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Fish Community Monitoring at Herbert Hoover National Historic Site

2008 & 2011 Status Report

Natural Resource Data Series NPS/HTLN/NRDS—2013/440

ON THE COVER
Hoover Creek, Herbert Hoover National Historic Site.
Photograph by: Heartland I&M staff

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Contents

Page

Figures iv

Tables iv

Abstract v

Acknowledgments vi

Introduction 1

Objectives 1

Methods 2

Study Area and Reach Selection 2

Fish Collection 2

Habitat and Water Quality 2

Data Analysis 2

Results 5

Fish Community 5

Habitat and Water Quality 6

Discussion 9

Literature Cited 10

Figures

Page

Figure 1. Site location in Hoover Creek for long-term fish monitoring at Herbert Hoover National Historic Site..... 4

Figure 2. Percentage of the reach covered by each fish cover category in Hoover Creek, 2008 and 2011. 7

Tables

Page

Table 1. Number of fish caught in Hoover Creek, 2008 and 2011.. 5

Table 2. Index of Biotic Integrity (IBI) scores and metric values for Hoover Creek, 2008 and 2011..... 6

Table 3. Width, depth, velocity, and substrate (mean + one standard error) of Hoover Creek within Herbert Hoover National Historic Site, 2008 and 2011..... 7

Table 4. Bank angle, percent bank vegetation, height, and substrate characteristics (% occurrence) and average bank stability score for Hoover Creek within Herbert Hoover National Historic Sites, 2008 and 2011. 8

Table 5. Water quality parameters (mean + one standard error) for Hoover Creek, 2008 and 2011..... 8

Abstract

Herbert Hoover National Historic Site (HEHO) is located in eastern Iowa where the dominate land use consists of row-crop and grassland agricultural practices. A portion of an unnamed tributary of the West Branch of Wapsinonoc Creek, known as Hoover Creek, flows through HEHO. In 2008 and 2011, the Heartland Inventory and Monitoring Network (HTLN) of the National Park Service (NPS) began monitoring fish communities, physical habitat, and water quality at a downstream reach of Hoover Creek within HEHO. The fish community was found to be diverse, but consisted of eight species moderately tolerant or tolerant to poor water quality and habitat conditions. Relative abundance of fish appeared to increase from 2008 to 2011; however, this finding is an artifact of the higher turbidity in 2008 making collection of smaller-bodied fishes difficult and not due to a true change in fish abundance. Overall, stream integrity was rated as fair (Index of Biotic Integrity score = 31) based on fish community composition. High turbidity, unstable banks, and predominately fine streambed substrates found at Hoover Creek, coupled with the absence of intolerant fish species and a fair IBI score suggest degraded habitat conditions and an impaired fish community.

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Introduction

Herbert Hoover National Historic Site (HEHO), located in eastern Iowa, is approximately 187 acres with 81 acres of restored prairie. An unnamed tributary of the West Branch of Wapsinonoc Creek, known as Hoover Creek, flows through HEHO. Approximately 1,300 m of the stream runs through the park with a small portion (~250 m) flowing adjacent to the restored prairie. The watershed of Hoover Creek is predominately agricultural, rural residential, and urban land use. The change in land use from the historic condition of tallgrass prairie has increased frequency of flooding, bank erosion, sedimentation, nutrient inputs, and other chemical pollution, altering the water quality and habitat of Hoover Creek. Several water quality (dissolved oxygen, turbidity, Nitrate+Nitrite nitrogen, and total Kjeldhahl nitrogen) and bacteria standards have been violated, resulting in the listing of Hoover Creek as an impaired stream under Section 303(d) of the Clean Water Act (Forman 2007, Iowa Department of Natural Resources 2010).

Many native fish populations in the Midwest have been adversely impacted throughout their ranges by a number of factors associated with land use changes, making it necessary to protect native fish species. Although anthropogenic disturbances at the watershed scale can dramatically alter a lotic system, protecting portions of prairie streams on publicly owned lands may offer refuges for native fish communities. Because changes or shifts in stream habitat availability and complexity and water quality determine biotic communities, including fish (Lazorchak *et al*. 1998), monitoring trends in fish community composition along with associated habitat conditions serves as a strong basis for measuring stream integrity. Trends in the composition and abundance of fish populations historically have been used to assess the biological integrity of streams (Karr 1981; Barbour *et al*. 1999; Moulton *et al.* 2002) because many fish species are considered intolerant of habitat alterations (Karr 1981; Robison and Buchanan 1988; Pflieger 1997; Barbour *et al*. 1999). Furthermore, the value of fish as environmental indicators and as a common recreational opportunity makes the status of fish diversity a topic that park visitors, landowners, and the general public can easily identify and can be used as a tool for resource management at HEHO.

Objectives

The specific objectives for fish community monitoring at HEHO are: (1) to determine the status and long term trends in fish richness, diversity, abundance, and community composition and (2) to correlate the long-term community data to overall water quality and habitat condition.

Methods

Details on methods of site selection, fish sampling, and habitat and water quality data collection not listed in this report can be found in the Protocol for Monitoring Fish Communities in Small Streams in the Heartland Inventory and Monitoring Network (Dodd et al. 2008).

Study Area and Reach Selection

A reach on Hoover Creek was selected just upstream of the downstream walking bridge (Figure 1). Reach length was defined as 20 times the mean wetted stream width with a minimum of 150 m, allowing inclusion of representative channel units (riffle, run, and pool habitats) located within the stream (Moulton et al., 2002). Because the stream at HEHO was small and narrow, the minimum reach length of 150 m was sampled.

Fish Collection

Fish communities were sampled in July 2008 and 2011. Fish were collected using a single pass with a pulsed DC backpack electrofishing unit throughout the sampling reach. During sampling, fish were collected with nets and placed in buckets containing aerated water from the stream. All fish were identified to species and counted. A subsample of 30 individuals per species were measured and weighed, and any anomalies (deformities, eroded fins, lesions, tumors, and blackspot parasite) were recorded. Fish that were too small or that were difficult to identify in the field were preserved for laboratory identification. All other fish were released back into the sample reach. Details on fish collection and sample processing techniques can be found in SOP#4 of Dodd et al. (2008).

Habitat and Water Quality

Physical habitat and water quality data were collected in conjunction with fish sampling. An 11 transect method was used to collect data on general channel morphology, fish cover, and bank conditions within the entire reach. In-stream habitat (depth, velocity, substrate, *etc*.) and fish cover (presence of boulders, hydrophytes, *etc*.) were assessed at three equally spaced points per transect (see Dodd et al. 2008, SOP #5 for a list of all habitat parameters collected). Fish cover along the banks (undercut banks, overhanging terrestrial vegetation, *etc*.) and bank/riparian stability were assessed on the left and right banks at each transect. Hourly water quality data (temperature, dissolved oxygen, pH, specific conductance, and turbidity) were collected using a calibrated water quality datalogger deployed upstream of the reach for approximately 24 hours. Detailed methods on habitat and water quality collection are located in Dodd et al. (2008).

Data Analysis

Biological metrics that reflect fish community diversity (species richness and Simpson's Diversity Index), abundance (catch per unit effort), composition (number and percent composition of sensitive taxa), and overall stream integrity (Index of Biotic Integrity) were calculated. Community diversity was assessed using Simpson's Diversity Index, which gives the probability that two individuals picked at random from the site are the same species. Therefore, the index decreases with increasing diversity and ranges from 0 (completely diverse) to 1 (no diversity). For community composition, number and percent composition of sucker (Catastomidae), sunfish (Centrarchidae; excluding tolerant species), and darter/sculpin/madtom (*Etheostoma* and *Percina*/*Cottus*/*Noturus*) species were calculated because these metrics are typically used in several Index of Biotic Integrity (IBI) calculations (Karr 1981, Dauwalter et al.

2003, Wilton 2004, Smogor 2005) and demonstrate sensitivity to human disturbance. The IBI developed by the Iowa Department of Natural Resources (Wilton 2004) was used to assess overall stream health and is calculated using 12 metrics: 1) number of native fish species; 2) number of sucker (*Catostomidae*) species; 3) number of sensitive species; 4) number of benthic invertivore species; 5) percent abundance of three dominant species; 6) percent of fish as benthic invertivores; 7) percent of fish as omnivores; 8) percent of fish as top carnivores; 9) percent of fish as simple lithophilous spawners; 10) fish assemblage tolerance index; 11) adjusted catch per unit effort (CPUE); and 12) percent of fish with deformities, eroded fins, lesions, or tumors (DELT). Each of the 12 raw metric values was scored from 0 to 10 based on formulas developed for the Iowa streams. The first 11 metric scores were summed and the % DELT metric was subtracted to calculate an IBI score that ranges from 0 to 100. Based on this IBI score, the overall integrity of the stream is classified from poor to excellent: poor = 0-25; fair = 26-50; good = 51-70; excellent = 71-100. More detailed methods on calculating the IBI metrics used in this report can be found in Wilton (2004).

Physical habitat and water quality data were summarized using averages with standard errors (SE) or percentages, where appropriate. Physical habitat data were analyzed as in-stream habitat, fish cover, and bank stability. Analysis of in-stream substrate data used the Wentworth code for particle sizes (see SOP #5 in Dodd et al. 2008 for the code categories and size ranges). For assessment of stream banks, categories of bank angle, percent vegetation, height, and substrate were used to assess overall bank stability. Water quality data were summarized using means and standard errors.

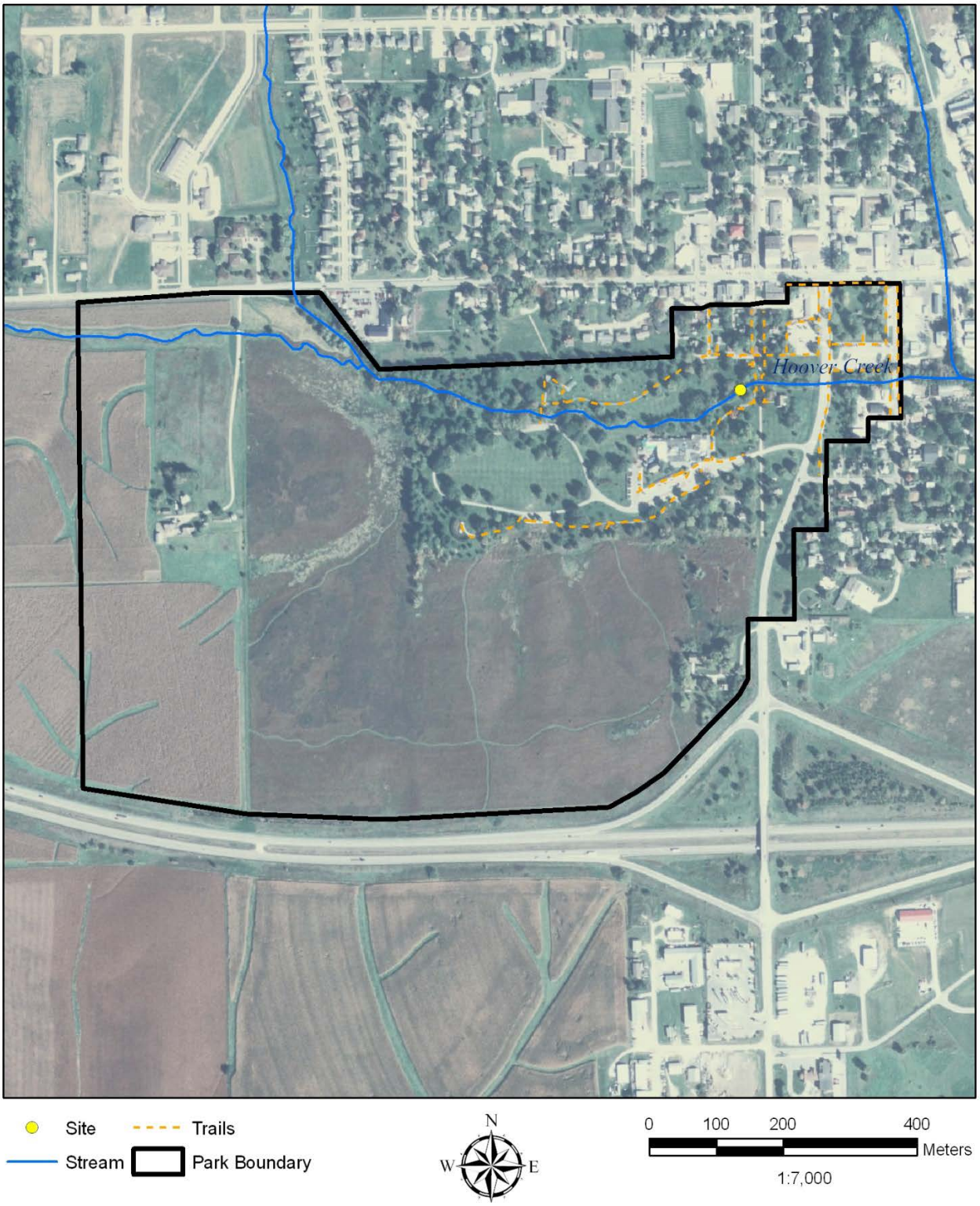

Figure 1. Site location in Hoover Creek for long-term fish monitoring at Herbert Hoover National Historic Site.

Results

Fish Community

The same eight species were collected from Hoover Creek in 2008 and 2011 (Table 1). All species collected were either moderately tolerant or tolerant to poor water quality conditions (Table 1) with no sensitive species collected at Hoover Creek (Table 2). Although benthic and sucker species are typically indicative of good stream conditions, the one benthic species (Johnny darter, *Etheostoma nigrum*, a benthic invertivore) and one sucker species (White sucker, *Catostomus commersoni*, an omnivore) collected were moderately tolerant to human disturbance. The most abundant species were the Creek chub (*Semotilus atromaculatus*, tolerant species) in 2008 and Johnny darter (moderately tolerant) in 2011 (Table 1). Due to the absence of sensitive species, lithophilic (gravel/sand) spawners, and top carnivores, stream integrity was rated as fair (IBI score of 31) in both years (Table 2). In addition, low adjusted CPUE in 2008 and higher occurrence of DELT anomalies in 2011 also contributed to a low IBI score. In 2008, adjusted CPUE (excludes tolerant species) was 11 times lower than that of 2011 (Table 2). This lower CPUE is due to lower catches of small minnows (Cyprinidae) and darters (Table 1) as a result of higher turbidity (see Water Quality section below) and less visibility caused by a rain event prior to sampling. The Simpson's Diversity index indicated high diversity (low index value of 0.22 in 2008 and 0.21 in 2011) due to both the high number of native species collected and the evenness in abundance among species (Table 2). However, fish community diversity consisted only of moderately tolerant and tolerant taxa.

Table 1. Number of fish caught in Hoover Creek, 2008 and 2011. Tolerance levels are: M = moderately tolerant and T = Tolerant to poor water quality and habitat conditions.

Family	Common Name	Scientific Name	Tolerance	2008	2011
Catostomidae	White sucker	*Catostomus commersoni*	M	7	13
Cyprinidae	Bigmouth shiner	*Notropis dorsalis*	T	2	25
Cyprinidae	Blacknose dace	*Rhinichthys atratulus*	M	1	87
Cyprinidae	Bluntnose minnow	*Pimephales notatus*	T	2	6
Cyprinidae	Central stoneroller	*Campostoma anomalum*	M	3	17
Cyprinidae	Common shiner	*Luxilus cornutus*	M	4	27
Cyprinidae	Creek chub	*Semotilus atromaculatus*	T	19	80
Percidae	Johnny darter	*Etheostoma nigrum*	M	8	114
Total				46	369

Table 2. Index of Biotic Integrity (IBI) scores and metric values for Hoover Creek, 2008 and 2011.

IBI Metric	2008	2011
Number of Native Species	8	8
Number of sucker species	1	1
Number of Sensitive Species	0	0
Number of Benthic Invertivore Species	1	1
% Abundance of 3 Dominant Species	73.9	76.2
% Benthic Invertivore	17.4	30.9
% Omnivore	19.6	5.1
% Top Carnivore	0.0	0.0
% Lithophilic Spawners	0.0	0.0
Tolerance Index	7.5	6.5
Adjusted CPUE (catch/100 ft) excludes tolerant & exotic species	4.7	52.3
% DELT Anomalies	0.0	3.0
IBI Score	31	31
Stream Integrity Rating	Fair	Fair

Habitat and Water Quality

Hoover Creek is narrow (< 5m) and shallow (<50 cm), which is typical of small headwater streams (Table 3). Both average depth and velocity were higher in 2008 than 2011 due to a rain event in 2008 and drier conditions in 2011. Dominant substrate size was very fine to medium sand (Wentworth code size of 2 to 4) in both years. Fish cover was primarily small woody debris (52% and 58% of the reach, respectively) and overhanging vegetation (45% and 60%, respectively) in both years (Figure 2). In 2008, 37% of the reach also consisted of root cover along the bank.

Banks were unstable (stability score between 11 – 15) with average stability scores of 12 in 2008 and 11 in 2011 (Table 4). Banks were steep and incised and consisted of highly erodible silt substrate. Banks in 2008 had higher percent of steep (> 60°) and incised (>1m) banks, and a lower percent of banks with >80% vegetation. Bank/riparian vegetation was predominately manicured lawn.

In 2008, a storm occurred during the water quality collection period on the night prior to fish sampling, dropping approximately 4 cm of rain and increasing the discharge from 0.06 m^3/s to 0.57 m^3/s during the night. Therefore, water quality data were analyzed by pre- and post- rain event for 2008. After the rain event, average water temperature, specific conductance, and pH declined, while average turbidity increased and exceeded the USEPA standards (EPA 2000) of 15 NTU (Table 5). Although dissolved oxygen decreased following the rain event, levels remained above the minimum Iowa standard of 4 mg/L in a 24 hour period (IAC 2012). The decline in dissolved oxygen is likely due to respiration occurring during nighttime hours rather than a result of the rain event. Comparing among years, average water temperatures were lower and specific conductance and dissolved oxygen were higher in 2011. Turbidity exceeded USEPA standards in 2011.

Table 3. Width, depth, velocity, and substrate (mean ± one standard error) of Hoover Creek within Herbert Hoover National Historic Site, 2008 and 2011.

	2008			2011		
Habitat Parameter	Mean	±	SE	Mean	±	SE
Width (m)	2.7	±	0.0	2.6	±	0.1
Depth (cm)	30.3	±	1.6	19.6	±	1.6
Velocity (m/s)	0.29	±	0.03	0.08	±	0.01
Substrate (Wentworth Code)	3.7	±	0.72	2.5	±	0.7

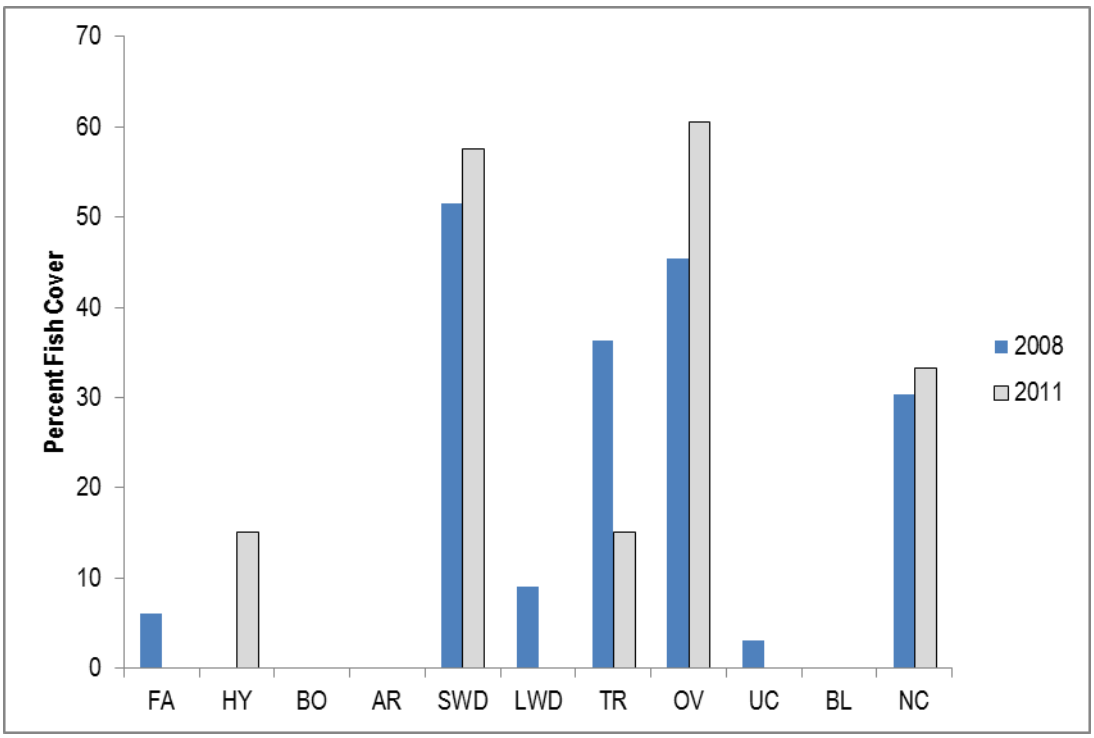

Figure 2. Percentage of the reach covered by each fish cover category in Hoover Creek, 2008 and 2011. Percentages for a reach do not add to 100% because multiple cover types were present at transects. FA = filamentous algae, HY = hydrophytes, BO = boulder, AR = artificial, SWD = small woody debris, LWD = large woody debris, TR = trees or roots, OV = overhanging vegetation, BL = bluff, UC = undercut bank, NC = no cover.

Table 4. Bank angle, percent bank vegetation, height, and substrate characteristics (% occurrence) and average bank stability score for Hoover Creek within Herbert Hoover National Historic Sites, 2008 and 2011.

Bank Parameter	2008	2011
Angle		
$<60^0$	18	36
$>60^0$	82	64
% Vegetation		
> 80%	68	90
50 - 80%	32	5
< 50%	0	5
Height		
< 1m	0	14
1 - 2m	27	72
2 - 3m	73	14
> 3m	0	0
Substrate		
Bedrock/Artificial	0	0
Boulder/Cobble	0	0
Silt	100	100
Sand	0	0
Gravel/Sand	0	0
Stability Score (Mean ± 1 SE)	12 ± 0.2	11 ± 0.2

Table 5. Water quality parameters (mean ± one standard error) for Hoover Creek, 2008 and 2011.

	2008						2011		
	Pre-rain Event (n =6)			Post-rain Event (n = 10)			(n = 19)		
Water Quality Parameter	Mean	±	SE	Mean	±	SE	Mean	±	SE
Water Temperature (˚C)	23.5	±	0.2	20.3	±	0.5	19.3	±	0.5
Specific Conductance (µS/cm)	392.5	±	1.7	250.5	±	11.2	509.7	±	0.6
Dissolved Oxygen (mg/L)	8.43	±	0.24	7.67	±	0.07	9.73	±	0.15
pH	8.00	±	0.02	7.52	±	0.06	7.79	±	0.01
Turbidity (NTU)	6.9	±	0.6	242.6	±	42.8	20.1	±	2.0

Discussion

The fish community in Hoover Creek was diverse with eight native species collected, but consisted entirely of moderately tolerant and tolerant species. The absence of sensitive species, gravel spawning species, or top carnivores in our samples resulted in an overall stream integrity rating of fair based on the IBI index. The lack of larger gravel substrate is likely the reason for the apparent absence of lithophilic spawners as well as the low percentage of benthic invertivores (feeders on bottom-dwelling invertebrates). The narrow and shallow characteristics of this headwater stream may explain the lack of larger top carnivore species in our collections. Furthermore, the fish assemblage in 2011 showed an increased incidence of disease and deformities, which may be due to higher stress during the dry conditions of 2011 or may also be a result of higher numbers of fish collected in 2011 increasing the likelihood of fish with anomalies. Although Hoover Creek was more turbid in 2008, making visibility to collect smaller species difficult and decreasing numbers of fish caught, the same eight species were collected in both years with similar evenness among species as indicated by the diversity index.

Turbidity levels exceeded USEPA water quality standards (EPA 2000) in both 2008 during a small rain event (< 5 cm) as well as in 2011 during drier conditions. Higher turbidity is typical in streams with watersheds dominated by agricultural land use, such as Hoover Creek. Turbidity can result from stream bank or streambed erosion as well as run-off from crop fields. Banks of Hoover Creek consisted of mowed grass, steep angles, and silt substrate, indicating unstable banks susceptible to erosion. Dissolved oxygen did not fall below the Iowa standard during our sampling. However, Foreman (2007) found that 14% of dissolved oxygen measurements taken in Hoover Creek during 2004-2006 fell below 5mg/L. These occurrences of low dissolved oxygen occurred during low flow and high temperatures and immediately after large rain events. High water temperatures and low dissolved oxygen cause stress in fish and may become lethal during the peak of summer in July and August. The decline in dissolved oxygen during our 24 hour sampling period in 2008 occurred as an artifact of timing of the rain event during the night. Dissolved oxygen declined during nighttime hours (due to respiration of aquatic plants and animals), but began increasing during dawn and early morning hours when plants/algae begin producing oxygen via photosynthesis.

Based on our data collected in 2008 and 2011, the fish community and physical habitat of Hoover Creek is degraded. Both Forman (2007) and Bowles et al. (2010) found that the invertebrate community in Hoover Creek was also impaired. Agricultural land use outside park boundaries is primarily responsible for the “flashy” nature of the stream and degraded water quality and habitat (Forman 2007). However, manicured lawns along the banks and tile drainage within the park may contribute to non-point and point source pollution. Establishing a riparian buffer of native grasses and trees could reduce surface flow run-off, therefore, reducing stream flows and the potential for stream bank erosion during storm events. In addition, removal of field tiles within the park will help improve water quality by reducing nutrient enrichment. Heavy input of nutrients can cause algae blooms that adversely affect dissolved oxygen needed for healthy fish communities.

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