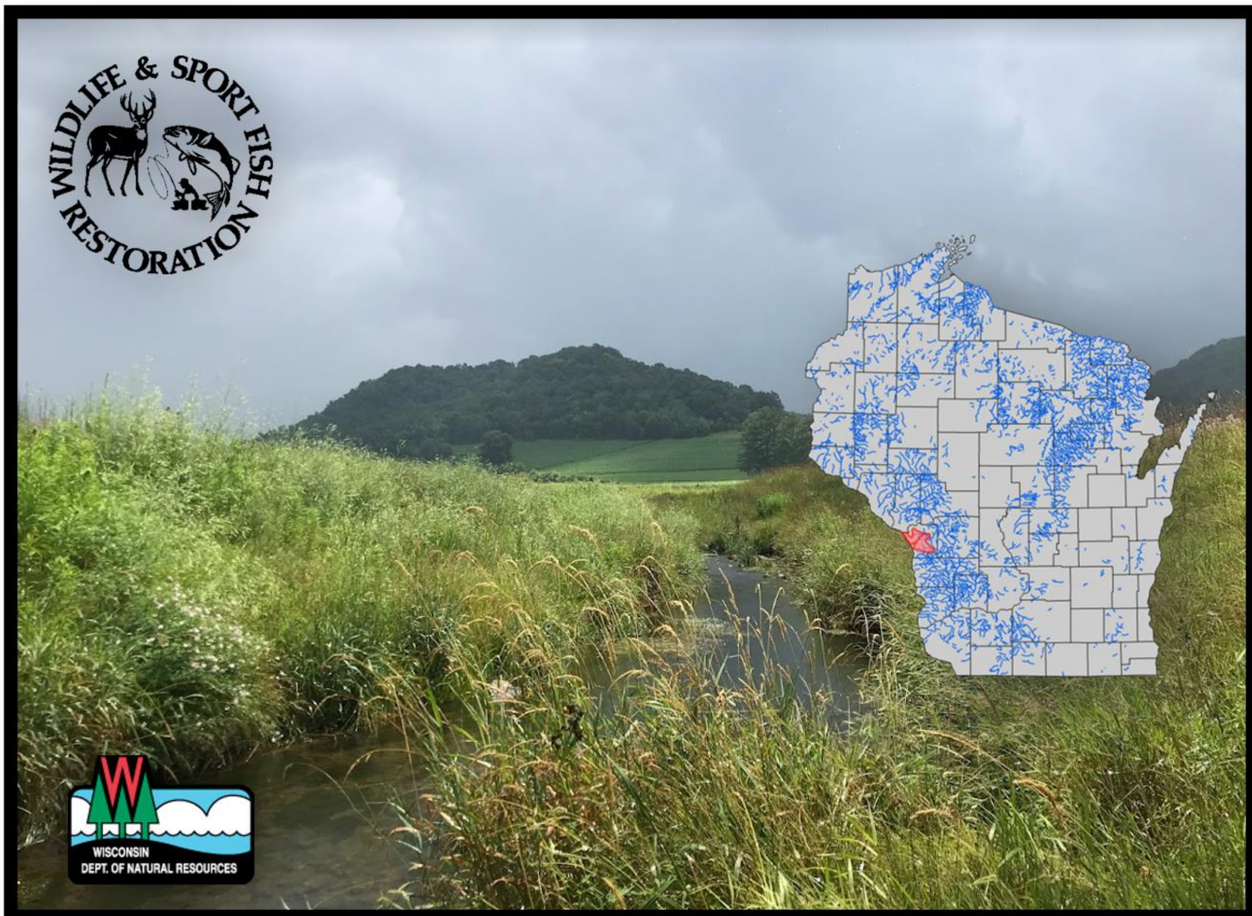
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Trout Population Trends and Fisheries Management in the Lower La Crosse River and Halfway Creek Watersheds



Bostwick Coulee Creek; Photo Credit: WDNR/Kirk Olson

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Executive Summary

The Lower La Crosse River and Halfway Creek watersheds drain 145.2 square miles of forested, agricultural and developed lands in La Crosse County. The area includes 12 trout streams totaling 62.3 miles of classified trout water, all of which are supported by natural reproduction. In 2023, the Wisconsin Department of Natural Resources (DNR) Bureau of Fisheries Management sampled fish populations at 39 sites on 20 streams and deployed nine temperature loggers on six streams to evaluate the current status of trout fisheries. Naturally reproduced brown trout *Salmo trutta* were captured in 28 sites with a mean relative density that was in the top 25th percentile of trout streams statewide. Brown trout were most abundant in Bostwick Coulee Creek and Halfway Creek, and their tributaries. Larger brown trout were found in larger stream sites, often where warm water forage fish were more abundant. Young of the year brown trout were most abundant in headwater tributaries of Halfway and Bostwick Coulee Creeks. Brook trout *Salvelinus fontinalis* were captured in 22 sites, with a mean relative density in the top 25th percentile of trout streams statewide. Brook trout were most abundant in streams where brown trout were absent or present in low numbers. This included streams in the Neshonoc Creek Sub-watershed, which was identified as a Brook Trout Reserve in 2017. Evaluation of long-term trends in trout abundance indicates that brown and brook trout populations have increased over the past 60 years, reflecting improvements in agricultural land use and fisheries management actions that have occurred over the past century. Based on 2023 July mean stream temperatures and composition of fish communities in electrofishing surveys, thermal conditions on all classified and several unclassified trout streams were well within the range suitable for trout. Mottled sculpin *Cottus bairdii*, an important component of cold-water stream fish communities elsewhere, were absent from our surveys, despite their presence in adjacent watersheds, suggesting the species has been extirpated. Since 1994, trout habitat projects have been completed on 7.1 miles of stream in the watersheds. Initial results from recent

trout habitat projects on Larson Coulee and Bostwick Coulee Creek indicate that trout relative density and/or or size increased after the projects were completed. However, in Larson Coulee Creek, we documented a modest increase in brown trout density and a small increase in stream temperature in the first year after the project was completed. This is concerning as brown trout have been shown to displace brook trout. Trout stocking has not occurred in the watersheds since 2014. Despite the lack of stocking, brook and brown trout populations have expanded, indicating that stocking is no longer necessary and potentially detrimental to the naturally reproducing populations in these two watersheds. Trout fishing in the watersheds has largely been regulated with statewide seasons and county-wide length and bag limits. Though no creel surveys have been completed in recent decades, the abundance of catchable (i.e. age 1 and older) and preferred size and larger trout (brown trout ≥ 12”, brook trout ≥ 8”) in the watersheds suggest that if there are negative population level impacts from harvest, they are not widespread. Though both brook and brown trout populations have expanded in these watersheds in recent decades, several challenges still face the fisheries. Current challenges include increased flooding and air temperatures due to climate change, changes in land use and displacement of brook trout by brown trout.

MANAGEMENT RECOMMENDATIONS

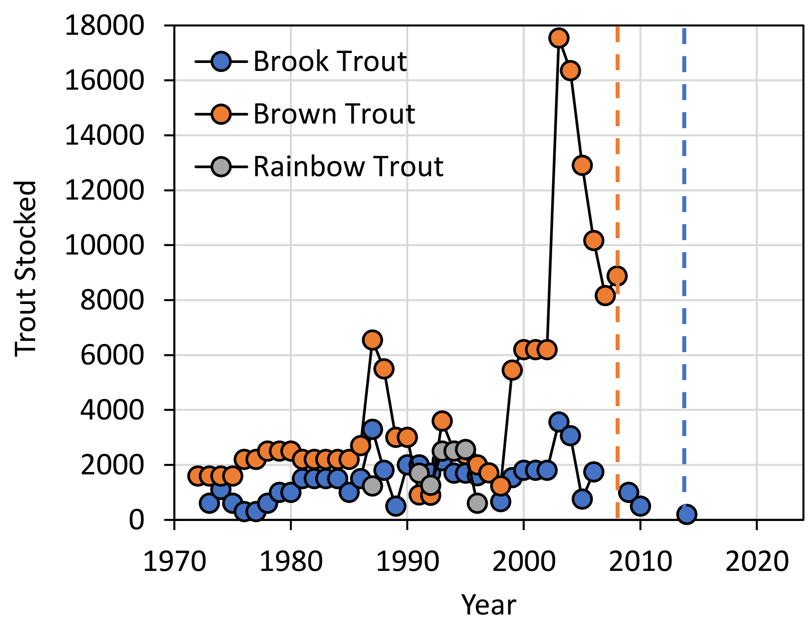
- Focus future stream restoration efforts in Halfway Creek and lower Bostwick Coulee Creek.
- Avoid complete riparian tree removal during habitat restoration projects and consider planting trees in areas lacking shade to increase thermal resilience of streams.
- Continue to collaborate with partners to promote land use practices that will protect or improve stream hydrology.
- Continue to assist in evaluation of waterway permits and fish kills.
- Pursue DNR streambank easements on Larson Coulee, McKinley Valley and Neshonoc Creeks.
- Consider additional habitat restoration on Larson Coulee Creek downstream of Asmus road, depending on results of ongoing habitat restoration evaluation.
- Do not stock trout unless fisheries surveys indicate that it is necessary.
- Maintain current trout angling regulations.
- Re-introduce mottled sculpin into Larson Coulee, McKinley Valley and Neshonoc Creeks.
- Complete opening weekend creel survey to evaluate amount and distribution of angler pressure.
- Re-evaluate these recommendations in 2031, when the next watershed survey is completed.

Introduction

The Lower La Crosse River and Halfway Creek watersheds drain 145.2 square miles of western La Crosse County and includes 62.3 miles of classified trout water on 12 streams. The two watersheds are located entirely within the Driftless Area, an area that was not glaciated during the multiple glacial expansions that have occurred in Wisconsin over the past 2.5 million years. The topography of the region reflects this history, with deep, well-developed stream and valley networks eroded through dolomite and sandstone bedrock (Fig. 1A, Appendix). The Driftless Area's often permeable bedrock allow high rates of groundwater recharge when overlying soils are not compacted by poor agricultural practices (Trimble 2013). Rainwater that reaches aquifers eventually emerges in valley bottoms, resulting in streams with stable discharge and thermal conditions, which are well suited to cold-water stenotherm species like trout (Potter 2019).

Early DNR fisheries investigations in the La Crosse River and Halfway Creek watersheds began in the 1950s. These early surveys revealed heavily eroded banks, limited in-stream habitat diversity, and poor thermal conditions. Overgrazing and poor cropping practices in the decades preceding these surveys resulted in decreased groundwater infiltration, increased flooding, and substantial increases in upland erosion and valley deposition (Trimble 2013). For example, up to 6 feet of fine sediment has been deposited on stream floodplains in the Halfway Creek Watershed since European settlement (Fitzpatrick et al. 2008). These changes led to the loss of naturally sustained trout populations in most Driftless Area streams by the early 1900s (Thorn et al. 1997) and were reflected in the poor conditions documented in these early surveys.

Figure 1 Number of brook, brown and rainbow trout stocked in Lower La Crosse and Halfway Creek Watersheds between 1972 and 2023. Feral (i.e., "Wild") Brook and Brown trout stocking began in 1999 in the watershed. All stocking was ceased after 2014.



Point source pollutants have also impacted trout habitat in the Halfway Creek and Lower La Crosse watersheds over the last century. For example, Bostwick Coulee Creek was the recipient of untreated discharge from a creamery that resulted in excessive algal growth and periodic hypoxia until the implementation of the Clean Water Act in the 1970s (DNR unpublished files), presumably limiting trout populations there. More recently, liquid manure spills into Bostwick Coulee Creek in 2000 and 2019 have resulted in fish kills impacting several miles of the stream's most productive waters and killing over 1,000 fish in each event. In 1988, direct runoff from a limestone quarry deposited several thousand cubic yards of clay into Halfway Creek, worsening the existing problem of excessive fine sediment in the stream and its floodplain. Both Halfway Creek and Bostwick Coulee Creek are currently listed as impaired on the Clean Water Act 303(d) list due to excessive sediment and phosphorus, respectively.

Despite the legacy of human impacts on streams in these two watersheds, conditions for trout have greatly improved over the past half-century. The implementation of upland conservation practices and changes in agricultural land use over this time period resulted in reduced flooding, increased base flows and improved riparian and in-stream habitat (Juckem et al. 2008, Trimble 2013). Trout stream habitat restoration and a transition to feral trout stocking (i.e., stocking of trout one or two generations removed from wild parents) by Wisconsin DNR and partners in recent decades further accelerated the recovery of trout populations in the region. Fisheries surveys conducted in recent decades reflect these changes as brook trout and brown trout populations have expanded (this report).

Table 1 Streams stocked in the Lower La Crosse and Halfway Creek Watersheds since 1972.

	YEAR RANGE		TOTAL STOCKED (# OF STOCKING EVENTS)		
STREAM	**Min.**	**Max.**	**Brook trout**	**Brown trout**	**Rainbow Trout**
Bostwick Creek	*1972*	*2008*	*500 (1)*	*93279 (44)*	*7507 (6)*
Gills Coulee Creek	*1987*	*2009*	*3172 (8)*	*900 (1)*	
Halfway Creek	*1972*	*2008*	*1080 (1)*	*60889 (36)*	*2955 (2)*
Larson Coulee Creek	*1973*	*2004*	*17860 (30)*	*900 (1)*	
Neshonoc Creek	*1973*	*2014*	*18805 (32)*	*1200 (1)*	*1000 (1)*
Pleasant Valley Creek	*1995*	*2010*	*1000 (2)*		*890*
Trib to Bostwick Wolter Rd.	*2003*	*2003*		*6140 (1)*	
Trib to Bostwick CTH M	*1981*	*1990*	*4040 (8)*		
Smith Valley Creek	*1987*	*1995*	*2721 (7)*		
McKinley Valley Creek	*1992*	*1996*	*1695 (5)*		

Previous trout habitat improvement by DNR and partners has involved direct manipulation of in-stream habitat features and riparian areas, largely following the methods described by White (1967) and Hunt (1993). Ten trout habitat projects have been completed in the Lower La Crosse and Halfway Creek watersheds since 1994.

Projects have been completed by a combination of government and non-government entities including: DNR, La Crosse County Conservation Department, Trout Unlimited, USDA – Natural Resource Conservation Service, and private landowners (Fig. 2A, Appendix). In total, trout habitat improvement work has been completed on six streams, encompassing 7.1 stream miles, or 11% of the classified trout water in the two watersheds. Trout habitat improvement projects have been completed on Gills Coulee Creek (2.9 miles), Bostwick Coulee Creek (2.4 miles), Larson Coulee Creek (0.93 miles) and Halfway Creek (0.4 miles).

Similar to the rest of the Driftless Area, the Lower La Crosse and Halfway Creek watersheds have a long history of widespread trout stocking. Though complete stocking records are only available after 1972, stocking likely occurred as early as the 1880s (Thorn et al. 1997). From 1972 to 1998, domestic brook and brown trout made up nearly all of the trout stocked in area streams, with a mean stocking rate of 2,417 and 1,325 fish per year, respectively (Table 1, Fig. 1). Rainbow trout *Onchorynchus mykiss* was also stocked, first in 1987, and then annually from 1991 to 1996 at a mean stocking rate of 1,764 fish peryear. In 1999, all trout stocking transitioned from domestic to feral brook and brown trout. In 2008, the DNR ceased brown trout stocking and transitioned to stocking only feral brook trout. All trout stocking ceased in 2014.

Since 1935, trout fishing in the two watersheds has been regulated through region-wide harvest rules and seasons (Table 2). From 1990 to 2016, all trout streams, except Bostwick Coulee, were managed with a five fish bag and 7-inch minimum length limit (MLL) and a harvest season extending from the first Saturday in May to the end of September. During that time, Bostwick Coulee was managed with a three fish bag and 9-inch MLL and the same harvest season. Early catch and release seasons were added in 2000, which began in mid-March and ended prior to the harvest season. In 2016, as part of a statewide trout regulations overhaul, all streams in La Crosse County were changed to a five fish bag limit with no minimum length limit. The start of the early catch and release season was also extended from the first Saturday in March to the first Saturday in January, and the end of the harvest season from Sept. 30th to Oct. 15th. A special regulation, requiring catch and release of brook trout on Garbers Coulee Creek was also enacted. The more liberal seasons and bag limits enacted at this time were supported by the evidence of limited angler harvest in area trout streams (DNR unpublished data) and the expansion of high-density brown trout populations in many of the region's cold-water streams (e.g., this report).

In recent decades, more attention has been given to conservation of native brook trout in these watersheds. In 2017, a DNR analysis revealed that the Neshonoc Creek Sub-Watershed (i.e., Larson Coulee, Gills Coulee, McKinley Valley and Neshonoc Creeks) were likely to support brook trout despite projected increases in air temperature and changes in precipitation due to climate change. Termed "Brook Trout Reserves", these streams were identified as having potential to support brook trout into at least mid-century (WDNR 2024, Mitro et al. 2019). Motivated by these results, DNR completed trout habitat restoration on 0.9 miles of Larson Coulee Creek in 2023 and 2024. The objective of this work was to increase habitat for all life stages of brook trout and maintain or improve thermal conditions by limiting riparian tree removal to shrubby and short-lived tree species (e.g. Box Elder *Acer negundo*), which may promote unstable banks and reduced in-stream habitat complexity (Trimble 2004). Large artificial bank covers (e.g., LUNKERS; Vetrano 1988) were also excluded from the project, which some speculate favor brown trout.

Table 2 Fishing regulations for streams in the Lower La Crosse and Halfway Creek watersheds since 1935. MLL = Minimum length limit, BL = bag limit, C&R = catch and release only.

YEAR	SPECIES	MLL (IN.)	BAG LIMIT (#/DAY)	START SEASON	END SEASON
1935	Trout spp.	7	15	Late April- Mid May	Early September
1949	Trout spp.	7	10	Late April- Mid May	Early September
1950	Trout spp.	6	10	Late April- Mid May	Early September
1957	Trout spp.	6	10	Late April- Mid May	August - Early September
1961	Trout spp.	6;13	10; 5	Late April- Mid May	Early September
1963	Trout spp.	6	10	Late April- Mid May	Early September
1972	Trout spp.	6	5	Early May	End of May
1979	Brown and Rainbow	6	5	Early May	End of May
1979	Brook	6	10	Early May	End of May
1979	Trout spp.	6	10	June	Mid-September
1990*	Trout spp.	9	3	Early May	End of September
1990	Trout spp.	7	5	Early May	End of September
2000	Trout spp.	NA	C&R	Early March	Early May
2016	Trout spp.	NA	C&R	Early January	Early May
2016	Trout spp.	0	5	Early May	Mid-October

*Only applied to Bostwick Coulee Creek, all other streams had a five bag/7 inch minimum length limit.

Though trout populations in the two watersheds have generally improved over the past half-century, there are several threats to the fishery. Some of the greatest challenges include more frequent flooding and warmer air temperatures due to climate change (WICCI 2018, Mitro et al. 2019), agricultural practices that negatively impact stream hydrology and habitat, and expanding brown trout populations that displace brook trout (Olson et al. 2024).

A comprehensive evaluation of trout fisheries management has not been completed in the Lower La Crosse and Halfway Creek watersheds. In 2023, we sampled 39 sites on 20 streams as part of a comprehensive watershed-based fisheries evaluation. In this report, we 1) summarize current and past fisheries data, 2) evaluate current fisheries management activities including: stocking, habitat restoration fishing regulations and DNR Fisheries property management, and 3) set objectives for future fisheries management.

Methods

STUDY AREA

The Lower La Crosse and Halfway Creek watersheds, drain 145.2 square miles and includes 62.3 miles of classified trout water. Both watersheds are located within the Driftless Area, a landscape unglaciated during previous glacial periods and characterized by flat ridge tops and valleys up to 600 feet deep that have been shaped primarily by wind and rain erosion and deposition. The underlying bedrock of the region is composed primarily of Ordovician dolostone at higher elevations, and Cambrian sandstone at lower elevations (Fig. 1A, Appendix). Groundwater infiltration is greatest on ungrazed and forested hillslopes (Trimble 2013), where the ground surface is close to porous bedrock. Groundwater captured in these, and other upslope areas, emerges in valleys as seeps and springs where non-porous bedrock layers cause lateral movement of groundwater to the surface (Potter 2019).

Land cover in the Lower La Crosse and Halfway Creek Watersheds is composed primarily of deciduous forest (42%), agricultural lands (24%) and developed lands (13.2%; Table 3; Fig. 3A, Appendix). Developed lands in the watershed are associated with the cities of La Crosse (2023 population =51,327), Onalaska (2023 population = 19,018), West Salem (2023 population = 5,298) and Holmen (2023 population = 11,581), all of which are located within the La Crosse River and Mississippi River valleys.

DNR managed lands comprise a small portion of the two watersheds. DNR properties and easements include 7.9 miles of classified trout water (13% of all classified trout stream miles; Fig. 2A, Appendix).

Figure 2 Stream barge electrofishing on lower Bostwick Coulee Creek. Photo Credit: Kirk Olson.

FISH SAMLPING

Electrofishing surveys were completed on 39 sites on 20 streams sampled between May 4th and September 18th. Depending on stream size, electrofishing was completed using a pulsed DC backpack electrofishing unit or DC stream barge with three anodes and dippers (Fig. 2). All wadable stream sampling was conducted following standardized single-pass electrofishing protocols utilized statewide by DNR (e.g., Lyons and Wang 1996). Following these protocols, sampled reaches were at least 35 times the mean stream width and electrofishing was completed in an upstream direction, with all species being collected. Station lengths ranged from 75 to 300 meters (mean = 137 meters), with only one station measuring less than 100 meters due to poor up and downstream sampling conditions (i.e., large log jams). All gamefish collected were measured to the nearest 0.1 inch and weighed to the nearest gram.

STREAM TEMPERATURE SAMPLING

Water temperature loggers (HOBO 64K Pendant Data Logger) were placed at nine sites on six streams in the two watersheds from late May to early September. Temperature loggers were mounted to rebar driven into the stream bed. Temperature loggers were programed to collect water temperature at one-hour intervals.

FISH AND STREAM TEMPERATURE ANALYSIS

Relative density (catch per effort, CPE) was estimated by dividing total catch by distance (in miles) of stream surveyed. Length cutoffs for young of year (YOY) and adult (i.e., age one and older) trout were determined based on length frequency distributions, which indicated that YOY trout were five inches in length and shorter (min = 1.0 in., mean = 2.6 in.). The relative density of preferred size and larger brook and brown trout (i.e., brook trout ≥ 8 in., brown trout ≥ 12 in.; Neumann et al. 2012) was also estimated. Relative densities were compared to those completed on sites where the species was present throughout Wisconsin between 2007 and 2014. Relative densities were also compared among the seven most well-known streams in the watershed, which were identified based on experience of DNR staff.

Patterns in brook and brown trout relative densities from 1956 to 2023 were visually evaluated by fitting a locally weighted regression line (loess fit) in the program R package ggplot2 (Wickham 2016) and statistically evaluated for monotonic trends using linear regression. Catch per effort values for brook and brown trout were log(x+10) transformed to improve normality and homoscedasticity of residuals.

Stream temperature data was summarized by July mean temperature, a metric that has effectively classified stream fish thermal guilds in Wisconsin and Michigan (Lyons et al. 2009).

Fish density, size structure and species composition were mapped using ArcGIS Pro 2.6.0. To evaluate spatial patterns in trout size structure, we estimated and mapped mean maximum length (i.e., the mean length of the five largest individuals in the sample) of brook and brown trout. Spatial patterns in thermal conditions were evaluated by mapping July mean water temperature at nine sites, and proportion of cool and cold-water stenotherm species in each of the 39 electrofishing sites (Lyons and Wang 1996).

Linear regression was used to evaluate whether density was associated with brown trout size by site sampled in 2023. Mean maximum length was regressed against age 1 and older relative density for the 30 sites where age 1 and older brown trout were captured. Age 1 and older relative density was log transformed prior to regression to improve normality and homoscedasticity of residuals.

One-way analysis of variance (ANOVA) was used to evaluate whether sites with higher densities of warmwater species (i.e., >200 fish permile) had larger mean maximum length of brown trout in 2023.

Table 3 Land cover in the Lower La Crosse and Halfway Creek watersheds based on Wiscland 2.0.

Land Cover Type	Area (acres)	% Total
Broad-leaved Deciduous Forest	50764	42.39
Crop Rotation	17734	14.81
Open Water	12004	10.02
Forage Grassland	11005	9.19
Developed, Low Intensity	10341	8.6
Forested Wetland	5804	4.85
Developed, High Intensity	5467	4.57
Emergent/Wet Meadow	4484	3.74
Coniferous Forest	1074	0.90
Idle Grassland	983	0.82
Barren	55	0.05
Floating Vegetation	7	0.006

All statistical tests were completed in Program R (ver. 3.5.0, R Core Team) with an α of 0.05.

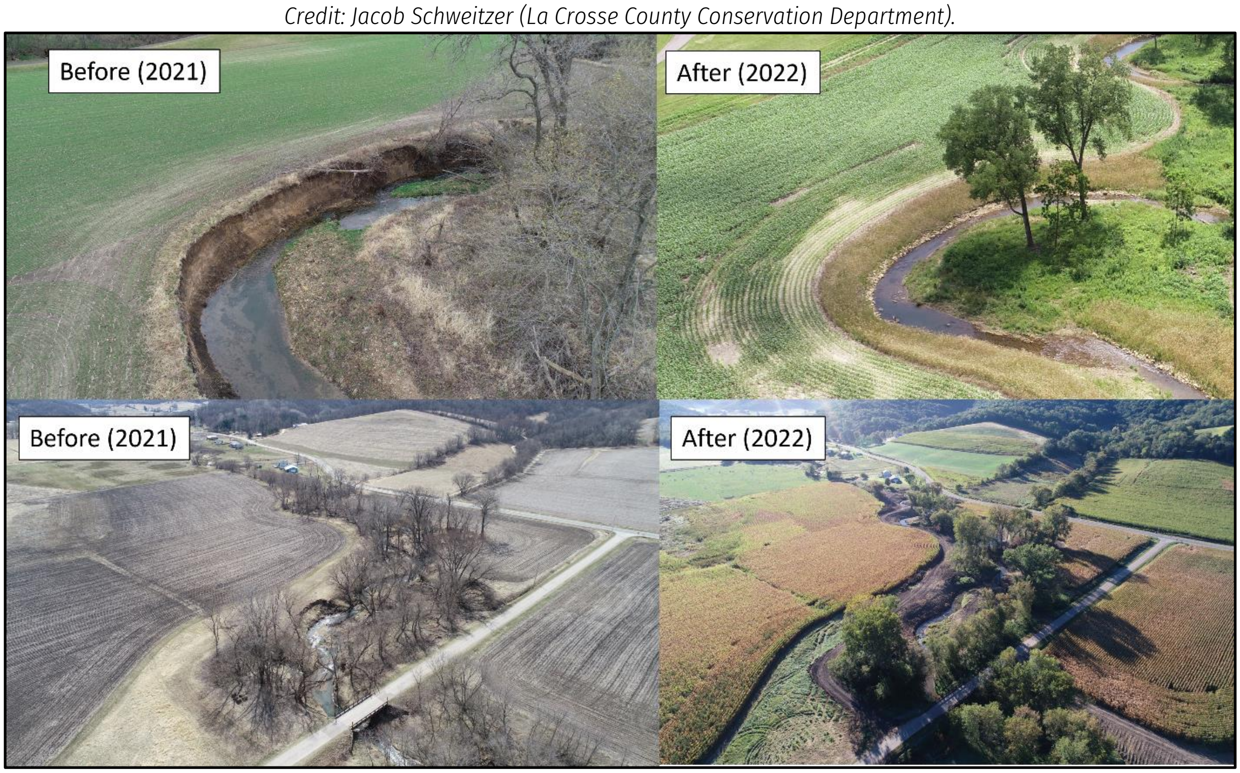
BOSTWICK COULEE CREEK HABITAT EVALUATION

We evaluated brown trout population response to trout habitat restoration projects completed upstream of Filter Road and Larson Rd in 2021 and upstream of Drogseth Road in 2023. Habitat restoration included sloping and stabilization of vertical banks along with additions of rock vortex weirs and large woody debris to improve adult trout habitat (Fig. 3). Single pass electrofishing surveys, following methods described above, were completed prior to habitat restoration work at all three sites and two years following the completion of habitat restoration two sites, and one year following completion of habitat restoration at one site. Relative abundance and length frequency changes in brown trout were evaluated prior to and one year after habitat restoration. Length frequency distributions were compared by non-parametric Kruskal-Wallis tests. A Bonferroni correction (i.e., α/n) was applied to control for experiment wise-error rate.

LARSON COULEE CREEK HABITAT EVALUATION

We evaluated brook and brown trout population response to habitat restoration on Larson Coulee Creek in 2023 using data from electrofishing surveys completed before the restoration in May 2023 and one year after in July 2024 in an upstream reference reach and within the restoration reach. Given the short duration after habitat restoration to evaluate a population response, we treated this analysis as a preliminary evaluation of trout population changes. In this preliminary analysis, we compared changes in age 1 and older brook and brown trout relative densities and length frequency distributions between 2023 and 2024. Young of the year were excluded from the analysis as young of the year fish collected in May 2023 were small (i.e., <2 in.) and likely not fully recruited to our sampling gear.

Figure 3 Bostwick Coulee Creek before and after the completion of a NRCS/La Crosse County Trout habitat and bank stabilization project in 2022. Top photos were taken upstream of Larson Coulee Rd. Lower photos were taken upstream of Drogseth Rd. Photo Credit: Jacob Schweitzer (La Crosse County Conservation Department).



To evaluate the thermal impact of partial riparian canopy removal associated with in-stream habitat restoration on Larson Coulee Creek, two temperature loggers (HOBO 64K Pendant Data Logger) were placed at the upstream and downstream ends of the restored reach prior to and following the completion of our habitat restoration work (Fig. 4). We restricted our analysis to the following periods: before (5/23/2023 -

7/13/2023) and after habitat restoration (5/23/2024 - 7/13/2024). The latter half of summer was excluded from our analysis due to a failure of the downstream temperature logger in 2024.

To account for the influence of weather variation from one year to the next, we evaluated the difference between downstream and upstream loggers before and after partial riparian canopy removal (i.e., a Before-After-Control-Impact type analysis). The difference in mean and maximum daily stream temperature between loggers was compared between the two periods using ANOVA. Changes in diel temperature patterns were also evaluated before and after partial riparian canopy by comparing mean temperature differences by hour over a 24-hour day.

Results

BROWN TROUT

Brown trout were captured in 28 of 39 sites and 13 of 20 streams in 2023 (Fig. 4A, Appendix). In sites where brown trout were present, mean relative density was 723 trout per mile (range = 16 – 5,514), which was in the top 25th percentile statewide. Brown trout relative density in five sites were in the top 10th percentile for brown trout streams in Wisconsin (i.e., CPE ≥ 1,344 trout per mile), four of which were located on Bostwick Coulee Creek and one which was located on an unnamed tributary to Halfway Creek.

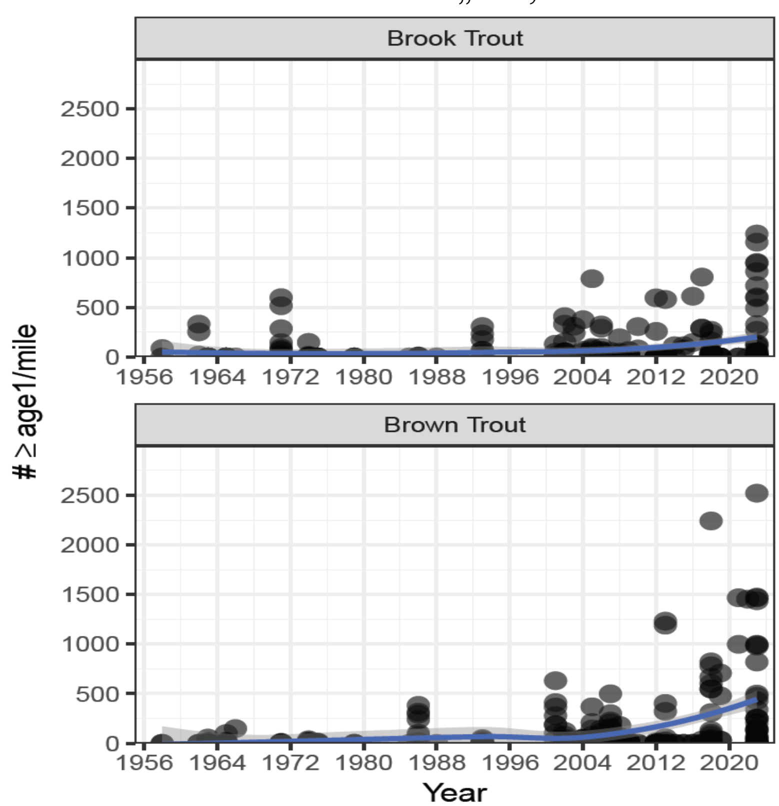
Figure 4 Larson Coulee Creek before and after the completion of a DNR Trout habitat restoration project. Note the removal of Box Elder near stream banks, increased stream habitat complexity through large wood and rock additions and stabilization of vertical banks.

Relative density of age 1 and older brown trout increased significantly from 1956 to 2023 (linear regression, $R^2 = 0.19$, $F_{1,260} = 61.3$, $P < 0.0001$; Fig. 5). Catch per mile of age 1 and older brown trout did not exceed 500 trout per mile at any site between 1956 and 2001. In 2023, brown trout catch per mile exceeded 500 at 11 of the 28 sites where brown trout were present.

Brown trout were present in all seven of the most popular streams in the two watersheds. Age 1 and older relative densities were the highest observed in five of the seven most popular streams in the watershed and were the second highest observed in the remaining two streams in 2023 (Fig. 6). Brown trout relative density was exceptionally high on Bostwick Coulee Creek in 2023, where the mean density of age 1 and older trout was 1,392 trout per mile. On average, relative density of age 1 and older brown trout increased a modest amount on Garbers Coulee, but we observed a substantial increase on the lower end of the stream, from 54 fish per mile in 2004 (the last time the reach was surveyed) to 820 fish per mile.

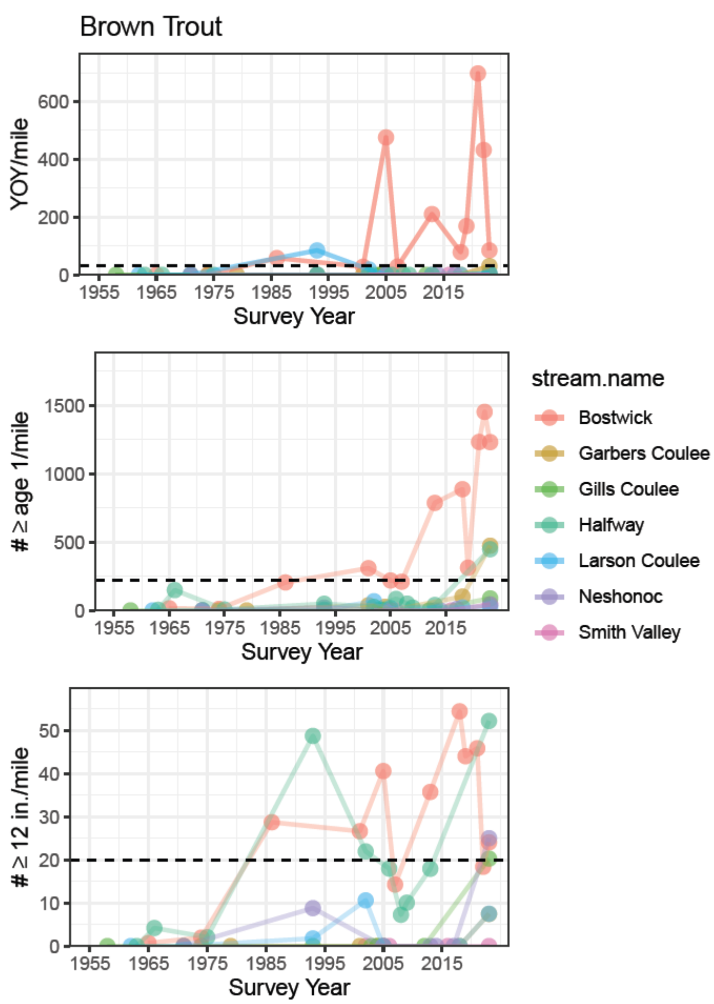
Young of the year trout catches were ranged from 0 to 1,167 trout per mile in sites where brown trout were present. Density of young of the year trout were highest in smaller, 1st or 2nd order streams (Fig. 4A, Appendix).

Figure 5 Catch per mile of adult brook trout (top panel) and brown trout (bottom panel) from electrofishing surveys completed between 1958 and 2023. Note the different y-axis scales.



Mean maximum length of brown trout ranged from 1.7 to 14.7 inches. Sites with larger mean maximum sizes (i.e., > 13.0 inches) were found on the lower reaches of Bostwick, Neshonoc and Halfway Creeks, but also in a 2nd order tributary to Bostwick Coulee Creek (Fig. 5A, Appendix). Mean maximum length of brown trout was positively correlated to adult relative density ($R^2 = 0.20$, $P = 0.007$). However, sites with the largest mean maximum sizes also had lower age 1 and older relative densities (i.e., < 1,000 fish per mile). This was the result of the wide variation of mean maximum size at lower age 1 and older brown trout densities (range of mean maximum size = 6.9 – 14.6 in.). Mean maximum size of brown trout was, on average, greater in sites with higher relative densities of warmwater fish (mean ± 1SD, sites with >200 warmwater fish per mile = 13.1± 1.1, sites with ≤ 200 warmwater fish per mile = 10.4 ± 2.6; ANOVA, $F_{1,25} = 6.6$, $P = 0.016$).

Figure 6 Mean relative density of brown trout sampled between 1956 and 2023 on six of the most popular streams in the Halfway Creek and Lower La Crosse Watersheds. Dashed lines represent median relative densities for trout streams surveyed throughout the Driftless Area.

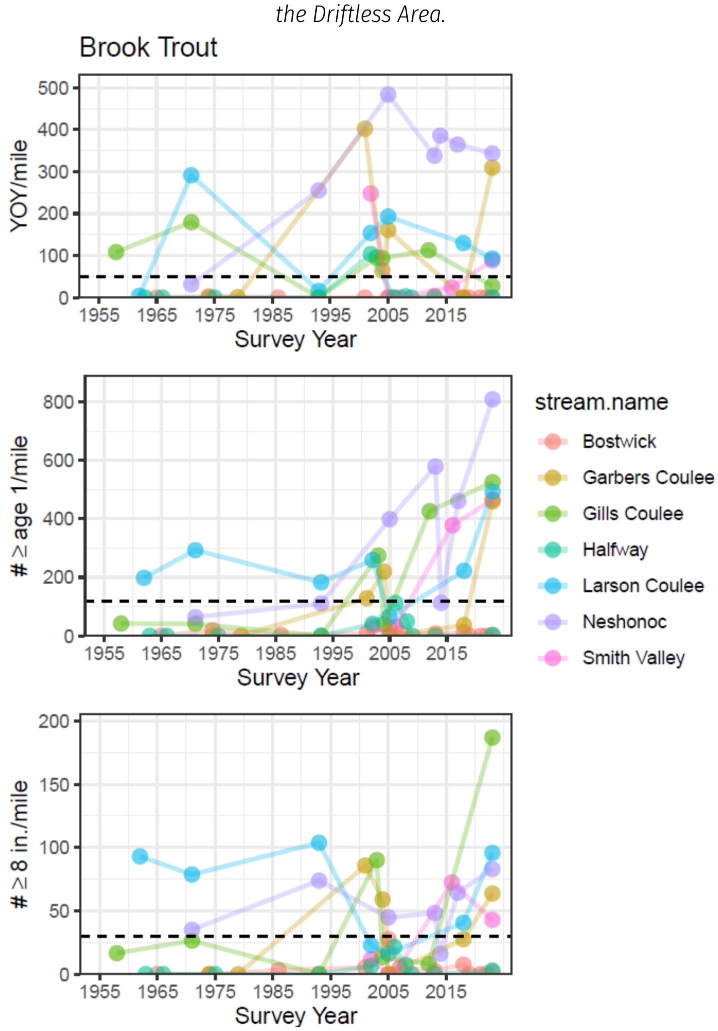


BROOK TROUT

Brook trout were captured in 22 of 39 sites and 13 of the 20 streams surveyed in 2023 (Fig. 6A, Appendix). Where brook trout were present, mean relative abundance was 539 fish per mile (range = 11 – 1,931), which was in the top 25th percentile statewide. Brook trout occurred in allopatry (i.e., in the absence of brown trout) in seven sites that were located in three streams.

Relative density of age-1 and older brook trout increased significantly between 1965 and 2023 (R^2=0.07, $F_{1,260}$ = 20.0, P < 0.0001; Fig 5). Mean catch per mile of age-1 and older brook trout was 398 fish per mile in 2023, which was in the top 20th percentile statewide and higher than all previous years surveyed in the watershed.

Figure 7 Mean relative density of brook trout sampled between 1956 and 2023 on six of the most popular streams in the Halfway Creek and Lower La Crosse Watersheds. Dashed lines represent median relative densities for trout streams surveyed throughout the Driftless Area.



Brook Trout were observed in all seven of the most popular streams in the watershed (Fig. 7). In Bostwick Coulee Creek and Halfway Creek, brook trout densities were less than 5 fish per mile in 2023. This represented a decline from the densities observed in the 2000s, which were also relatively low (i.e., <150 fish per mile). In the five remaining streams, mean Age-1 and older brook trout densities were the highest observed in 2023. On these streams, relative densities of 8 inch and large brook trout increased over the last decade, while young of the year relative densities were stable in all but Garbers Coulee Creek, where relative densities of young of the year brook trout were highly variable over time and relatively high in 2023. Though we observed a mean increase in relative abundance at Garbers Coulee Creek, this was the result of a substantial increase in relative densities at an upstream site that masked a large decline at downstream. Age 1 and older brook trout relative density declined in a downstream reach from 376 fish per mile in 2004 (the last time the reach was surveyed) to 60 fish per mile in 2024.

Brook trout densities were greatest in headwater sites and sites located within the Brook Trout Reserve (Fig. 6A). Young of the year brook trout were most abundant in headwater sites. Quality size brook trout (i.e., ≥8 in.) were most common in streams within the Brook Trout Reserve. Sites with the largest mean maximum length of brook trout were also found within the Brook Trout Reserve (Fig. 7A).

Table 4. Non-salmonid species captured in electrofishing surveys in 2023. Cool/cold represents whether the species is classified as cool or coldwater stenotherm species in Lyons and Wang (1996). Mean CPE represents mean catch per mile for each species in sites where the species was captured.

Common Name	Scientific Name	Sites Captured	Mean CPE (where found)	Cool/Cold?
American Brook Lamprey	Lethenteron appendix	3	21	X
Banded Darter	Etheostoma zonale	1	14	
Bluegill	Lepomis macrochirus	1	14	
Bluntnose Minnow	Pimephales notatus	1	32	
Brook Stickleback	Culaea inconstans	5	121	X
Burbot	Lota lota	1	9	X
Central Mudminnow	Umbra limi	1	18	
Creek Chub	Semotilus atromaculatus	2	43	
Emerald Shiner	Notropis atherinoides	1	18	
Fathead Minnow	Pimephales promelas	1	6	
Green Sunfish	Lepomis cyanellus	1	17	
Johny Darter	Etheostoma nigrum	7	92	
Largemouth Bass	Micropterus nigricans	1	38	
Logperch	Percina caprodes	1	47	
Longnose Dace	Rhinichthys cataractae	5	121	
Mississippi Silvery Minnow	Hybognathus nuchalis	1	114	
Smallmouth Bass	Micropterus dolomieu	2	40	
Spotfin Shiner	Cyprinella spiloptera	1	107	
Spottail Shiner	Hudsonius hudsonius	1	290	
Western Blacknose Dace	Rhinichthys obtusus	3	20	
White Sucker	Catostomus commersonii	7	309	

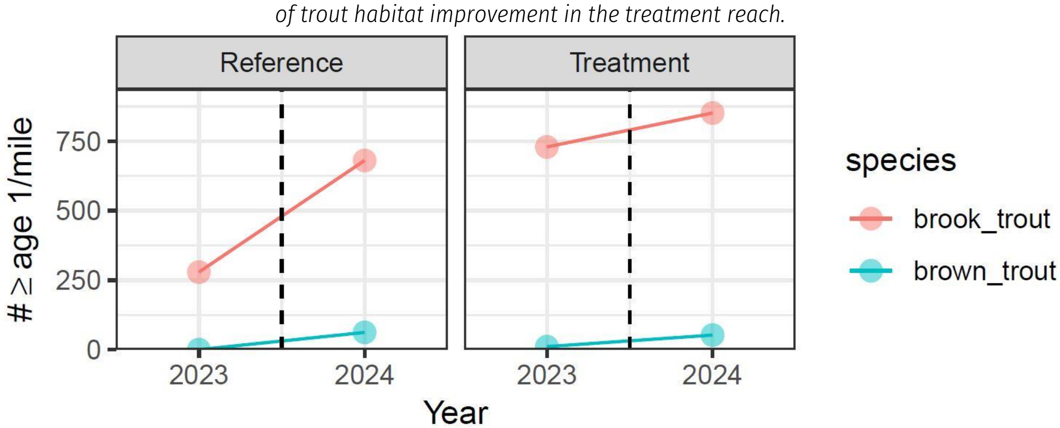
NON-SALMONID SPECIES

In total, 21 non-game species were captured in 2023 (Table 4). None of the species captured were state or federally listed as threatened or endangered. The three most frequently captured non-game species were white sucker *Catostomus commersonii* and johny darter *Etheostoma nigrum*, which were found in seven sites, followed by longnose dace *Rhinichthys cataractae*, which was found in five sites. Three cool or cold-water stenotherm species were captured, including american brook lamprey *Lethenteron appendix*, brook stickleback *Culaea inconstans* and burbot *Lota lota*. No sculpin species *Cottus spp.* were captured in 2023.

STREAM THERMAL CONDITIONS

Stream thermal conditions varied across the two watersheds but were well within the range suitable for trout at every site surveyed (Fig. 8A, Appendix). Mean July water temperatures ranged from 13.3 to 18.9°C at the 11 sites where temperature loggers were placed. Stream temperatures generally appeared to increase from upstream to downstream. The coldest July mean temperatures were observed on lower order streams, including Larson Coulee (13.3-14.7°C), Eggens Coulee Creek (a tributary to Neshonoc Creek; 13.6°C) and Garbers Coulee Creek (15.3°C). The warmest July mean stream temperatures were observed at the downstream-most sites on Bostwick Coulee Creek (18.1°C) and Halfway Creek (18.9°C). Proportion of cool and coldwater stenotherm species in fish surveys were consistent with stream temperatures at the 11 sites where temperature loggers were deployed. Similar to results from temperature loggers, the proportion of cool and coldwater species in fish surveys generally increased from up to downstream. One exception was a site located on a third-order unnamed tributary to Halfway Creek, where the proportion of cool and coldwater species was 16%.

Figure 8 Relative abundance of age-1 and older brook and brown trout from the reference (UST Erickson Rd) and treatment (UST CTH M) reaches on Larson Coulee Creek before and after trout habitat improvement. Vertical dashed lines represent the timing of trout habitat improvement in the treatment reach.



LARSON COULEE CREEK HABITAT EVALUATION

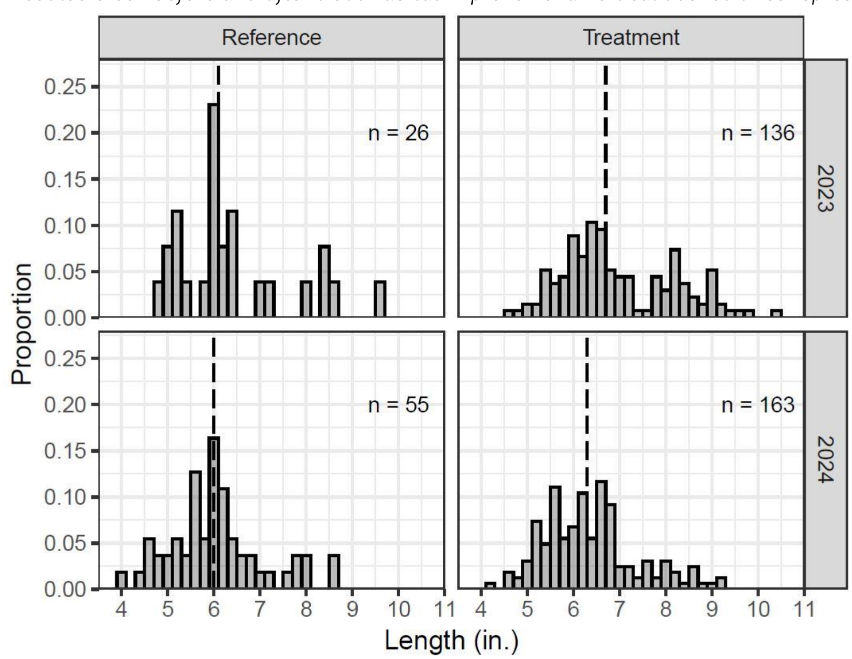
Age 1 and older brook and brown trout relative densities increased in both the reference and treatment site in the year following trout habitat restoration (Fig. 8).

Brook trout relative density in the treatment and upstream reference reach increased by 402 and 122 fish per mile respectively. In the reference reach, age-1 and older brown trout relative density increased from 0 fish per mile to 61 fish per mile. In the treatment reach, age-1 and older brown trout relative density increased from 21 to 52 fish per mile.

Age 1 and older brook trout sizes decreased from 2023 to 2024 in our treatment reach (Kruskal-Wallis, $P<0.0001$), but remained similar in our reference reach (Kruskal-Wallis, $P=0.30$; Fig. 9). The proportion of fish <7 in., specifically, increased in the treatment site in 2024.

Following partial tree removal on Larson Coulee Creek, we did not observe a change in the difference of daily mean temperature between up and downstream loggers (change in difference = +0.06°C, $F_{1,102} = 0.94$, $p = 0.35$). We did observe a statistically significant increase in the mean maximum daily temperature difference after partial canopy removal (change in difference = +0.27°C, $F_{1,102} = 4.29$, $p = 0.04$). Changes in mean stream temperature difference over a diel period indicated that the largest increases occurred in the latter half of the day (hours 13 – 23, Fig. 8), with the largest difference occurring at hour 17 (+0.29°C increase). Standard deviation in the differences between up and downstream increased across all time periods following partial canopy removal. Stream temperatures after partial tree removal remained within the range suitable for brook trout, with 74% of hourly observations after tree removal measured between 12 and 16°C and no observations exceeding 20°C.

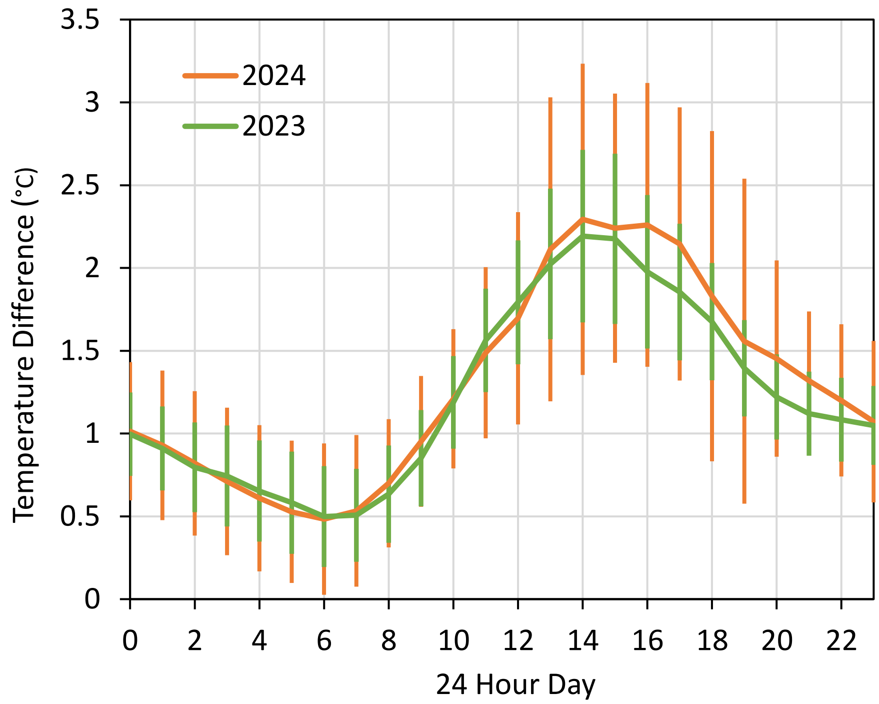
Figure 9 Length frequencies of age-1 and older brook trout captured from reference (UST Erickson Rd) and treatment (UST CTH M) reaches on Larson Coulee Creek before and after trout habitat improvement. Vertical dashed lines represent median lengths.



BOSTWICK COULEE CREEK HABITAT EVALUATION

Age 1 and older brown trout density after habitat restoration was relatively unchanged and within 0.07 and 1.4% of pre-habitat restoration values. Relative abundance of young of the year trout appeared to decline at all three sites, between 72-91%. Relative abundance of 12 inch. and larger trout declined at Filter and Larson Rd. sites by 100 and 32%, respectively, while remaining relatively unchanged at the Drogseth Rd. site (Fig. 11). Length frequency distributions shifted toward larger individuals and fewer young of the year sized fish after habitat restoration at all three sites (Kruskal-Wallis test < 0.0001 for all three sites; Fig. 12). Median length of brown trout at Drogseth, Filter and Larson Road sites increased by 0.6, 2.0 and 3.6 inches, respectively.

Figure 10 Mean hourly temperature difference (°C) between stream temperature loggers located downstream and upstream of a habitat restoration project on Larson Coulee Creek that included partial tree removal (1.32 stream miles). Positive values indicate warmer mean water temperatures at the downstream temperature logger. The green line represents mean hourly temperature differences from May 23 – July 14 in 2023, prior to partial tree removal. The orange line represents mean hourly temperature differences for data collected between May 23 – July 13, following partial tree removal. Error bars signify ±1 SD.



Discussion

TROUT POPULATION STATUS AND TRENDS

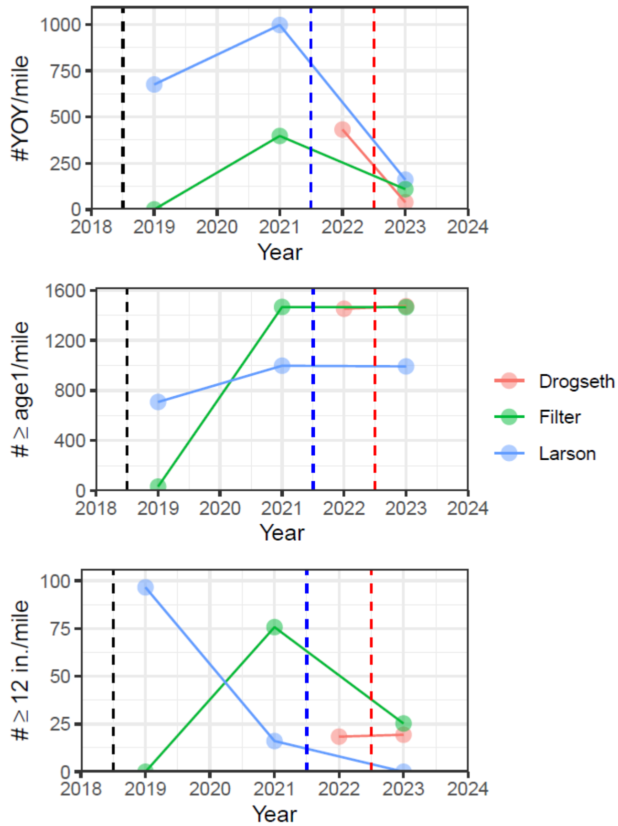
Our evaluation of electrofishing surveys completed between 1956 and 2023 revealed increases in both brook and brown trout relative densities in the Halfway Creek and Lower La Crosse River watersheds. The most rapid increases have occurred over the past 20 years, with brown trout increasing more rapidly than brook trout (Fig. 5). These findings mirror those from nearby watersheds (Olson et al. 2021, Olson 2022, Olson 2023) and are indicative of improvements in stream habitat that have occurred over the better part of the last century (Thorn et al. 1997, Trimble 2013) and stocking of feral trout that began in the late 1990s. Since stocking was ceased in 2014, all the fish that we sampled in 2023 were of natural origin. The more limited increases we observed in brook trout may reflect negative interactions with rapidly expanding brown trout populations, which have been well documented in the Driftless Region (Hoxmeier and Dieterman 2016, Olson et al. 2024), or greater overall production potential of brown trout in these waters.

Brown Trout

In 2023, naturally reproducing brown trout were captured in 72% of sites sampled in the two watersheds. Where brown trout were present, relative density of catchable (i.e., age 1 and older) brown trout were high, in the top 25th percentile statewide. brown trout were most prevalent in upper Halfway Creek and Bostwick Coulee Creek and its tributaries (Fig 4A). Bostwick Coulee Creek had the highest relative densities of all streams surveyed, with a mean relative density exceeding 1,300 catchable brown trout per mile. This exceptionally high density likely reflects the combination of brown trout stocking history (Table 1), extensive adult habitat restoration work (Fig 2A) and greater proportion of dolomite and limestone bedrock in the watershed, which has been associated with greater trout population productivity (Kwak and Waters 1997, Fig. 1A).

Relative density of quality size brown trout (i.e., 12 inches and larger, Neumann et al. 2012) was, on average, near the median for Wisconsin Trout streams where brown trout were present. Quality size brown trout were most abundant in Halfway Creek, lower Bostwick Coulee Creek and two smaller tributaries of each stream. Sites with larger brown trout (i.e., sites with mean maximum length ≥ 13 inches) were generally found in lower watershed sites, but also in two tributaries to Bostwick Coulee and Halfway Creeks (Fig. 5A). Sites with higher densities of warm water species (e.g., potential forage species such darter and minnows) also had higher mean maximum lengths. These reaches that are more thermally marginal for brown trout, also support an abundance of quality prey, possibly allowing for increased growth. Large brown trout are often found in lower watershed sites on larger streams (Clapp et al. 1990, Dieterman et al. 2006, Carlson et al. 2016). These larger streams are typically warmer during the summer months than those upstream and may support populations of warmwater forage fish. Untangling the importance of these correlated attributes (i.e., stream temperature, warmwater forage fish abundance, stream size) was not possible with our survey design but is worth investigating in future studies.

Figure 11 Relative abundance of brown trout by length category captured at three sites before and after trout habitat restoration on Bostwick Coulee Creek. Habitat restoration work was completed after electrofishing surveys in 2021 at Filter and Larson Rd. and in 2022 at the Drogseth Rd. The vertical blue dashed line represents the completion of habitat restoration work at Filter and Larson Rd sites and vertical red dashed line represents completion of trout habitat restoration at the Drogseth Rd. site. Filter and Larson Rd. sites were impacted by a 2019 fish kill, signified by a black vertical dashed line.

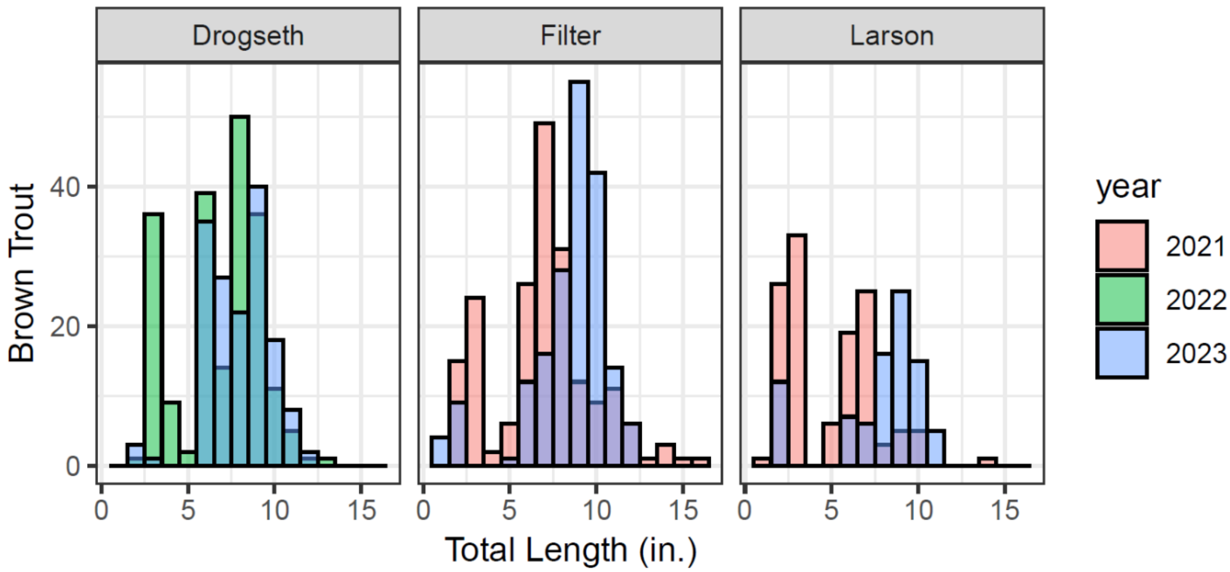


Young of year brown trout relative densities were more variable than age 1 and older relative densities in our watersheds, consistent with populations in nearby watersheds (Olson 2022, Olson 2023). Many stream dwelling populations of trout experience variable recruitment, as density independent factors (i.e., flooding during vulnerable early life stages) can greatly influence survival of juvenile trout (Lobón-Cerviá and Ríncón 2004). Relative densities of young of the year trout were greatest in headwater streams, where age 1 and older densities were lower. This is likely the result of lower predation and competition with age 1 and older trout in these shallower headwater streams and highlights the importance of these small streams in supporting downstream populations, where few young of the year were captured.

In contrast to the expectation of density dependent growth, brown trout density was positively associated with mean maximum length. This pattern has also been observed in nearby watersheds (Olson 2022, Olson 2023) and a lack of association between brown trout growth and population density was documented in streams of southeastern Minnesota (Carlson et al. 2016). Driftless streams are dynamic systems and density-independent factors (i.e., environmental variation) likely play a major role in salmonid population dynamics (Cattanèo et al. 2007, Blum et al. 2018).

Alternatively, this pattern may also be explained by the presence of dominance hierarchies exhibited in stream-dwelling salmonids (e.g., Fausch 1984) that allow the most dominant fish to achieve high growth and size, even when trout densities are high.

Figure 12 Length frequency of brown trout captured via electrofishing on Bostwick Coulee Creek before and after habitat restoration. Drogseth was sampled one year after restoration. Filter and Larson were sampled two years after habitat restoration.



Brook Trout
In 2023, naturally reproducing brook trout were captured in 56% of sites and 13 of 21 streams surveyed in the two watersheds. Where they were present, brook trout relative densities were high. On average, age 1 and older densities were in the top 25th percentile statewide. Brook trout relative densities and sizes were highest where brown trout were absent or present in very low numbers. This is consistent with patterns observed in watersheds nearby (Olson et al. 2021, Olson 2022, Olson 2023). Like brown trout, young of the year brook trout were generally most abundant in smaller headwater sites, highlighting the importance of these habitats for natural reproduction.

Brook trout were largely absent from Halfway and Bostwick Coulee Creeks and their tributaries, sites where brown trout were present in moderate to high densities. An exception to this pattern was a single site in the headwaters of Bostwick Coulee Creek Tributary (i.e., Grabers Coulee Creek), where brown trout occurred in lower densities. Unfortunately, an ongoing expansion of brown trout appears to be occurring on this stream as relative density of brown trout has increased in the downstream site, while brook trout have declined. Brook trout were most abundant in tributaries to the Neshonoc Creek Sub-Watershed, which is a Brook Trout Reserve (Fig. 6A). Brook trout were also abundant in Smith Valley Creek, where brown trout were present in low densities.

The distribution of brook and brown trout in these two watersheds is likely the result of stocking history and competitive interactions between the two species. Brown trout were typically not stocked into streams where brook trout were naturally reproducing or stocked (e.g. Larson Coulee Creek) and vice-versa (e.g. Halfway Creek; Table 2). Establishment and expansion of naturally reproducing brown trout in recent decades appears to have driven brook trout declines in some areas, consistent with observations in nearby watersheds and recent literature (Hoxmeier and Dieterman 2016, Olson et al. 2024).

HABITAT

About 11% of classified trout stream miles in the two watersheds have received trout habitat improvement. These projects have been carried out with multiple goals in mind (e.g., trout habitat improvement, reduction of sediment and nutrient transport), but all have employed methods similar to those described by Hunt (1993). Recent trout habitat projects completed on Bostwick Coulee and Larson Coulee Creeks provided an opportunity for us to evaluate the impact of these projects shortly after habitat restoration.

Trout habitat restoration on Bostwick Coulee Creek was completed by La Crosse County in 2021 and 2022. The goal of the project was primarily to stabilize eroding banks that were contributing to phosphorus loading and, secondarily, to improve stream habitat for trout. The project included flood plain sediment removal, bank stabilization and addition of large wood and vortex weirs for trout habitat. Observations following the completion of these projects indicate that fewer actively eroding banks were present (Fig. 3), and electrofishing surveys documented little change in trout densities, but improved population size structure (Fig. 11 and 12).

Trout habitat restoration on Larson Coulee Creek was completed by DNR with the primary goal of improving habitat for brook trout. The stream has been identified as a Brook Trout Reserve, with moderate densities of brook trout, few brown trout and suitable thermal conditions predicted until at least mid-century (DNR 2024). Trout habitat restoration designs on the creek included: increasing floodplain size by floodplain material removal, bank shaping and seeding, riprapping the largest vertical banks (i.e., >5 ft.), adding coarse woody debris throughout and avoiding removal of larger canopy trees that were providing stream shading (e.g., Cottonwood *populus deltoides* and Willow *Silax spp.*). In the year following habitat restoration, brook and brown trout densities increased in both reference and upstream reference reaches. Size structure of brook trout declined in the reference reach, owing to more fish being captured between 5 and 7 inches (likely age-1 trout). This may reflect greater survival of young of the year trout to age 1 in the first year after trout habitat restoration. The overall increases of trout in both the treatment and adjacent reference reaches may be due to movement of trout from the improved reach, where densities and (presumably) intraspecific competition were higher, to areas of lower trout density. These “spillover” improvements have been noted in other studies (e.g. Brudvig et al. 2009, Carl et al. 2025). The increases across reference and treatment sites may also simply be the result of differences in environmental conditions from one year to the next (e.g., annual variation in stream discharge) that increased trout survival.

We observed a small but notable increase in brown trout relative abundance (31-61 trout per mile increase) after trout habitat restoration on Larson Coulee Creek. Previous trout habitat work in Wisconsin has been shown to favor brown trout where brook and brown trout occur in sympatry (Avery 2004). The habitat project on Larson Coulee Creek employed a modified approach with the hope that the work would not favor brown trout. It is possible that any improvement in adult trout habitat such as cover and increased depth may favor brown trout, which have life-history attributes (i.e., larger size, later maturity, greater longevity and maximum size; Becker 1983), that may be favored by these changes. Whether the increase in brown trout represents the start of a population expansion or a stable and modest increase in abundance, will be determined in sampling planed over the next several years.

Stream thermal conditions warmed slightly in the year following our habitat restoration on Larson Coulee Creek. We did not observe a statistically significant increase in average daily temperatures, but we did observe a statical and meaningful increase in daily peak temperatures. Specifically, we observed a 0.27° C increase in the maximum daily temperature difference between temperature loggers upstream and downstream of the habitat restoration reach. Maximum temperature differences typically occurred in the latter half of the day, when air temperatures were presumably warmest. Despite this modest warming, stream temperatures remained exceptional for brook trout. A total of 74% of May - July hourly water temperature observations were within the optimal temperature for brook trout growth (12-16°C) and maximum temperatures never exceeded 20°C, 5°C below upper incipient critical temperatures and 8-11 °C below upper critical maximum temperatures (25°C and 28-31°C, respectively; Kovach et al. 2019). These changes may also be temporary, as riparian vegetation becomes established, providing shade and facilitating stream narrowing (Trimble 2004). Additional monitoring of at least 2-3 years should occur before conclusions are drawn on the thermal impact of these habitat projects.

Given the short duration of post-restoration monitoring, these results should be considered preliminary. Trout population changes, particularly for larger and older age groups (i.e., >3 years old) are expected to take several years. This was evident in surveys done one and two years after habitat restoration on Bostwick Coulee Creek. Where post-habitat surveys were completed only one year after habitat restoration, a modest increase in population size structure was noted (0.6 in. increase in median length), while more substantial increases in size were documented in sites where post-habitat surveys were completed two years later (2.0 and 3.6 in. increases in median length).

Of the classified trout waters in the two watersheds, Halfway Creek and lower Bostwick Coulee Creek are good candidates for future trout habitat improvement projects. Both of these sites exhibit low to moderate brown trout densities (i.e., <500 fish per mile), no brook trout, excessive bank heights and little in-stream adult trout habitat. DNR streambank easement currently exists on 0.32 miles of Halfway Creek.

Figure 13 Photo of an overgrazed reach of Larson Coulee Creek in 1969.

TROUT STOCKING

Trout stocking was widespread in the region for many decades before the start of standardized record keeping by WDNR in 1972 (Thorn et al. 1997). DNR stocking records since 1972 indicate that brook and brown trout stocking occurred in nearly all of the larger classified trout waters in the two watersheds until 2014 (Table 1). However, brook and brown trout were generally not stocked into the same streams. For example, brook trout were almost exclusively stocked into what are now classified as Brook Trout Reserve streams and brown trout were primarily stocked into Bostwick and Halfway Creeks. It was believed that brown trout were more resilient to degraded stream habitats, so primarily brown trout were stocked into Bostwick Coulee and Halfway Creeks (DNR files). However, recent literature suggests the difference in tolerance for degraded habitats between these species is minimal (e.g. Wehrly et al. 2007, Alberto et al. 2017).

Despite stocking being ceased in 2014, brook and brown trout populations have continued to increase. This continued increase may be the result of stocked fish suppressing recruitment of higher-surviving wild fish (Mitro et al. 2004) and/or the continued increase in base-flows documented region-wide that have improved trout habitat availability (Kochendorfer and Hubbart 2010).

BROOK TROUT CONSERVATION

Unlike most streams in the southern half of the Driftless Area, Larson Coulee Creek and Gills Coulee Creek were found to support naturally reproducing brook trout since DNR fisheries surveys began in the 1950s (Fig. 7, DNR files). These populations persisted in the two streams despite poor land use and riparian overgrazing (Fig. 13). Extensive groundwater inputs in headwaters, in combination with fair adult trout habitat in upper reaches appear to have allowed naturally reproducing populations to maintain moderate abundance in these streams. Larson Coulee Creek was noted as the highest quality of the two streams in 1959, supporting a popular fishery in the complete absence of stocking. Despite fisheries managers demonstrating that stocking was not required to sustain the fishery, regular stocking of brook trout continued in Larson Coulee Creek until 2004.

The Neshonoc Creek sub-watershed of the Lower La Crosse River was identified as a Brook Trout Reserve in 2017 based the higher likelihood of the species persisting as the climate warms (Mitro et al 2019). Our surveys confirmed that brook trout continue to persist in streams throughout this sub-watershed in moderate to high densities and largely in the absence of brown trout (Fig. 6A). The Neshonoc sub-watershed Brook Trout Reserve is characterized as thermally resilient to warming air temperatures and with significant opportunities to secure and enhance habitat. Within the watershed, Larson Coulee, Neshonoc and McKinley Valley Creeks and their tributaries are all eligible for streambank easement purchase through the Knowles-Nelson streambank easement program.

Currently, Wisconsin DNR holds streambank easements on 1.7 miles of Larson Coulee Creek, of which 0.9 miles have been restored between 2023 and 2024. This recent habitat work aimed to maintain canopy shading and increase in-stream habitat complexity for brook trout. In the first year after restoration, it appears that thermal conditions have marginally warmed, and brook trout and brown trout densities have increased. Continued monitoring will need to occur to see how these changes respond to continued establishment of herbaceous riparian vegetation and whether brown trout densities continue to increase or remain at low numbers. Future habitat work in the sub-watershed should not be completed until the evaluation of this work is done. In addition, if brown trout numbers continue to increase, this stream may be a good candidate for brown trout removal before a population becomes well established.

The lineage of brook trout present in the Neshonoc sub-watershed is currently unknown. Nearby streams in the upper La Crosse River Watershed exhibit limited recent hatchery ancestry and may be of native origin, though the complex history of brook trout stocking and rapid population divergence in Wisconsin has made determinations difficult (Erdman et al. 2022, Erdman et al. 2024). Extensive stocking of domestic fish between 1973 and 1998, and subsequent stocking of putative native Wisconsin Fish until 2004 into Larson Coulee Creek, have likely influence the genetic structure of the population, compared to upstream populations on the La Crosse River, where stocking has been less frequent.

FISHING REGULATIONS

Trout regulations in the two watersheds have primarily been managed with statewide season and county base size and bag regulations. The only exception to this is Grabers Coulee Creek, where a special regulation which requires the release of brook trout was enacted in 2016 in hopes of preventing the expansion of brown trout there. Recent creel surveys competed on Bohemian Valley (2016), Timber Coulee (2016) and the West Fork Kickapoo (2022) creeks indicate that angler pressure is high on area streams, but harvest is low. Given results from these creel surveys, and the increasing populations of brook and brown trout we documented, it seems very unlikely that population densities are being limited by overharvest (i.e. recruitment overfishing). It is possible that numbers of larger fish may be limited on certain streams by preferential harvest of larger fish, as we observed selective harvest of larger trout in these nearby creel surveys (DNR unpublished data). However, we cannot evaluate whether this is occurring without additional information (e.g., angler harvest and trout growth surveys) on streams where size structure is limited. Opportunities to catch preferred size and larger trout were common in both watersheds, suggesting that, if overharvest of larger trout is occurring, it is not extensive.

NON-SALMONID SPECIES

We captured relatively few non-salmonid species in our surveys. This result is typical for Wisconsin's quality coldwater streams, which often only support trout and sculpin species (Lyons and Wang 1996). We did not capture any sculpin in our surveys, despite the presence of suitable habitat and presence of other coldwater and coolwater species. Mottled sculpin are also common in the Upper La Crosse River Watershed (Becker 1983, DNR unpublished data).

The presence of mottled sculpin in the Upper La Crosse River Watershed may reflect the difference in land use history there. Nearly all lands in the Upper La Crosse River Watershed have been held by the US military since 1909. As a result, this area did not experience the same intense agricultural land use as other streams in the Driftless Area. This may have allowed coldwater fish species, including brook trout and mottled sculpin to persist. For example, genetic analysis of brook trout in the upper watershed have found lower levels of potential hatchery introgression there (Erdman et al. 2022).

Natural re-colonization of mottled sculpin in the Lower La Crosse Watershed has likely not occurred due to the sedentary nature of the species. Mottled sculpin home ranges are typically less than 11 m^2 (Petty and Grossman 2007). Like salmonids, the species requires relatively stable stream temperatures associated with significant groundwater inputs. Based on our fish community and stream temperature results, it is highly likely that suitable habitat for mottled sculpin exists in the watershed, particularly in the coldest streams, which are located within the Brook Trout Reserve. Sculpin are widespread in trout streams throughout North America and, where they are found, are an important prey item of trout and component of the stream food webs (Adams and Schmetterling 2007).

Management Recommendations

HABITAT

1. Focus future stream restoration efforts on Halfway Creek and lower Bostwick Coulee Creek and employ methods that increase habitat resilience to flooding.

   We identified that these reaches have potential for stream habitat work to improve existing brown trout populations. Stream habitat in these reaches is limited due to an excess of fine post-settlement alluvium in the floodplains and trout densities are lower (i.e., <500 fish per mile). Future projects in these reaches incorporate elements that increase stream channel habitat resilience to flooding, such as removing a portion of post-settlement alluvium and encouraging no or limited riparian grazing.

   <u>Supporting DNR Guidance</u>
   2020 DNR Trout Management Plan: Objective 1.1, Strategy 1.1.A, Action 1.1.A.5

2. Avoid complete riparian tree removal and consider planting trees in areas lacking shade to increase the thermal resilience of streams to ongoing and projected increases in summer air temperatures (WICCI 2018).

   We observed evidence of warming in stream temperatures during the summer months on Larson Coulee Creek in the year after partial riparian tree removal. Given the thermal resilience of the stream, these increases were not enough to be of concern for trout. However, summer air temperatures are predicted to continue to increase in future, so stream shading will become more important. Shading from trees has been shown to slow the warming of streams in other parts of the state (Simmon et al. 2015).

   <u>Supporting DNR Guidance</u>
   2020 DNR Trout Management Plan: Objective 1.1, Action 1.1.A.8

3. Continue to collaborate with internal (e.g., DNR Watershed Management Bureau) and external partners (e.g., La Crosse County Land and Water

Conservation) involved in upland management to promote land use practices that will benefit stream hydrology.

Supporting DNR Guidance:
2020 DNR Trout Management Plan: Objective 1.1, Action 1.1.A.8

4. Continue to assist with the evaluation of waterway permits and fish kills. Document, evaluate and estimate monetary impacts of fish kills when they occur. Thoroughly evaluate permits that include headwater pond construction, which have been shown to warm downstream waters in multiple area streams (e.g. Berger et al. 1979).

   Supporting DNR Guidance:
   2020 DNR Trout Management Plan: Objective 1.3

BROOK TROUT RESTORATION

1. Pursue DNR streambank easements on the following Brook Trout Reserve streams and their tributaries: Larson Coulee, McKinley Valley and Neshonoc Creeks.

   DNR streambank easements provide DNR and collaborators the ability to manage in-stream and riparian vegetation to increase their resilience to climate change (e.g. increasing air temperatures and more frequent flooding). DNR streambank easements are perpetual.

   Supporting DNR Guidance
   2020 DNR Trout Management Plan: Objective 2.1, Strategy 2.1.B, Action 2.1.B.2

2. Consider additional habitat restoration on Larson Coulee Creek pending results from the ongoing habitat evaluation.

   Larson Coulee Creek currently supports a robust brook trout population within a Brook Trout Reserve. This population appears to have initially benefited from recent habitat work between Asmus and Erickson roads, which utilized a different approach than standard trout habitat projects (i.e. Hunt 1993). This project incorporated more large wood into the stream channel, removed fewer trees from the riparian area, used less riprap on streambanks, and removed more floodplain sediment than is common for these projects. Unfortunately, this work may also be benefitting brown trout, which displace brook trout, as we saw evidence of a population becoming established. Given these initial findings, continued restoration on easements downstream of Asmus Road should wait until the evaluation of the project is complete.

Supporting DNR Guidance
2020 DNR Trout Management Plan: Objective 2.1, Strategy 2.1.B, Action 2.1.B.3

TROUT STOCKING

1. Do not stock trout.

   Stocking has not occurred in the watersheds since 2014. Since 2014, trout densities have increased, indicating that stocking is no longer necessary.

   Supporting DNR Guidance
   2020 DNR Trout Management Plan: Objective 2.1, Strategy 2.1.B, Action 2.1.B.3

FISHING REGULATIONS

1. Maintain current angling regulations.

   Angler harvest is largely unknown in the watershed but is assumed to be limited based on recent creel surveys on nearby streams (DNR unpublished data). If future evaluations of angler harvest or trout populations (see Monitoring, below) suggest size or density suppression by overharvest or density dependent growth (i.e., stunting), regulation changes may be considered.

NON-SALMONID SPECIES

1. Re-introduce mottled sculpin into Larson Coulee, McKinley Valley and Neshonoc Creeks from source populations in the upper La Crosse River Watershed.

   Mottled sculpin are absent from the Lower La Crosse River Watershed, despite their abundance in the upper portion of the watershed and suitable habitat conditions on the streams listed (Appendix 1, Fig 8A). A suitable source for mottled sculpin transfers in the Upper La Crosse River Watershed was recently identified (Steven Rood, U.S. Army Fisheries Biologist, pers. comm.).

   Supporting DNR Guidance:
   NR 1.01

MONITORING

1. Update out of date trout stream classifications in the watershed.

   During the 2023 watershed survey, we sampled three streams which were previously unclassified but supported naturally reproducing brook and/or brown trout. In addition, all of the current Class III waters should be updated to Class I or II as they all support naturally reproducing trout.

Two of the three unclassified streams (an unnamed tributary to Bostwick Coulee and Halfway Coulee Creeks) were classified in 2024, prior to the completion of this report.

Supporting DNR Guidance:
2020 DNR Trout Management Plan: Objective 3.3, Strategy 3.3.A

2. Complete opening weekend angler creel survey to evaluate level of angler use on area streams.

   No quantitative information is available on contemporary angler use or harvest on area streams. Creel surveys on nearby streams suggest that though angler pressure is high, harvest is very limited (DNR unpublished data). Opening weekend creel surveys require only limited resources and provide a snapshot of angler use during the two most popular trout fishing days of the year (DNR unpublished data). This information will be valuable in gauging angler use of area streams and whether more involved creel surveys are warranted to evaluate angler harvest.

   Supporting DNR Guidance:
   2020 DNR Trout Management Plan: Objective 3.1, Action 3.1.A.1

3. Complete a comprehensive watershed survey and updated watershed report in 2031.

   Based on our current eight-year watershed rotation schedule, the next comprehensive survey of the Lower La Crosse and Halfway Creek watersheds will occur in 2031. At that time, management recommendations in this plan will be evaluated and revised if necessary.

   Supporting DNR Guidance:
   2020 DNR Trout Management Plan: Objective 3.1, Action 3.1.A.1

PROPERTY MANAGMENT

1. Monitor and maintain the existing 3.6 miles of streambank easement in the watersheds.

   With changes in land ownership on many parcels in recent years, existing easements will need to be monitored to ensure land use activities are consistent with easement agreements and that landowners are aware of the existence of streambank easements. In 2025, prior to the completion of this report, two angler walk-in access points on Halfway Creek, which traversed multiple new landowners were posted. Easement documents were also mailed to landowners.

Supporting DNR Guidance:
2020 DNR Trout Management Plan: Objective 2.2, Strategy 2.2.B, Action 2.2.C.2

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Appendix

Figure 1A. Bedrock geology, springs and classified trout water in the Lower La Crosse and Halfway Creek Watersheds. Thick black lines represent HUC 10 watershed boundaries.

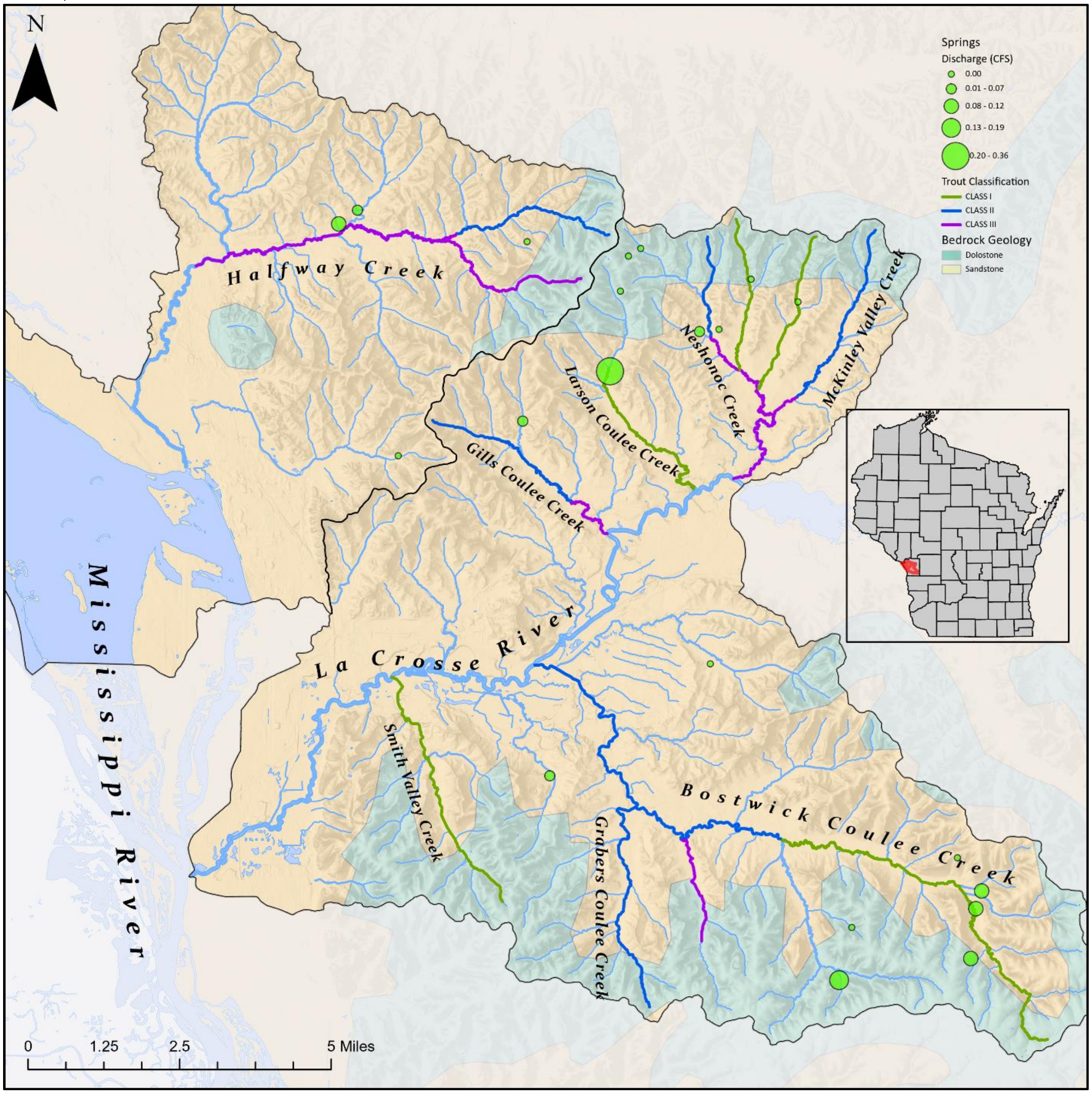

Figure 2A Location and date of trout habitat projects completed in the Lower La Crosse and Halfway Creek Watersheds.

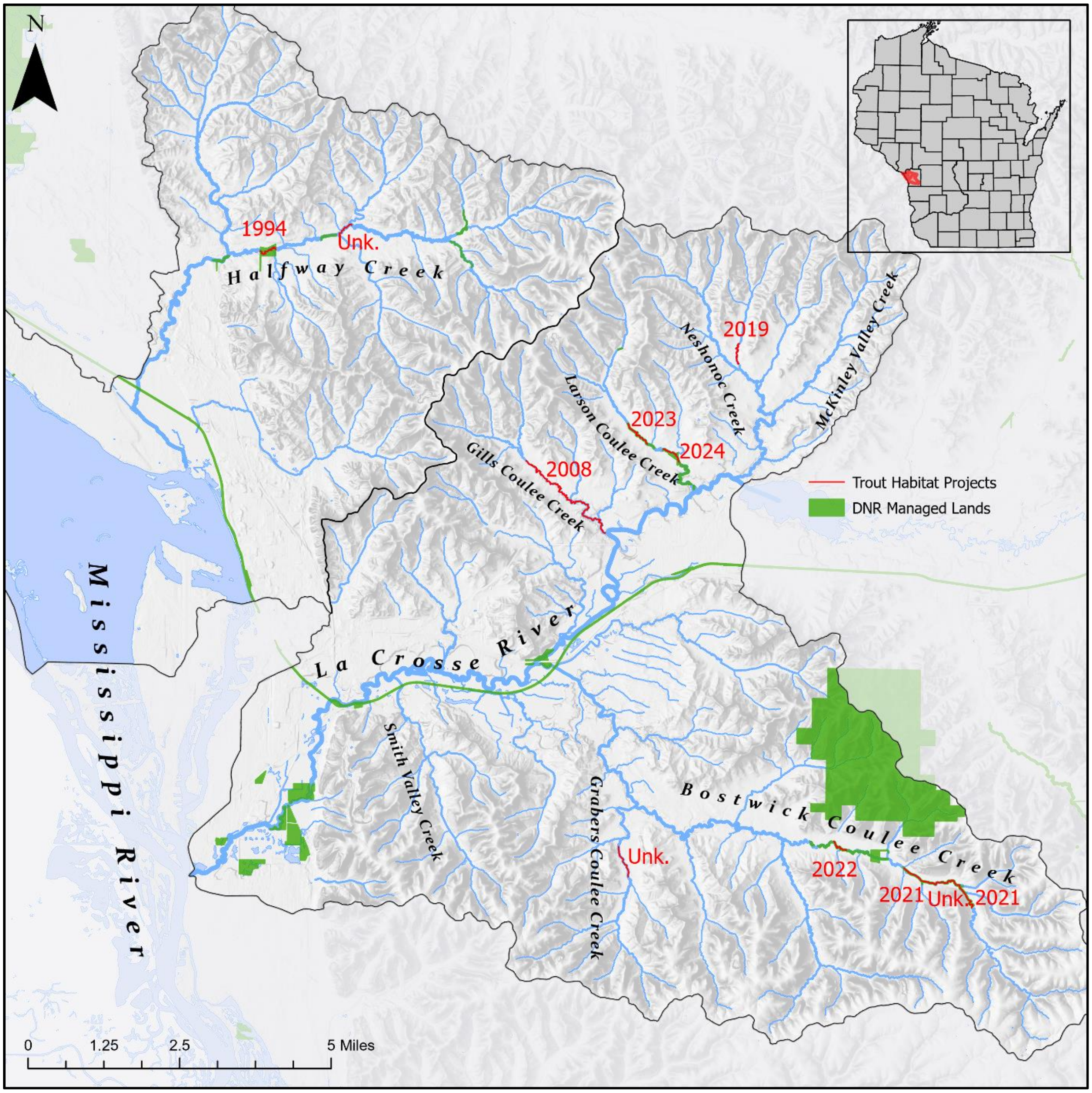

Figure 3A Land cover in the Halfway Creek and Lower La Crosse River Watershed. Land cover based on level 2 Wiscland classifications, updated in 2016.

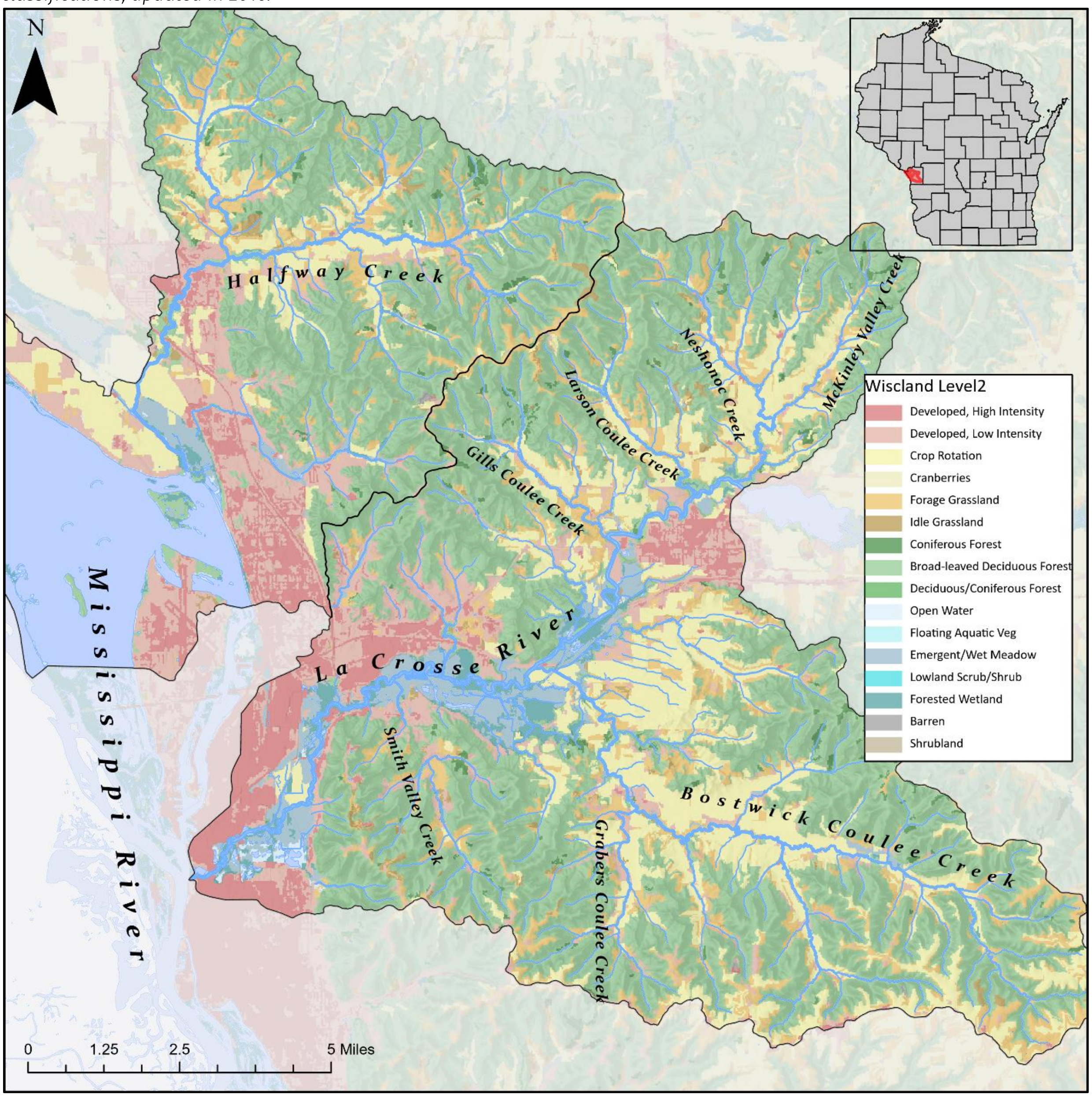

Figure 4A Electrofishing catch per mile of brown trout in 39 sites surveyed in the Lower La Crosse and Halfway Creek watersheds in 2023.

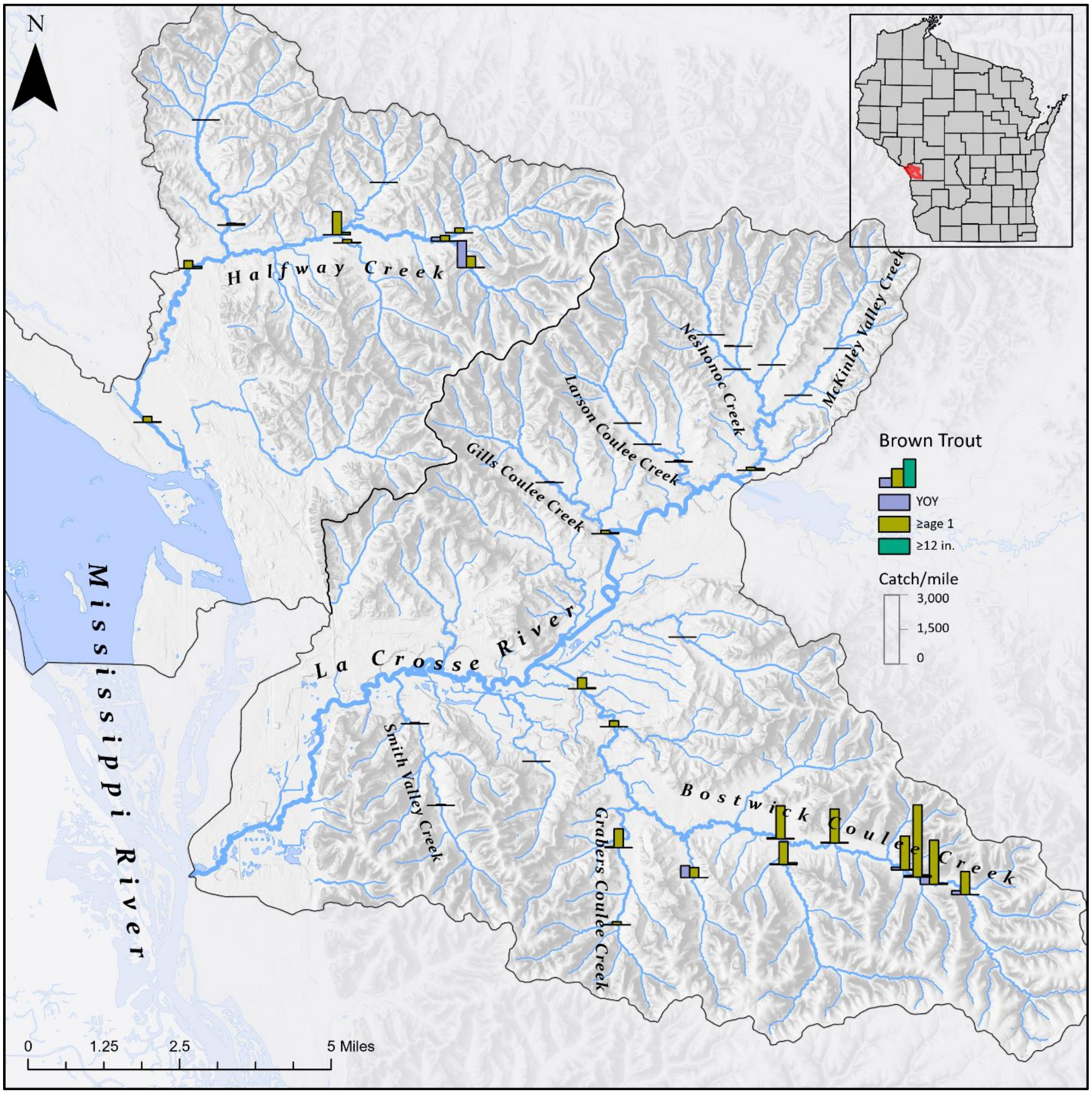

Figure 5A Brown trout mean maximum length (i.e., mean of the five largest individuals) in the 39 sites sampled in 2023 in the Lower La Crosse and Halfway Creek watersheds.

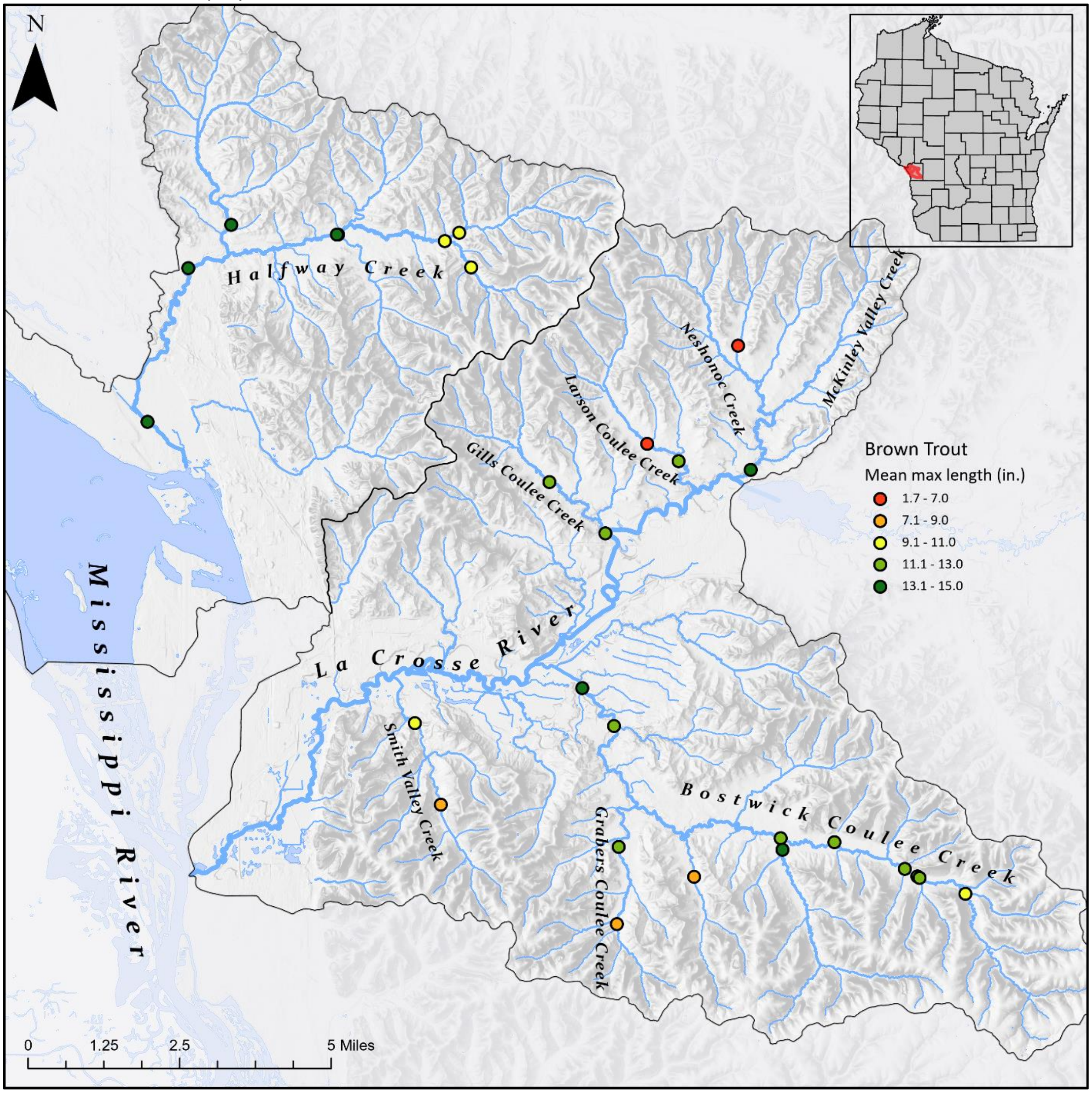

Figure 6A Electrofishing catch per mile of brook trout in 39 sites surveyed in 2023 in the Lower La Crosse and Halfway Creek watersheds. Green shaded area represents designated brook trout Reserve. Green asterisks indicate sites where brook trout occurred in the absence of brown trout.

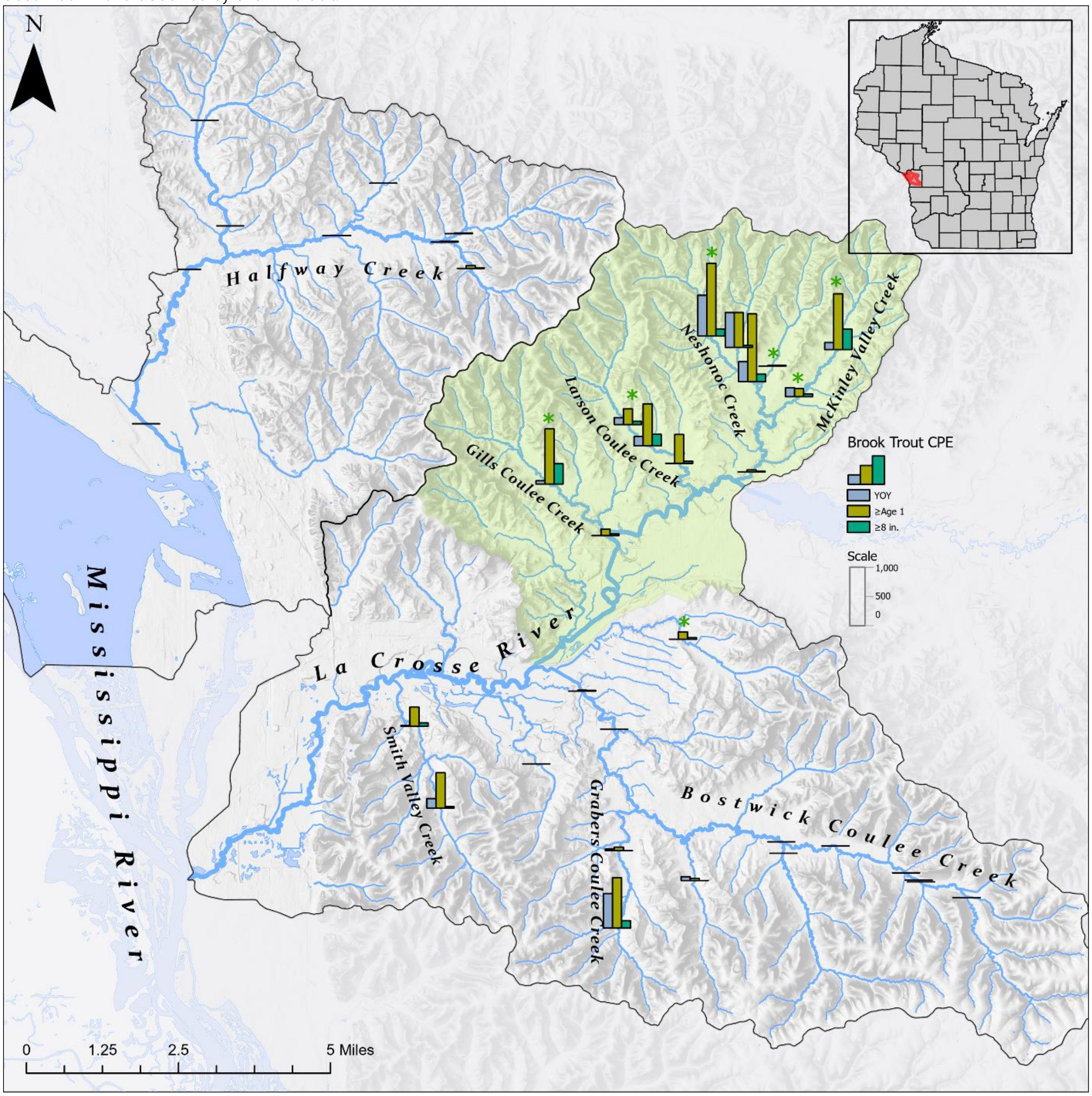

Figure 7A Brook trout mean maximum length (i.e., mean of the five largest individuals), in the Lower La Crosse and Halfway Creek Watersheds.

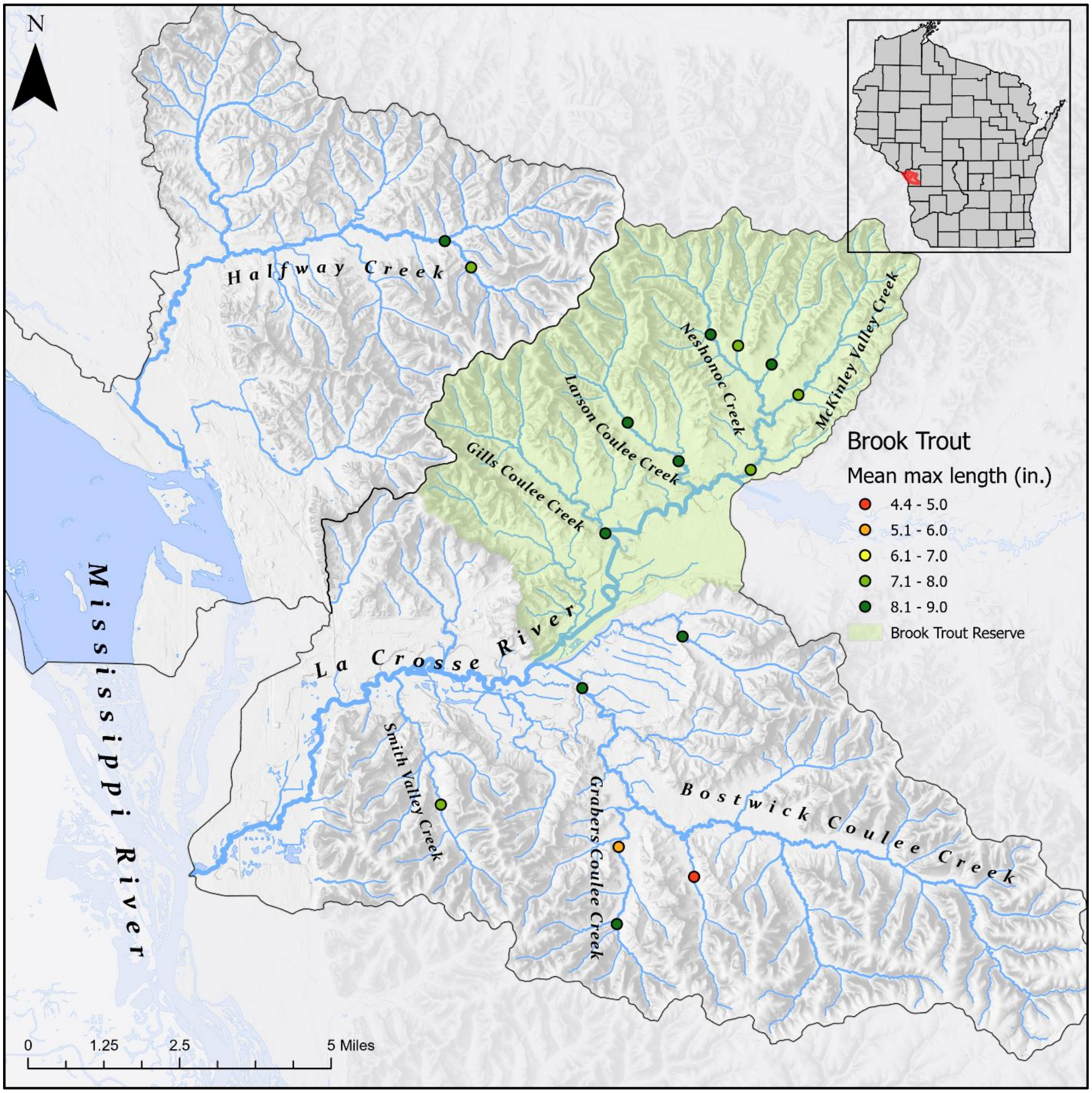

Figure 8A Stream thermal conditions based on July mean water temperature and proportion of cool/cold water stenotherm species captured in electrofishing surveys. Darker green colors reflect colder summer stream temperatures.

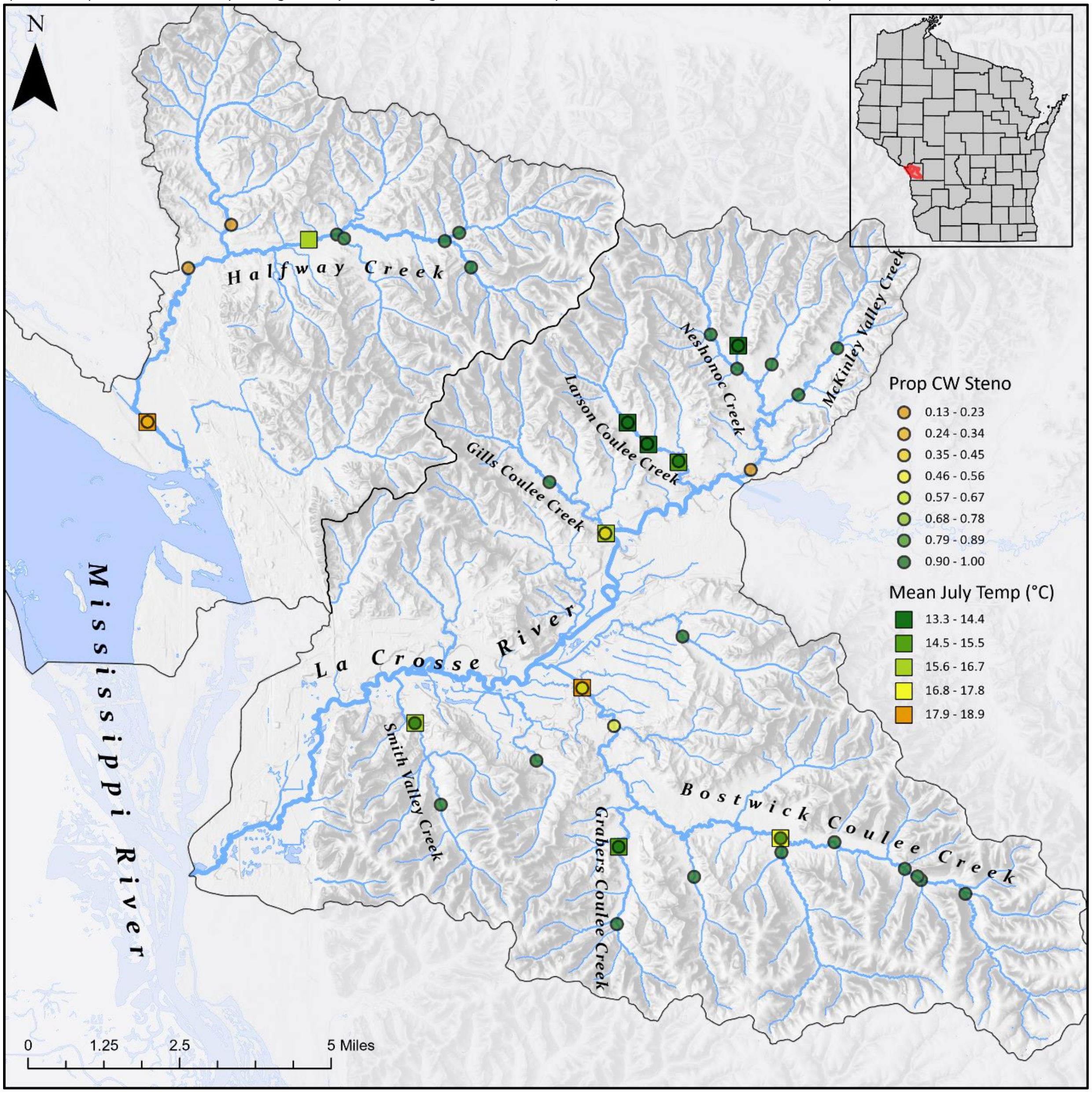

Figure 9A Predicted (2081-2100) July mean stream temperatures from the FishVis (Stewart et al. 2016).