



Aquatic Community Monitoring at Effigy Mounds National Monument, 2008–2017

Natural Resource Report NPS/HTLN/NRR—2023/2562



ON THE COVER

Dousman Creek in 2008 (upper panel) and 2014 (lower panel), Effigy Mounds National Monument, Iowa.
Photography by NPS/HEARTLAND INVENTORY AND MONITORING NETWORK

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Abstract

Dousman Creek, located in northeastern Iowa, is a Class “B” coldwater stream that supports a trout population and is listed among the Outstanding Iowa Waters (Iowa Department of Natural Resources 2010, 2016). The Heartland Inventory and Monitoring Network (Heartland Network) of the National Park Service (NPS) has been monitoring aquatic communities (fish and invertebrates) in Dousman Creek within Effigy Mounds National Monument since 2008. Corresponding physical habitat and water quality were also collected during biotic sampling. The objectives of this long-term monitoring program are to assess the status and trends in the biotic stream community and relate these trends to environmental variables.

The purpose of this report is to summarize the baseline aquatic community data collected during three sampling events conducted from 2008 to 2017. The fish community was dominated by the intolerant cool/cold-water species brown trout (*Salmo trutta*) and mottled sculpin (*Cottus bairdii*) in 2008, while more tolerant white sucker (*Catostomus commersonii*) and johnny darter (*Etheostoma nigrum*) were most abundant in 2014. During 2017, fish community composition was more evenly distributed among species present. Benthic invertebrate samples were dominated by the moderately intolerant mayfly genus *Pseudocloeon* and blackfly genus *Simulium* in 2008 and 2014, while the invertebrate samples in 2017 were dominated primarily by a tolerant, mayfly taxa (*Baetis*) and Oligochaetes. The abundance of aquatic invertebrates in 2017 was more than ten times lower than invertebrate abundance in 2008 and 2014. Water quality data collected by the Heartland Network did not indicate any of the five parameters (temperature, dissolved oxygen, pH, specific conductance, or turbidity) exceeded the Iowa Department of Natural Resources water quality standards, however the number of hourly measurements were low (4–20 measurements) depending on year sampled. Three years of data are currently insufficient to fully characterize the stream integrity of Dousman Creek based on fish and invertebrate communities. Continued long-term monitoring of Dousman Creek will allow for better assessment of the biotic integrity and overall quality of the stream.

Acknowledgments

We thank Rodney Rovang and Jessica Salesman at Effigy Mounds National Monument for maintaining communication with the Heartland Network regarding disturbance events in Dousman Creek, as well as for assistance during field sampling. We also thank the many Heartland Network interns and partners for assistance in the field and with laboratory processing of samples.

Introduction

Land use changes that degrade water quality and stream habitat are a major factor in shifts or declines in fish and aquatic invertebrate communities throughout the Midwest. Aquatic communities serve as important biological indicators for understanding and detecting changes in stream integrity and health. Because both fish and aquatic invertebrates are relatively long-lived and sensitive to habitat and water quality alterations, they can reflect cumulative impacts over a longer time-period that cannot be detected through discrete water quality sampling.

In 2008, the Heartland Inventory and Monitoring Network (Heartland Network) of the National Park Service (NPS) began monitoring fish and invertebrates and related habitat data in Dousman Creek within Effigy Mounds National Monument (NM; Bowles et al. 2010; Bowles et al. 2021; Dodd 2016; Dodd et al. 2021). Dousman Creek is a Class B (CW1) cold-water stream that supports a trout population and is listed among the Outstanding Iowa Waters (Iowa Department of Natural Resources 2010 and 2016). Class B (CW1) waters have temperature and flow that are suitable for the maintenance of a variety of cold-water species, including reproducing

and non-reproducing populations of trout and associated aquatic communities. Cool- and cold-water species within the Midwest region are particularly at risk due to compounding factors of land use and climate change that can result in increasing water temperatures and degradation of suitable habitat. Through collection and interpretation of biological community and habitat data, we can obtain a broader and more complete science-based understanding of stream health and aquatic community integrity that can inform resource management decisions. By protecting portions of Dousman Creek, the park may offer refuges for native cool- and cold-water species.

The objectives of long-term monitoring are to (1) determine the status and trends of aquatic invertebrate and fish diversity, abundance, and community metrics and (2) relate the invertebrate and fish community to overall water quality and habitat conditions. This report presents additional analysis of aquatic data collected in 2017 in comparison to 2008 and 2014 data sets (Bowles et al. 2010; Dodd 2016) and relates these findings to stream habitat and water quality conditions.

Methods

Methods and procedures used for site selection, data collection, and analyses in this report follow Heartland Network protocols for monitoring aquatic invertebrates and fish communities within Wadeable Streams (Bowles et al. 2021; Dodd et al. 2021). Samples were collected in July/August at one 150-m reach of Dousman Creek (Figure 1) in 2008, 2014, and 2017.

Aquatic Invertebrates

Three benthic invertebrate samples and related habitat data were collected within three successive riffles, resulting in nine samples for the reach. A Surber stream bottom sampler (500- μ m mesh, 0.09 m²) was used to collect the benthic samples. For each invertebrate sample, current velocity, depth, and qualitative habitat variables for embeddedness, periphyton, filamentous algae, and aquatic vegetation were estimated within the sampling net frame. Dominant substrate size within this frame was visually assessed using the Wentworth scale (Wentworth 1922). Benthic samples were sorted in the laboratory following a subsampling routine (Bowles et al. 2021). Taxa were identified to the lowest practical taxonomic level (usually genus) and counted.

Six metrics that reflect richness, diversity, density, and impairment were calculated for each sample. Richness metrics included taxa richness and Ephemeroptera, Plecoptera, Trichoptera richness (EPT richness). Diversity metrics included Shannon diversity index and evenness (where 0 = no evenness and 1 = maximum evenness). Densities were measured and reported as the ratio of sensitive EPT to more tolerant Chironomidae (EPT density/[EPT density + Chironomidae density]), and this ratio ranged from 0 to 1. Status of impairment was calculated using the Hilsenhoff Biotic Index (HBI). HBI uses both taxa abundance and the tolerance of taxa to disturbance (i.e. tolerance value) to calculate an index ranging from 0 to 10, with 10 being most tolerant (Hilsenhoff 1988). Therefore, larger HBI values indicate greater impairment.

For invertebrate data analysis, each of the six metrics (taxa richness, EPT richness, Shannon diversity index, evenness, density, and impairment) was calculated for the nine samples collected within the

reach for that year. Each metric was then averaged across the three samples collected within a riffle to obtain a mean ($n = 3$ samples/riffle). The means for each of the three riffles were then averaged to calculate a mean for the reach ($n = 3$ riffles/reach). Qualitative habitat data were converted to midpoints of each category and analyzed using means and 95% confidence intervals. For more detailed information on field and laboratory methods and calculation of metrics, see Bowles et al. 2021.

Fish Community

Fish and related stream habitat were sampled throughout the stream reach using standardized operating procedures (Dodd et al. 2021). Fish were collected using a pulsed direct current backpack electrofishing unit and dip nets. Fish were identified to species, measured, and inspected for diseases or abnormalities in the field. Stream habitat measures related to channel morphology (velocity, depth, width, dominant substrate using Wentworth scale), fish cover (presence of cover types such as woody debris, boulders, hydrophytes, etc.) and riparian/bank habitat (bank angle, vegetation, height, and substrate categories) were collected at 11 transects within the sampled reach.

Biological metrics that reflect community richness and diversity (species richness, Simpson's diversity index), abundance (catch per effort), and overall stream integrity (Index of Biotic Integrity, IBI) were calculated. Simpson's diversity index (SI) gives the probability that two individuals picked at random from the site are the same species. The index decreases with increasing community diversity, ranging from 0 (completely diverse) to 1 (no diversity). Because of this inverse relationship between community diversity and the Simpson's diversity index, the inverse of Simpson's diversity index (1-SI) is used in this report. The IBI developed for Wisconsin cool- and cold-water streams (Lyons et al. 1996) was used to assess overall stream integrity based on fish community data. This cool/cold-water IBI uses five metrics: (1) number of intolerant species, (2) percent of individuals that are tolerant species, (3) percent of individuals that are top carnivores, (4) percent of individuals that are stenothermal cool- and cold-water species (native

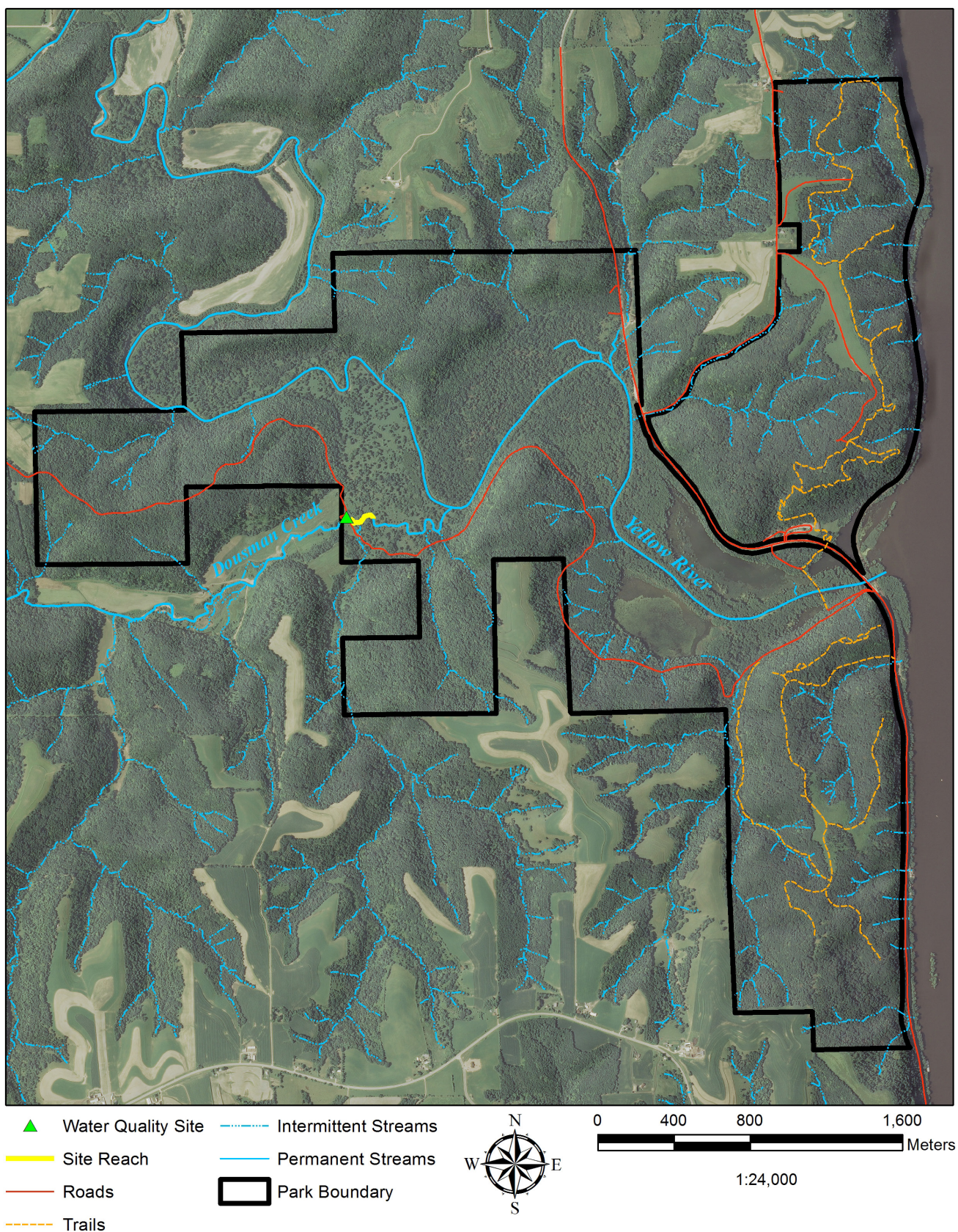


Figure 1. Map showing the sampling reach (thicker, yellow line just east of the water quality location (green triangle) on Dousman Creek, Effigy Mounds National Monument, Iowa.

and exotic), and (5) percent of salmonid individuals that are brook trout (*Salvelinus fontinalis*). This index ranges from 0 to 100 with increasing values indicating greater stream integrity.

Quantitative physical habitat data (i.e., width, depth, and velocity of the stream) were summarized using means with 95% confidence intervals. Qualitative habitat data related to channel morphology (i.e., substrate size and embeddedness) were converted to midpoints of each category and analyzed using means and 95% confidence intervals. Presence/absence of fish cover and categorical bank data (i.e., bank angle, bank vegetation, etc.) were analyzed as percentage of the reach. For greater details on field methods and calculation of fish community metrics, see Dodd et al. (2021).

Water Quantity and Quality

Stream discharge and water quality were measured at the upstream end of the sample reach. Discharge was collected by taking depth and velocity readings at equally spaced intervals along a 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 during sampling. Number of hourly measurements varied between years (4–20 measurements). Water quality data were summarized using means and 95% confidence intervals.

Results

Aquatic Invertebrates

A total of 43 invertebrate taxa have been collected in Dousman Creek across all three years sampled, with 21% of these taxa considered sensitive to poor water quality conditions (Table 1). Although mean taxa richness and percentage of total sensitive taxa were lowest in 2014 (7.8 taxa and 11%, respectively), the 95% confidence intervals for mean taxa richness suggest no differences in number of taxa collected among years. (Figure 2, upper panel and Table 1). In 2008 and 2014, the community was dominated primarily by the moderately intolerant mayfly genus *Pseudocloeon* and the black fly genus *Simulium*, but was dominated by more tolerant taxa, the *Baetis* mayfly and Oligochaetes, in 2017 (Table 1). True flies in the Chironomidae family were also abundant in 2008 and 2014 (Table 1). Percentage of the community that consisted of EPT taxa ranged from 17% in 2014 to 32% in both 2008 and 2017 (Table 1). Mean EPT richness was lowest in 2014 and highest and most variable in 2017, but 95% confidence intervals suggest average EPT richness was similar between all three years (Figure 2, lower panel). Mean EPT density was also lowest in 2014 with the 95% confidence intervals indicating that EPT density for

2014 differs from 2008 and 2017 (Figure 2, lower panel). The larger mean EPT density for Dousman Creek in 2008 and 2017 was due to lower density of Chironomidae among samples compared to 2014 (Table 1).

Mean community diversity and evenness increased in 2017 (Figure 3, upper panel). The 95% confidence intervals for mean evenness indicated invertebrate abundance in 2017 was more evenly spread across taxa in the community compared to 2008 and 2014 (Figure 3, upper panel). Mean HBI values (which are based on taxa abundance and tolerance values) indicated the invertebrate community was in good condition in 2008 and 2014 (scores of 4.7 and 4.8, respectively) but in fair condition in 2017 (score of 5.8; Figure 3, lower panel). The fair rating in 2017 was due to a few samples having high numbers of tolerant Oligochaetes relative to the total abundance of invertebrates in the sample, thus elevating the overall average HBI. Overall abundance of invertebrates was low in 2017 and highest in 2014. It is worthy to note that richness, diversity, evenness, and HBI metrics showed the greatest variability (i.e. largest confidence intervals) among samples and riffles at the site during 2017.

Table 1. Invertebrate taxa and number of individuals collected at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Sensitive taxa are those with a tolerance value less than or equal to three.

Phylum	Class	Order	Family	Genus	Sensitive Taxa?	2008	2014	2017
Annelida	Hirudinea	–	–	–	No	2	–	2
Annelida	Hirudinea	Branchiobdellida	–	–	No	–	2	–
Annelida	Oligochaeta	–	–	–	No	111	172	174
Arthropoda	Arachnida	Trombidiformes	“Hydracarina”	–	No	19	16	5
Arthropoda	Crustacea	Amphipoda	Gammaridae	<i>Gammarus</i>	No	111	44	35
Arthropoda	Crustacea	Isopoda	–	–	No	–	–	1
Arthropoda	Crustacea	Isopoda	Asellidae	<i>Caecidotea</i>	No	90	9	7
Arthropoda	Insecta	Coleoptera	Dryopidae	<i>Helichus</i>	No	–	–	2
Arthropoda	Insecta	Coleoptera	Dytiscidae	<i>Agabus</i>	No	2	10	–
Arthropoda	Insecta	Coleoptera	Elmidae	–	No	–	–	1
Arthropoda	Insecta	Coleoptera	Elmidae	<i>Optioservus</i>	Yes	15	2	4
Arthropoda	Insecta	Coleoptera	Elmidae	<i>Stenelmis</i>	No	–	10	1
Arthropoda	Insecta	Collembola	–	–	No	9	–	1
Arthropoda	Insecta	Collembola	Entomobryidae	–	No	–	66	–
Arthropoda	Insecta	Diptera	–	–	No	2	–	–

Table 1 (continued). Invertebrate taxa and number of individuals collected at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Sensitive taxa are those with a tolerance value less than or equal to three.

Phylum	Class	Order	Family	Genus	Sensitive Taxa?	2008	2014	2017
Arthropoda	Insecta	Diptera	Athericidae	<i>Atherix</i>	Yes	–	–	9
Arthropoda	Insecta	Diptera	Ceratopogonidae	<i>Bezzia (Palpomyia)</i>	No	–	4	–
Arthropoda	Insecta	Diptera	Chironomidae	–	No	529	1262	73
Arthropoda	Insecta	Diptera	Empididae	<i>Clinocera</i>	No	–	2	–
Arthropoda	Insecta	Diptera	Muscidae	<i>Limnophora</i>	No	4	2	–
Arthropoda	Insecta	Diptera	Simuliidae	<i>Prosimulium</i>	Yes	–	–	6
Arthropoda	Insecta	Diptera	Simuliidae	<i>Simulium</i>	No	1949	8330	62
Arthropoda	Insecta	Diptera	Tipulidae	<i>Dicranota</i>	Yes	37	–	–
Arthropoda	Insecta	Diptera	Tipulidae	<i>Tipula</i>	No	2	–	–
Arthropoda	Insecta	Ephemeroptera	Baetidae	–	No	379	98	90
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Acentrella</i>	No	–	–	12
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Baetis</i>	No	6	–	141
Arthropoda	Insecta	Ephemeroptera	Baetidae	“ <i>Pseudocloeon</i> ”	No	3450	544	–
Arthropoda	Insecta	Ephemeroptera	Tricorythidae	<i>Tricorythodes</i>	No	–	–	1
Arthropoda	Insecta	Orthoptera	Tridactylidae	<i>Ellipes</i>	No	–	–	2
Arthropoda	Insecta	Plecoptera	–	–	Yes	4	–	–
Arthropoda	Insecta	Trichoptera	Brachycentridae	<i>Brachycentrus</i>	Yes	1	–	2
Arthropoda	Insecta	Trichoptera	Glossosomatidae	<i>Glossosoma</i>	Yes	5	–	1
Arthropoda	Insecta	Trichoptera	Hydropsychidae		No	2	–	–
Arthropoda	Insecta	Trichoptera	Hydropsychidae	<i>Ceratopsyche</i>	Yes	–	2	6
Arthropoda	Insecta	Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i>	No	–		3
Arthropoda	Insecta	Trichoptera	Hydropsychidae	<i>Hydropsyche</i>	No	–	10	–
Arthropoda	Insecta	Trichoptera	Hydroptilidae	<i>Hydroptila</i>	No	–	–	4
Arthropoda	Insecta	Trichoptera	Uenoidae	<i>Neophylax</i>	Yes	2	–	–
Mollusca	Bivalvia	–	–	–	No	–	–	1
Mollusca	Gastropoda	–	–	–	No	–	–	1
Mollusca	Gastropoda	Basommatophora	Physidae	<i>Physella</i>	No	5	–	–
Nematoda	–	–	–	–	No	5	102	6

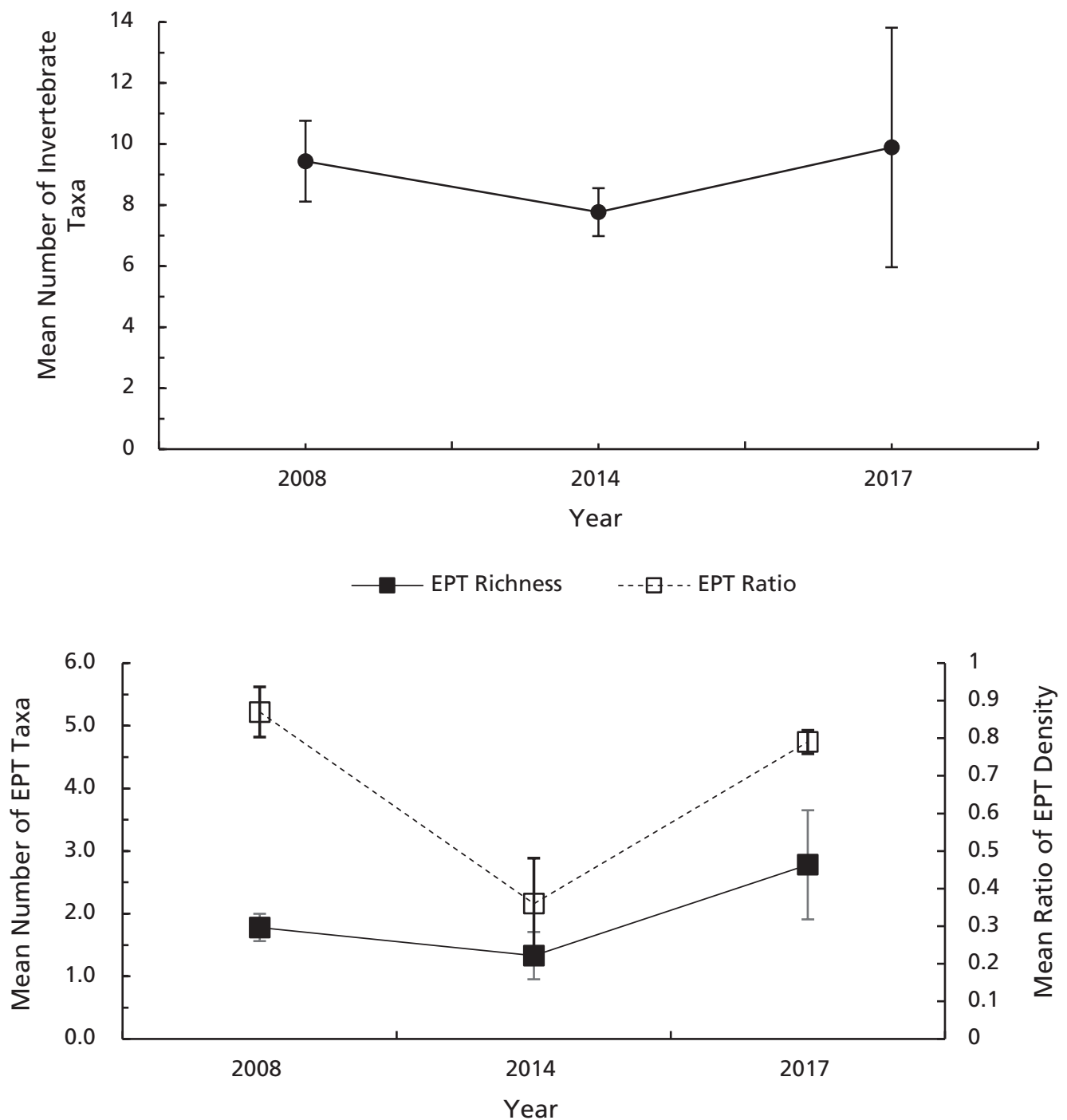


Figure 2. Mean invertebrate taxa richness (upper panel) and mean Ephemeroptera, Plecoptera, and Tricoptera (EPT) richness and density ratio (lower panel) for Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Error bars represent 95% confidence intervals. N = 3 riffles for all years.

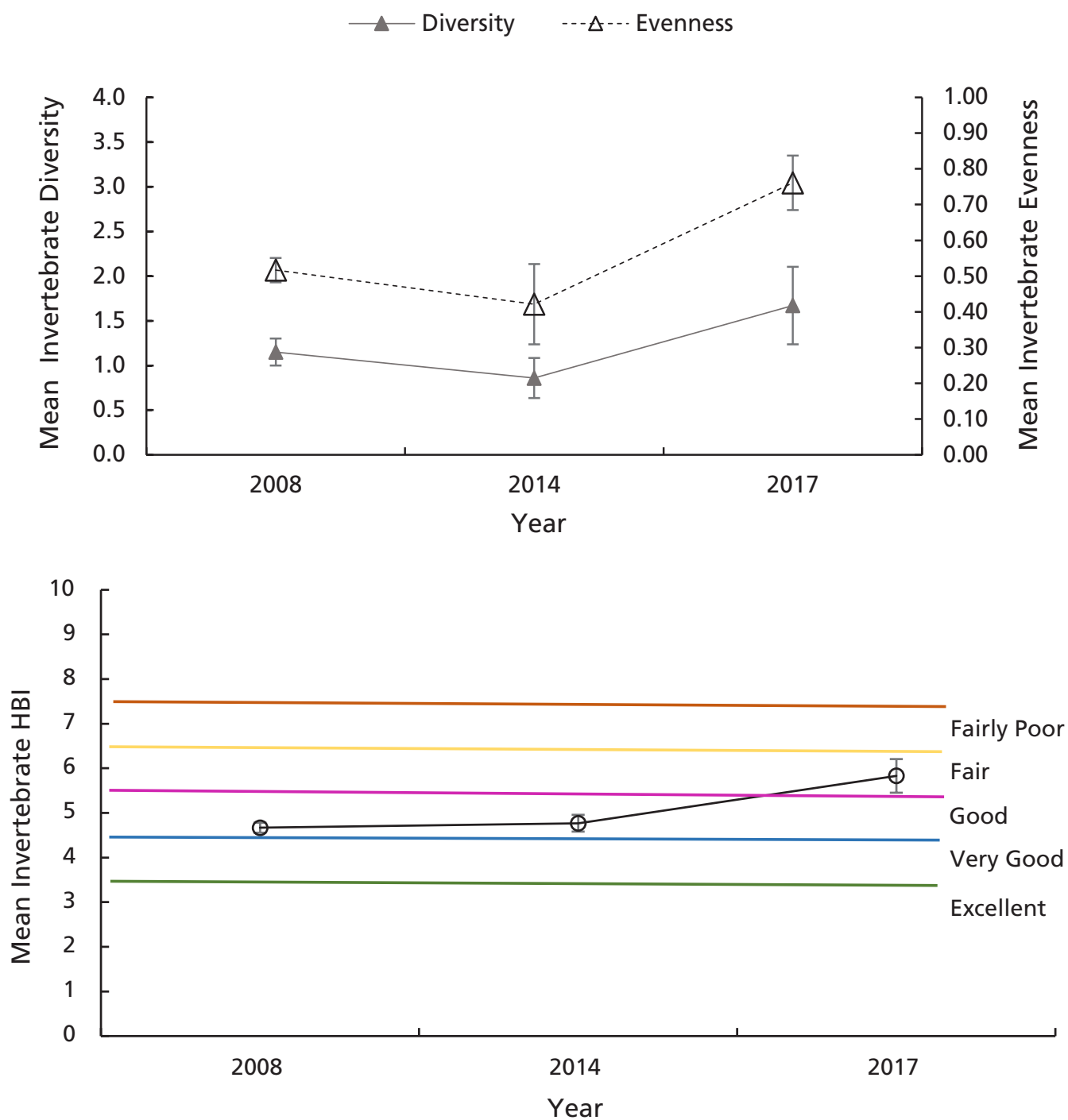


Figure 3. Mean Shannon's diversity and evenness index (upper panel) and mean Hilsenhoff's Biotic Index (HBI; lower panel) for invertebrates in Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Error bars represent 95% confidence interval. N = 3 riffles for all years. Horizontal lines in bottom graph represent the community rating based on HBI score.

Fish Community

Fourteen fish species were collected at Dousman Creek across the three years sampled (Figure 4) with species richness ranging from 7 in 2017 to 11 in 2014 (Figure 5). In 2008 and 2017, mottled sculpin (*Cottus*

bairdii) was the most abundant species with brown trout (*Salmo trutta*) also abundant in these years (Figure 4). Both fish are cool-water species and intolerant to poor habitat and water quality conditions. Fish abundance was highest and

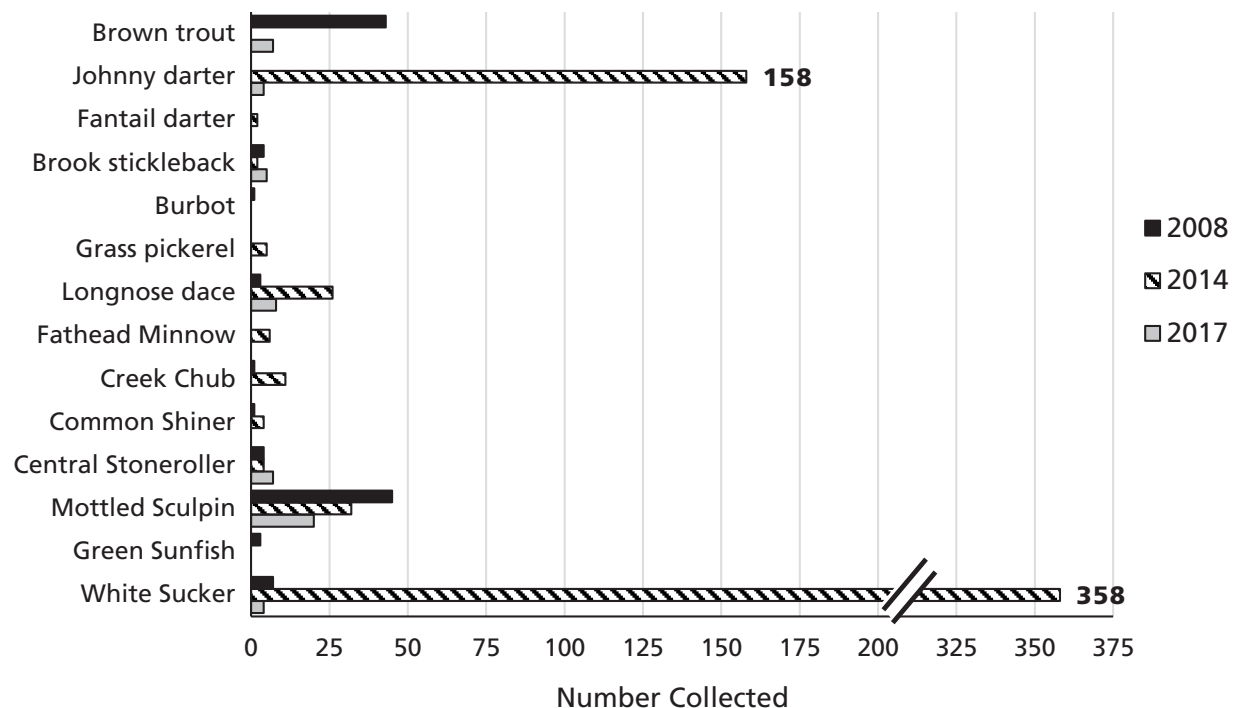


Figure 4. Fish species and number collected in the sample reach on Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017.

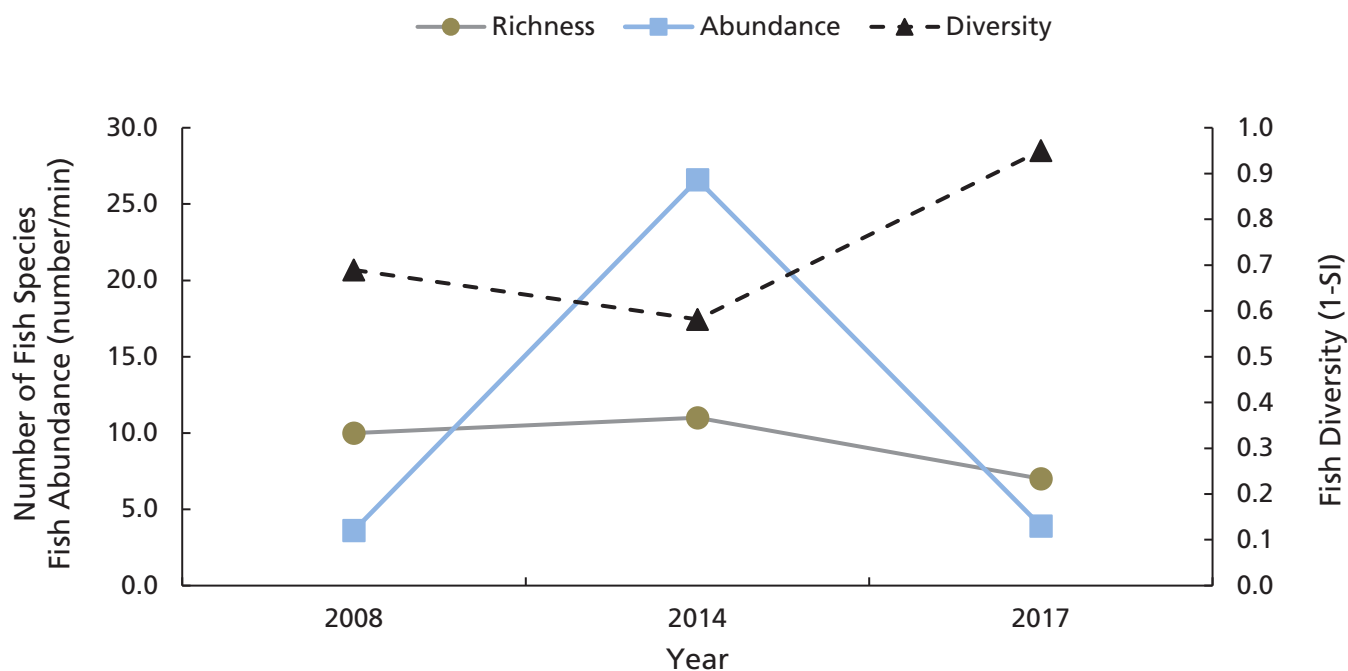


Figure 5. Fish species richness, fish abundance, and community diversity in the sample reach at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017.

community diversity was lowest during 2014 (Figure 5) due to high numbers of white sucker (*Catostomus commersonii*) and johnny darter (*Etheostoma nigrum*; Figure 4). Dominance of the community by these two tolerant species coupled with the absence of brown trout (cool-water carnivore) resulted in a poor IBI rating (score of 10) in 2014 compared to a fair rating in 2008 and 2017 (Figure 6).

Stream Habitat and Water Quantity

Stream flow was lowest in 2014 ($0.15 \text{ m}^3/\text{s}$), possibly due to sampling in mid-August when baseflows are typically low, while flow was highest in 2008 ($0.41 \text{ m}^3/\text{s}$) when the site was sampled in early July (Figure 7). Sampling was delayed until August in 2014 due to a large flood event within the Yellow River watershed in late June (USGS Gauge 05389000; Figure 8). For stream depth, the 95% confidence intervals indicated that 2008 had greater mean depth compared to 2014 and 2017 (Figure 9, lower panel). Mean velocity within the reach was similar across years (Figure 9, lower panel), and depths of riffles were consistently shallow ($0.13\text{--}0.17 \text{ m}$) with moderate velocity ($0.42\text{--}0.62$) on average (Figure 9, upper panel).

Mean substrate size in both riffles and within the reach declined over time, with 2008 having larger substrates than 2017 (based on 95% confidence intervals of the means; Figure 10, both panels). Riffle substrate shifted from large pebble in 2008 to small pebble in 2017, and substrate within the reach shifted from small pebble to medium gravel. Mean embeddedness of riffle substrates was greater and most variable in 2014 (Figure 10, upper panel). Average substrate embeddedness within the reach showed a slight increase over time (from 58% to 76%), although 95% confidence intervals indicate mean embeddedness was not substantially different among years (Figure 10, lower panel). Smaller average substrate sizes coupled by higher embeddedness of riffle and reach substrates suggest that the large flood event in June 2014 deposited finer substrates within the sample reach. The continual decline in substrate size and increased embeddedness within the reach during 2017 suggests that other anthropogenic activities upstream of the park coupled with spate events may be impacting the creek through continued sediment deposition.

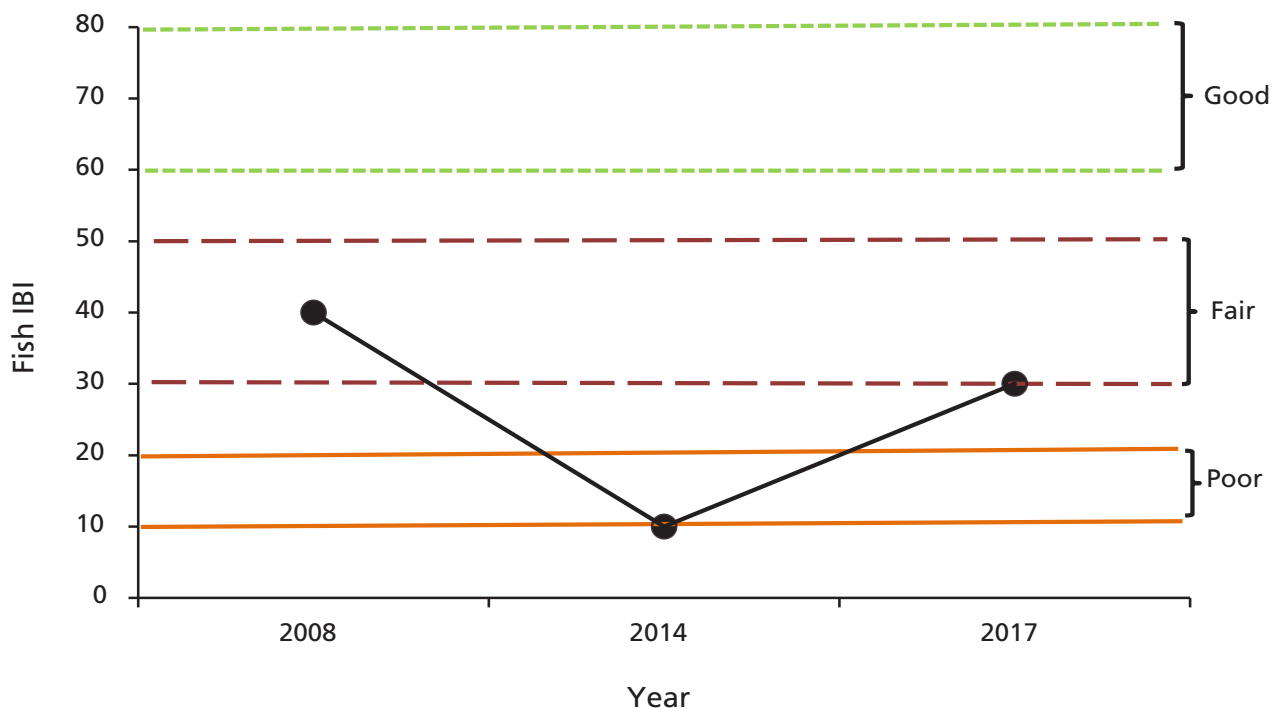


Figure 6. Index of Biotic Integrity (IBI) scores and ratings for fish communities in the sample reach of Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017.

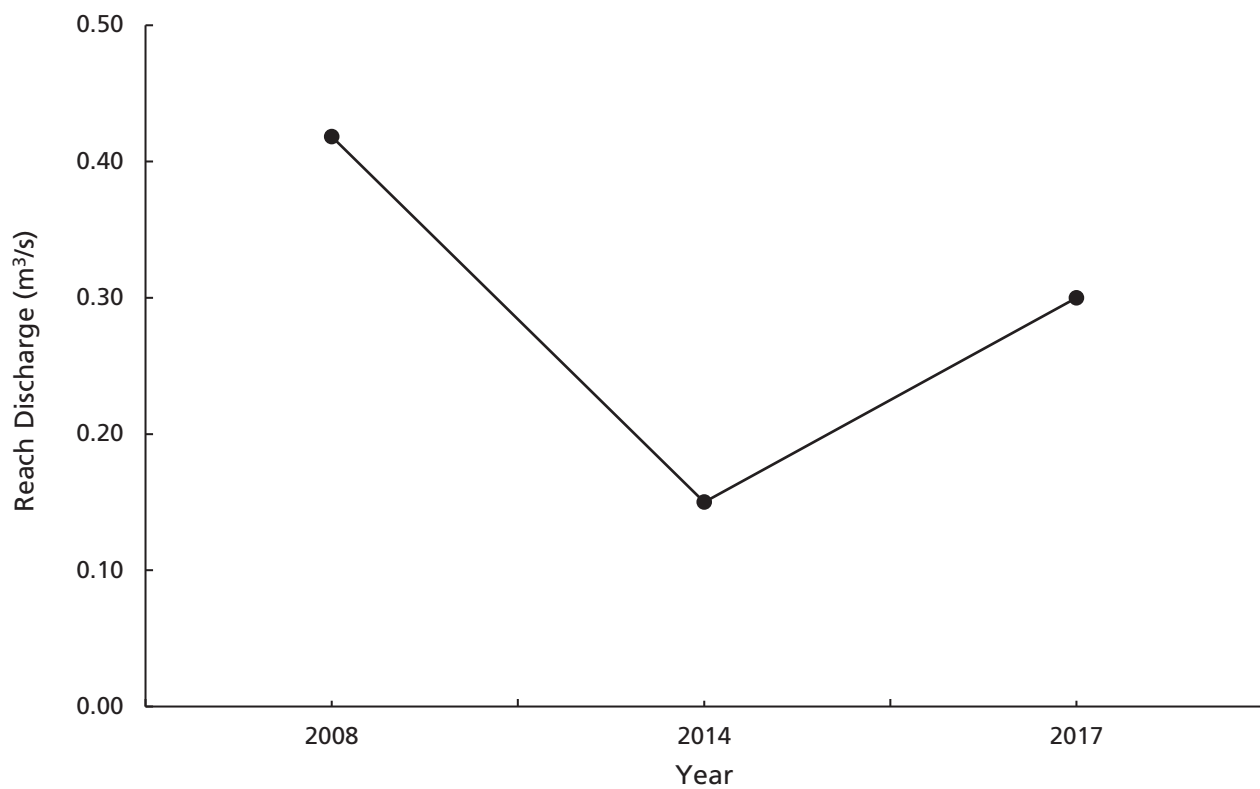


Figure 7. Total discharge of sample reach at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017.

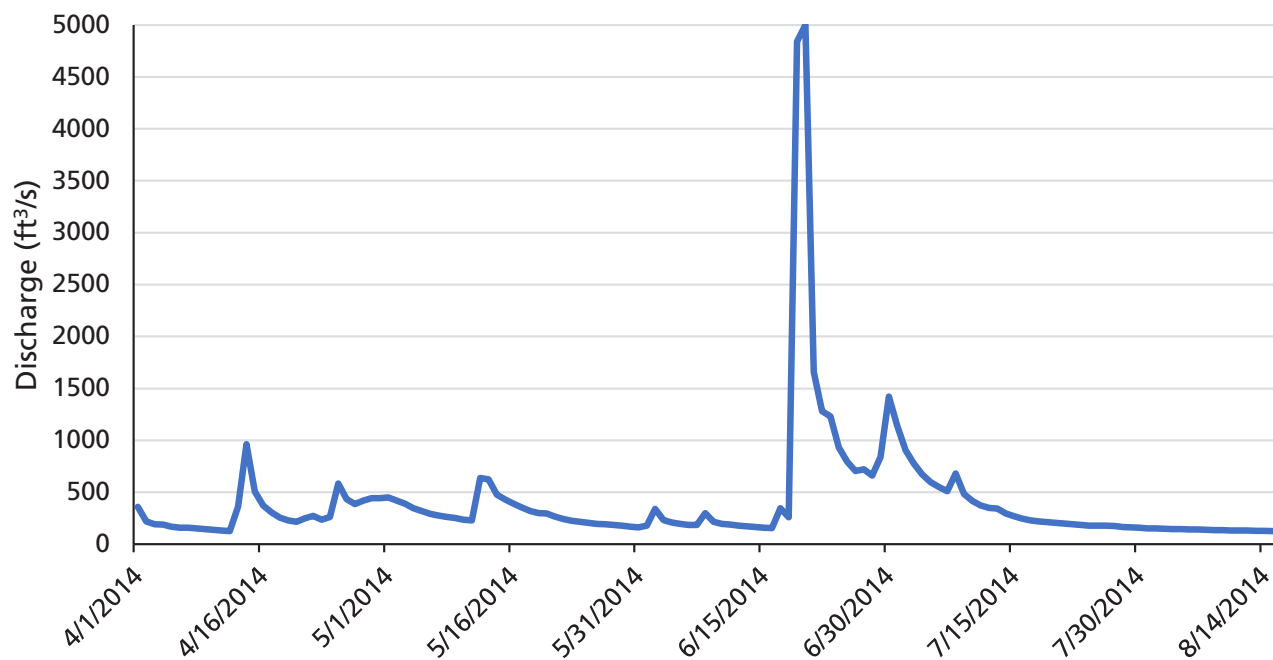


Figure 8. Discharge of the Yellow River in 2014 at USGS gauge 05389000 near Ion, Iowa. Data were taken from the [USGS National Water Information System website](https://waterdata.usgs.gov/ia/nwis/uv?site_no=05389000) at https://waterdata.usgs.gov/ia/nwis/uv?site_no=05389000.

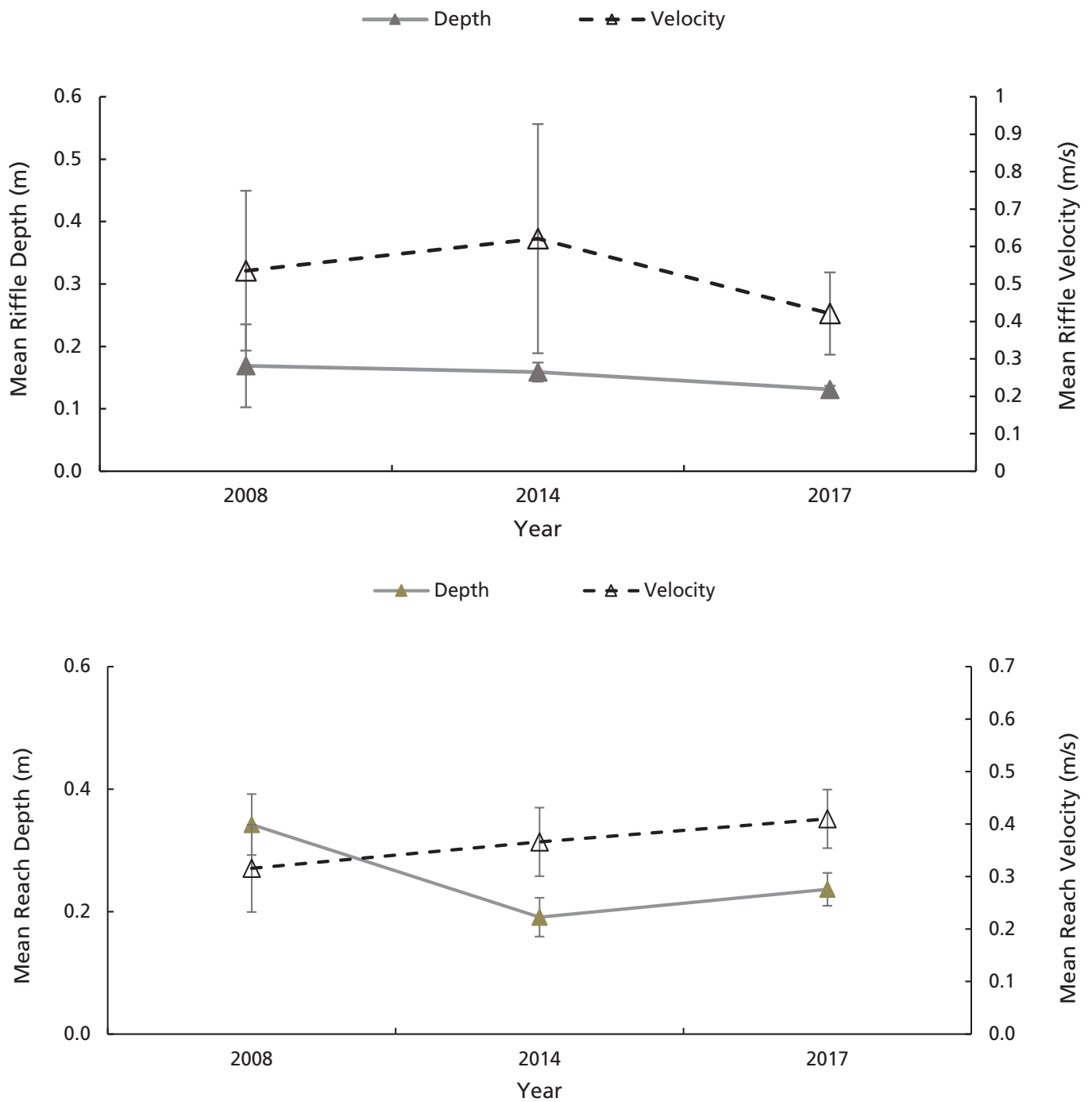


Figure 9. Mean depth and velocity of riffle habitat (upper panel) and mean depth and velocity for the entire sample reach (lower panel) at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Error bars represent 95% confidence interval. N = 3 for riffles and N = 33 for the reach.

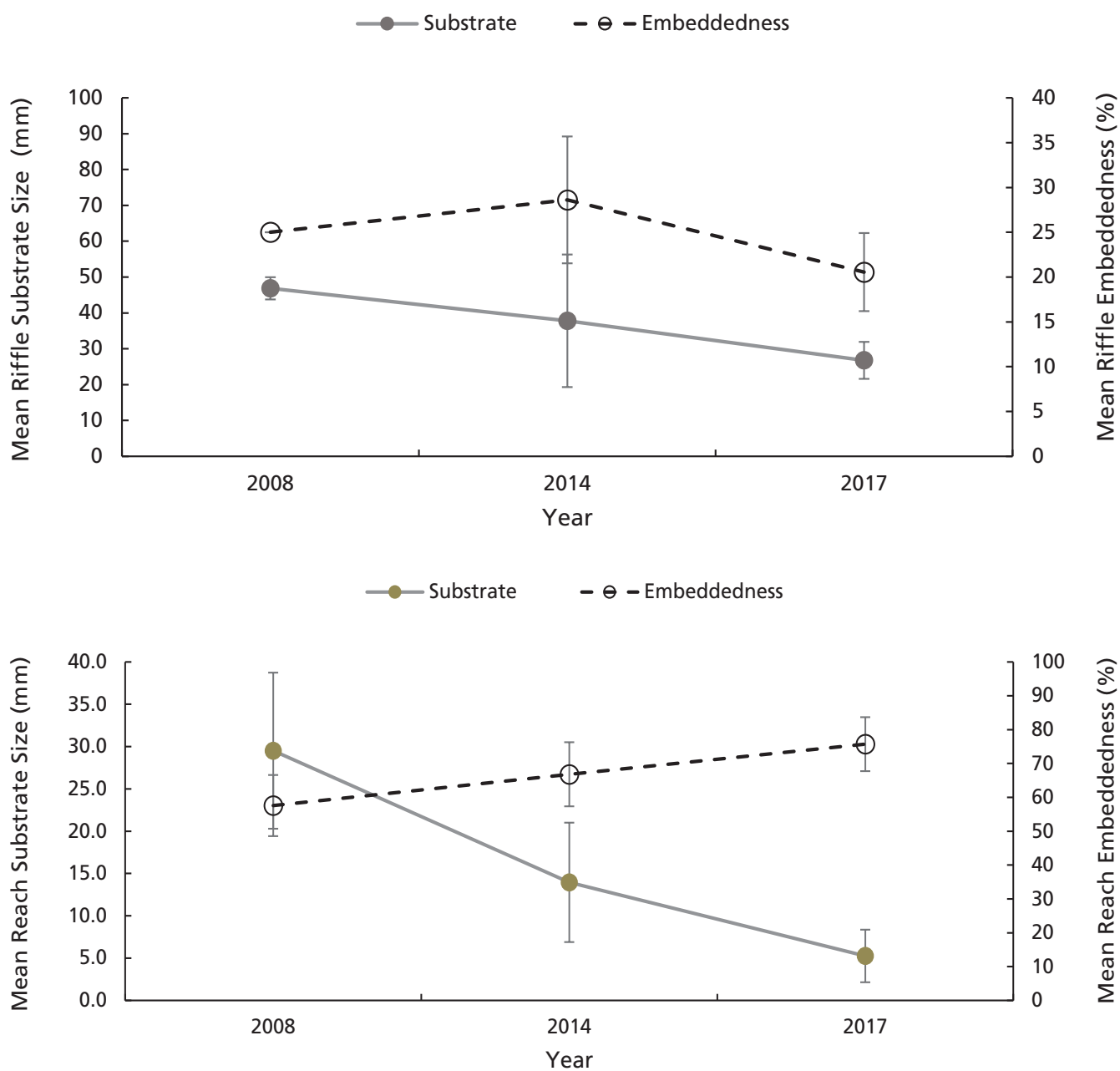


Figure 10. Mean substrate size and embeddedness of substrate within riffle habitat (upper panel) and mean substrate size and embeddedness for the entire sample reach (lower panel) at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Error bars represent 95% confidence interval. N = 3 for riffles and N = 33 for the reach.

Table 2. Percentage of total for bank habitat categories (bank angle, percent vegetation, height, and substrate type) along the sample reach at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017.

Bank Parameter Category	Measurement/Description	2008	2014	2017
Angle	< 60°	50	95	55
	> 60°	50	5	45
Vegetation	> 80%	86	55	68
	50–80%	9	45	32
	< 50%	5	0	0
Height	< 1m	14	0	18
	1–2m	36	68	41
	2–3m	36	32	27
	> 3m	14	0	14
Substrate	Bedrock	5	0	0
	Cobble/Boulder	0	0	0
	Silt	27	55	59
	Sand	55	45	27
	Gravel/Sand	14	0	14

Mean percent of aquatic vegetation (hydrophytes, HY) and periphyton (small benthic algae) within riffles were low among years, with average periphyton not exceeding 25% in any year sampled and vegetation present in only one sample in 2017 (Figure 11). Mean percentage of the reach with hydrophytes present was relatively low across years, never exceeding 15%, and filamentous algae (FA) was not collected within the reach (Figure 12). The most dominant cover types present for fishes were small woody debris (SWD), ranging from 30% to 48% and overhanging bank vegetation (OV) at 30% in 2017 and 45% in 2008 (Figure 11).

Bank angle, height, and substrate were more similar in 2008 and 2017. During 2014, there was a higher percentage of banks with angles less than 60 degrees compared to 2008 and 2017 (Table 2). Banks consisted entirely of fine sediment (silt and sand) in 2014 compared to 2008 and 2017 when banks also consisted of gravel substrates.

Water Quality

All water quality parameters measured during collection of fish and invertebrates were within the water quality standards for cold-water Iowa streams

(Idaho Department of Natural Resources 2019). The average temperature in Dousman Creek did not exceed the 24°C threshold as defined in Iowa’s designation of Type I cold-water streams—Class B (CW1)—but was the most variable water quality parameter among years (Table 3). Mean pH was fairly consistent across years and stayed within Iowa’s water quality standards of 6.5 to 9.0 (IAC 2019). Dissolved Oxygen ranged from 8.75 mg/L in 2017 to 10.59 mg/L in 2014, well above the state water quality criteria of 5.0 mg/L. It’s worth noting that the number of hourly data points and the time of day and month that water quality data were collected varied between years. In 2014, data were collected during a 20-hour period in mid-August while less than eight data points were collected in 2008 and 2017 during afternoon and evening hours in early and mid-July. When only considering the 3-4 hours of afternoon/evening data collection in all three years, average water temperature between 2008 and 2014 became more similar (16.4°C and 15.8°C, respectively), but most other parameters changed very little from those values in Table 3.

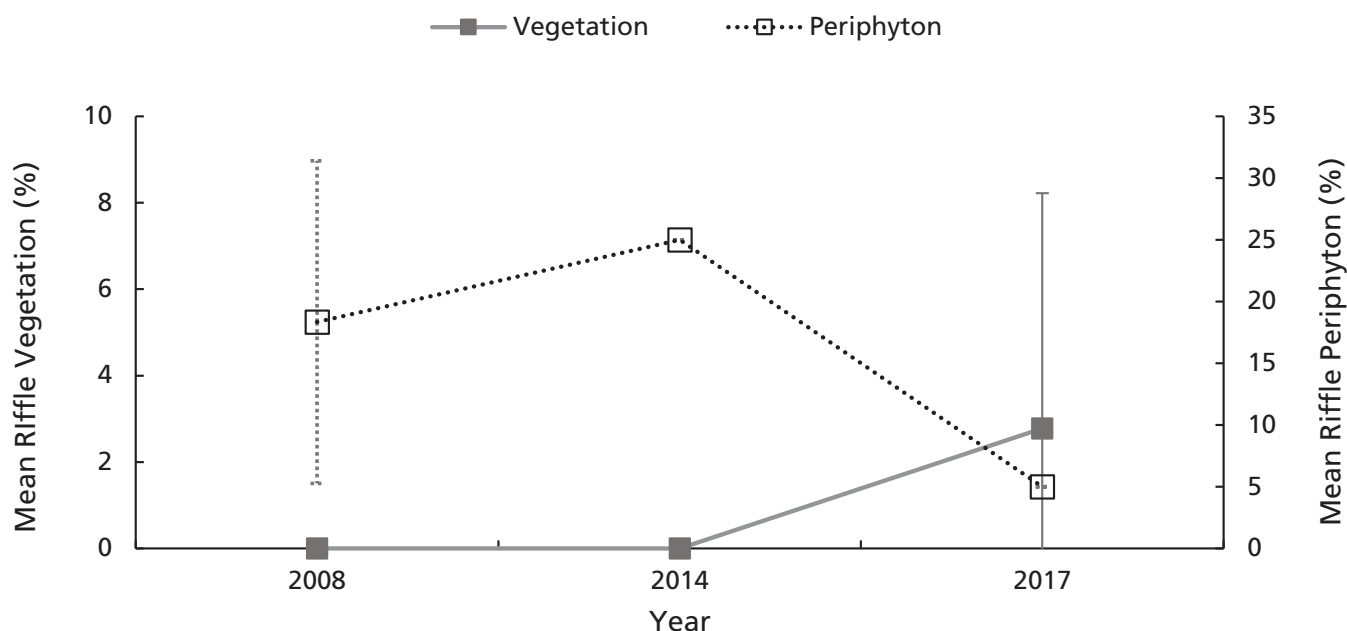


Figure 11. Mean percent vegetation and periphyton within riffle habitat sampled at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Error bars represent 95% confidence interval. N = 3 riffles for all years.

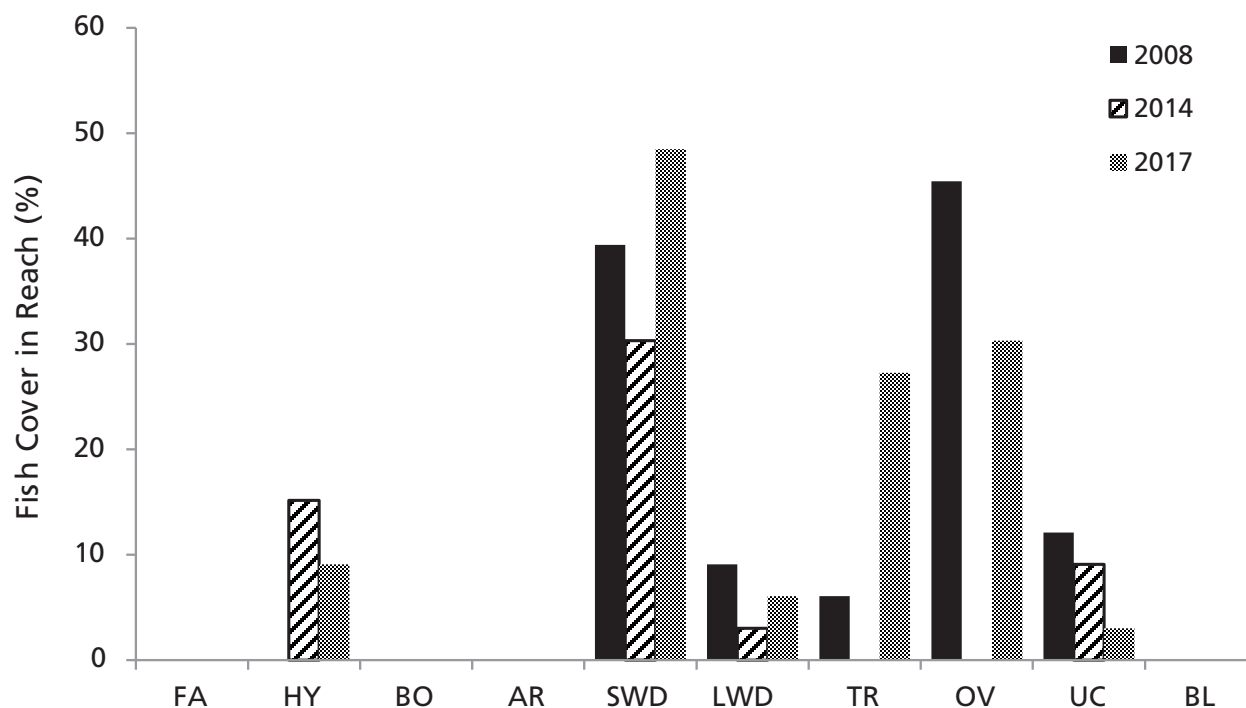


Figure 12. Percent of fish cover types present within the sample reach at Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. FA = Filamentous algae, HY = Hydrophytes, BO = Boulder, AR = Artificial, SWD = Small Woody Debris, LWD = Large Woody Debris, TR = Trees and Roots, OV = Overhanging vegetation, UC = Undercut bank, and BL = Bluff.

Table 3. Mean water quality data with 95% confidence interval (CI) for Dousman Creek, Effigy Mounds National Monument in 2008, 2014, and 2017. Data were collected hourly with calibrated data loggers.

Water Quality Parameter	2008 (n = 7)		2014 (n = 20)		2017 (n = 4)	
	Mean	95% CI	Mean	95% CI	Mean	95% CI
Average Water Temperature (°C)	15.2	±1.0	12.7	±0.8	20.5	±2.5
Average Specific Conductance (µS/cm)	562.4	±2.2	483.9	±0.9	558.5	±1.0
Average Dissolved Oxygen (mg/L)	10.52	±0.33	10.59	±0.24	8.75	±0.66
Average pH	8.05	±0.04	7.97	±0.02	8.37	±0.19
Average Turbidity (NTU)	3.20	±0.93	4.14	±0.73	4.6	±0.25

Discussion

Preliminary aquatic community data suggest the stream integrity of Dousman Creek is in fair to good condition. Because Dousman Creek is a Class B (CW1) cold-water stream, this creek is expected to have low taxa richness and diversity of both invertebrates and fish and a high percentage of cool- or cold-water taxa. Community composition was dominated by cold-water, sensitive fish species (mottled sculpin and brown trout) in both 2008 and 2017, but more tolerant fish (white sucker and johnny darter) dominated the community in 2014 with no brown trout collected. This low proportion of cool-water sensitive species was evident in the fish IBI which indicated poor stream integrity for 2014. A similar pattern also emerged for the invertebrate data where number and percent of sensitive taxa, EPT richness, and EPT ratio were lowest in 2014. However, the community in 2014 did consist predominately of *Simulium*, a moderately sensitive blackfly taxon.

The poorer condition of the invertebrate and fish communities in 2014 is likely due to a large flood event (USGS gauge 05389000, located outside the park) that occurred earlier in the summer, depositing fine sediments throughout the stream. During sampling in 2014, crew members frequently lost their footing in approximately 0.5 m of unconsolidated sand and silt deposits. This heavy sediment deposition was also evident through the decline in substrate size within riffles and the increased substrate embeddedness within the reach. In 2017, substrate size continued to decline, and embeddedness continued to increase, likely due to known anthropogenic disturbances located upstream of the park (i.e., riparian vegetation removal and restructuring of banks and the stream channel on adjacent land). Although we did not conduct an observer error study, the project leader conducted

habitat sampling in both 2008 and 2014, and a well-trained, vetted crewmember collected habitat data in 2017. This leads us to conclude that habitat changes found in 2014 and 2017 are true changes rather than observer error.

With continued anthropogenic disturbances upstream of the park, even typical small spates may cause major impacts to Dousman Creek through increased magnitude of flooding, bank erosion, stream bed scouring, and deposition of fine sediments once waters recede. Disturbances to flow and habitat can displace fish and invertebrates, reduce or eliminate essential habitats, and change water temperatures and water quality to levels that are less optimal for cold-water biotic communities. Continual sedimentation in the future will likely adversely affect the aquatic invertebrate community and benthic fishes in Dousman Creek.

The water quality data did not show deviations from Iowa's water quality standards. However, water quality data in this report represent only a snapshot of the broad temporal range of conditions and are intended to describe the prevailing conditions that influence aquatic communities during the sampling timeframe. Because the duration of water quality measurements is short and the biotic community is constantly exposed to fluctuating stream conditions, the invertebrate and fish data are better assessments of water quality conditions and stream integrity.

This three-year dataset presents the preliminary status of the biotic community within Dousman Creek but cannot provide any clear trends at this time. Additional years of monitoring will be necessary to fully characterize the integrity of this stream and provide the park with trends in the aquatic community.

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