of Hoover Creek has previously been shown to be impaired (Foreman 2007). Hoover Creek has higher nitrate + nitrite-N and total Kjeldahl nitrogen (TKN) levels in comparison to other eastern Iowa streams with a median for nitrate + nitrite-N being almost 8 times that of other regional streams (Foreman 2007). Although Iowa currently does not have a water quality standard for nitrate + nitrite-N, the U.S. Environmental Protection Agency (USEPA) recommends nitrate + nitrite-N concentrations be less than 1.965 mg/L and TKN concentrations be less than 0.64 mg/l (USEPA 2000). Foreman found that approximately 84% of the samples from Hoover Creek were in violation of the EPA standards for nitrate + nitrite-N and 17% were in violation for TKN concentrations. Foreman (2007) attributed these high nutrient levels to agricultural non-point pollution in the watershed. The high turbidity values recorded for Hoover Creek following a rain storm are likely due to much of the watershed lying in an agricultural area with substantial row crop production and associated exposed soils. Iowa currently does not have a water quality standard for turbidity, but the USEPA recommends that turbidity in this region not exceed 15 NTU (USEPA 2000). Foreman (2007) reported that approximately 35% of the turbidity samples from Hoover Creek violated this proposed standard. Hoover Creek remains listed as an impaired stream under Section 303(d) of the Clean Water Act due to fecal coliform bacteria levels exceeding the state standard (Iowa Department of Natural Resources 2010).

Foreman (2007) conducted the only other study of aquatic invertebrates in Hoover Creek using a multihabitat approach described in the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods, a qualitative approach that used only family-level invertebrate identifications (Wilton 2004). The findings of that study showed the invertebrate community in Hoover Creek was dominated by organisms that were largely tolerant of pollution and habitat deterioration. Foreman (2007) also reported that while overall taxa richness ranged from 10-14 taxa, over 75% of the total benthic density typically was dominated by only 3 taxa. Also, the % EPT among samples was low with a maximum of only 3.9% (Foreman 2007). Although the methods used by Foreman (2007) are not comparable to those used in this study, the findings are similar. Benthic metrics, particularly taxa richness and EPT richness for Hoover Creek were roughly one-third those expected for regional reference streams (Wilton 2004). The dominant EPT taxa represented in Hoover Creek were the caddisfly genera *Cheumatopsyche* and *Hydroptila*, and the mayfly family Baetidae all of which are moderately intolerant of disturbance. Moreover, no stoneflies (Plecoptera) were collected, and other sensitive EPT taxa were rare in samples. Because the results of this study are based on a single sampling event, the data are insufficient to accurately judge the integrity of this stream. However, the available evidence from this study and that of Foreman (2007) strongly suggests Hoover Creek is impaired.

Future invertebrate sampling events at Hoover Creek should include a composited multihabitat sample as described in Wilton (2004). A multihabitat sample in addition to the methodology described in Bowles et al. (2008) will allow investigators to calculate the IOWATER Advanced Benthic Macroinvertebrate Indexing Methods. Using this index to evaluate future benthic collections from Hoover Creek will allow site managers to directly compare its invertebrate

community structure relative to Iowa reference streams (Wilton 2004) in addition to assessing long-term trend in this resource.

There are few available options to park management for mitigating water quality impairment of Hoover Creek flowing through HEHO because some of the impacts to water quality and associated effects on the invertebrate communities originate upstream of the park boundaries. Indeed the impacts of urbanization often are so pervasive that mitigation strategies are rarely effective (Booth 2005, Paul et al. 2009) without major efforts to restore stream function and processes. Widening and maintaining riparian buffer zones along Hoover Creek in the Historic Site will aid in protecting aquatic life as well as in-stream habitat from local chemical runoff and sedimentation. Riparian buffers can be improved by restoring native grasses to areas where they occurred historically. Improved buffer zones will reduce bank erosion within HEHO by reducing stream velocity and the amount of water entering the streams. A reduction in impervious surfaces (sidewalks, trails and parking lot) within the park and minimizing mowing in the riparian buffers would also help stabilize the riparian zone and in-stream habitat. All of these actions are necessary for completing the goals for stream restoration and stabilization described in the Historic Site's Prairie Management Plan, General Management Plan, and Stream Management Plan (National Park Service 2003, 2004, 2006). Several drain pipes emptying directly into Hoover Creek in the Historic Site should be closed or rerouted to the extent practical. Aquatic invertebrate monitoring at HEHO provides a sound tool to recognize both deterioration and chronic decline of water quality.

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Appendix. Aquatic invertebrate data collected from Hoover Creek, Herbert Hoover National Historic Site, 2008. TV= tolerance value. Sample numbers are for riffles (1-3) and samples taken at left, middle, and right channel.

Phylum	Class	Order	Family	Genus	TV	Samples								
						1L	1M	1R	2L	2M	2R	3L	3M	3R
Nematoda						0	0	0	0	0	1	0	2	1
Nematomorpha					5	0	0	1	0	0	0	0	0	0
Annelida	Oligochaeta				8	23	40	44	68	27	62	62	27	30
Arthropoda	Arachnoida	Hydracarina			5.7	1	3	3	3	1	2	0	0	1
	Insecta	Ephemeroptera	Baetidae		4	2	8	9	10	13	13	1	0	2
				Pseudocloeon	4.4	0	40	35	6	12	19	1	7	0
		Trichoptera	Hydropsychidae		4	5	0	22	20	29	46	3	5	8
				Ceratopsyche	1.4	0	0	0	4	5	1	1	2	1
				Cheumatopsyche	6.6	11	62	35	46	7	23	0	5	0
		Trichoptera	Hydroptilidae	*Hydroptila*	6.2	4	12	9	0	0	0	5	6	13
		Diptera	Chironomidae		6	152	101	187	37	38	90	128	157	184
			Empididae	*Hemerodromia*	6	1	5	2	6	6	3	0	1	0
			Ceratopogonidae		6	3	4	0	0	1	4	0	3	0
			Simuliidae	*Simulium*	4.4	23	10	0	52	45	89	0	0	1

Appendix. Continued.

Phylum	Class	Order	Family	Genus	TV	Samples								
						1L	**1M**	**1R**	**2L**	**2M**	**2R**	**3L**	**3M**	**3R**
			Tipulidae	*Tipula*	7.7	0	1	0	0	1	0	0	0	0
		Coleoptera	Elmidae	*Dubiraphia*		0	0	1	1	0	0	0	2	1
				Optioservus	2.7	5	0	0	0	0	0	0	0	0
				Stenelmis	5.4	4	13	5	8	25	17	3	2	6
	Crustacea	Isopoda	Asellidae	*Lirceus*	7.7	0	4	4	4	4	5	2	13	13
	Crustacea	Decapoda			6	0	0	4	0	0	0	1	0	3
Mollusca	Bivalvia	Veneroidea	Corbiculidae	*Corbicula*	6.3	8	2	1	2	1	0	2	1	0
	Gastropoda	Bassommatophora	Physidae	*Physa*	8	0	7	0	0	0	0	0	0	0
TOTAL						**242**	**312**	**363**	**267**	**215**	**375**	**209**	**233**	**264**