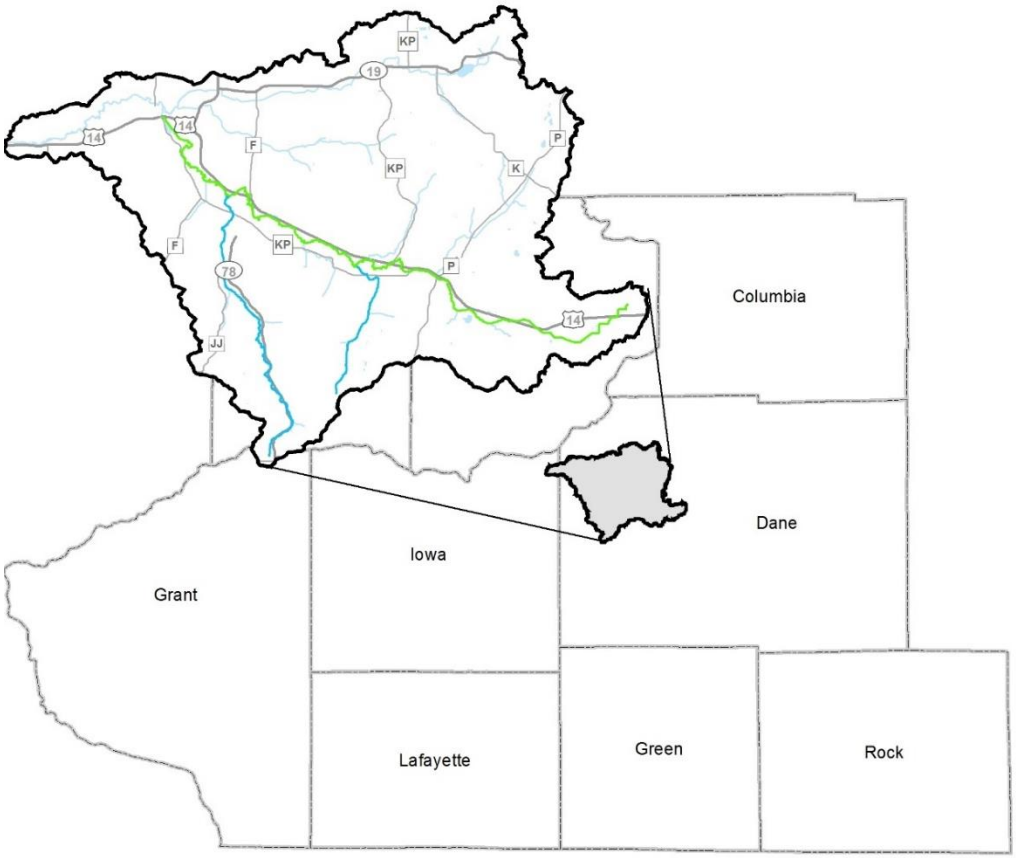
Trout Stream Management and Status Report of Black Earth Creek Watershed

Dane County, Wisconsin 2019



Dan Oele
Fisheries Biologist- Dane, Green, Rock County
Wisconsin Department of Natural Resources
Fitchburg, Wisconsin
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Questions or comments about this report? Please contact the author at: (608) 275-3225 or daniel.oele@wisconsin.gov

Watershed Location
Black Earth Creek Watershed, Dane County including Black Earth Creek, Brewery Creek, Garfoot Creek, Vermont Creek, and Halfway Prairie Creek.

Purpose of Survey
WDNR baseline trout rotation surveys
Assess trout stream classification
Assess natural reproduction and recruitment
Assess current trout population abundance

Dates of Fieldwork
June 20, 2019 – August 29, 2019

Fish Species Observed in the Survey

All fish encountered were collected and recorded including banded darter, bluegill, bluntnose minnow, brook stickleback, brook trout, brown bullhead, brown trout, channel catfish, common carp, common shiner, creek chub, emerald shiner, fantail darter, fathead minnow, green sunfish, johnny darter, Mississippi silvery minnow, mottled sculpin, northern hog sucker, northern pike, rainbow trout, shorthead redhorse, silver redhorse, smallmouth bass, spotfin shiner, white sucker, yellow bullhead (Appendix Table 1).

Executive Summary

Our watershed assessment of the Black Earth Creek fishery in 2019 revealed a concerning pattern of widespread recruitment failures at the youngest life stages. The average yearling catch rates across all surveyed sites within Black Earth Creek were 22 per mile compared to the driftless median rate of 214 per mile, nearly ten times fewer. Even the catch rate at the highest performing site (Jovina Street in Zander Park) is 33% less than the Driftless median (75 per mile). An important caveat is our summer 2019 survey was preceded by extreme flooding in fall of 2018, which impacted adult densities and recruitment success to an unknown extent. It is possible our surveys indicated artificially low trout abundances as a direct result of this flooding but our long-term trend sites within Black Earth Creek suggests trout abundances across all size classes have been in decline for several years, indicating the low adult abundances are likely a combination of poor recruitment and lack of suitable habitat. The decline is especially apparent at the Park Street site which has experienced precipitous declines in all size classes since the mid-2000's. Even with the lower catch rates of smaller fish, Black Earth Creek is still a great place to catch a larger than average size trout with good catch rates of fish over 12".

A healthy river ecosystem, including the trout fishery, is a reflection of- and dependent on- the health of the major tributaries and land use within the watershed. Cold water tributaries of Brewery, Garfoot, and Vermont Creeks each lack diversity in trout habitat features. Poor riparian land management, lack of in-stream habitat, and channel modifications have resulted in unacceptably low trout abundances throughout much of their length. However, the headwaters of Garfoot and Vermont rivers are in a better condition than their lower reaches. Headwater sampling sites in each river showed increased catch rates of trout, improved habitat scores, and colder water. For example, headwaters of Garfoot Creek offer a unique brook trout fishery in its uppermost reaches where springs provide the coldest and highest quality water and the Vermont Creek Fishery area had higher habitat scores and had higher catch rates compared to its lower sites.

In addition to physical habitat, stream temperature, and flow are important factors structuring the fish community of a trout stream. A constant flow of cold groundwater buffers the stream from variable flows and fluctuations in temperature in summer and winter. Black Earth Creek is susceptible to temperature fluctuations with summer water temperatures regularly exceeding 68-70F and a temperature profile more akin to a smallmouth bass stream, and a warmer water fish community lower in the watershed that comes with increased temperatures (e.g. northern pike, smallmouth bass, white suckers, carp).

The decrease in trout abundances across all size classes throughout the Black Earth Creek watershed indicate chronic recruitment failures and is indicative of a lack of physical habitat across all life stages. Although not every stream segment can or should hold high abundances of trout across all size-classes, much of the watershed could be improved from a trout habitat perspective. Historical investments in habitat improvement projects implemented in the late 90's and early 2000's are largely gone or not functioning as designed and need to be revisited. In response to data collected during this survey, WDNR Fish Management is in the planning process of major habitat improvement projects within lower Black Earth Creek and its tributaries. Dane County staff are also interested in improving trout habitat and streambank health along the parcels they own or have easements on. Our current goal is to complete 1-2 miles of habitat improvement in 2022.

Introduction

Summary of the Watershed

Black Earth Creek (BEC) originates west of the town of Middleton in Dane County, flows westward 27 miles through the towns of Cross Plains, Black Earth Creek, and Mazomanie before its confluence with Blue Mounds Creek in Iowa County and eventually joins the Wisconsin River. The watershed encompasses 105 square miles with a mix of forested (37%), agricultural (37%), grasslands (16%), and developed (10%).

The headwaters of BEC are heavily influenced by stream channelization, sedimentation, and low flows. As a result, the fish community is comprised of only species tolerant of reduced stream flows and poorer water quality and offer little in terms of recreational angling opportunities. Groundwater springs near the town of Cross Plains (and others throughout the watershed) provide constant baseflows of cold, high quality water supporting a valuable recreational trout fishery from Cross Plains to Mazomanie with a transitional cold-warmwater fishery downstream. Agricultural sources of runoff include cropland erosion, barnyard runoff and manure spreading on fields. Although agricultural nonpoint source pollution has in many cases been addressed through the Priority Watershed Project for Black Earth Creek, the stream is at risk of degradation when agricultural sources are poorly managed. Increased development within the watershed are additional sources of stormwater runoff, groundwater withdrawal, nutrient additions, and associated aquatic habitat degradation.

Brewery Creek is an unclassified tributary of BEC and originates in the wetland complexes and springs along HWY P. The watershed is small, spanning 2.7 miles as it flows south toward the village of Cross Plains and meets BEC southwest of the HWY 14 bridge crossing. Despite problems associated with nonpoint source pollution and channel straightening, this creek has a quality brown trout fishery with cold water and good water quality indicator species like mottled sculpin in the middle and lower reaches. In the reaches below HWY P crossing, the substrate is primarily clay, with little gravel or silt and trout spawning habitat and nursery areas are very limited. Upstream in the straightened and ditched wetland areas, the water is warmer with an organic and silty substrate incapable of supporting trout or a fishery but serves as an important buffer from warm water and nutrient loading into the trout waters in Cross Plains and Black Earth Creek itself. Anglers can access the stream via several road crossings and a public park.

Garfoot Creek is a class II trout stream flowing north from the headwater areas along Garfoot Road near Mineral Point Road. The stream flows through small patches of forests and active agricultural lands and suffers from bank erosion, channel straightening, and poor riparian buffers in many areas. WDNR owns a parcel south of HWY KP and has several public fishing easements along the banks. Garfoot joins Black Earth Creek within publicly accessible easements and the Black Earth Creek Fishery Area just north of HWY KP.

Vermont Creek originates near the town of Mount Horeb and is class II trout water from the headwaters near HWY J and HWY 78 flowing north to the confluence with Black Earth Creek in the village of Black Earth. The fish habitat and land use is patchily distributed with good water quality and increased trout abundances intermixed with straightened, silty stretches suffering from erosion and runoff with only tolerant fish species observed (e.g. yellow bullhead and white suckers). WDNR owns three large fishery areas along the river and several public fish easements.

Halfway Prairie Creek is not classified trout water. It originates in a spring complex at Indian Lake County Park near Roxbury, flows southwest where it gains gradient and velocity from additional wetland complexes and springs. The watershed is heavily agricultural with extensive channel and riparian vegetation modifications. The stream parallels HWY 19 through Marxville where it joins Black Earth Creek just east of Mazomanie. The fishery is limited and comprised of mostly warm water species, but a few brown trout persist in the lower reaches of the river. Dane County and local landowners are currently collaborating on habitat improvement projects in the lower reaches to improve the trout waters in those areas.

Population declines in Black Earth Creek

With the watershed dominated by intensive agriculture and increasing development and impervious surfaces, acute runoff events initiated by rapid snowmelt and/or heavy spring precipitation running off into the river is a threat that has the potential to negatively impact trout populations on an annual basis. This was likely the cause of a major 2001 fish kill stretching from Cross Plains to the village of Black Earth in 2001. WDNR staff collected 150 dead trout, but the actual number of fish killed was much higher and appears to have had lasting negative impacts to the trout population (e.g. 2001 WDNR report noted over 700 trout per mile before the fish kill at South Valley Road compared to an average of 150 trout per mile in 2014-2019, and 220 per mile observed in 2021). Unaffected by the incident, BEC at the eastern reaches of Cross Plains area didn't suffer population declines, with ~1300 trout per mile in a 2001 post fish kill survey which was higher than the 2019 survey (855 per mile) and nearly identical to the 2021 survey results (1363 trout per mile).

Potential sources of runoff detailed in the WDNR report following the kill event noted animal waste disposal, manure spreading, point source discharges, and urban stormwater runoff leading to inadequate dissolved oxygen as well as acute toxicity from pesticide application as likely causes. In response, WDNR, USGS, and conservation partners initiated a robust stream monitoring protocol including automated water quality data and routine fish sampling to better understand the ecology of the stream and the stressors to the fish community.

Severe winter conditions coupled with summer drought conditions in 2013-2014 also caused region-wide population declines detected in our trend surveys in Black Earth Creek. In an effort to maintain a healthy river ecosystem and trout fishery, substantial investments have been made in the watershed to mitigate these stressors, improve trout habitat, and provide angler access (e.g. Priority Watershed Project, Trout Stamp Habitat Projects, easements, land acquisitions).

Current Status

Class 1 trout streams are those with high quality habitat with sufficient levels of natural reproduction to sustain the fishery and no stocking is required. Class 2 streams are those in which some natural reproduction occurs but not enough to utilize all available food and space and stocking is required to maintain a desirable fishery. Class 3 streams are those in which trout habitat is marginal with no natural reproduction occurring and requires stocking of catchable sized trout to provide a fishing opportunity. Black Earth is a class I stream from its headwaters near Middleton to the village of Mazomanie at the HWY 14 bridge. Garfoot and Vermont Creeks are class II trout while Brewery Creek and Halfway Prairie Creeks are unclassified (Figure 1).

Stocking has occurred throughout the watershed utilizing brook, brown, and rainbow trout of various sizes (Table 1). No stocking has occurred within Brewery Creek since a 2001 (500 large

fingerling brook trout and 1,000 small fingerling brown trout). Upper Garfoot Creek is stocked with brook trout annually, but the lower reaches have been stocked with brown trout as recently as 2008. Vermont Creek is stocked with brown trout annually. Black Earth Creek is not routinely stocked since it is class I trout water, but periodic stocking of surplus hatchery rainbow and brown trout has occurred to provide additional angling opportunities and help boost the fishery in the lower reaches.

Black Earth Creek and all three tributaries are regulated under the standard 8" minimum, 3 daily bag limit for trout with the exception of Black Earth Creek downstream of South Valley Road to the HWY 14 bridge which has an 18" minimum, 1 daily bag limit for trout (Figure 2). This special regulation was initiated in 2018 in response to persisting low adult density in the lower reaches of the river after the 2013-2014 declines in abundance and recruitment.

Between public parks and road crossings, WDNR fishing easements, and WDNR Fishery Areas, there are many fishing and recreational opportunities in the watershed (Figure 3). Along Black Earth Creek, there are twelve road crossings anglers can enter the water via the road right-of-way. Designated public fishing access within public lands or easements are located just east of Cross Plains at Stagecoach Road, the WDNR fishery area east of Cross Plains, within the village of Cross Plains at Zander Park, WDNR fishing easements east of HWY KP, the WDNR Fishery Area north of HWY KP west of Salmo Pond and downstream of South Valley Road. Closer to the village of Black Earth, WDNR owns fishery areas near HWY F and further downstream just west of the village, with easement lands in between. The Wolf Run trail and stream re-meander project area is open to the public and offers fishing and recreational opportunities in the tailwaters of the Class I trout waters near HWY 14 in Mazomanie.

Significant resources have been invested in the Black Earth Creek Watershed from a variety stakeholders with the shared goals of improving the water quality, stream bank health, and trout habitat. For example, Black Earth Creek was a Priority Watershed project during the mid-1980's through the 90's and resulted in significant declines in nutrient loading to the system (full report link https://pubs.usgs.gov/wri/wri034163/pdf/wrir03-4163.pdf). Numerous other projects involved improving trout habitat including LUNKER structure installations, stream bank easement and land acquisitions, trout habitat improvement projects, and angler access brushing from a variety of organizations including Trout Unlimited, local governmental bodies, WDNR, and conservation groups. Though the work is ongoing with room for additional improvements, these efforts have drastically improved the ecological function of the watershed including trout habitat and improved stream bank health considerably. Current habitat management goals are focused on maintaining angler access and increasing overhead cover and in-steam habitat to improve adult trout densities.

Methods

To better understand natural reproduction and recruitment, WDNR restructured when trout surveys are conducted in each watershed. Beginning in 2019, all sampling sites within the Black Earth Watershed Group were sampled on a rotational basis and will be conducted every 6 years thereafter. This offers efficiency of focusing the majority of our sampling efforts in one watershed in a given year and enables us to assess natural reproduction and recruitment of trout within the watershed in that year.

Understanding the natural reproduction capacity and recruitment of a stream is critical to managing trout populations. In our fishery assessments, natural recruitment is defined by juvenile fish surviving to age 1. Natural reproduction is the presence of age 0 fish (young-of-

year; YOY) which are difficult to accurately assess since their vulnerability to electrofshing gear is more variable than larger sized fish. Additionally, young-of-year fish are not evenly distributed since they often occur upstream in nursery habitats and migrate downstream to adult and juvenile habitats later in life. Therefore, documenting a lack of young-of-year fish does not mean there is a necessarily a complete lack of natural recruitment.

To better assess recruitment to age 1, all stocking of fingerling trout was suspended the year prior to these surveys in Black Earth Creek and its tributaries. Our assumption was that all yearling (age-1) trout are from natural recruitment somewhere in the watershed and all YOY (age-0) trout are from natural reproduction. If previous stocking occurred, age-2 and older fish are assumed to be from mixed sources. This stocking and sampling protocol allows us to make important inferences regarding the status of the trout fishery. High levels of natural reproduction, natural recruitment, and several age classes without stocking are indicative of self-sustaining class 1 waters. We infer put and grow stocking was effective if we observe an absence or low abundance of yearling trout but an abundance of adult trout and conclude a given stream should be class 2. Marginal waters where only stocked fish survive during early spring and summer with limited carry-over and no reproduction are class 3.

All 25 stream sites were surveyed with either a tow behind barge stream shocking unit or backpack electrofishing unit. Backpack electrofishing units consist of a backpack mounted control box in which the operator controls the anode with one hand and nets fish with the other. These are used on small streams or headwater areas that are relatively shallow and narrow. Tow behind stream shockers are used in larger wadable rivers and consist of three-person teams in which a generator is mounted in a barge that is towed by one individual. Two additional individuals canvas the stream with anodes connected to the output box collecting stunned fish using standard dipnets.

The number of fish sampling sites in a particular stream was dependent on the stream segment length following WDNR Fish Management Handbook protocols. One sampling site is required for stream segments less than 1.5 miles, two sites for stream segments 1.5-3 miles, and one site every three miles on long rivers (minimum 3 sites). The length of each fish survey at a particular site is determined by stream width; thirty-five times the mean stream width on segments greater than 3 meters and 100 meters minimum for streams less than 3 meters wide.

For each sampling site, we calculated the catch-per-unit-effort (CPUE) by dividing the number of fish collected by the length of the survey yielding a # of trout per mile estimate. This procedure allows for straight-forward analyses of catch rates within and among stream sites as well as regional and statewide comparisons in a standardized manner. Fish length data are analyzed by size classes and age groups of interest. These groups include the number of age 0 (YOY), age 1 yearlings, and adult trout (age 2+). YOY are fish less than 4 inches in length, yearlings are between 4 and 7.9 inches for brown trout, and adults are considered greater than 8 inches for brown trout. Preferred sized fish are often of special interest to anglers and are fish greater than 12 inches for brown trout.

All fish encountered during the survey were collected. We record the species of fish, total length (nearest tenth of an inch) and weight (nearest .01 lb) using digital hanging scales to assess body condition. Non-trout species are counted to calculate the cold-water index of biotic integrity (IBI) score (0-100). For added context, catch rates of mottled sculpin (less tolerant of poor water quality and a cold-water indicator species) and white sucker (tolerant of poor water quality and warmer water) were also evaluated as a proxy for water temperature profiles at each survey

station. The Fisheries Management Handbook chapter 510 details each of the sampling protocols in greater detail.

Water quality and habitat metrics were also collected at each survey site. Streamflow (cubic feet per second, cfs) was calculated at one cross-sectional transect at each site using a HACH FH950 handheld flow meter. Temperature, dissolved oxygen, and specific conductivity, and pH are also measured using a handheld YSI Pro 2030 meter. Stream habitat metrics were collected using a WDNR qualitative habitat rating form. For streams less than 10 m wide, ratings included riparian buffer width, bank erosion, pool area, width: depth ratio, riffle: riffle or bend: bend ratio, fine sediments, and cover for fish (Appendix Figure 1). For streams greater than 10 m wide, ratings include bank stability, maximum thalweg depth, riffle: riffle or bend: bend ratio, rocky substrate, and cover for fish (Appendix Figure 2). All data is recorded digitally using weatherproof handheld Toughbook™ laptops and a custom software application.

We sampled fifteen sites in Black Earth Creek, four in Brewery Creek, four in Garfoot Creek, three in Vermont Creek, and one site in Halfway Prairie Creek (Figure 1). All fish were returned to the stream, except for a subsample of trout collected for age and growth analyses within Black Earth Creek. Brown trout otoliths were dissected, air dried, mounted in epoxy, thin cross-sectioned using a low-speed saw, and polished until annuli are clearly visible under a standard dissecting microscope to infer age. Two readers independently reviewed each fish structure and reached a consensus age estimate for each fish.

Age and length data informed age-length keys which estimated the age frequency of the whole population based on the aged subsample. Mean length at age was computed by pooling all fish within an age class for brown trout in Black Earth Creek. Age frequency distributions were generated for brown trout to infer year class strength and generalized growth trajectory.

Relative weights were computed for brown trout to evaluate the body condition. Relative weight (W_r) compares the observed weight of the fish to a standard weight expected given the length. Relative weight values between 75 and 100 indicate normal weight for a given length. A relative weight value greater than 100 indicates that a fish was in excellent condition. A relative weight value less than 75 indicates that a fish was in poor condition.

Temperature profiles from WDNR trend monitoring stations and United States Geological Survey stations were compiled and analyzed to provide insights into thermal characteristics of Black Earth Creek and compared to other streams in Wisconsin for added context related to water temperature and the composition of sport fish. Annual mean precipitation data for the watershed were summarized using NASA's daymet v4 dataset and associated R packages at the HUC 12 scale.

Summer stream sampling dates began on June 27 and concluded on August 12, 2019. A summary of the survey stations, species observed, and trout lengths are summarized in Appendix Table 1.

Results

For trout management objectives, the watershed can be parsed into major reaches separated by their thermal characteristics and stream position: 1) Upper BEC containing the cool-warm headwaters stretching upstream of Cross Plains at HWY P upstream to the wetland complexes west of Middleton, 2) the cool-cold Middle BEC stretch encompassing the waters in Cross Plains at HWY P downstream to South Valley Road, 3) Lower BEC cool-warm waters from

South Valley Road downstream to Mazomanie HWY 14 bridge, 4) the three major tributaries capable of supporting trout (Brewery, Garfoot, and Vermont Creeks).

Black Earth Creek

Summary

Brown trout were collected in 13 of 15 sites we sampled in 2019 (11 within the classified trout water, 2 downstream in the Village of Mazomanie, Figure 1). Within the classified water, creek-wide average catch rates for YOY (<4”) was 11 per mile, yearling (4-8”) 24 per mile, adult (>8”) 100 per mile, preferred (>12”) 91 per mile, and fish size ranged 3”-20” (Figure 4, Table 2, Appendix Table 1). YOY (natural reproduction) were observed in five locations. Yearling brown trout (4-8”) were observed in seven of the eleven locations but none exceeded the statewide or driftless median catch rates (Figure 6). Adult brown trout (>8”) were observed in 9 of the survey locations (Figure 7) while larger brown trout (>12”) were collected at nearly all of the sites (ten) with seven locations exceeding the Driftless median catch rate of 44 per mile (Figure 8).

Mottled sculpin were observed throughout the entire watershed from Hudson Street downstream of the classified waters in Mazomanie to the upper reaches east of Cross Plains. However, the highest abundances were in the classified trout waters from the Shoe Box Landing upstream to Jovina Street in Zander Park. White suckers were observed in the reaches from Hudson Street in Mazomanie to Cross Plains with the highest numbers observed at Park Street Bridge, Scherbel Road, and HWY KP in Cross Plains stations.

Coldwater Index of Biotic Integrity Scores for Black Earth Creek

Median coldwater IBI score across all sites in Black Earth Creek was 20 (out of 100, average score 24) and lagged behind the statewide trout stream (60), Driftless trout stream (50), and Dane County (50) median scores. Average qualitative habitat ratings for Black Earth Creek was 55% (out of 100) with the majority of the stations scoring as “Good” or “Fair” and one station scored “Excellent”. Riparian buffer and bank erosion scores were generally high (average 11 and 12 out of 15 respectively) but other physical habitat scores were lower including, pool area (5 out of 10), width: depth ratio (6.25 out of 15), riffle habitat (6.9 out of 15), fine sediments present (7.5 out of 15), and cover for fish (8 out of 15). Average temperature across all 13 stations was 63°F (ranged 59-68). Average stream flow was 73 cfs (ranged 5.3 - 128.5 cfs) with an average width of 8 meters (Table 4).

Upper Black Earth Creek

The upper Black Earth Creek survey sites (Brewery Road Snowmobile bridge, Stagecoach Road, Low Road) had the lowest stream flows, poorest habitat scores, and warmest temperatures recorded (Table 4) resulting in trout densities far below regional benchmarks for YOY, yearling, and adult sized fish (Table 2, Figures 5 -7). The upper most reaches of the headwaters (e.g. Low Road and upstream) have insufficient flow and in-stream habitat to support a robust trout fishery but with catch rates exceeding the driftless median rates, the Brewery Road bridge and Stagecoach Road sites offer anglers the potential to land a fish >12” (Figure 8). Note the HWY P road crossing and next upstream driveway bridge were not surveyed as part of this report but with adequate flows and decent habitat, offer angling opportunities too. Though the area is largely deficient in trout habitat, it serves as an important wetland and groundwater protection area.

Middle Black Earth Creek

With above average habitat scores, diverse stream channel morphology, colder stream temperatures, increased spring fed flows, and higher IBI scores, Middle Black Earth Creek contains the highest quality trout waters in the watershed (Tables 2-3). For example, the survey sites at Jovina Street, HWY KP in Cross Plains, and Scherbel Road have the highest catch rates across all size classes (Figures 4 - 8). Survey stations at Zander Park near Jovina Street (50 YOY per mile) and HWY KP in Cross Plains (34 YOY per mile) had the highest catch rates of YOY but neither met the Driftless area median catch rate (75 YOY per mile, Table 2, Figure 5). The Zander Park, HWY KP, and Scherbel Road sites exceeded the driftless median catch rates for trout >8" (>300 per mile) and fish >12" (>44 per mile, Figure 7 & 8).

Lower Black Earth Creek

Lower Black Earth Creek (downstream of South Valley Road crossing) had low catch rates of all sizes (e.g. YOY, yearling, adult catch rates well below regional benchmarks) except for the >12" category (Table 2, Figures 4-8). The coldwater IBI scores were low at all sites, reflecting the mixed cool-warmwater fishery we observed (e.g. carp, smallmouth bass, northern pike, brown trout, minnow species, Table 4). The stream temperature profile was consistently cold enough to support trout, but the habitat available for trout in this area is patchily distributed. For example, habitat scores varied from a high of 87 along the restored, well-buffered prairies along Wolf Run Trail to a low of 40 near the Shoe Box Landing with a sparse riparian buffer and eroded banks. Areas with higher trout abundances offered deep pools, overhead cover, spawning substrates, and shade in comparison to stretches with lower catch rates that contained little overhead cover, poor width:depth ratio, monotonous channel morphology with excessive aquatic plants, and incised and eroded banks.

Annual Trend Sites

Survey stations within the village of Cross Plains in Zander Park, South Valley Road, and Park Street on Black Earth Creek have been sampled with enough regularity to explore population trends spanning several years. These three stations are trend sites where we survey the same location, with the same gear, at the same time of year annually (Figures 9 - 11). Though a reduction in overall trout abundances is apparent, the Zander Park area in Cross Plains has had a stable population and remains the stretch of river with the highest catch rates across the entire watershed. Downstream at the South Valley Road trend station, the catches have remained stable but at much lower abundances than recorded upstream. The furthest downstream trend station is at the Park Street crossing east of the village of Black Earth and the fishery there has experienced a decline in trout of all size classes since the mid 2000's.

The data from the three WDNR trend monitoring stations show Black Earth Creek to be a trout stream with a stable, but much reduced population compared to historical highs. The Zander Park station has consistently held the highest abundance of trout within the watershed, typically exceeding 1,000 trout per mile in total CPUE with catch rates of all sized trout exceeding values observed in the lower stations (Figure 9). Prior to 2014, total catch rates at the South Valley Road station were much higher than any of the data in 2014-2019. To avoid bias associated with mismatched sampling dates in the data sets, only 2014-2019 data are detailed in this report for the South Valley Road site. Although trout abundances are lower than previous surveys, the trout population at South Valley Road has above average catch rates of larger fish (Figure 10). The lowest trend site is at the Park Street Bridge crossing and has experienced the most

pronounced decline in the trout fishery across all size classes since 2009 (Figure 11) but experienced modest increases in 2021 surveys.

Age Data

Age estimates derived from brown trout otolith samples ranged from 1-5 years old. The fish within the subsample ranged in length from 5" to 17". As a result, the age-length key does not contain the youngest age-0 YOY or largest fish ≥18" (Figure 12). We purposefully did not sacrifice the oldest or youngest fish for age analyses but did assign fish < 4" to age 0. Age estimates ranged from zero to five (Figure 13). Mean relative weight of brown trout in Black Earth Creek is 89.8, indicating the trout were in excellent body condition. Only two fish (2%) were in poor body condition (below the relative weight index score of 75, Figure 14). Since fish were collected from Upper BEC in Cross Plains at Zander Park to Lower BEC in Wolf Run Trail, the age demographics and data presented here represent a composite age and growth trajectory for the main-stem BEC and there may be finer scale growth trajectory differences between the lower, middle, and upper reaches of BEC.

Tributaries of Black Earth Creek

<u>Brewery Creek</u>

Of the four locations we sampled, brown trout were observed in three of them (Figure 15). No YOY production was observed. Creek-wide average catch rates for yearling trout were (4-8") 8.5 per mile, adult (>8") 38 per mile, preferred (>12") 51 per mile, and fish size ranged 7"-17" (Table 2, Appendix Table 1). Yearling brown trout catch rates were low and only two stations had trout of this size class (HWY 14 and Brewery Road). Catch rates for trout 8-12" fish were generally low and observed lower in the creek. The lower three stations exceeded the Driftless median catch rate for preferred sizes. Although no fish weights were collected, all trout appeared to be in excellent body condition.

Mottled sculpin were observed in the three lower stations including HWY 14, Brewery Road, and St. Francis Street stations. The highest catch rates of mottled sculpin were found at the Brewery Road station. White suckers were found in low abundances nearest the confluence with BEC at the HWY 14 and Enchanted Valley crossings.

Median IBI score across all sites in Brewery Creek was 55 (out of 100, average score 45) and lagged behind the statewide trout stream median (60) but was slightly higher than median Driftless trout stream (50) and Dane County (50) median scores. Individual station scores are detailed in Table 4. Average qualitative habitat ratings for the stations in Brewery Creek was 40% (out of 100) but all scored generically "Fair". Riparian buffer varied greatly (0 – 15) with lower urbanized stations receiving lower scores than the upper reaches (average 7.5 out of 15). Other physical habitat scores (creek-wide averages) were similarly variable with bank erosion more extensive in the steeper gradient portions of the urbanized lower reaches than the upper reaches (average score 10 out of 15), pool area was universally rare (2.25 out of 10), width: depth ratio was generally good (9 out of 15), riffle habitat and lack of fine sediments was best in the lower reaches whereas the upper two stations had heavier fine sediments and no riffle habitat. Cover for fish (2.5 out of 15) was universally rare in the four stations we surveyed. Average temperature across all four stations was 61.5°F (ranged 61-62). Average stream flow was 8.0 cfs (ranged 5.7 – 9.5 cfs) with an average width of 2.5 meters (Table 4).

Garfoot Creek

All four stations we surveyed contained brown trout and the three upper stations contained brook trout (Figure 16, Table 3). Average brown trout catch rates for YOY (<4”) = was 3 per mile, yearling (4-8”) = 6 per mile, adult (> 8”) = 19 per mile, preferred (>12”) = 37 per mile, and fish size ranged 3”-17” (Table 2, Appendix Table 1). YOY trout were observed at only the station nearest the confluence with BEC but catch rates across all size categories were generally below regional and statewide benchmarks. However, two stations (confluence with BEC and HWY KP) had catch rates of >12” fish which surpassed regional and statewide values. Although no fish weights were collected, all trout appeared to be in excellent body condition.

Garfoot Creek had a modest but fishable brook trout population supported through limited natural reproduction and stocking. Natural reproduction was documented in the uppermost reaches at the Observatory Road station. A combination of stocked and naturally produced fish were observed at the upper three stations (HWY KP, Fishery Area, Observatory Road). However, adult (>7”) catch rates are relatively low with only the upper site exceeding the Driftless median rate. No yearling brook trout were observed in the watershed. Mottled sculpin were sampled in all four stations and white suckers were rare. The highest catch rates of mottled sculpin were found at the HWY KP Road crossing.

Average coldwater IBI score across all sites in Garfoot Creek was 67.5 (out of 100) and exceeded the statewide trout stream (60), Driftless trout stream (50), and Dane County (50) medians. Average qualitative habitat ratings for the stations in Garfoot Creek was 50% (out of 100) and all scored as “Good” or “Fair”. Riparian buffer scores were generally good (average 10 out of 15) but the upper most reaches scored higher than the lower stations. Bank erosion was minor to minimal in most areas (average score 8.75 out of 15), pool area was rare (3.25 out of 10) and the width: depth ratio was poor to adequate in most areas (7.5 out of 15). Riffle habitats were generally scarce (3.75 out of 15) but the Michaelis Road station scored better than others (10). Fine sediments were common in the lower reaches and rare in the uppermost Observatory Road station (5 out of 15). Cover for fish was good throughout most of the stations (12.25 out of 15). Average temperature across all four stations was 58°F (ranged 56-60). Average stream flow was 9.6 cfs (ranged 5.7– 14.8 cfs) with an average width of 3.1 meters (Table 4).

Vermont Creek

Trout abundances within the three stations we surveyed in 2019 were patchily distributed with most fish observed at the southernmost WDNR fishery area and the largest size classes observed at the Michaelis Road station (Figure 17). Catch rates for all other size classes were generally low at each station. Creek-wide average catch rates for YOY (<4”) = 4.2 per mile, yearling (4-8”) = 12 per mile, adult (>8”) = 95 per mile, preferred (>12”) = 61 per mile, and average fish length was 12.9” (Table 2). The Michaelis Road station was the only site where trout abundances surpassed the driftless area median rates (>12” size). Mottled sculpin were dominant in the upper most station but were outnumbered by a wide margin compared to white suckers in the lower two stations.

Average IBI score across all sites in Vermont Creek was 30 (out of 100) and lagged behind the statewide trout stream (60), Driftless trout stream (50), and count trout stream (50) median scores. Average qualitative habitat ratings for the stations in Vermont and scored 53% (out of 100), overall “Good” or “Fair” ratings. Riparian buffer scores were good to excellent, all scored between 10 and 15 out of 15 but other physical habitat scores (creek-wide averages) were low including bank erosion (average score 8.3 out of 15), pool area (3 out of 10), width: depth ratio

(6.6 out of 15), riffle habitat (5 out of 15), fine sediments present (8 out of 15), and cover for fish was present in most areas (10 out of 15). Average temperature across all three stations was 61°F. Average stream flow was 15.5 cfs (ranged 10.6 – 19.4 cfs) with an average width of 4.6 meters (Table 4). Although no fish weights were collected, all trout appeared to be in good body condition.

Halfway Prairie Creek

We surveyed one station on Halfway Prairie Creek just upstream of the confluence with Black Earth Creek. No YOY trout were observed and catch rates of all size classes was well below regional medians (Figure 18). The average IBI score was 30 and well below the regional, county, and driftless median rates (Table 4).

Discussion

A trout fishery is unsustainable without consistent YOY recruitment and yearling survival. Our watershed assessment of the Black Earth Creek fishery in 2019 revealed a concerning pattern of widespread recruitment failures at the youngest life stages. For example, none of the survey sites within the entire watershed assessment had YOY (< 4") or yearling (4-8") catch rates approaching the driftless or statewide median values. Even the catch rate at the highest performing site (Jovina Street in Zander Park) is 33% less than the Driftless median (75 per mile). The average yearling catch rates across all surveyed sites within Black Earth Creek were 22 per mile compared to the driftless median rate of 214 per mile, nearly ten times fewer.

For trout within the size category >8", only two survey locations in the entire watershed had adult abundances exceeding the driftless median rates. The two high performing areas for adult catch rates were observed near Cross Plains at the HWY KP and Jovina Street sites. The driftless median catch rate (300 per mile) for adult sized fish is 3.27 times greater than the average observed catch rates across all the other sites within Black Earth Creek and the three major tributaries (92 per mile).

However, a major caveat to this report is the 2018 flooding reduced young fish abundances observed in the 2019 survey at an unknown rate which may not have been indicative the natural reproduction capacity of the watershed pre-flood. It is possible that the floods displaced or eliminated most of the YOY and yearling sized fish which would have influenced the results of our survey in 2019 and the conclusions of this report.

The intense floods of 2018 scoured much of the riverbed to native river rock and exposed more spawning habitats than what were once available. Our annual trend surveys will continue to monitor the trout populations and I would not be surprised to see a lag effect where the floods in 2018 exposed extensive gravel and rock beds that trout now have access to as spawning redds thereby increasing natural reproduction in subsequent years. At the time of this writing, 2021 BEC survey at Jovina Street in Cross plains showed increased YOY production with 93 YOY per mile which exceeded the Driftless median rate of 75 YOY per mile. Catch rates of yearling (4-8") and adult (>8") trout were also much higher in Zander Park in 2021 (592 and 542 per mile, respectively) but total catch rates of all trout at the South Valley Road and Park Street were still low (219 and 108 per mile, respectively). The pattern of increased YOY production in 2021 is consistent among other 2021 surveys, with Story Creek posting a bumper crop of YOY at 436 YOY per mile.

Though we detected reduced trout abundances at younger life stages, we observed more of largest age class fish. 60% of all the sites sampled in the watershed had catch rates for preferred sized fish (>12”) exceeding statewide and driftless benchmarks and anglers report steady catches of these larger sized class fish. The majority of the sites on Black Earth had elevated catch rates of this size category and each of the three tributaries had at least one site exceeding the driftless median (Brewery Creek had 3 of 4 sites, Garfoot Creek had 2 of 4, and Vermont Creek 1 of 3 sites).

Though the increased catch rates of larger fish represents a positive highlight of the fishery, a closer examination of the trend sites within Black Earth Creek suggests trout abundances across all size classes have been in decline for several years; indicating the low adult abundances are likely a combination of poor recruitment and lack of suitable habitat. The decline is especially apparent at the Park Street site which has experienced precipitous declines in all size classes since the mid-2000’s. Angler anecdotes and the trends are similar for the South Valley Road Crossing, where fewer and fewer adult trout have been observed or caught over the years. In these stations, the trout abundances are among the lowest detected over many years of monitoring. Perhaps the lone bright spot in the entire watershed is the stretch of Black Earth Creek upstream from HWY KP to Zander Park where our trend site at Jovina Street indicated a relatively stable population of multiple size and age classes dating to 2007-present. Even here, the catch rates have remained markedly lower compared to only a few years prior.

The tributaries of Black Earth Creek

A healthy river ecosystem, including the trout fishery, is a reflection of- and dependent on- the health of the major tributaries and land use within the watershed. The Brewery Creek trout fishery is confined to the urbanized and steeper gradient reaches between St. Francis Street and the confluence with Black Earth Creek at US HWY 14 in the village of Cross Plains. The channel is incised in many locations due to increased flows and subsequent bank erosion. The substrates are largely compacted clay with a few cobble and gravel outwashes (mostly road pack in origin). The riparian buffer scores were very low and mostly comprised of backyard lawns with little riparian vegetation or in-stream habitat features. The headwater areas upstream of HWY P are much lower gradient and have agricultural histories (e.g. straightened, ditched, silt-laden substrates) rendering them devoid of suitable trout habitat but are important cold-water inputs as they drain groundwater springs and increase flows of cold-water downstream. The partially ditched wetlands in the headwaters soak up warm surface water, protecting the colder water downstream from thermal pollution.

Garfoot and Vermont Creeks are similar in their trout fishing opportunities, habitat, and land use. Both tributaries suffer from heavy channel modifications from their agricultural influences. These rivers have been straightened, ditched, and or routed away from their natural channels resulting in poor trout habitat throughout their middle and lower reaches. The substrates in these areas are a mixture of clay and silt with heavy loads of fine particles resulting in few spawning habitats. Natural river processes like meandering and bend pool formations are very important habitat features of a river as they provide cover and refuge for trout and scour gravel for trout spawning habitat while providing a diversity of depths. Poor riparian land management, lack of in-stream habitat, and channel modifications have resulted in unacceptably low trout abundances in both tributaries throughout much of their length due to a lack of diversity of habitat types. However, the headwaters of both rivers are in a better condition than their lower reaches. Headwater sampling sites in each river showed increased catch rates of trout, improved habitat scores, and colder water. For example, headwaters of Garfoot Creek offer a unique brook trout fishery in its uppermost reaches where springs provide the coldest and

highest quality water and the Vermont Creek Fishery area had higher habitat scores and had elevated catch rates compared to its lower sites.

Little attention has been paid to smaller tributaries of Black Earth like Halfway Prairie Creek. This tributary enters Black Earth Creek near Mazomanie downstream of the classified trout waters. The Temperature profile for Halfway Prairie indicated the temperatures were suitable for trout during some parts of the year but summer maximum readings exceeded optimal temperatures for cold water species. Additionally, the stream has been heavily modified and is largely devoid of gamefish or cold-water indicator species. Without extensive channel re-meanders, habitat improvements, groundwater protection, and wetland restoration, streams like this (and others like Wendt Creek) will continue to have little recreational or angling interest but likely serve as important cool and cold-water inputs to Lower Black Earth Creek. Another challenge to rehabilitating these streams is the lack of public access features which is a prerequisite for many programs aimed at improving the health of the stream. Dane County has begun to implement a habitat improvement project near the confluence of Halfway Prairie Creek and Black Earth Creek with a goal of improving the cold-water features in this area. Future fish surveys will assess the impact on the fishery with hopes of expanding the cold-water resources in the area.

Addressing trout habitat in the watershed

The lack of survival from YOY to yearling and resulting low adult densities identifies a key bottleneck to a robust trout fishery within the watershed. Non-point runoff and associated sedimentation and nutrient loading to the stream combined with a lack of in-stream habitat are likely the major factors negatively impacting the trout fishery. Even if we assume 2018-2019 was an isolated poor recruitment year due to extreme flooding and not a negative sign of the overall status and trend of the fishery, the YOY and nursery areas we identified are valuable known commodities, producing trout despite most other areas failing to do so in a ‘down year’. The few survey sites with existing YOY and yearling production (e.g Shoe Box, Scherbel Road, KP, Jovina St., Brewery Road, Observatory Road, and HWY 78) need to be protected from development and agricultural sources of environmental degradation (e.g. sediment and nutrient inputs).

In many high density, naturally reproducing trout streams, the hydrologic connectivity between the main-stem river, headwaters, and small tributaries provide adult spawning trout high-quality spawning habitats not found in the main river corridors thereby boosting adult abundances as YOY’s born and raised in tributaries recruit to yearlings and find adult habitats in the main river later in life. The only area with consistent YOY recruitment is within the village of Cross Plains in Zander Park which offers direct access to spring fed groundwater, gravel for spawning adults, and diversity of cover for trout of all age classes within the stream (e.g. riffles, pools, runs, depth, vegetated margins). In contrast, lower Black Earth Creek and lower reaches of Garfoot and Vermont have long reaches of monotonous habitats with poor width: depth ratios, reduced velocity, silty substrates, and a lack in-stream habitat all of which offers few suitable spawning or nursery areas. The headwaters of Black Earth Creek are cold enough to support trout, but the stream thread is completely channelized, suffers from low stream flows, has a substrate dominated by silt, and offers little in-stream or riparian cover for fish. With extensive habitat improvements and riparian land use changes, the headwaters could offer trout additional habitats, particularly at YOY and Yearling stage but is unlikely to support adult densities attractive to most anglers.

Poorly performing areas of the river and tributaries have several common attributes including heavy silt substrates, little overhead cover for trout (e.g. downed trees), and riparian trees are often removed for easy paddler navigation and perceived flood mitigation. Long stretches of the stream have little shade or shrubbery along the banks, allowing ample sunlight to penetrate the river and thick mats of nuisance vegetation (e.g. sago pondweed or curly leaf pondweed) dominate the substrate and increasing stream temperatures in the process. Along the sun-soaked banks, invasive wild parsnip poses a significant risk to any would-be anglers during peak growing season. Replacing this vegetation with long lived, native hardwoods and shrubs would benefit angler accessibility and provide substantial shade to the stream thereby reducing stream temperatures in the hottest summer months. Thick in-stream vegetation in shallow lakes can pose a significant risk to fish health as the plant material dies and decomposes and the resulting processes consumes a significant portion of the available dissolved oxygen. It is unclear if this process is similar in lower Black Earth Creek when dense mats of Eurasian milfoil, sago, or curly leaf pondweed decomposes (or diurnal respiration) but may be another factor contributing to low trout abundances in those areas and warrants closer study.

Fishery assessments in the late 2000's and early 2010's showed Black Earth Creek to have much higher adult brown trout densities than what we observed in the 2019 survey (e.g. Park Street trend survey, Figure 11). The average catch rate of all trout across multiple sites spanning from Park Street upstream to the Village of Cross Plains was 525 trout per mile from the years 2000-2012 compared to 231 per mile in 2019. Once famous for larger sized fish, lower Black Earth Creek had an average catch rate of 85 trout per mile >12" compared to 35 per mile observed across all site downstream of South Valley Road in 2019. Changing thermal regimes, physical habitat alterations, and aging habitat improvement projects are likely factors contributing to the observed declines.

The decrease in trout abundances across all size classes throughout the Black Earth Creek watershed indicate chronic recruitment failures and is indicative of a lack of physical habitat trout need at different stages of their lifecycle. Although not every stream segment can or should hold high abundances of trout across all size-classes, much of the watershed could be improved from a trout habitat perspective. Historical investments in habitat improvement projects implemented in the late 90's and early 2000's are largely gone or not functioning as designed and need to be revisited. In response to data collected during this survey, WDNR Fish Management is in the planning process of major habitat improvement projects within lower Black Earth Creek and its tributaries. Dane County staff are also interested in improving trout habitat and stream bank health along the parcels they own or have easements on. Our current goal is to complete 1-2 miles of habitat improvement in 2022.

Providing adequate habitat for multiple life stages of trout including increasing adult spawning habitats, YOY nursery, and yearling habitats will improve the total trout population of the watershed. Areas with adequate gradient to promote exposed gravel trout use to build redds could be enhanced to promote additional natural reproduction through expanded riparian buffers and habitat improvement projects. Improvements in these areas should attract adults building redds in spawning riffles and offer juvenile trout nursery habitat with vegetated margins of the stream and overhead cover. Adult trout habitat improvement initiatives should address limited overhead cover and an overall lack of habitat diversity within the river channels aimed at reverting decades of extensive riverbed modifications to a more natural river condition including adding depth with pools and deeper runs. Though much of the watershed has relatively minor bank erosion, there are several areas that suffer chronic bank erosion and river incision which increases nutrient and sediment loads to the system. The most degraded reaches suffer from excessive erosion resulting in wide, relatively shallow runs with little trout habitat and unsuitable

stream temperatures for trout (e.g. yellow bullhead in Vermont Creek, smallmouth bass and pike in lower BEC).

In addition to physical habitat, stream temperature, and flow are important factors structuring the fish community of a trout stream. A constant flow of cold groundwater buffers the stream from variable flows and seasonal fluctuations in temperature. A generous gift from Trout Unlimited enabled continuous in-stream temperature monitoring throughout the watershed. We used these temperature loggers and the USGS stream gauges to evaluate stream flow and temperature data throughout the watershed. These analyses indicate Black Earth Creek is vulnerable to extreme heat and cold temperature fluctuations (Figure 19). In contrast, Tader Creek, a small stream in Bayfield County dominated by brook trout and sculpin holds steady 50-55F all year round whereas the temperature of Black Earth Creek is on a similar trajectory as the smallmouth bass river of Blockhouse River, fluctuating from 40F in winter to over 70F in summer. The Big Green River, a revered Class I trout stream in Crawford County with a high-density trout fishery, undergoes a seasonal fluctuation but to a lesser degree than Black Earth or Blockhouse. The dramatic shifts in temperature are known correlates to trout declines and if Black Earth continues this trajectory, will continue to be more similar to smallmouth bass rivers than similar sized trout rivers. We should not be surprised that fish assemblages are expected to shift accordingly. Though we can do little to increase or supplement groundwater flows, we can protect existing spring complexes and restore wetlands (like those found in Upper Black Earth Creek) while increase shading to the riparian corridor to help moderate the harshest impacts of extreme summer temperatures. These actions are especially prudent with climate change projections indicating the upper Midwest can expect to experience increasing precipitation and rising temperatures.

We may already be experiencing a shift towards a warmwater fish community further downstream in the classified trout waters of Black Earth Creek where trout dominated only a decade ago. In contrast to healthy trout streams which have simple fish communities (e.g. only two species with mottled sculpins and trout), many sampling sites in the watershed had not only more complex fish communities, but contained species more tolerant of poorer water quality and higher temperatures (e.g. white suckers, common shiners, brook sticklebacks, common carp, and creek chub). Warmer water gamefish like smallmouth bass and northern pike have been observed downstream of South Valley Road suggesting the temperature profile of the river has begun to shift towards a cool-warm water transitional fishery in those areas even though above average precipitation and resulting river flows have remained high. A thorough groundwater monitoring and flow path study may help elucidate the sources and temperature profiles of the sources of water into Black Earth Creek aiding in management and conservation goals as sources of cold water can be protected and the impacts of warmwater mitigated.

Balancing the needs of a healthy river with a robust trout fishery with considerations for safe paddling while protecting valuable croplands and infrastructure within the floodplain will remain a potential source for user conflicts within the watershed. Even with extensive habitat improvements and groundwater protection, agricultural land use and development pressures will continue to stress the health and stability of the trout fishery within Black Earth Creek watershed. As villages and municipalities continue to grow, community leaders should balance development with the impacts of increased urbanization can have on a sensitive cold-water fishery. Agricultural lands long dry and profitable have been rendered fallow due to increased precipitation and flooding in recent years (Figure 20). Precipitation is at an all-time high in the Great Lakes region and is expected to continue with more frequent, more intense events forecasted to be the norm. Nutrient management plans and cover crop programs would be major improvements within the watershed but novel programs balancing agricultural livelihoods

in flood-prone areas while promoting healthy ecological landscapes could be explored to ensure future generations enjoy a robust trout fishery. For example, Dane County's harvestable buffer program could provide a template which allows grasses to grow near the river and is harvestable by farmers while the stream bank health improves, and the river receives reduced runoff. More aggressive programs could provide incentives to landowners to leave sensitive flood prone areas fallow in exchange for public access and payment while retaining other private property rights. Paddlers, anglers, and conservation groups need to coordinate riparian management activities in consultation with property managers and owners to ensure safe paddler access and passage but leaving ample downed wood and trees in the river recognizing downed wood as a natural process which serves important ecological functions and fish habitat.

In addition to climate change, land use, and physical habitat stressors, invasive species like New Zealand Mudsnails continue to colonize Wisconsin's trout streams including Black Earth Creek. Research is underway to determine any impacts new invaders like mudsnails pose to the trout fishery and ecology of the stream. Established invasives like curly leaf pondweed and milfoil displace native vegetation, form dense mats, senesce and decompose depleting dissolved oxygen concentrations in the process. Anglers and paddlers need to be mindful transporting these organisms between the waterways they recreate in. Freezing gear or robust disinfecting chemicals (bleach, Vircon) are the best ways to be sure your gear is free of aquatic invasive species between trips.

Management Goals and Objectives

1) **Goal**- Restore adult abundance to support recreational fishery to historical levels and expectations
   Objectives
   a. 400 trout/mile stream electrofishing catch rate of adult trout >8" in Middle BEC
   b. 250 trout/ mile stream electrofishing catch rate of adult trout >8" in Lower BEC

2) **Goal** - Restore the abundance of preferred size trout to support recreational fishery to historical levels and expectations
   Objectives
   a. 100 trout / mile stream electrofishing catch rate of adult trout >12" in Middle BEC
   b. 100 trout / mile stream electrofishing catch rate of adult trout >12" in Lower BEC
   Strategies
   a) Maintain 18" minimum length limit, 1 daily bag limit for Lower BEC
   b) Continue temporary use of surplus Timber Coulee brown trout stockings in Lower BEC if available from Nevin hatchery
   c) Invest Trout Stamp habitat funds to conduct 1-2 miles of habitat improvement projects in Middle and Lower Black Earth Creek before next watershed survey and evaluate fishery response
   d) Continue to invest in and promote riparian shade trees to help keep stream water temperatures as cold as possible with added benefits of promoting open savannah ecotype that will help shade out terrestrial invasive species like wild parsnip as well as nuisance aquatic vegetation

3) **Goal** – Restore natural reproduction and recruitment catch rates to observed historical rates or Driftless median benchmarks within the watershed
   Objectives
   a) Middle BEC – 500 trout/ mile 4-8"
   b) Lower BEC – 214 trout/ mike 4-8" (Driftless median)

Strategies

a) Conduct 1-2 miles of Trout Stamp funded habitat improvement within the publicly accessible reaches of Black Earth Creek and 0.5 miles of habitat work in Vermont and Garfoot Creeks (little public access in Brewery Creeks and intensely developed).
b) Continue to collaborate with landowners and conservation partners to promote robust stream corridor buffers and nutrient management plans

4) **Goal** – Increase natural recruitment of brown trout on class 2 waters Vermont and Garfoot Creeks

Objectives – Increase yearling recruitment to 188 per mile (statewide median) without additional stocking.

Strategies

a) Collaborate with local landowners, conservation organizations, and government agencies to improve land use practices.
    a. Acquire easements or lands to increase buffer areas and encourage native vegetated riparian corridors.
b) Improve habitat and water quality to increase survival and recruitment of naturally reproduced fish within the watershed.

Additional Management Recommendations:

1) Revisit trout classifications in 2024 rotation schedule
    a. Brewery (currently unclassified), Vermont, and Garfoot Creek are functioning as Class II systems and provide angling opportunities in some locations.
        i. Natural recruitment and yearling survival need to be improved to upgrade to Class I
    b. Classify Brewery Creek as Class II trout waters.
2) Maintain harvest opportunities with current regulation of 8” minimum, 3 daily bag limit in most of the watershed.
    a. Maintain 18” minimum, 1 daily bag limit in Black Earth Creek from South Valley Road downstream to HWY 14 bridge to reduce harvest and increase adult abundances.
3) Evaluate angler-use and harvest within the watershed using angler creel survey before next 2024 sampling effort.
4) Continue targeted Stream Bank Easement outreach to secure public fishing easements along select stretches of rivers in the watershed.
5) Continue to promote brook trout population in upper Garfoot Creek to extent feasible
    a. Additional easements/ acquisitions would benefit the fishery with added habitat improvement opportunities
    b. If brown trout become dominant, discontinue brook trout stocking

Tables and Figures

Table 1. Trout stocking in the Black Earth Creek, Garfoot Creek, and Vermont Creek 2014-2020 (Brewery Creek last stocked with 500 large fingerling brook trout and 1,000 small fingerling brown trout in 2001). Stocking events with an asterisk were provided by surplus hatchery production and not initially requested.

Stream	Species	Age	2014	2015	2016	2017	2018	2019	2020
Black Earth Creek	Brown	Broodstock	300	300					544
	Brown	Small Fingerling			2250*				
	Brown	Large Fingerling						4813	
	Rainbow	Broodstock	25	22	22	24	47	38	
	Rainbow	Yearling	4745	3484	536				
	Rainbow	Small Fingerling					7533*		19195*
	Brook	Broodstock			60				
Garfoot Creek	Brook	Large Fingerling	563	3040	1500	450		1347	
	Brook	Broodstock				100			
Vermont Creek	Brown	Large Fingerling	296	877	780	1096		500	

Table 2. Brown trout catch rates in 2019. Catch Per Unit Effort units are numbers of fish per electrofishing mile.

River	Station Name	N	Mean Length (In)	<4" YOY CPUE	4-8" Yearling CPUE	>8" CPUE	>12" Preferred CPUE	>15" Memorable CPUE	>18" Trophy CPUE	Total CPUE
Black Earth	West Hudson St.	3	17.7	0	0	16.1	0	10.7	5.4	16.1
	Wolf Run Trail	10	13.6	0	0	47.3	37.8	14.2	0	47.3
	Olson Road	5	14.6	0	0	18.9	18.9	11.4	0	18.9
	Shoe Box Landing	26	11.3	16.7	12.5	79.4	62.7	25.1	4.2	108.7
	Park Street	8	14.8	0	0	33.4	29.3	20.9	0	33.4
	South Valley Road	28	12.5	0	10.2	132.8	76.6	40.8	5.1	143.1
	Scherbel Road	55	12.9	8.1	8.1	207.8	162.9	48.9	8.1	224.1
	HWY KP	68	11.1	34.5	80.5	666.7	264.3	126.4	0	781.7
	Zander Park (Jovina St.)	85	9.7	50.3	130.8	673.9	170.9	10.1	10.1	855
	Brewery Trail-xing	14	11.9	9.2	9.2	110.4	64.3	27.6	0	128.7
	Stagecoach Road	16	12.6	0	11.8	177.5	130	11.8	0	189.3
Brewery	Up of HWY 14	14	11.3	0	9.2	119.6	55.2	9.2	0	128.7
	Brewery Road	12	12	0	26.8	134.1	67.1	26.8	0	160.9
	St. Francis Street	10	14.2	0	0	115.9	90.1	38.6	12.9	128.7
Garfoot	BEC Confluence	8	11.2	10.7	10.7	64.4	32.2	21.5	0	85.8
	HWY KP	9	13.7	0	0	90.5	60.4	50.3	0	90.5
	WDNR Fishery Area	5	11.8	0	0	53.6	32.2	0	0	53.6
	Observatory Road	2	7.9	0	13.4	13.4	0	0	0	26.8
Vermont	WDNR Fishery Area	25	9.4	11.9	23.8	262.3	11.9	0	0	298
	Michaelis Road	15	14.6	0	10.7	150.2	128.7	75.1	21.5	160.9
	HWY KP	4	14.8	0	0	36.8	36.8	9.2	0	36.8
Halfway Pr.	US confluence BEC	8	10.9	0	16.1	48.3	24.1	8	0	64.4

Table 3. Brook trout catch rates in 2019. Catch Per Unit Effort units are numbers of fish per electrofishing mile.

River	Station Name	N	Mean Length (In)	<4" YOY CPUE	4-7" Yearling CPUE	>7" Adult CPUE	>10" CPUE	Total CPUE
Garfoot	HWY KP	1	7.80	0.00	0.00	10.06	0.00	10.06
	WDNR Fishery Area	3	9.63	0.00	0.00	32.19	10.73	32.19
	Observatory Road	8	6.78	40.23	0.00	67.06	13.41	107.29

Table 4. Coldwater index of biotic integrity (IBI) scores, temperature, flow, stream width, and habitat ratings for the Black Earth Creek and major tributaries. Site ID reference Figure 1 and are listed in order from downstream to upstream.

Waterbody (Site ID)	Station	IBI Score	Temperature (°F)	flow (cfs)	Mean Stream Width (meters)	Habitat Score
Black Earth Creek	**2019 Average**	**24**	**63**	**73.0**	**8.4**	**55**
25	Hudson Rd Mazo	20	59	115.1	13.4	40
26	Bridge St. Mazo	30	60	128.5	12.7	57
20	Wolf Run Trail	30	64	92.0	9.0	87
15	Olson Road	20	63	100.0	11.0	69
22	Shoe Box Landing	30	61	92.0	11.0	48
13	Park Street	20	63	100.0	11.0	44
12	South Valley Road	20	64	100.0	9.0	63
16	Scherbel Road	20	65	60.0	9.0	67
18	HWY KP (near boardwalk)	30	63	56.0	5.0	57
19	Zander Park (Jovina St.)	30	60	55.0	6.0	47
14	Brewery Road Snowmobile xing	20	68	37.1	5.7	43
17	Stagecoach Road	30	68	7.8	3.3	62
23	Low Road	10	61	5.3	3.2	30
Brewery Creek	**2019 Average**	**45**	**61.5**	**8.0**	**2.5**	**40**
5	upstream of HWY 14	60	62	8.5	3.0	33
6	Brewery Creek Road	50	61	8.5	2.7	43
11	St. Francis Street	60	62	9.5	2.4	40
7	Enchanted Valley	10	61	5.7	2.2	43
Garfoot Creek	**2019 Average**	**67.5**	**58**	**9.6**	**3.1**	**50**
24	upstream confluence of BEC	60	60	14.8	3.1	67
1	HWY KP	70	58	8.8	3.0	43
2	WDNR FA near Garfoot Rd	60	58	9.2	3.6	35
3	Observatory Road	80	56	5.7	2.5	53
Vermont Creek	**2019 Average**	**30**	**61**	**15.5**	**4.6**	**53**
9	HWY KP	10	65	19.4	5.6	43
10	Michaelis Road	10	63	16.6	5.5	53
4	WDNR Fishery Area	70	55	10.6	2.7	63
Halfway Prairie						
21	Upstream near confluence	30	63	24.0	6.2	57
Dane County	**County 5 Yr Median (2015 – 2019)**	50				
Statewide	**Statewide 5 Yr Median (2015-2019)**	60				
Driftless Area	**Driftless 5 Yr Median (2015 - 2019)**	50				

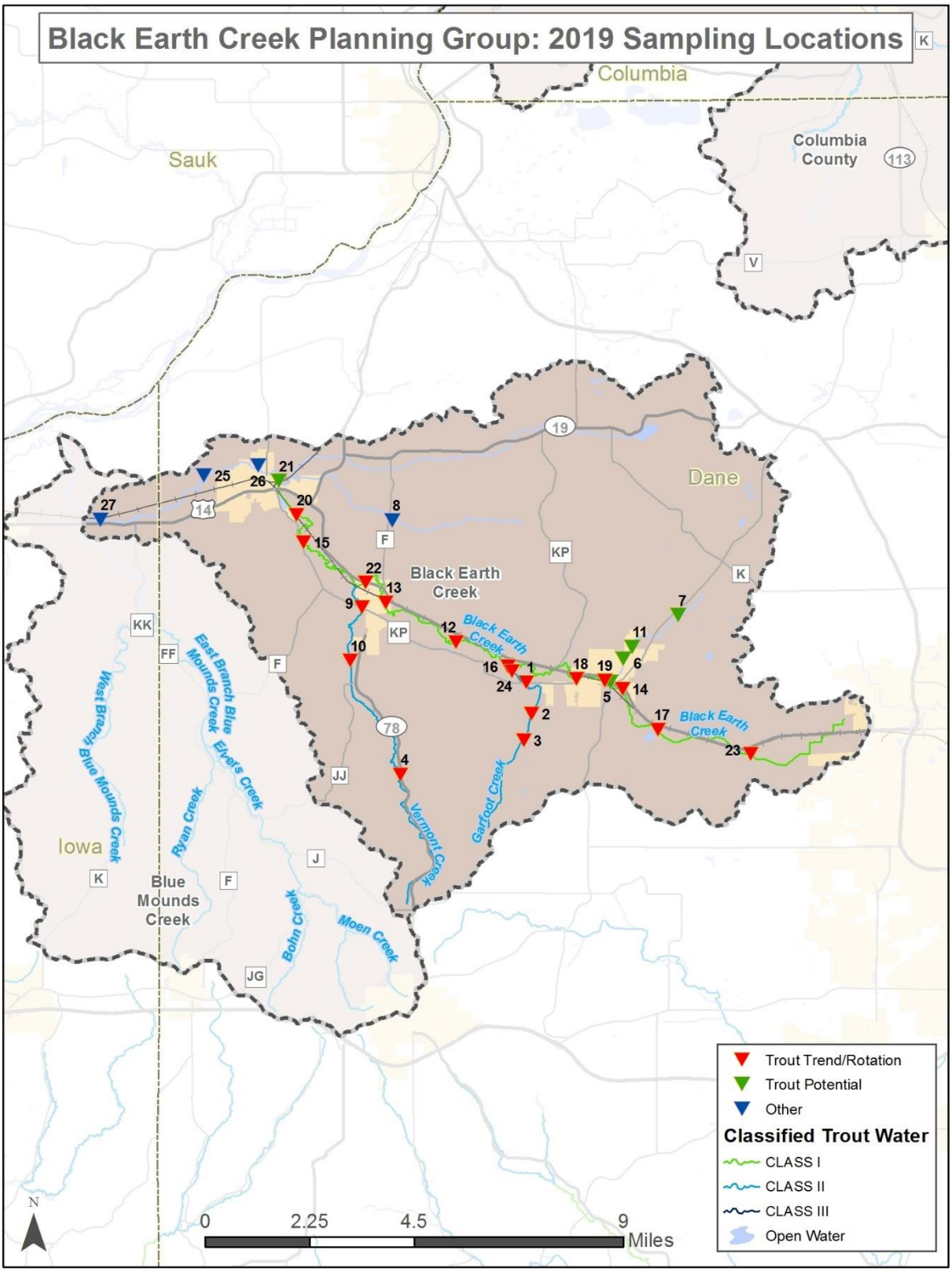

Figure 1. Stream classification and 2019 fishery assessment sampling sites within the Black Earth Creek Watershed.

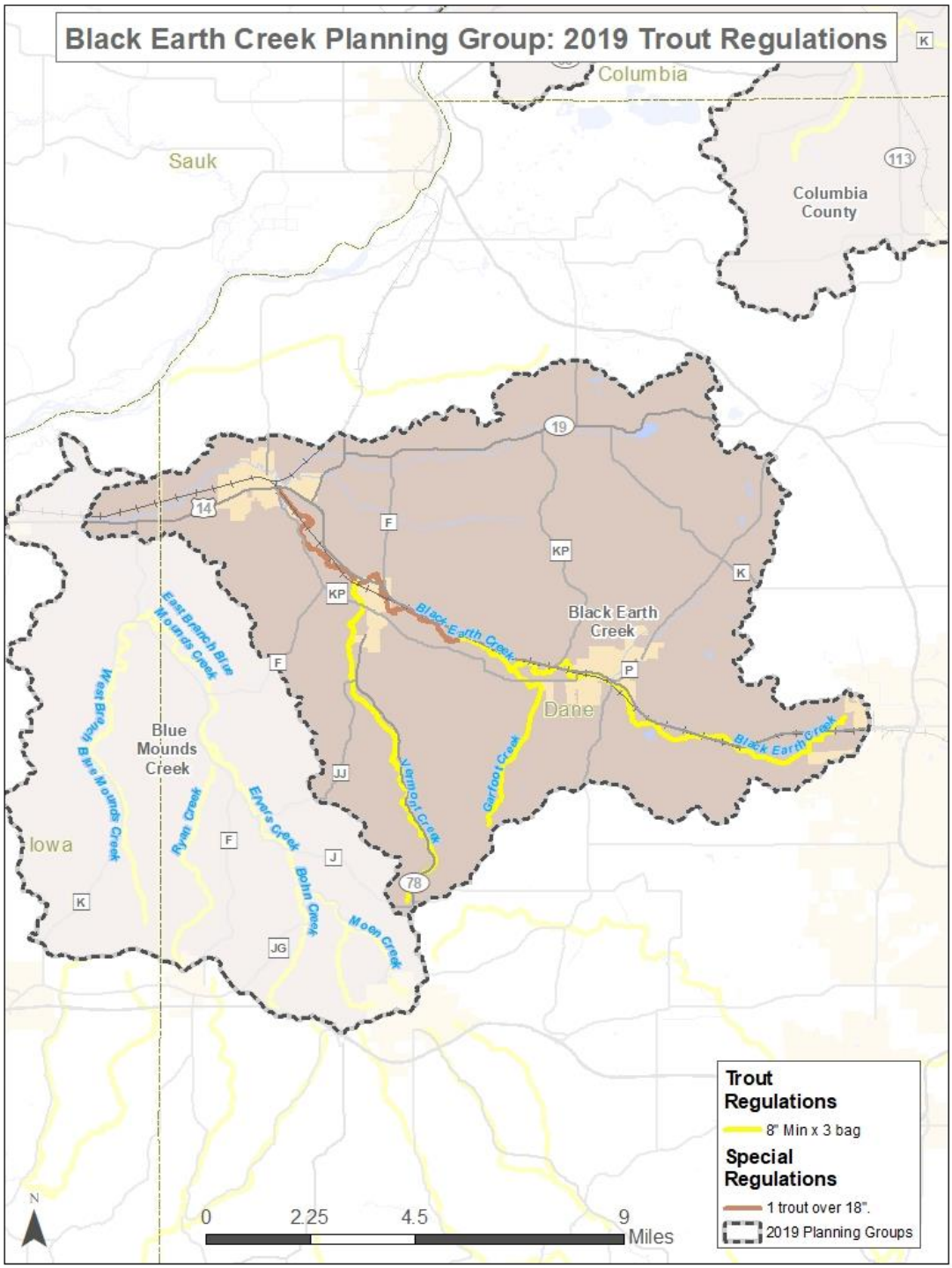

Figure 2. Black Earth Watershed trout streams are regulated under the county base 8” minimum length and 3 daily-bag limit except the segment downstream of South Valley Road to HWY 14 Bridge on Black Earth Creek which has an 18” minimum, 1 daily bag limit.

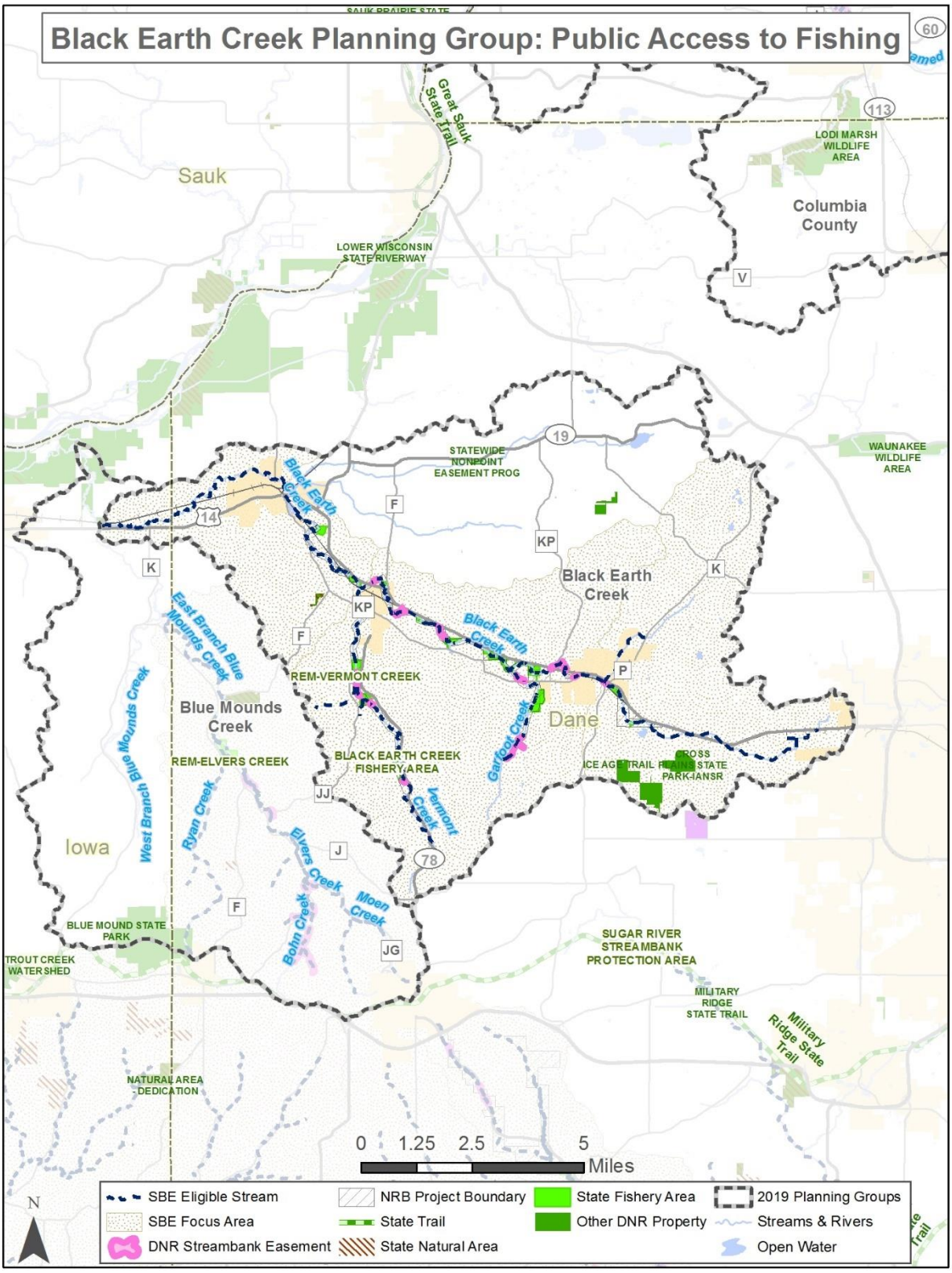

Figure 3. Black Earth Creek Watershed group public access points and WDNR Stream Bank Easement program eligible waters.

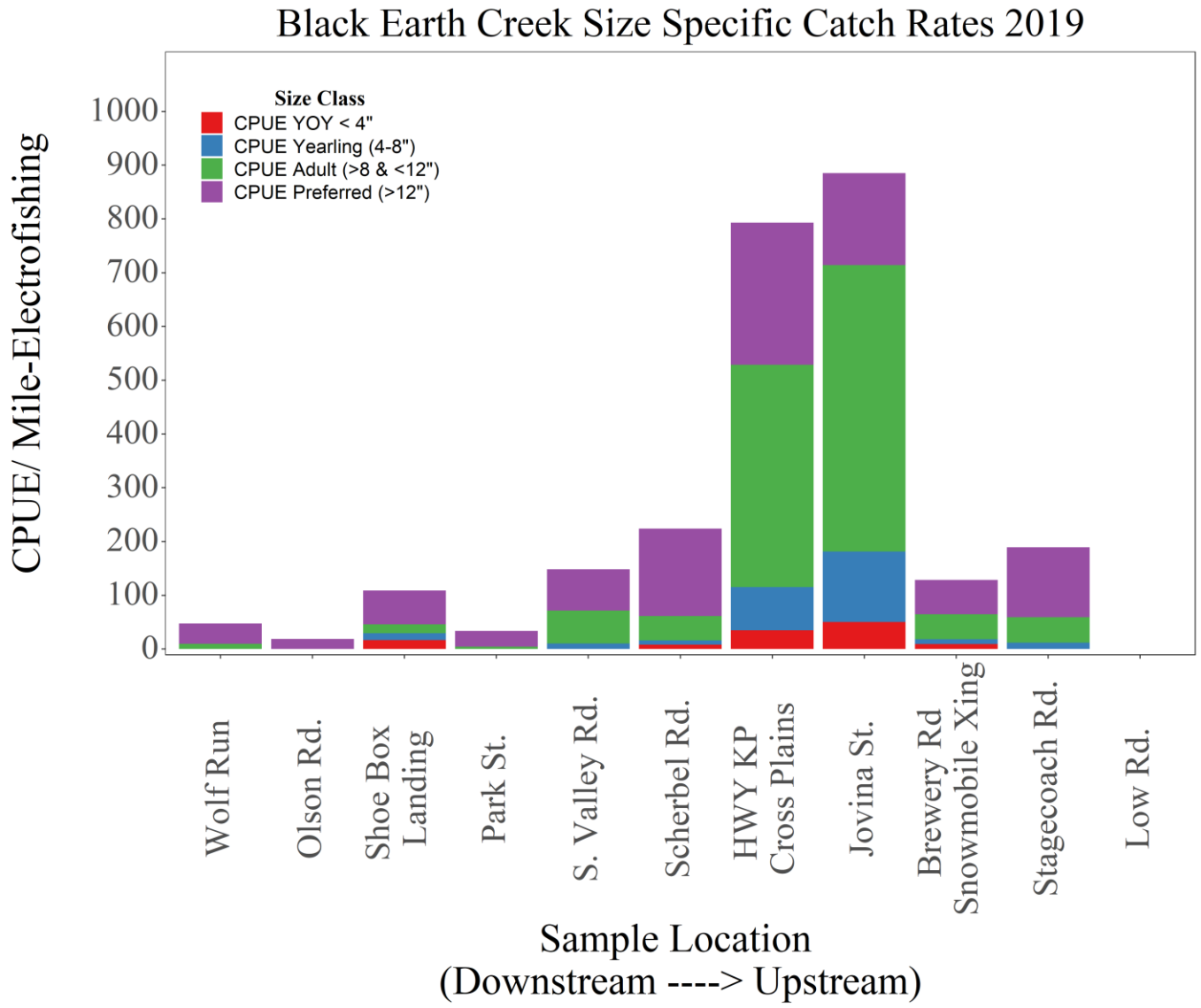

Figure 4. Size specific catch rates of brown trout observed in Black Earth Creek 2019.

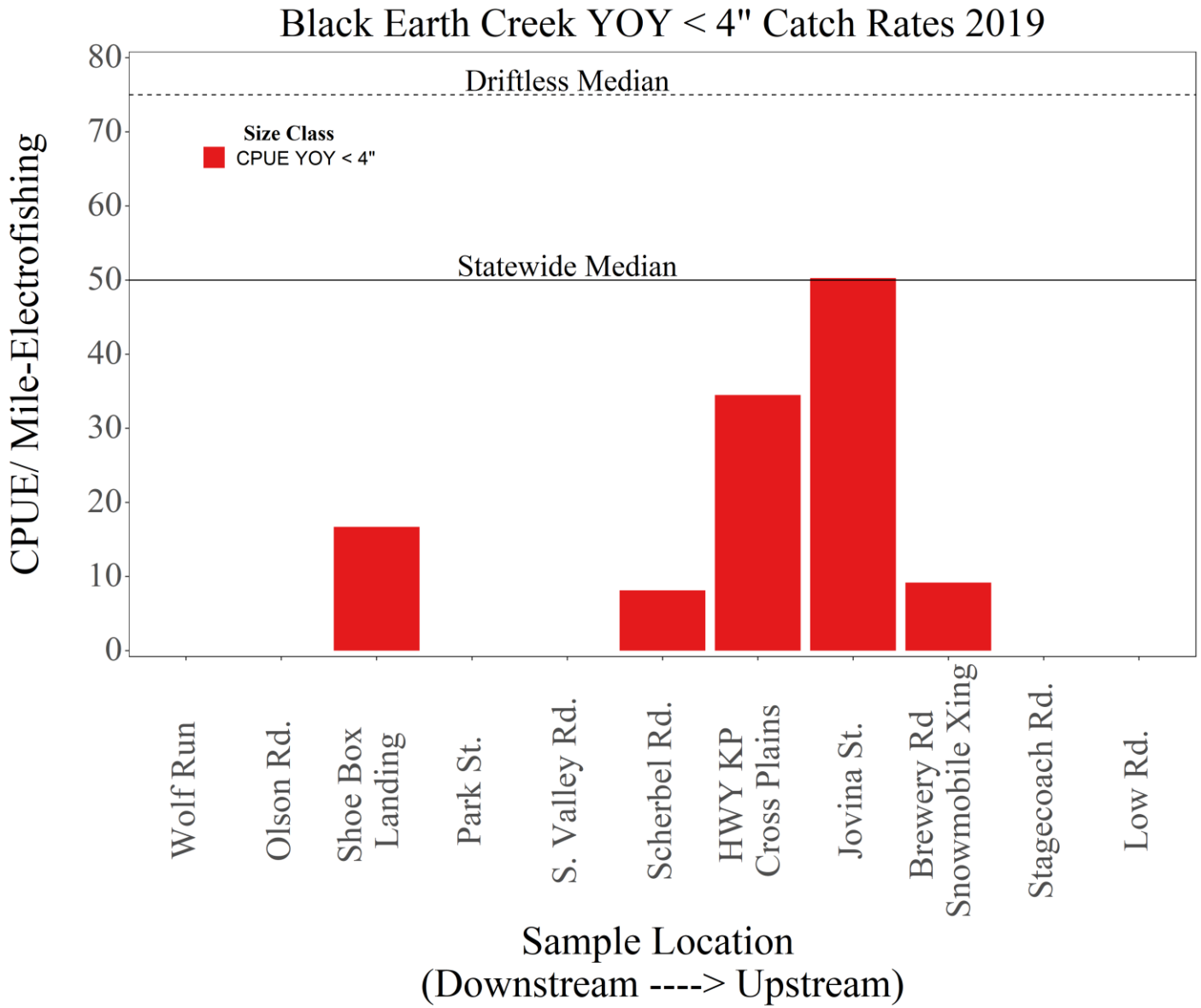

Figure 5. Young-of-year size brown trout catch rates observed in Black Earth Creek 2019.

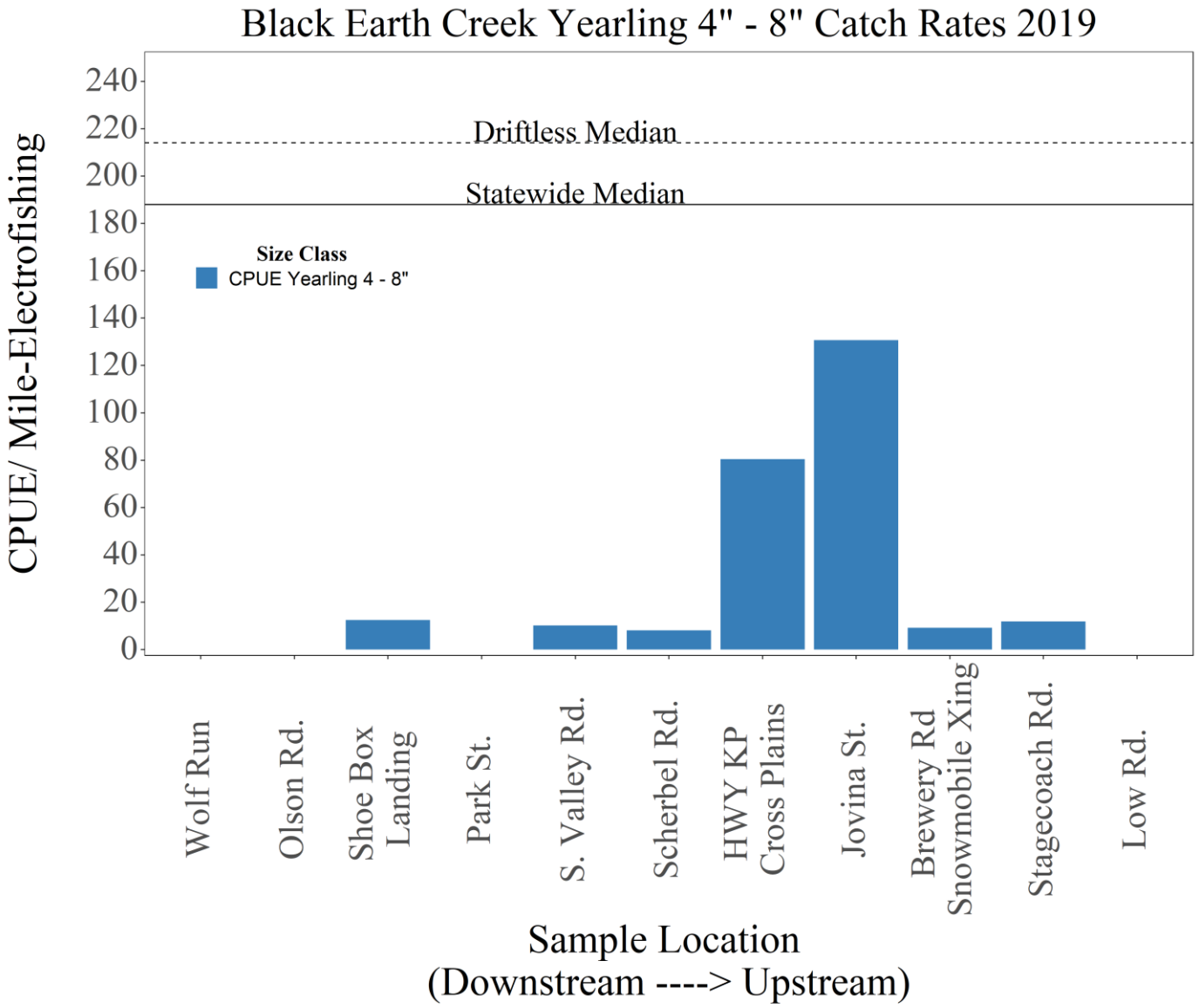

Figure 6. Yearling brown trout catch rates observed in Black Earth Creek 2019.

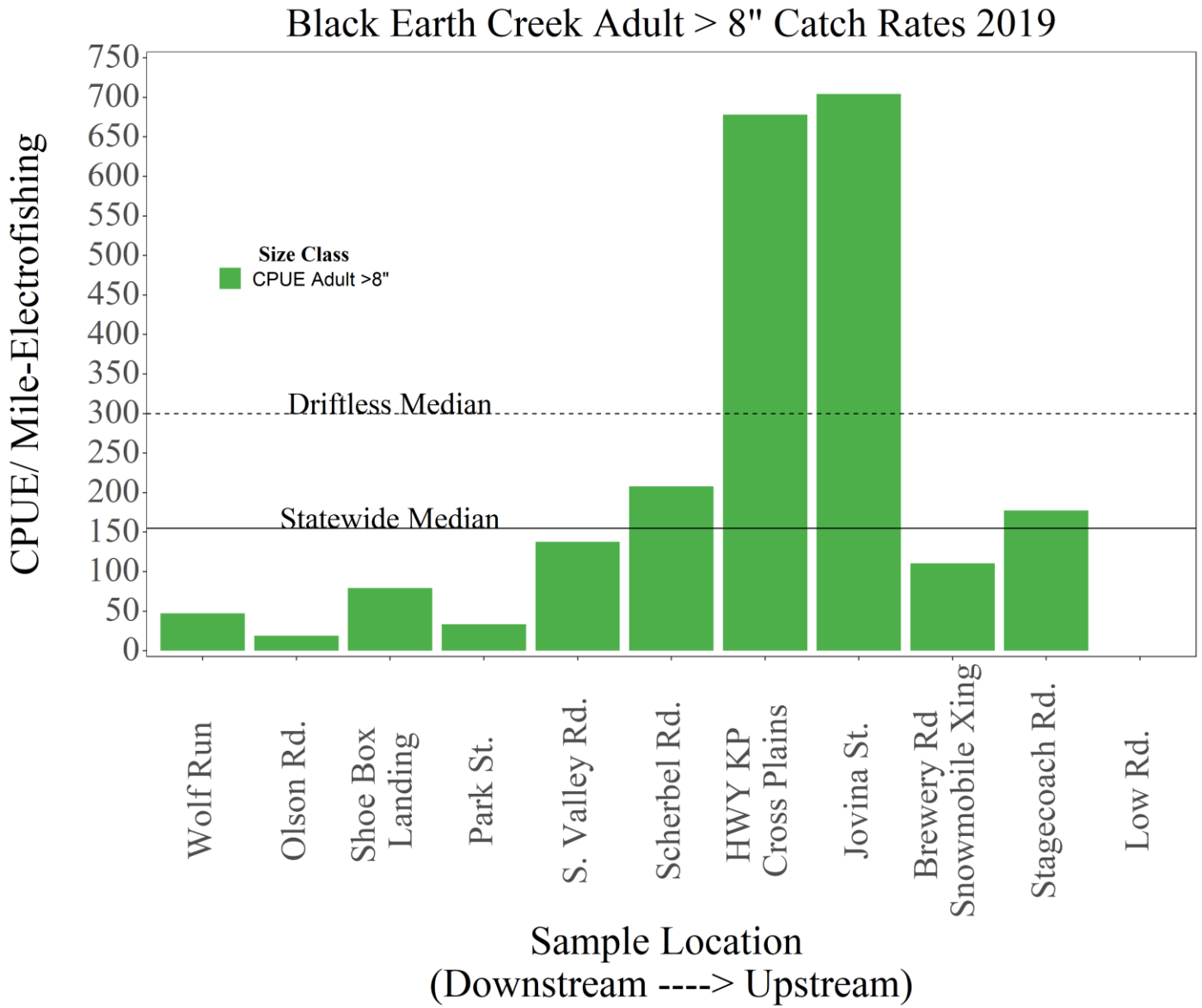

Figure 7. Adult brown trout catch rates observed in Black Earth Creek 2019.

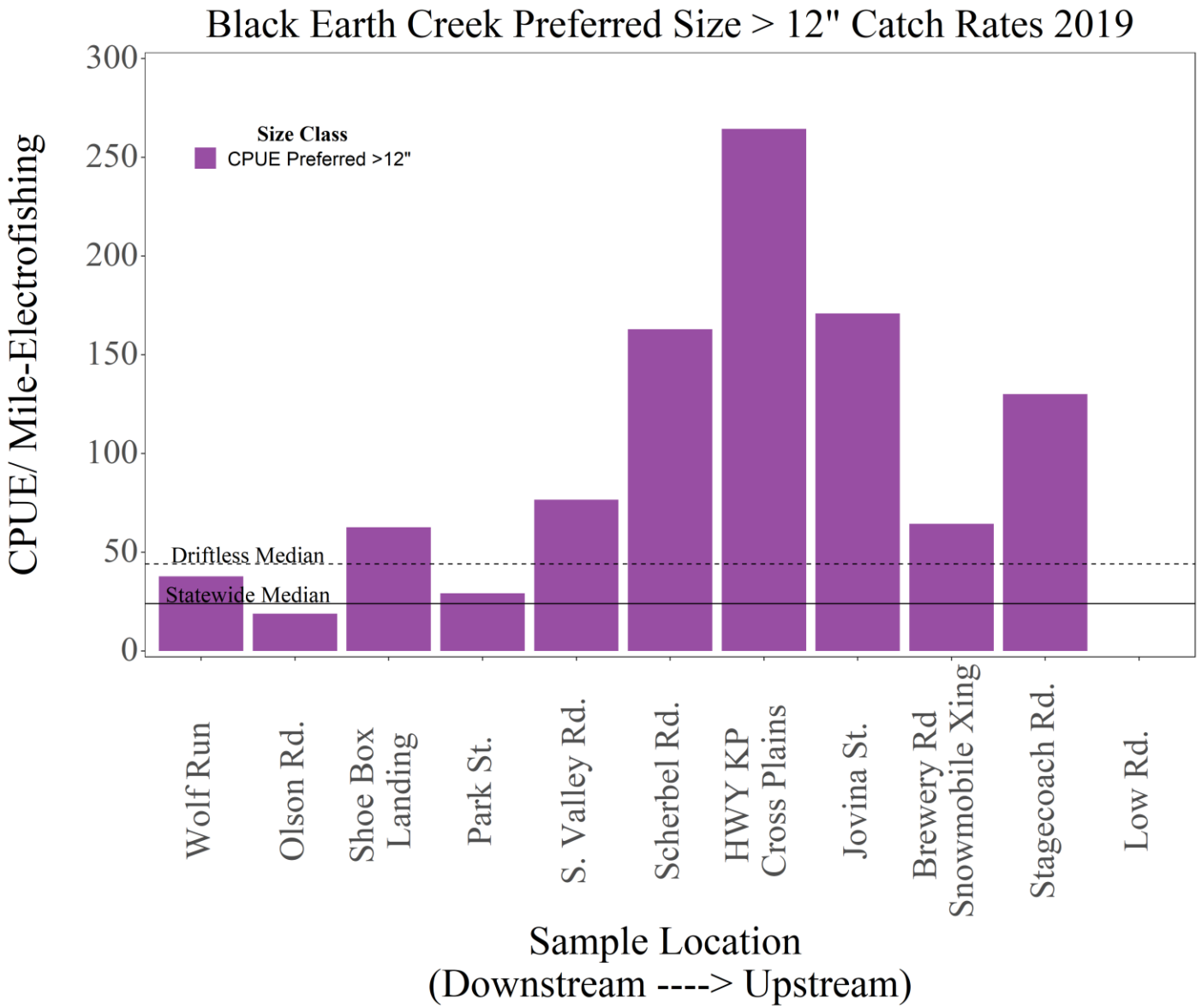

Figure 8. Preferred size brown trout catch rates observed in Black Earth Creek 2019.

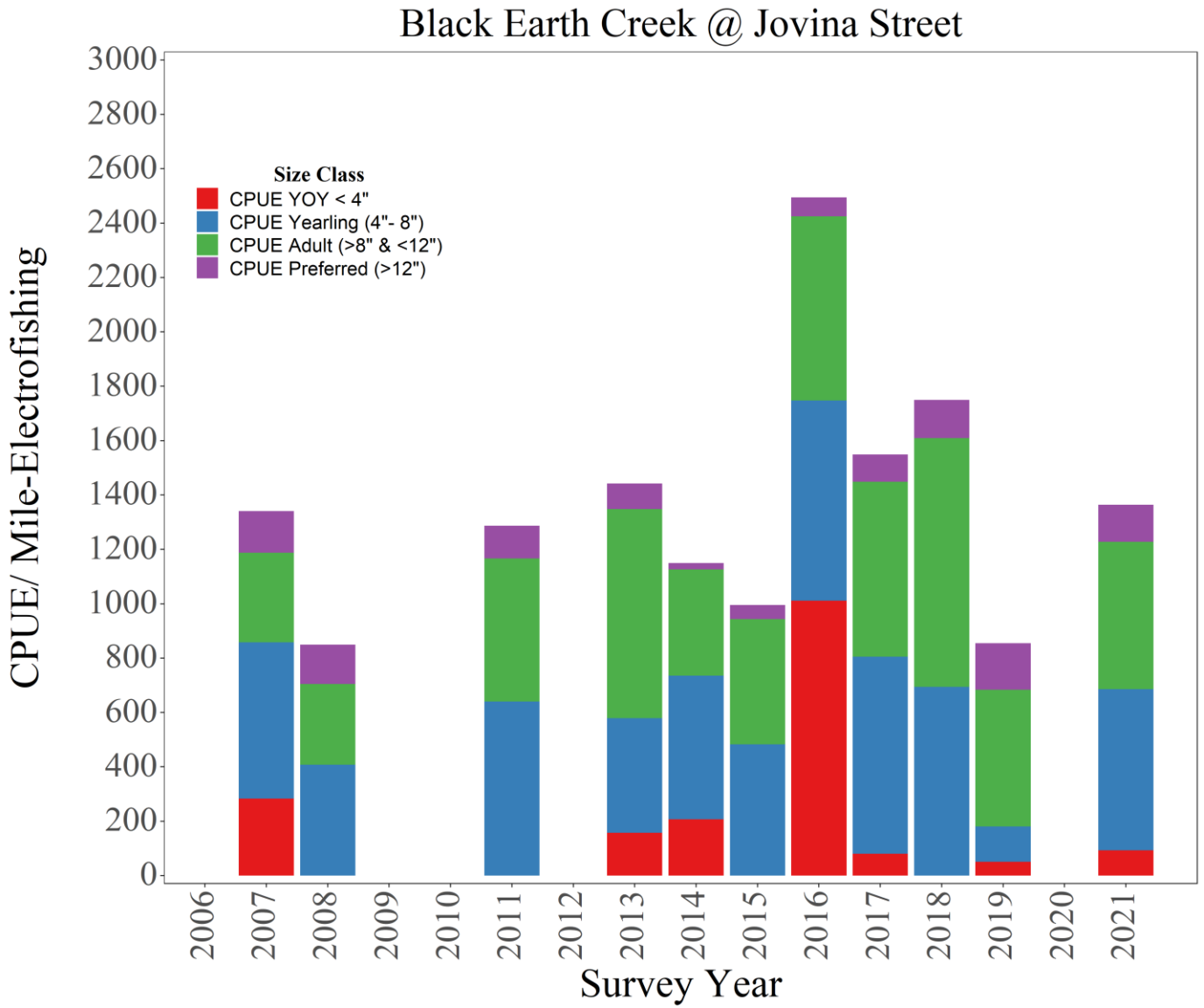

Figure 9. Size specific catch rates of brown trout observed in Black Earth Creek in Zander Park near Jovina Street 2007 - 2021(no surveys conducted in 2020 due to COVID).

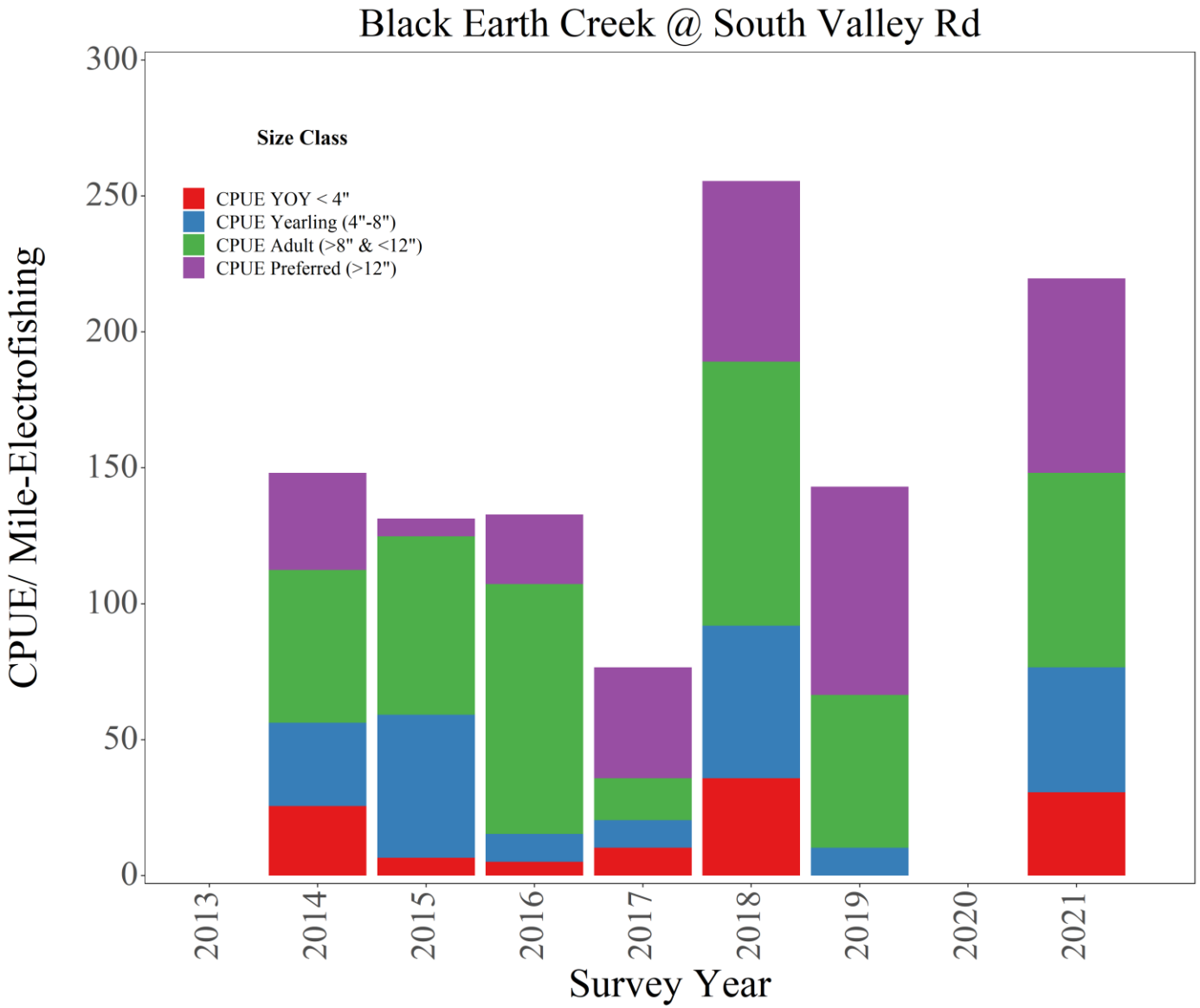

Figure 10. Size specific catch rates of brown trout observed in Black Earth Creek at South Valley Road crossing 2014 - 2021(no surveys conducted in 2020 due to COVID).

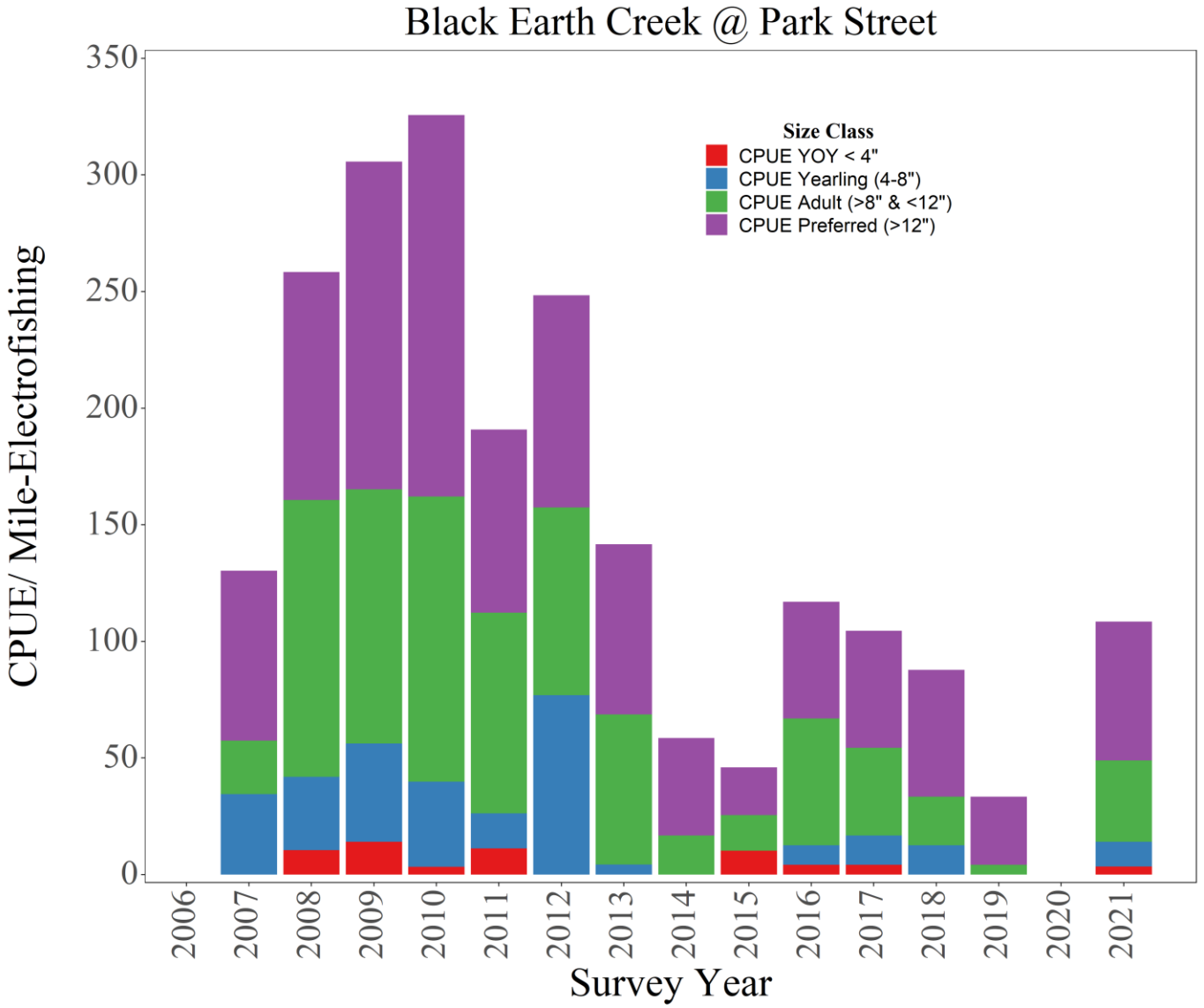

Figure 11. Size specific catch rates of brown trout observed in Black Earth Creek at Park Street Road crossing 2007 – 2021 (no surveys conducted in 2020 due to COVID).

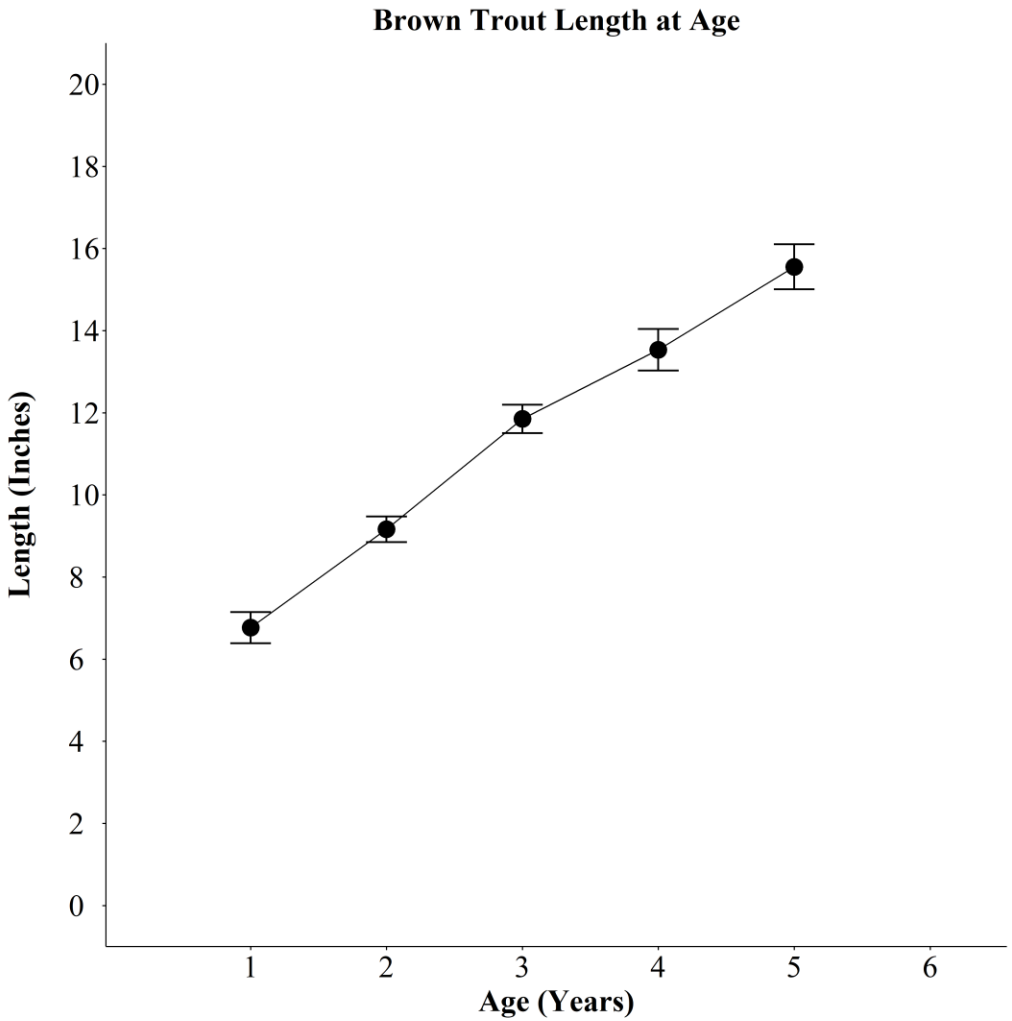

Figure 12. Mean length at age estimates for brown trout in Black Earth Creek 2019. Error bars represent 95% confidence intervals around the mean.

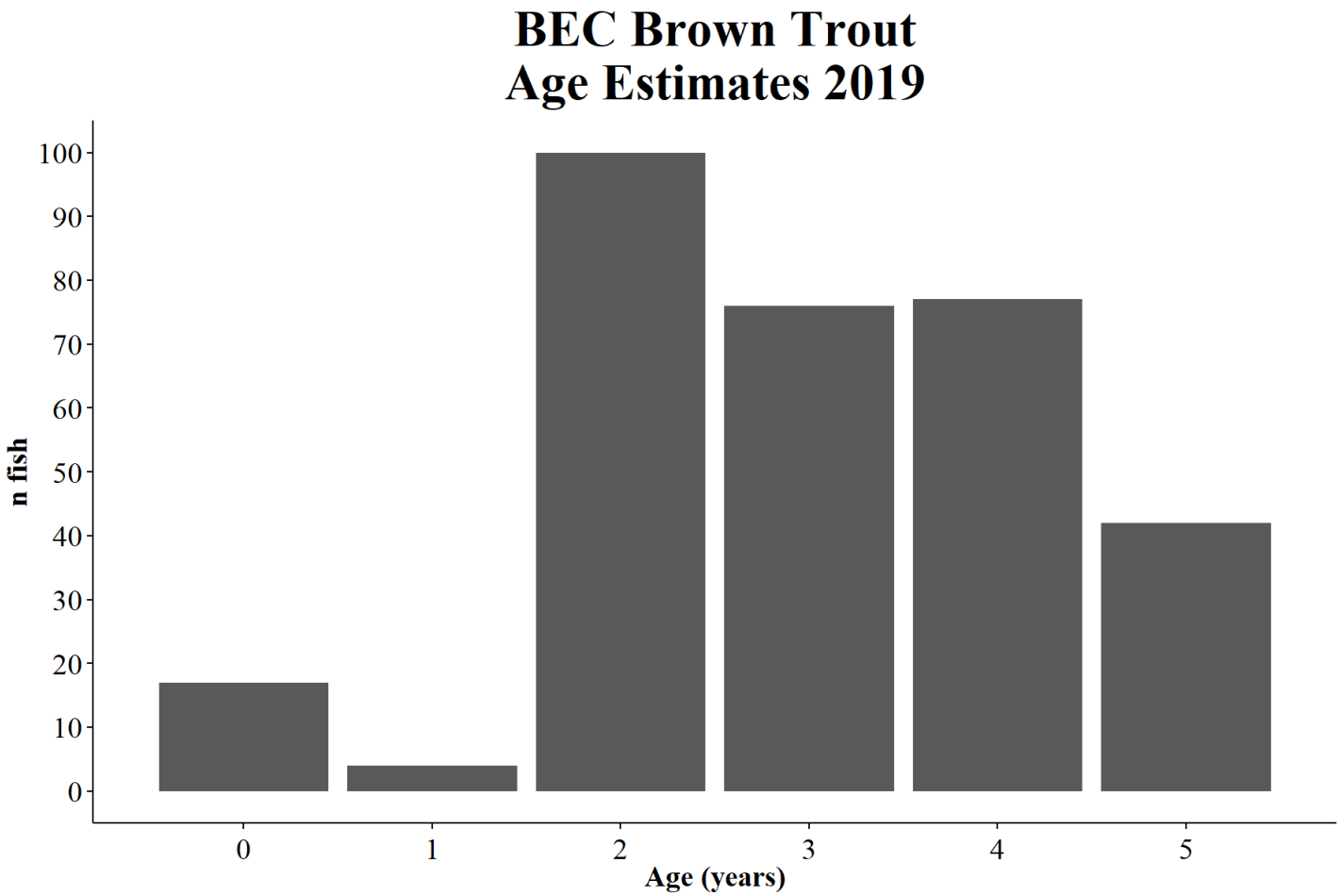

Figure 13. Black Earth Creek brown trout age estimates. Data derived from 6287usubsampled brown trout otoliths to develop a length-at-age key, then applied to larger sample of 321 fish collected during summer electrofishing surveys.

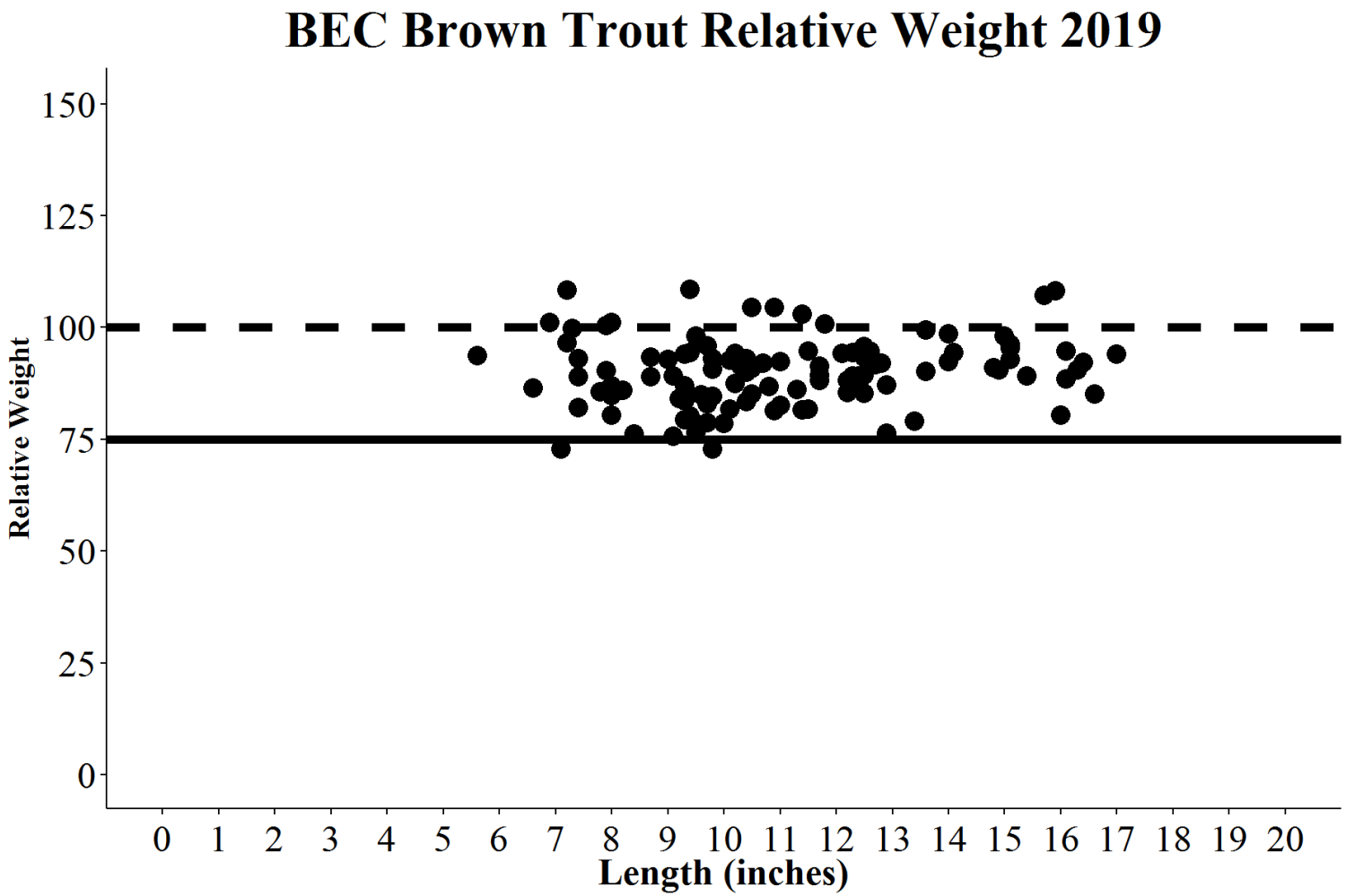

Figure 14. Relative weights of brown trout collected during the 2019 Black Earth Creek survey. A relative weight value greater than 100 (dashed line) indicates that a fish is in excellent condition while a relative weight value less than 75 (solid line) indicates that a fish is in poor condition.

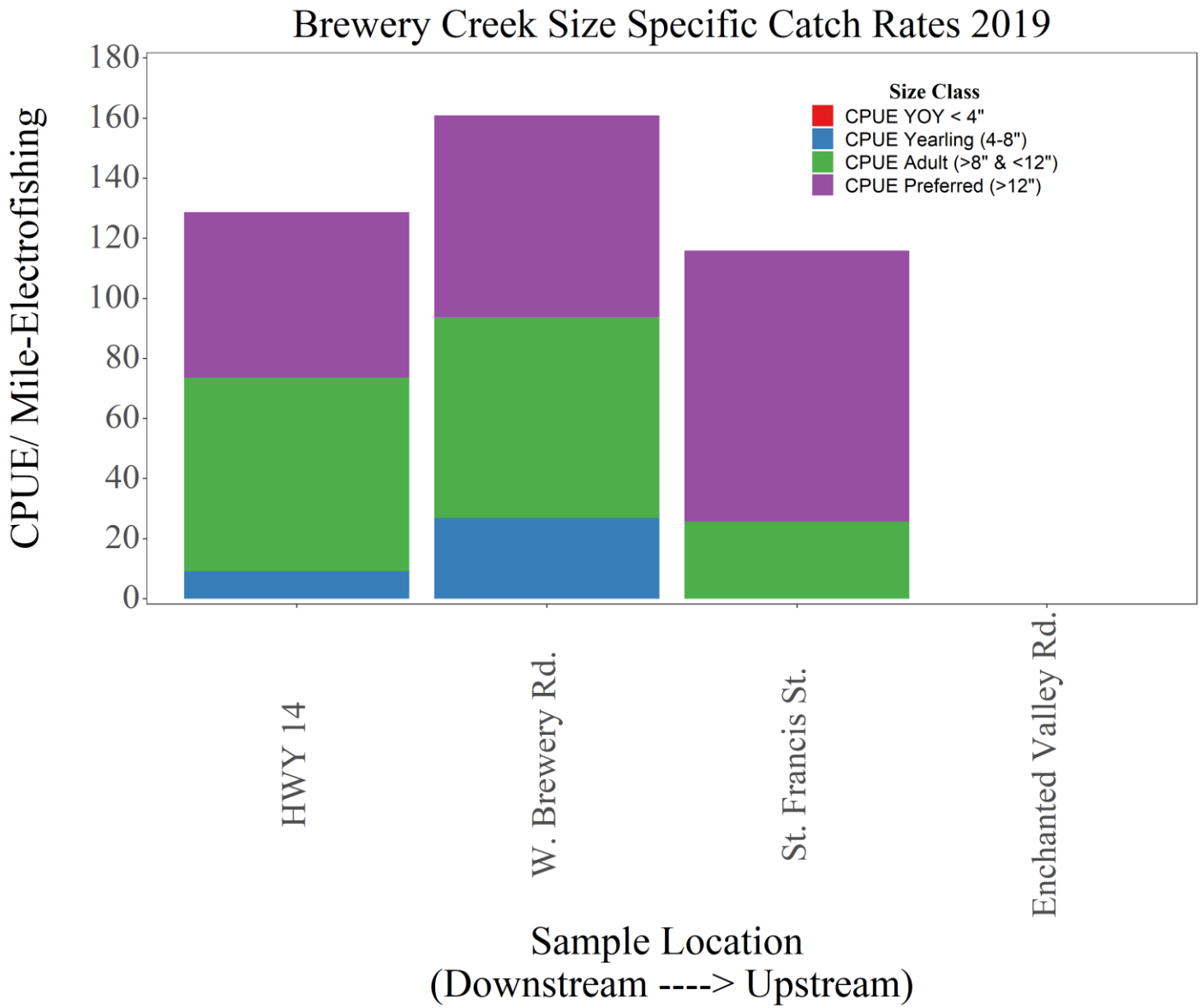

Figure 15. Size specific catch rates of brown trout observed in Brewery Creek 2019.

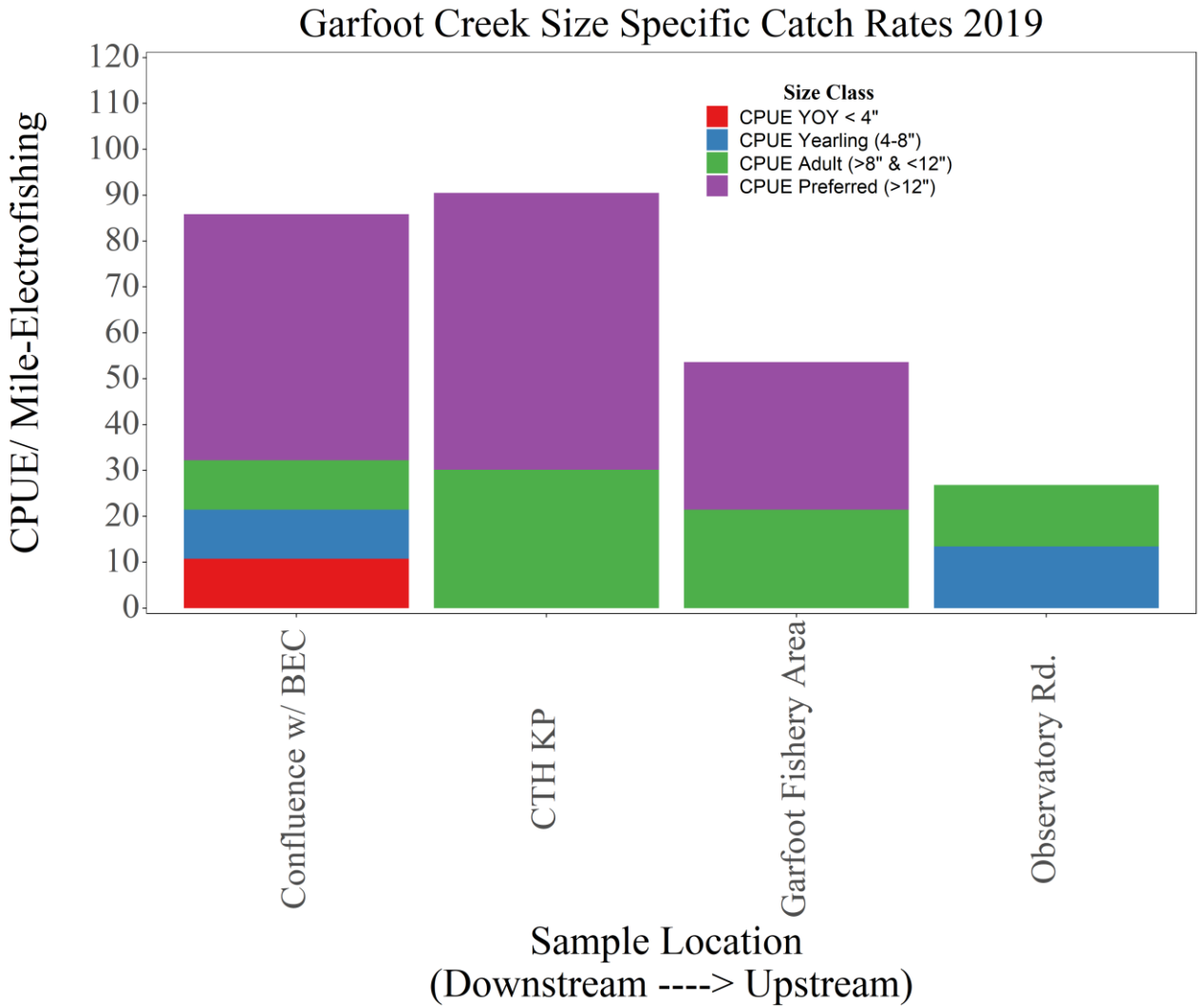

Figure 16. Size specific catch rates of brown trout observed in Garfoot Creek 2019.

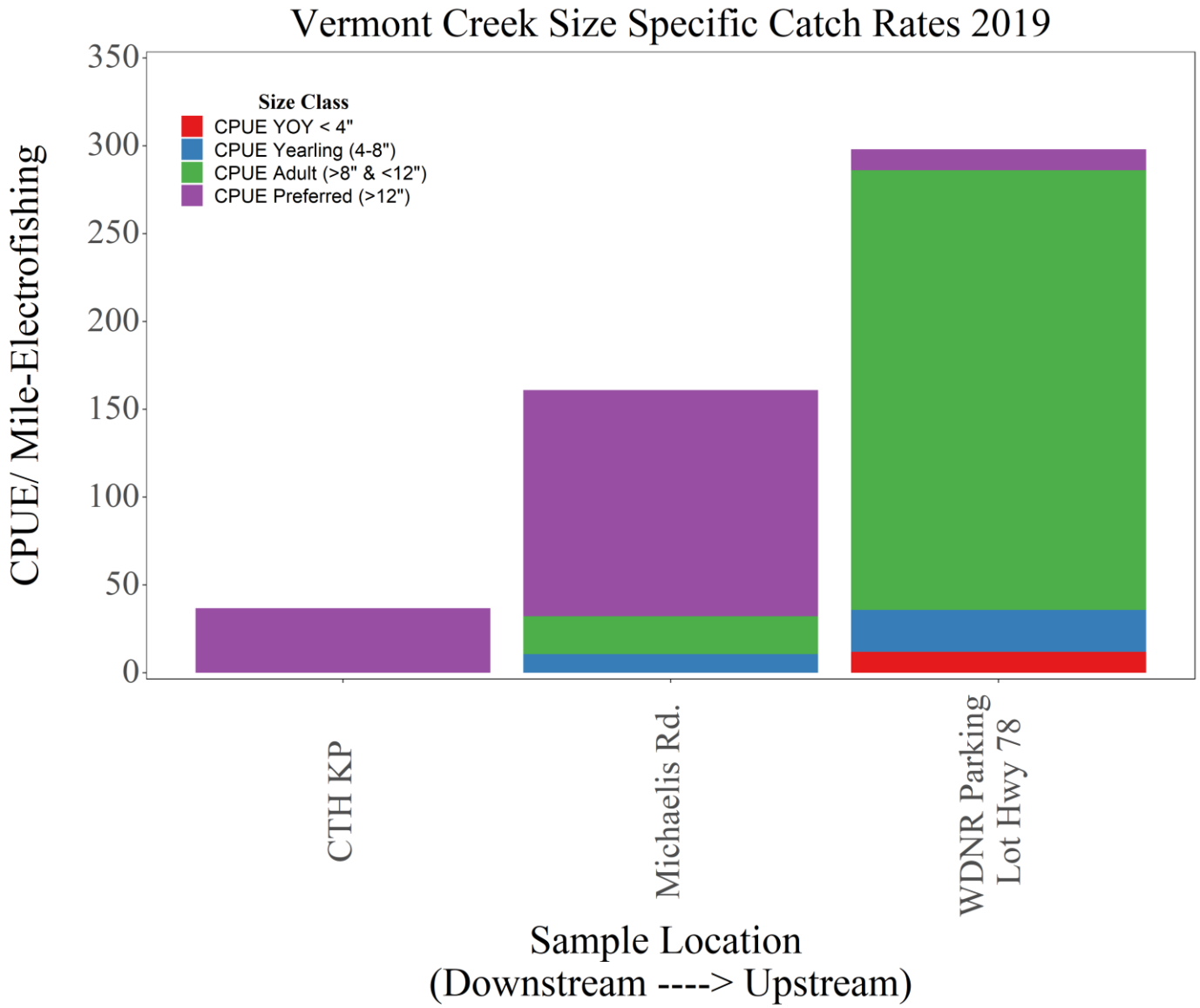

Figure 17. Size specific catch rates of brown trout observed in Vermont Creek 2019.

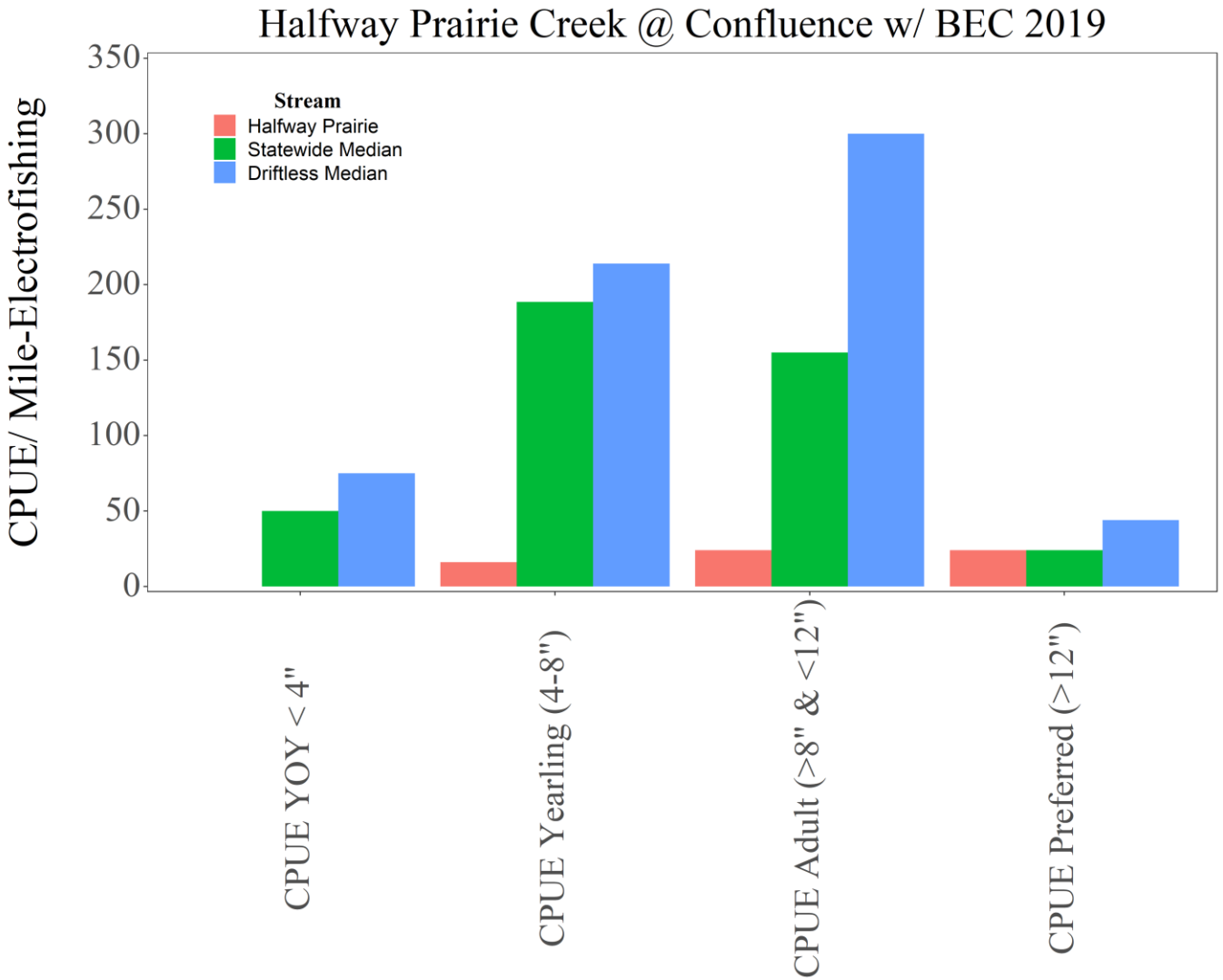

Figure 18. Size specific catch rates observed in Halfway Prairie Creek 2019 compared to statewide and Drifltess median benchmarks.

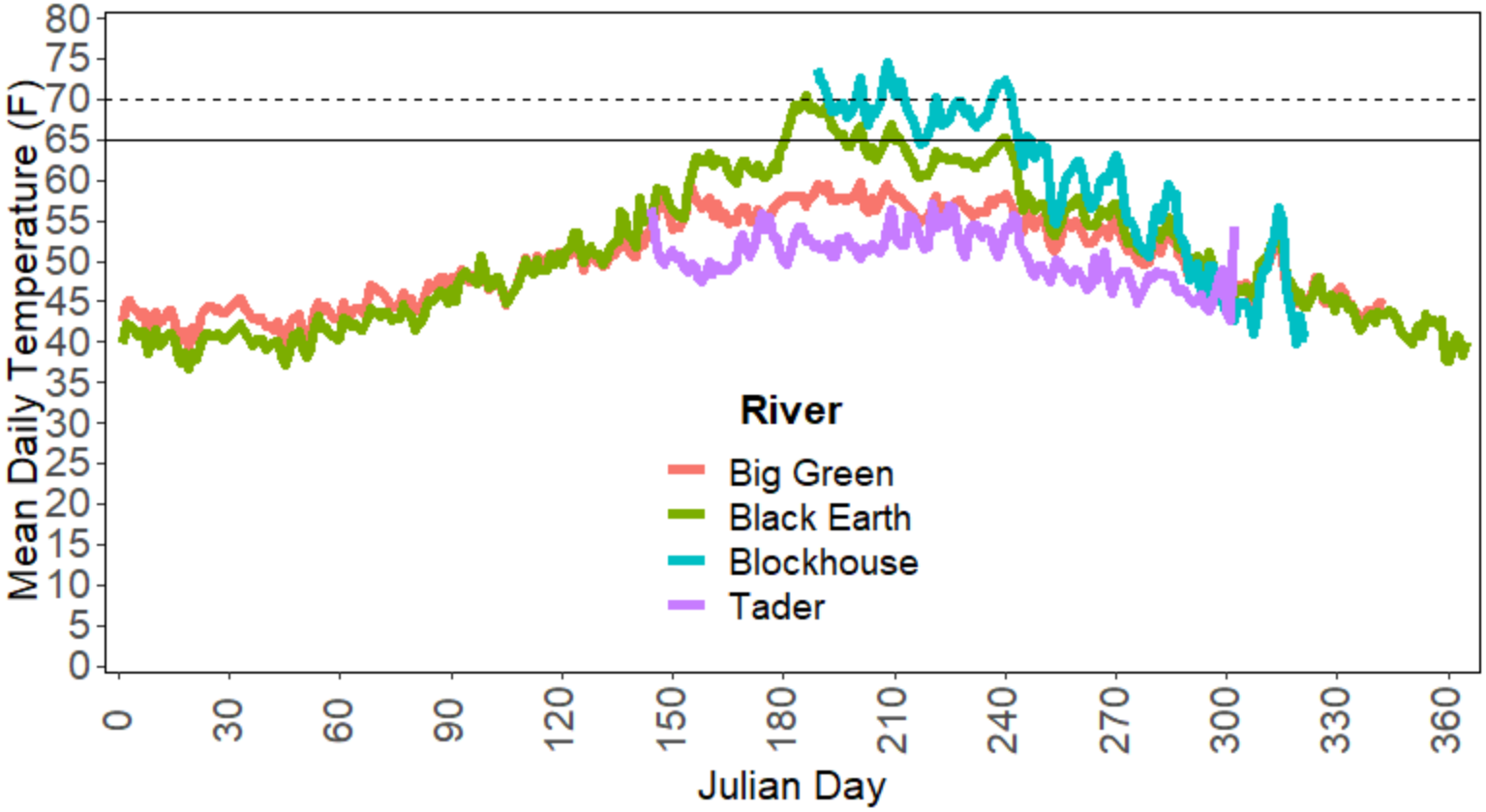

Figure 19. Mean daily temperature profiles for Class 1 trout streams Big Green River (brown trout), Black Earth Creek (brown trout), and Tader Creek (Brook Trout) compared to warm-water smallmouth fishery of Blockhouse River (smallmouth bass) in 2020.

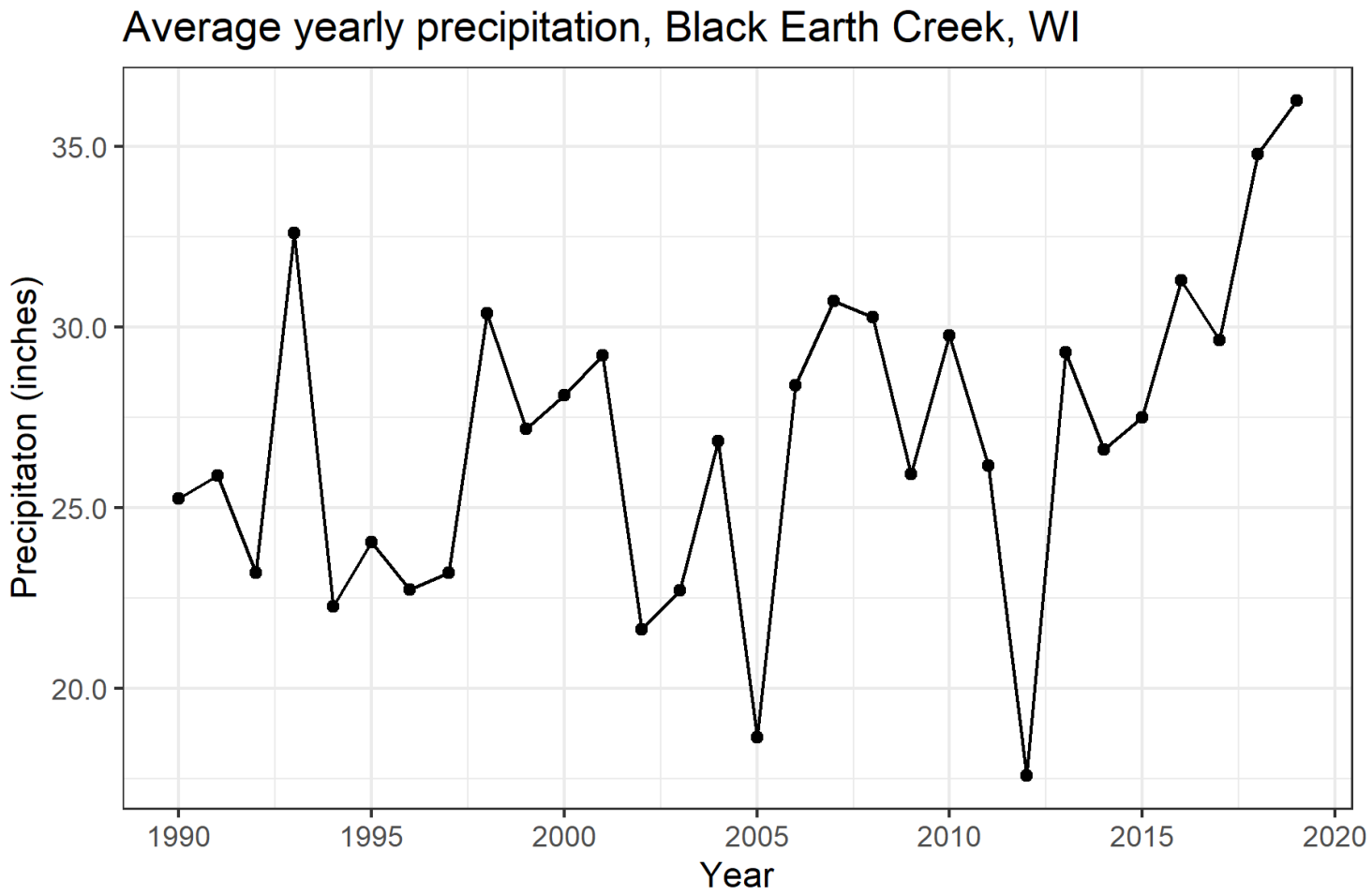

Figure 20. Total annual precipitation in Black Earth Creek watershed (HUC 12) 1990- 2019).

Appendices

Appendix Table 1. Species composition of all fish encountered in 2019 surveys.

Waterbody Name	Station Description	Species	N	Minimum Length	Average Length	Maximum Length
Black Earth	**HWY KP (near boardwalk)**	brown trout	68	2.70	11.06	17.80
		mottled sculpin	54			
		rainbow trout	1	9.10	9.10	9.10
		white sucker	96			
	South Valley Road	brown trout	28	6.90	12.45	18.40
		mottled sculpin	5			
		northern pike	1	27.00	27.00	27.00
		rainbow trout	1	11.40	11.40	11.40
		white sucker	78			
	Zander Park Jovina St.	brown trout	85	3.20	9.73	19.60
		mottled sculpin	80			
		rainbow trout	3	9.40	10.00	10.80
		white sucker	57			
	Olson Road	banded darter	3			
		brown trout	5	12.30	14.60	16.00
		Miss. silvery minnow	6			
		mottled sculpin	13			
		northern hog sucker	7			
		shorthead redhorse	1			
		silver redhorse	1			
		smallmouth bass	1	15.40	15.40	15.40
		white sucker	25			
	Shoe Box Landing	brown trout	26	3.30	11.33	18.50
		common shiner	5			
		creek chub	4			
		green sunfish	1			
		mississippi silvery minnow	5			
		mottled sculpin	46			
		northern hog sucker	8			
		northern pike	1	20.00	20.00	20.00
		shorthead redhorse	4			
		smallmouth bass	1	13.80	13.80	13.80
		white sucker	77			
	Hudson Road Mazomanie	banded darter	2			

	brown trout	3	17.00	17.73	19.20
	common carp	1			
	emerald shiner	1			
	fantail darter	4			
	fathead minnow	1			
	johnny darter	1			
	mississippi silvery minnow	4			
	mottled sculpin	1			
	northern hog sucker	11			
	spotfin shiner	1			
	white sucker	42			
Park Street	brown trout	8	11.50	14.81	16.30
	common carp	3			
	mottled sculpin	6			
	northern hog sucker	2			
	silver redhorse	1			
	white sucker	160			
Scherbel Road	brown trout	55	3.10	12.90	20.00
	mottled sculpin	26			
	white sucker	124			
Low Road	bluntnose minnow	5			
	brook stickleback	47			
	creek chub	32			
	fathead minnow	7			
	mottled sculpin	1			
	white sucker	40			
Brewery Road Trail Xing	brown trout	14	3.00	11.94	16.00
	mottled sculpin	7			
	white sucker	42			
Bridge St. Mazomanie	brown trout	2			
	channel catfish	1	22.20	22.20	22.20
	mottled sculpin	1			
	northern hog sucker	3			
	shorthead redhorse	1			
	white sucker	4			
Wolf Run Trail	brown trout	10	8.60	13.60	17.80
	common shiner	9			
	northern hog sucker	7			

		shorthead redhorse	6			
		smallmouth bass	3	9.10	12.53	14.30
		white sucker	25			
	Stagecoach Road	brown trout	16	7.40	12.57	16.50
		creek chub	17			
		green sunfish	16			
		mottled sculpin	44			
		white sucker	7			
Brewery Creek	**Enchanted Valley Road**	brook stickleback	2			
		fathead minnow	1			
	Brewery Creek Road	brown trout	12	6.90	11.96	15.00
		green sunfish	1			
		mottled sculpin	89			
	Upstream HWY 14	brown trout	14	6.90	11.33	17.00
		mottled sculpin	47			
		white sucker	2			
	St Francis Street	brown trout	10			
		mottled sculpin	43			
Garfoot Creek	**Observatory Road**	brook trout	8	2.80	6.78	10.80
		brown trout	2	7.50	7.85	8.20
		mottled sculpin	15			
	CTH KP	brook trout	1	7.80	7.80	7.80
		brown trout	9	8.00	13.66	16.50
		mottled sculpin	107			
		rainbow trout	2	11.70	12.55	13.40
		white sucker	3			
	WDNR Fishery Area	bluntnose minnow	3			
		brook trout	3	7.60	9.63	12.50
		brown trout	5	10.90	11.76	12.70
		mottled sculpin	13			
		white sucker	1			
		yellow bullhead	1			
	Confluence with BEC	brown trout	8	3.40	11.24	16.40
		mottled sculpin	19			
Vermont Creek	**WDNR Fishery Area**	brown trout	25	3.00	9.37	12.40
		mottled sculpin	17			
	CTH KP	brown bullhead	1			
		brown trout	4	13.40	14.80	17.30
		creek chub	3			
		green sunfish	1			
		mottled sculpin	45			
		white sucker	110			

	Michaelis Road	brown trout	15	7.00	14.57	21.40
		creek chub	3			
		mottled sculpin	32			
		white sucker	76			
Halfway Prairie	**RR xing Upstream of Confluence**	brown trout	8	7.60	10.86	15.80
		common carp	1			
		creek chub	3			
		johnny darter	1			
		mississippi silvery minnow	1			
		mottled sculpin	5			
		northern hog sucker	11			
		shorthead redhorse	4			
		white sucker	10			

Wadable Stream Qualitative Fish Habitat Rating for Streams < 10 m wide

Form 3600-532A (R 6/07) Page 2 of 2

Rating Item	Excellent	Good	Fair	Poor	Score
Riparian Buffer Width (m) Width of contiguous undisturbed land uses; meadow, shrubs, woodland, wetland, exposed rock	Riparian zone well protected; buffer wide (> 10.0 m) 15	Riparian zone protected, but buffer width moderate (5.0 - 10.0 m) 10	Riparian zone moderately disturbed, buffer narrow (1.0 - 4.9 m) 5	Most of the riparian zone disturbed, buffer very narrow or absent (< 1.0 m) 0	
Bank Erosion Width of bare soil on bank, along transects	No significant bank erosion; < 0.20 m of bank is bare soil 15	Limited erosion; 0.20 - 0.50 m of bank is bare soil 10	Moderate erosion; 0.51 - 1.0 m of bank is bare soil 5	Extensive erosion; > 1.0 m of bank is bare soil 0	
Pool Area % of stream length in pools	Pools common; wide, deep, slow velocity habitat, balanced by other habitats; 40 to 60% of station 10	Pools present; not frequent or over-abundant; 30 to 39% or 61 to 70% of station 7	Pools present, but either rare or overly dominant, few other habitats present; 10 to 29% or 71 to 90% of station 3	Pools either absent or dominant, not balanced by other habitats; < 10% or > 90% of station 0	
Width:Depth Ratio Average stream width divided by average thalweg depth in runs and pools	Streams very deep and narrow; width/depth ≤ 7 15	Stream relatively deep and narrow; width/depth 8-15 10	Stream moderately deep and narrow; width/depth 16-25 5	Stream relatively wide and shallow; width/depth > 25 0	
Riffle:Riffle or Bend:Bend Ratio Average distance between riffles or bends divided by average stream width	Diverse habitats; meandering stream with deep bends and riffles common; ratio < 10 15	Diverse habitats; bends and riffles present, but not abundant; ratio 10 to 14 10	Habitat diversity low; occasional riffles or bends, ratio 15 to 25 5	Habitat monotonous; riffles or bends rare; generally continuous run habitat; ratio > 25 0	
Fine Sediments % of the substrate that is < 2 mm (sand, silt, or clay)	Fines rare or absent, < 10% of the stream bed 15	Fines present but limited, generally in stream margins or pools; 10 to 20% of stream bed 10	Fines common in mid-channel areas, present in riffles and extensive in pools; 21 to 60% 5	Fines extensive in all habitats; > 60% of stream bed covered 0	
Cover for Fish % of the stream area with cover	Cover/shelter for fish abundant; > 15% of stream 15	Cover common, but not extensive; 10 - 15% of stream 10	Occasional cover, limited to one or two areas; 5 - 9% of stream 5	Cover rare or absent; limited to < 5% of stream 0	
				Total Score	

Appendix Figure 1. Qualitative habitat rating sheet for streams less than 10 meters wide.

Wadable Stream Qualitative Fish Habitat Rating for Streams > 10 m wide

Form 3600-532B (R 6/07) Page 2 of 2

Rating Item	Excellent	Good	Fair	Poor	Score
Bank Stability % of bank protected by rock or vegetation	No significant bank erosion; ≥ 90% of bank protected; < 10% bare soil	Limited erosion; 70 to 90% of bank protected; 10 - 30% bare soil	Moderate erosion; 50 to 69% of bank protected; 31 - 50% bare soil	Extensive erosion; < 50% of bank protected; > 50% bare soil	
	12	8	4	0	
Maximum Thalweg Depth Average of the four deepest depths recorded	Stream very deep; ≥ 1.5 m	Stream relatively deep; 1 - 1.5 m	Stream moderately deep; 0.6 - 0.9 m	Stream relatively shallow; < 0.6 m	
	25	16	8	0	
Riffle:Riffle or Bend:Bend Ratio Average distance between riffles or bends divided by average stream width	Diverse habitats; meandering stream with deep bends and riffles common; ratio < 10	Diverse habitats; bends and riffles present, but not abundant; ratio 10 to 14	Habitat diversity low; occasional riffles or bends, ratio 15 to 25	Habitat monotonous; riffles or bends rare; generally continuous run habitat; ratio > 25	
	12	8	4	0	
Rocky Substrate % of substrate, by area, that is bedrock, boulder, rubble/ cobble, or gravel	Extensive rocky substrate; ≥ 65% of the stream bed	Moderate rocky substrate; 45 - 65% of stream bed	Limited rocky substrate; 15 - 44% of stream bed	Rocky substrate uncommon; < 15% of stream bed	
	25	16	8	0	
Cover for Fish % of the stream area with cover	Cover/shelter for fish abundant; ≥ 12% of stream	Cover common, but not extensive; 7 - 12% of stream	Occasional cover, limited to one or two areas; 2 - 6% of stream	Cover rare or absent; limited to < 2% of stream	
	25	16	8	0	
				Total Score	

Appendix Figure 2. Qualitative habitat rating sheet for streams greater than 10 meters wide.