Lower Bois Brule River Creel Survey
Douglas County, Wisconsin
2016-2018

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Abstract

The Wisconsin Department of Natural Resources (DNR) conducted a creel survey on the lower Bois Brule River from fall 2016 through spring 2018 to document angler pressure, harvest and catch rates of lake-run salmonids. The survey in-part used trail cameras, which were found to effectively monitor angler pressure and resource popularity on this high-profile recreational fishery. This was the first creel survey in Wisconsin to use the technology. A post-creel-survey angler questionnaire was also used to document angler demographics and perceptions of the fishery. In-person creel and remote trail cameras displayed similar trends in angler pressure by season, with highest pressure in the fall, followed by the spring. Slightly less than 70,000 angler-hours were estimated for those seasons, and steelhead was the most targeted species.

Total steelhead catch during each of the two survey years was 5,623 and 6,240, which either approached or exceeded the total run and thus demonstrated the species' vulnerability to harvest without the protective regulations and catch-and-release fishing that are currently in place and commonly practiced. Harvest was correspondingly low, with an exploitation rate of 3% in each year. Brown Trout, Chinook Salmon and Coho Salmon catches were lower, though more commonly harvested, compared to steelhead.

Most anglers resided in Minnesota and Wisconsin, and Minnesota anglers outnumbered Wisconsin anglers. More anglers fly fished than those who fished with artificial lures and bait. Overall, anglers were satisfied with their fishing experience, the lower river fishery and its management. Unsatisfied anglers cited excessive angler pressure and crowding as the primary reason for dissatisfaction. Angler recruitment was stable compared to other popular coldwater sport fisheries in the state.

When compared with previous lower river creel surveys over the past 70 years, the lengths of angler-caught adult steelhead were variable and without apparent trend, which likely reflected Lake Superior's influence on growth through variable environmental, forage and other conditions. The lower river fishery and its management were generally viewed with many different perspectives, though several topics were found to uniformly appeal. The survey did not indicate the need for regulation changes at this time. Future creel surveys, angler questionnaires, quantitative fisheries surveys, and a focus on steelhead management will continue to be necessary on the lower river.

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Introduction

Recreational fishing is arguably the most popular outdoor activity on the lower Bois Brule River in the spring and fall of any given calendar year. From its mouth at Lake Superior upstream to U.S. Highway 2 in the Town of Brule, the locally and regionally known “lower river” has attracted generations of Lake Superior migratory trout and salmon anglers, the most common of which are shown in Appendix 1.

Steelhead (Rainbow Trout; *Oncorhynchus mykiss*) has been documented for decades as the target species in the lower river. (Niemuth 1970; DuBois and Pratt 1994). However, other species such as Brown Trout (*Salmo trutta*), Coho Salmon (*O. kisutch*) and Chinook Salmon (*O. tshawytscha*) have broadened the angling opportunities and helped create a unique lower river sport fishery. Pink Salmon (*O. gorbuscha*) and Atlantic Salmon (*S. salar*) have occasionally been observed over the years, as has the migratory (“coaster” or “coastal”) form of Brook Trout (*Salvelinus fontinalis*), the only salmonid native to the river. The lower river’s historic and contemporary popularity demonstrate the continual need to collect data to compute angler pressure, catch rates, harvest rates and exploitation to inform fisheries management decisions and identify challenges facing the steelhead fishery.

Angler interests in the lower river’s fish populations date to the 1870s (Scholl et al. 1984), with the observations of abundant migratory Brook Trout during that time (O’Donnell 1944). Intense fishing pressure and aggressive landscape alterations from the late 1800s through early 1900s catalyzed over-exploitation and instream habitat degradation, which decimated the Brook Trout population. The recreational fishery subsequently shifted when domestic strains of Brook Trout and non-native Rainbow Trout were introduced in the river in the 1890s (O’Donnell 1945; MacCrimmon and Gots 1972) and Brown Trout in 1920 (O’Donnell 1945). These species were joined in the early 1970s by stray Pacific salmonids such as Chinook Salmon and Coho Salmon from introductions outside Wisconsin.

Numerous creel surveys have been conducted over the past 80 years: 1936, 1940, 1943-44 (O’Donnell 1945); 1948-49 (Brasch 1950); 1954 (Daly 1954); 1962-64 (Niemuth 1970); 1973 (Swanson 1974); 1978-79 (Scholl et al. 1984); 1984, 1986, 1990 and 1992 (DuBois and Pratt 1994), and their location and timing varied by season and river segment. The most recent lower river creel survey was conducted specifically for steelhead during the spring and fall of 1990.

The absence of a creel survey since 1990, the lower-than-average steelhead runs from 2011 through 2015, anecdotal reports of decreased angler catch rates during this period and indiscriminate suggestions for regulation changes, prompted a new lower river survey that evaluated angler catch, harvest, pressure and systematically documented the perceptions of the fishery and its management. We developed a standard in-person creel survey, deployed remote trail cameras and distributed an angler questionnaire. The objectives of this report were to: (1) summarize the findings from angler interviews, remote trail camera records and angler questionnaire; (2) discuss the findings relative to previous creel surveys and DNR fishway data; (3) discuss the findings in a regional and national context and (4) present management recommendations for the lower river.

Study Area

The Bois Brule River has been described or recapitulated by numerous authors over the last 75 years (Bean and Thomson 1944; Salli 1962; Scholl et al. 1984; Dubois and Pratt 1994) and is excerpted here to provide general background for the sport angler. The lower Bois Brule River possesses unique hydraulic and hydrologic characteristics along its 24.5-mile course through rural northern Wisconsin (**Fig. 1**). The lower river flows through a mixed upland landscape of forest and farmland and is underlain by abundant remnant red clay soils that once composed the bottom of glacial Lake Duluth (Bean and Thomson 1944). In addition to its upstream groundwater sources, the lower river responds significantly and rapidly to rainfall and snowmelt events. The common heavy sediment-laden runoff noted earlier by Bean and Thomson, Jr. (1944) persists today, as do variable meso-habitats of slow, deep sand-silt meanders, gravel-cobble-boulder rapids and bedrock ledges with interspersed large wood and dense streamside speckled alder (**Fig. 2**).

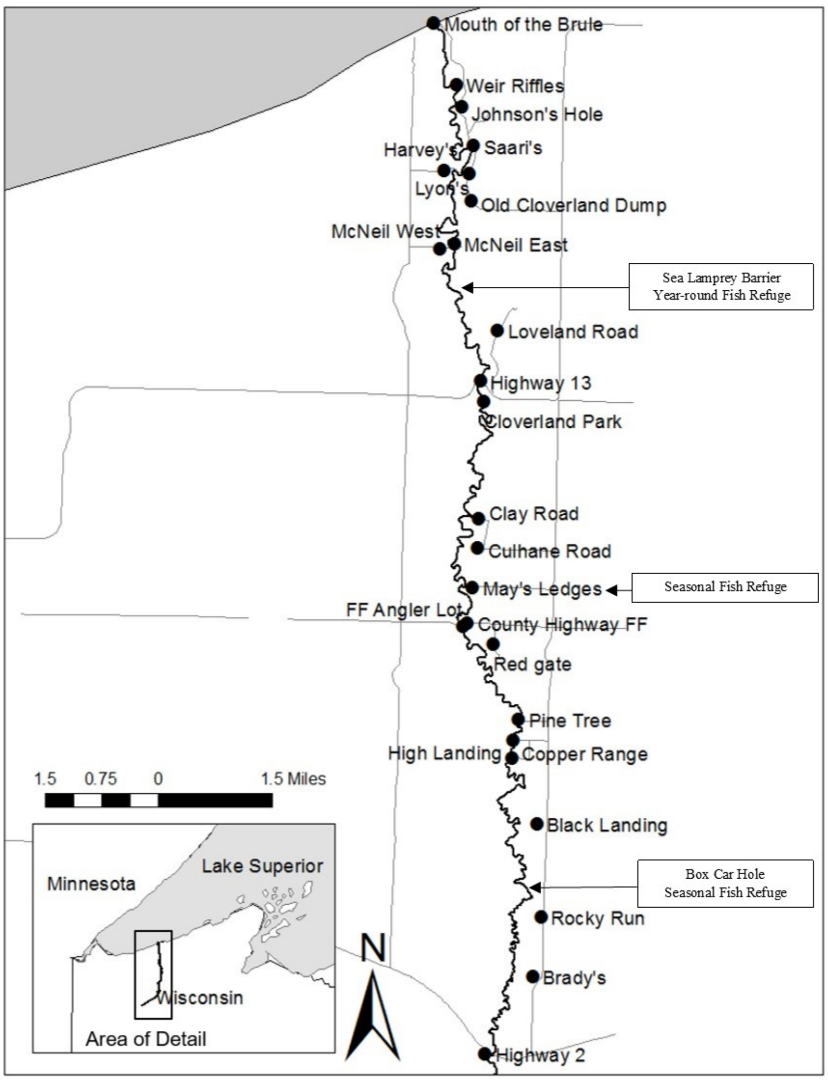


Figure 1. Lower Bois Brule River map and creel survey area.

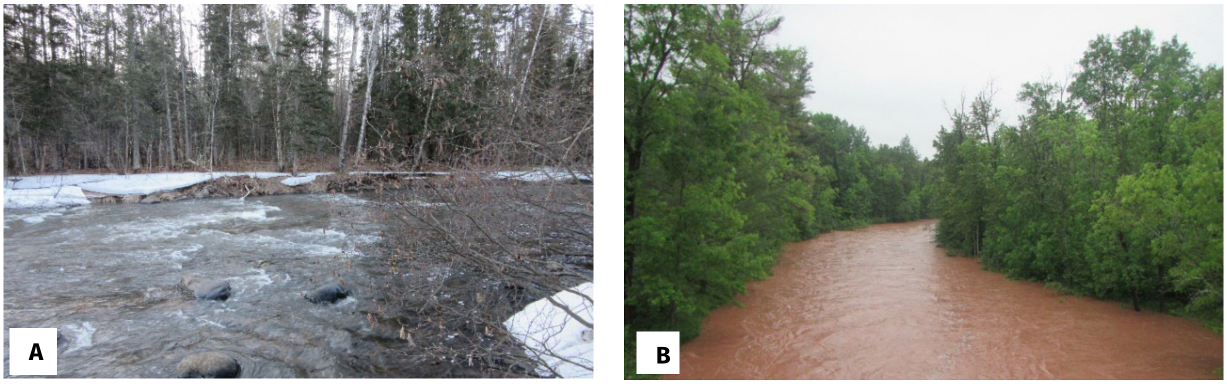


Figure 2. Lower Bois Brule River physical features: early spring (Photo A); following summer rain event (Photo B). Credits: Wisconsin DNR.

The lower river is sourced by its counterpart “upper river,” which, while also set in a rural, forested landscape, boasts unique hydraulic and hydrologic characteristics unlike the lower river. The upper river and its watershed drain the pitted glacial outwash formed by the burial and subsequent melting of ice blocks during Pleistocene glacial times (Bean and Thomson 1944). The upper river’s headwaters conveys the outlet of Glacial Lake Duluth (Leverett 1928); the glacial outwash (mainly sand), long known as “the Barrens,” that extends over 100 miles northeasterly into the Bayfield Peninsula shapes the upper river’s rich springs and establishes a distinctive aquatic environment unmatched by any other in the region. The outwash absorbs (rather than sheds) a high percentage of rainfall that gravitationally seeps into the groundwater table, which delivers the water at a uniform rate to the upper river (Bean and Thomson 1944). DuBois and Pratt (1994) noted this stabilizes the river flow regime and moderates water temperatures.

A prominent feature of the lower river is the constructed sea lamprey barrier and companion fishway (**Fig. 3**) approximately six miles upstream from Lake Superior. The barrier was installed in 1986 to reduce the river’s contribution to Lake Superior’s sea lamprey population by blocking individual lamprey from migrating upstream to preferred spawning areas. Simultaneous concerns for sea lamprey control and the barrier’s effects on migratory trout and salmon passage spurred a DNR-managed video recording program to confirm salmonid passage and validate fishway design. While the video recording program had revealed acceptable passage, it remained active into present times to monitor the migratory fish community. A fish refuge exists adjacent to the barrier and fishway, where fishing is prohibited within 500 feet upstream and 500 feet downstream.

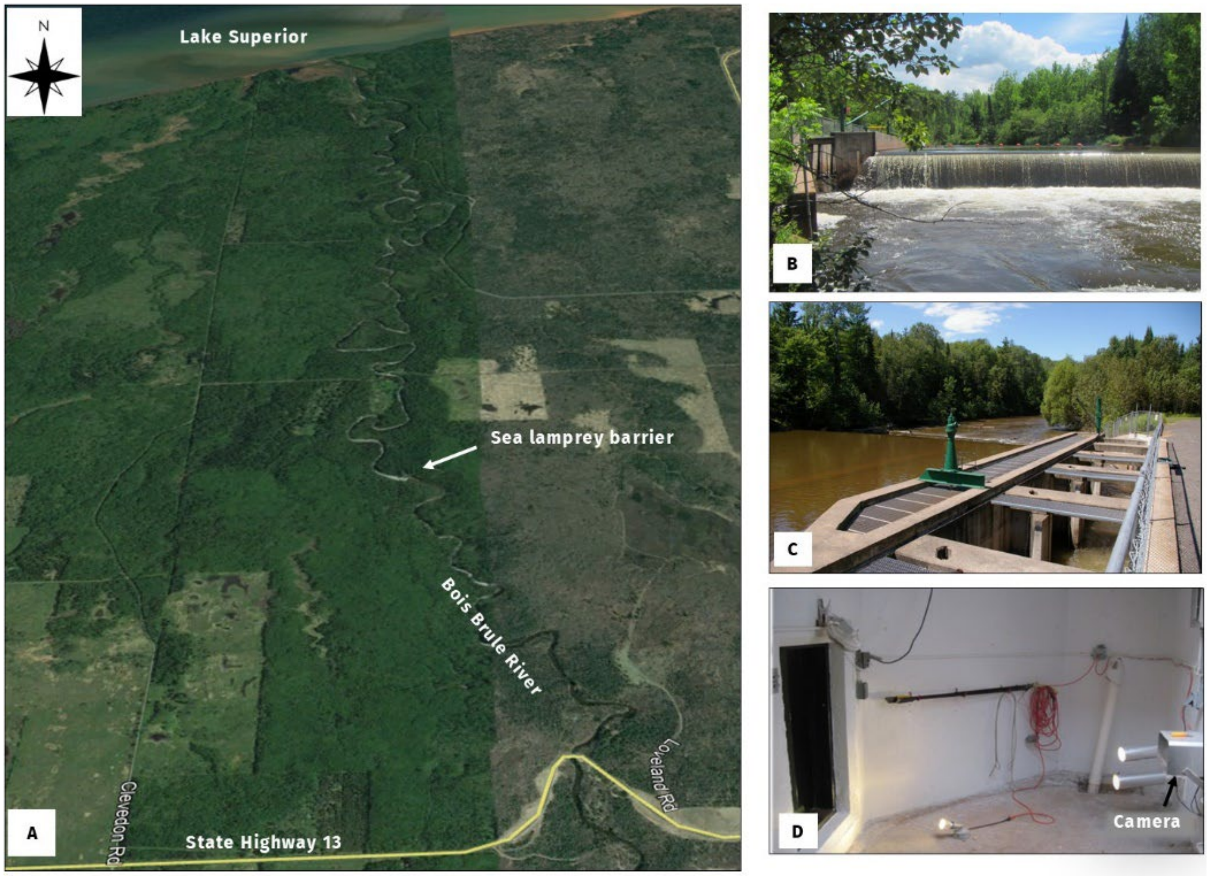


Figure 3. Lower Bois Brule River sea lamprey barrier and fishway. A—Aerial photograph looking downstream (north), Credit: Google Earth; B—sea lamprey barrier and fishway entrance looking upstream. C—fishway looking downstream. D—fishway video camera and observation window. Credits: Wisconsin DNR.

DuBois and Pratt (1994) described the various fisheries management techniques implemented over the years throughout the lower and upper rivers. These included stocking, length and bag limits, open and closed seasons, refuges and in-channel habitat modifications. Today's early spring season and extended fall season were derivatives of seasons noted by (Brasch 1950) during and prior to 1948 that were intended to provide harvest opportunities for lake-run salmonids not otherwise offered in the sport fisheries during other times of the year. The current season is from the last Saturday in March to Nov. 15. Fluctuating length limits over the years eventually culminated in today's 26-inch minimum length limit for steelhead, inaugurated in 1993, to allow adult steelhead to spawn at least once before being legally harvested. This limit had increased from the 12-inch minimum length, along with lower bag limits, imposed in 1989 to reduce harvest of pre-smolt salmonids as well as larger, stream-resident Brown Trout (DuBois and Pratt 1994). Seasonal no-fishing refuges exist at the locally known "Box Car Hole" from July 15 to Oct. 31 and "Mays Ledges" from Sept. 1 to May 31 (**Fig. 1**), while a year-round no-fishing refuge exists within 500 feet upstream and 500 feet downstream of the sea lamprey barrier.

Methods

The lower Bois Brule River sport fishery was surveyed using a combination of standard, in-person, creel survey methods, supplemented by angler vehicle monitoring via remote, motion-detecting cameras (i.e., trail cameras). The creel survey encompassed 25 public access points that consisted of gravel parking areas and mainly single-track walking trails between the parking areas and river. The survey spanned the course of two steelhead run years (July 2016–May 2017 and July 2017–May 2018) each partitioned into three major strata (Brown Run, Fall Run, Steelhead Run) based on expected variation in angler pressure and lake-run salmonid phenology (i.e., timing of spawning migrations) in the lower river (**Table 1**). The two-year period was intentionally planned to accommodate any environmental changes such as weather and river flow.

Table 1. Run years and stratum assignments for the 2016-2018 lower Bois Brule River creel survey. Asterisks indicate periods of non-camera use and only in-person surveys were conducted.

	RUN YEAR: FALL 2016-SPRING 2017		RUN YEAR: FALL 2017-SPRING 2018	
STRATA	Start	End	Start	End
BN	7/15/2016*	9/11/2016*	7/17/2017	9/10/2017
FR	9/12/2016* (9/23/2016)	11/15/2016	9/11/2017	11/15/2017
SR	3/25/2017	5/28/2017	3/31/2018	5/20/2018

ENVIRONMENTAL CONDITIONS

The two-year creel period intended to capture any variability of meteorological and stream flow conditions between those years. Average air temperatures and cumulative precipitation were calculated from National Oceanic and Atmospheric Administration (NOAA) measurements on the mainstem Bois Brule River (Global Historical Climatology Network ID no. USC00471131). The average river flow was calculated from United States Geological Survey (USGS) stream gauge measurements on the mainstem Bois Brule River (ID no. 0402550), 1.4 miles downstream from Nebagamon Creek and 1.7 miles upstream from Little Bois Brule River. Meteorological and stream flow data were downloaded from NOAA and USGS websites, then summarized and analyzed with descriptive statistics (e.g., maximum, average, etc.).

IN-PERSON CREEL

The in-person portion of the creel survey was completed by a single, full-time (i.e., 40 hours per week) creel clerk following a stratified random bus-route sampling design (e.g., Pollock et al. 1994, Jones and Pollock 2012). The creel clerk was randomly assigned a morning (AM, 6:00-14:00) or evening (PM, 14:00–22:00) shift on three random weekdays, every weekend day and national holiday. During the fall, the creel clerk's evening shift was adjusted to match the legal fishing day on the lower Brule River (i.e., not to exceed 0.5 hours after sunset). The clerk was assigned one of three loops (**Appendix 2**), based on a weighted-random assignment using information from opening day (i.e., last Saturday in March) car counts on the lower Brule collected between 1986-2016 (DNR files). The creel clerk began the shift at a randomly assigned access point within the loop and was randomly assigned a clockwise or counterclockwise direction of travel. Creel clerk time allotments at each angler access are also shown in **Appendix 2** and were weighted based on opening day car counts from 1986-

2016. The creel clerk recorded the number of vehicles upon arrival and departure from each access point and interviewed anglers who had completed their fishing trips during the clerk's scheduled time at an access point. When time allowed, creel clerks opportunistically collected completed angler interviews at unscheduled access points. Incomplete fishing trip interviews were also occasionally collected, but these were later excluded from certain analyses where incomplete interviews could bias estimates (e.g., catch rate estimation; Pollock et al. 1994).

Angler interview by DNR Fisheries Technician, Brad Freiherr (right), photographed by DNR trail camera. A harvested Chinook Salmon is present on the measuring board. Credit: Wisconsin DNR.

Anglers fishing as a group were interviewed as one party to increase sampling efficiency. Each interview collected information on catch, harvest, trip length and angler demographics (**Appendix 3**). The creel clerk also recorded whether the interviewee was angling or not and if anglers had completed their trip. All harvested fish were examined by the clerk for fin clips and tags and total lengths were recorded. The clerk also recorded total lengths of released fish reported by anglers. Lastly, the clerk gathered contact information from anglers who volunteered, when asked, in completing an additional questionnaire (described below).

TRAIL CAMERAS

Motion-detecting trail cameras (**Appendix 4**) were installed near the entrance of 21 of the 25 angler access points along the lower river. The remaining four angler access points were excluded because they were located on private property (i.e., Culhane Road and County Highway FF) or because the site lacked a suitable deployment location (i.e., Highway 13 and Highway 2). Trail cameras were mounted 10 to 15 feet high in a 10 to 18-inch diameter (at breast height) tree and angled toward the access road (**Fig. 4**). Based on initial field tests, this setup appeared to increase the likelihood of successfully capturing passing vehicles and was expected to decrease the likelihood of vandalism. Cameras were programmed to take a series of three photos, with one second between each, at each motion-detect event. Trail camera placement was considered acceptable when the camera consistently detected a test vehicle driven to and from the angler access at normal speed (10 to 20 MPH). Signs were posted at each access point to inform users of the presence of trail cameras (**Appendix 5**).

Figure 4. Aerial photograph of Brady's Hole angler access illustrating trail camera placement typical of the lower Bois Brule River creel survey, Credit: Google Earth. Inset photo shows Aaron Nelson, DNR Fisheries Technician, maintaining the trail camera. Credit: Wisconsin DNR.

Photographs were downloaded from cameras on an approximate weekly basis and saved on an external hard drive for processing. Permanent and LTE Fisheries staff assigned to creel survey tasks were authorized to access the photographs. During processing, Fisheries staff recorded the date, arrival and departure times of individual vehicles, and when visible, recorded license plate states to document angler residency (**Fig. 5**).

Figure 5. Example images from lower Bois Brule River creel survey trail cameras showing time and date stamps. Credit: Wisconsin DNR.

ANGLER PRESSURE

The in-person creel survey and trail camera photograph data were used in combination to estimate angler pressure. First, vehicle hours were estimated by trail cameras and creel clerk counts. Angler hours were then estimated for each site (n = 25) and strata (n = 12; i.e., three major run period strata split into weekend and weekdays for each year) combination by multiplying total vehicle hours by mean anglers per vehicle, based on creel interviews. Total angler hours were estimated as the sum of angler hours estimated from trail cameras and, where cameras were not deployed, estimates from the in-person creel survey. Catch and harvest rates were estimated from angler interviews and multiplied by angler pressure to estimate total catch and harvest. Specific calculations are described in detail, below.

Of the 21 angler access points where trail cameras were deployed, it was determined that vehicle counts from one site were not reliable due to the presence of a private residence located off the end of the angler parking area. In addition, cameras were not deployed until 11 days after the 2016 Fall Run stratum had begun and cameras failed at two sites over the course of an entire strata (**Table 1, Table 2**). For the remaining sites and strata, total vehicle hours were estimated from trail cameras by summing the duration all vehicles spent in an angler lot. Vehicles that spent less than 0.5 hours in an angler lot were assumed to not be fishing and were excluded from the estimate of vehicle hours. In some cases, only an arrival or departure photograph of a vehicle was detected. Angler pressure was estimated from these instances for each lot and stratum using the following calculation:

$$ADVH = \left(N - (N \times TA)\right) \times MVH$$

where, $ADVH$ is the estimated vehicle hours from vehicles that were only photographed on arrival or departure, N is the number of vehicles photographed only on arrival or departure, TA is the proportion of vehicles that turned around (i.e., spent less than 0.5 hour at the access point), and MVH is the mean vehicle hours for vehicles that did not turn around. To estimate total vehicle hours, this value was added to vehicle hours from vehicles that were photographed on both arrival and departure for each site and stratum.

The trail cameras occasionally failed due to power loss (i.e., dead batteries), full memory cards or user error (**Table 2**). In these cases, vehicle hours were estimated for the missing period using a reference site, which was based on proximity and similarities in angler pressure. Vehicle hours at the reference site during the missing period were summed and multiplied by a correction factor to calculate the vehicle hours added to the angler lot for the missing period (e.g. van Poorten et al. 2015; Hining and Rash 2016):

$$VH_{am} = VH_{rm} \times \left(\frac{VH_{ap}}{VH_{rp}}\right)$$

where VH_{am} is the estimated vehicle hours at lot a during the time period where the camera malfunctioned m, VH_{rm} is the vehicle hours from a reference lot r during the time period where the camera at site a malfunctioned m, VH_{ap} is vehicle hours from the site where the camera malfunctioned a during a period where the camera at site a was functioning properly p, and VH_{rp} is the vehicle hours for the reference site r during the period where site a had a functioning camera p.

Table 2. Angler access points and remote camera use during the 2016-2018 lower Bois Brule River creel survey, Douglas County.

ACCESS	DAYS SAMPLED	DAYS MISSED	% MISSING
1 - Mouth of the Brule	238	21	9
2 - Weir Riffles	278	14	5
3 - Johnson's Hole	282	10	4
4 - Saari's Lot	284	8	3
5 - Lyon's Lot	270	22	8
6 - Old Cloverland Dump	277	15	5
7 - McNeil's East	282	10	4
8 - McNeil's West	273	19	7
9 - Harvey's	281	11	4
10 - Cloverland Park	241	0	0
11 - Highway 13*	0	-	-
12 - Drew's Landing/Loveland Road	292	0	0
13 - Clay Road/Bachelor's	276	16	6
14 - Culhane Road*	0	-	-
15 - May's Ledges	278	14	5
16 - CTH FF Roadside*	0	-	-
17 - CTH FF Angler Lot	276	16	6
18 - Red Gate**	0	-	-
19 - Pine Tree	292	0	0
20 – Copper Range/Coop Park	264	28	11
21 - High Landing	275	17	6
22 - Black Landing	280	12	4
23 - Rocky Run	292	0	0
24 - Brady's Hole	268	24	9
25 - Highway 2*	0	-	-
	Average	**13**	**5**

**Not installed due to private property or unsuitable deployment locations.*
***Excluded from data analysis due to potential sampling bias from nearby private residence.*

Similar to the in-person creel survey described below, angler hours were estimated from vehicle hours by multiplying vehicle hours by the mean number of anglers per vehicle from the in-person creel survey by major run-period strata. Angler hours were then corrected for non-anglers by multiplying this estimate by the proportion of anglers estimated at each site by major run-period strata from the in-person creel survey.

Daily vehicle hours for each day and site combination for the in-person creel survey were estimated by multiplying the average number of vehicles observed by a creel clerk at a site by the number of hours the creel clerk was present at a site and dividing the result by the proportion of the entire angling day sampled (e.g. Pollock at al. 1994). For example, if the creel clerk observed an average of two vehicles over a one-hour period at a site, and the angling day was 16 hours, we estimated 32 vehicle hours at that site over the course of the angling day (i.e.,$(2\ vehicles \times 1\ hour\ sampled)/(1\ hour\ sampled/16\ hour\ anling\ day) = 32\ vehicle\ hours/day$)). Daily angler hours were then estimated for sampled days by multiplying vehicle hours by mean anglers per vehicle, estimated from angler interviews for each major run period strata. Angler hours were then corrected for non-anglers based on the proportion of non-anglers interviewed at each site for the fall (i.e., Brown Run and Fall Run strata) and spring periods separately, based on expected differences in non-angler use. Non-anglers made up, on average, only 7% of users surveyed at access points and were observed at 12 of the 25 access points. Average daily angler pressure estimates from sampled days were then expanded to the entire stratum (Pollock et al. 1994) and summed to estimate total angler hours. Number of trips was estimated by dividing total angler hours by mean trip length estimated from arrival and departure times via trail cameras by run period strata.

Vehicles parked at Clay Road/Bachelor's on the 2016 early season opening day. Credit: Wisconsin DNR.

Variance and standard error estimates for angler pressure followed calculations recommended by Pollock et al. (1994) for a bus-route sampling design and treating individual days as replicates. Variance and standard errors were estimated from the in-person creel survey for periods when cameras were not deployed and used to estimate 95% confidence interval estimates. It was assumed that trail cameras provided a near-census of angler activity where they were deployed based on the high detection probabilities observed (see evaluation below) and near continuous monitoring of access sites. Due to staffing limitations, several sites were only sampled by the creel clerk once during the weekend 2016 Brown Trout stratum in 2016, a period when trail cameras were not deployed. Because of this, variance could not be estimated from the in-person creel survey for this stratum. However, this stratum was estimated to represent only a small portion of the total angler pressure estimated during the creel survey (3.2% of total angler hours) and its exclusion was not expected to substantially influence variance estimates. 95% confidence intervals were calculated by $\bar{x} \pm z_{\propto/2} \times SE$, where $z_{\propto/2}$ is the upper z-score from a standard normal distribution at ½ of α (i.e., 1.96 for 95% confidence intervals).

CATCH AND HARVEST

Catch and harvest were estimated by multiplying angler pressure (angler hours), for each year, stratum and day type (i.e., weekend or weekday) combination, by catch or harvest rate (fish/hr.). Since the analysis included only completed interviews from access points, catch and harvest rates were estimated as the ratio of means (i.e., mean catch or harvest divided by mean effort; Pollock et al. 1997). Steelhead exceeding 12 inches in total length were considered adult lake run fish as few resident Rainbow Trout are believed to be present in the lower Brule and juveniles typically out-migrate prior to reaching 12 inches in length (Dubois 2001). Brown Trout equal to or greater than 15 inches in length were considered adult lake-run fish based on the greater likelihood of encounter during its migration season within the creel period and it being the typical minimum length of up-migrating lake-run Brown Trout at the fishway (DNR files). Similarly, Brook Trout, Coho Salmon and Chinook Salmon greater than 12 inches were considered adult lake-run fish based on observations from the fishway (DNR files). Exploitation was estimated by dividing total harvest by adult spawning run size estimated from the fishway, as detailed in Dubois and Pratt (1994). In addition, lengths of adult, lake-run salmonids caught by anglers were compared to the adult lake-run population using individual length measurements from the fishway.

Approximate catch and harvest 95% confidence limits were estimated by multiplying catch and harvest rates by upper and lower 95% confidence limits of angler pressure. This approach did not account for variance associated with catch and harvest rate estimation, which biased the 95% confidence intervals to only represent a minimum estimation of true 95% confidence intervals.

IN-PERSON CREEL AND TRAIL CAMERA COMPARISON

We compared estimates of angler pressure between the in-person creel survey and trail cameras at sites and time periods when both methods were deployed (**Table 1, 2**). A staff shortage during the 2017 Brown Run stratum resulted in the creel clerk starting 23 days after the installation of trail cameras. Despite this, we obtained between two and nine samples for all but the weekday stratum at the nine sites, which were expanded to the entire 2017 Brown Run stratum for the in-person creel pressure estimate. Angler pressure was estimated for the missing weekday stratum at nine sites using the same correction described previously for missing trail camera days.

Detection probabilities were estimated for individual trail cameras and evaluated. Detection probability estimates were possible due to the positioning of our trail cameras, which required vehicles to pass by the camera twice. Detection probability, p_i, was estimated using calculations similar to Laughlin et al. (2020),

$$p_i = d_i / s_i$$

where d_i is the number of vehicles detected both entering and departing the access point and s_i are all the vehicles detected passing the camera, including those only detected on arrival or departure. Probability of detecting a vehicle (at least once) was then estimated by

$$p(\mathrm{d})_i = 1 - (1 - p_i)^2.$$

95% confidence intervals for the proportion were estimated assuming a binomial distribution and using the function "binom.test" in Program R ver. 3.5.2 (R Core Team 2018).

Trip length estimates from creel interviews and trail cameras were also compared across the entire creel survey period and among major run strata. Statistical comparisons were completed using non-parametric Kruskal-Wallis test and post-hoc Dunn test using the package "FSA" (Ogle 2016) in Program R ver. 3.5.2 (R Core Team 2018).

ANGLER DEMOGRAPHICS AND RESIDENCY

Demographic and residency information was compared among strata. State residency for the Spring Run stratum was also compared before and after Minnesota's North Shore tributaries creel survey began, around the time of ice-out, to explore pressure on those tributaries and any potential relations to pressure on the lower river. North Shore tributary creel surveys began on April 5, 2017 and April 26, 2018 (Peterson 2017; Peterson 2018).

ANGLER QUESTIONNAIRE

The lower Bois Brule River angler questionnaire was designed to assess angler perceptions and opinions regarding the lower river fishery, separate from the catch information gathered during the creel survey interview. The questionnaire was adapted from Toshner et al. (2016) and consisted of four parts: angling experiences during the creel period (fall 2016 – spring 2018), angler history on the lower river, specific information about fish caught and opinions on regulations and angler demographics. The questionnaire was several pages in length, and therefore intended to be answered separately from the creel interview. All questionnaires were distributed shortly after the conclusion of the two-year creel period to accommodate batch processing and standardization of a contiguous 60-day response period.

During each creel interview, anglers were asked whether they were interested in answering the questionnaire. All anglers who agreed to participate were asked their preference for receiving the questionnaire, either print or electronic edition. Anglers could select only one edition, both of which were exact duplicates. The two editions were intended to minimize cost while reaching as many anglers as possible. Anglers were then asked for their corresponding postal address or email address, depending on the preferred edition. Anglers who received the print edition also received an accompanying postage-paid return envelope. The online edition was created in SurveyMonkey®, the hyperlink for which was sent to anglers. Results were compared across the entire sampled group and among demographics.

Results

ENVIRONMENTAL CONDITIONS

The 2017-2018 survey year was significantly colder (t=4, df=300, p<0.001) and had a significantly higher stream flow (t=24.1, df=23,734, p<0.001) than 2016-2017 (**Table 3**). The 2017-2018 survey year also had higher average cumulative rainfall and more intense rain events (total=16.6 inches; average=0.1-inch per event) than 2016-2017 (total=7.5 inches; average=0.06-inch per event). The six observations of cumulative precipitation were insufficient for statistical analyses relative to stream flow. The average air temperature on opening day was 35°F in 2017 and 19.5°F in 2018, and ice out at Highway 13 occurred on Feb. 20, 2017 and March 15, 2018. Overall, the 2017-2018 survey year was colder, wetter and experienced higher river flows than 2016-2017.

Table 3. Environmental conditions during the 2016-2018 lower Bois Brule River creel survey.

YEAR	STRATA	MEAN AIR TEMPERATURE (ºF)	CUMULATIVE PRECIPITATION (IN)	MEAN DISCHARGE (CFS)
2016 – 2017	BN	65.2	2.7	171.2
	FR	49.2	1.5	156.5
	SR	44.2	3.3	258.6
	Average	52.4	2.5	195.8
2017 – 2018	BN	60.8	4.9	165.6
	FR	43.0	8.6	220.4
	SR	39.9	3.1	261.3
	Average	46.8	5.5	215.6

ANGLER PRESSURE

Over the course of the 2016-2018 creel survey, a total of 3,984 vehicles were counted, 1,316 anglers were interviewed by creel clerks and 20 trail cameras were successfully deployed at angler access points over a period of 292 days (**Table 2**). Total angler pressure during the 2016-2017 and 2017-2018 run years were not significantly different, estimated at 88,124 (95% C.I. = 5,617) and 82,226 (95% C.I. = 4,065) angler hours for the 2016-2017 and 2017-2018 run years, respectively (**Fig. 6**). Based on the 24.5 miles of river sampled, the lower Bois Brule River experienced 19.3 and 19.7 angler hours per mile per day in 2016-2017 and 2017-2018 run years, respectively. Angler pressure exhibited a similar pattern by strata for the two run years, with the Fall Run stratum receiving the most angler pressure, followed by the Spring Run and Brown Run strata (**Fig. 7**).

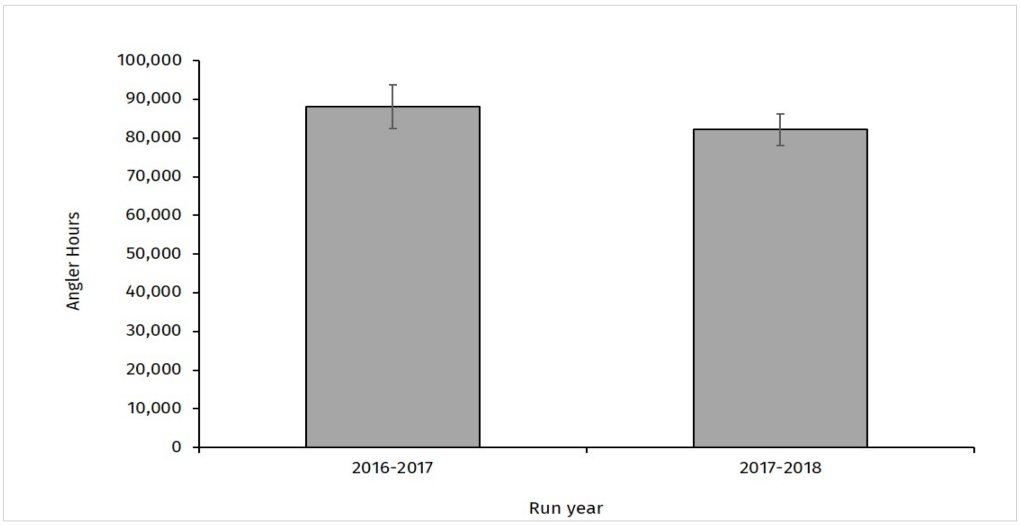


Figure 6. Total angler hours estimated by run year. Error bars represent 95% confidence intervals.

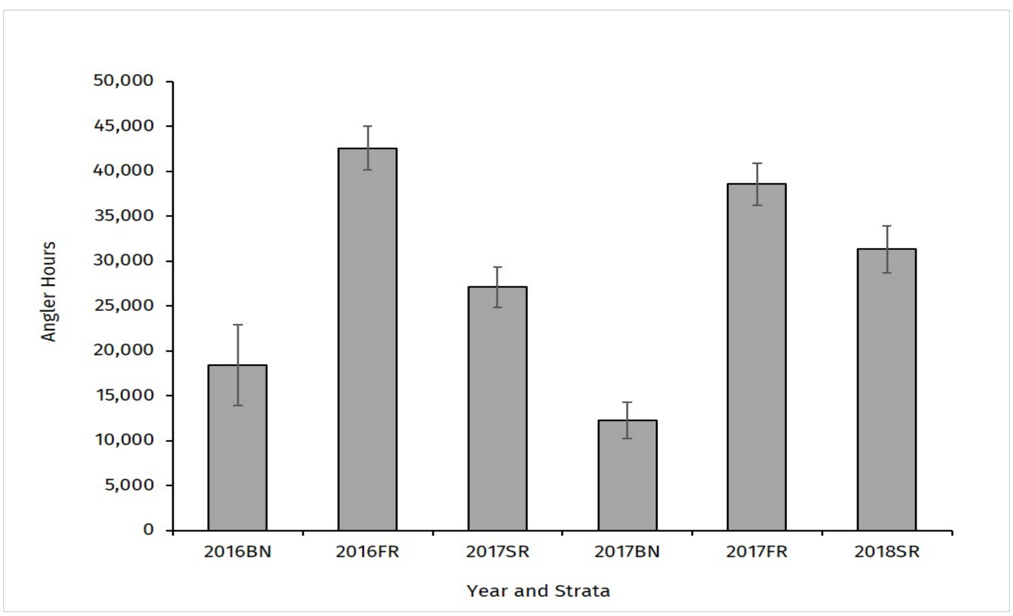


Figure 7. Angler pressure: hours by strata.

Considering the entire creel survey period, angler pressure was concentrated at either end of the survey reach (i.e., Highway 2 and the mouth of the Brule) and throughout the middle portion of the lower river (i.e., High Landing downstream to Clay Rd., **Fig. 8**). Distribution of angler pressure by access site varied by the three run period strata. During the Brown Run, angler pressure was more unevenly distributed than the other two strata, with a greater proportion of angler pressure at the mouth of the Brule and at Highway 2 in Brule, WI (**Fig. 9**). Angler pressure during the Fall and Spring Run periods were more evenly distributed across access points with the greatest proportion of angler pressure occurring in the middle section of the lower river.

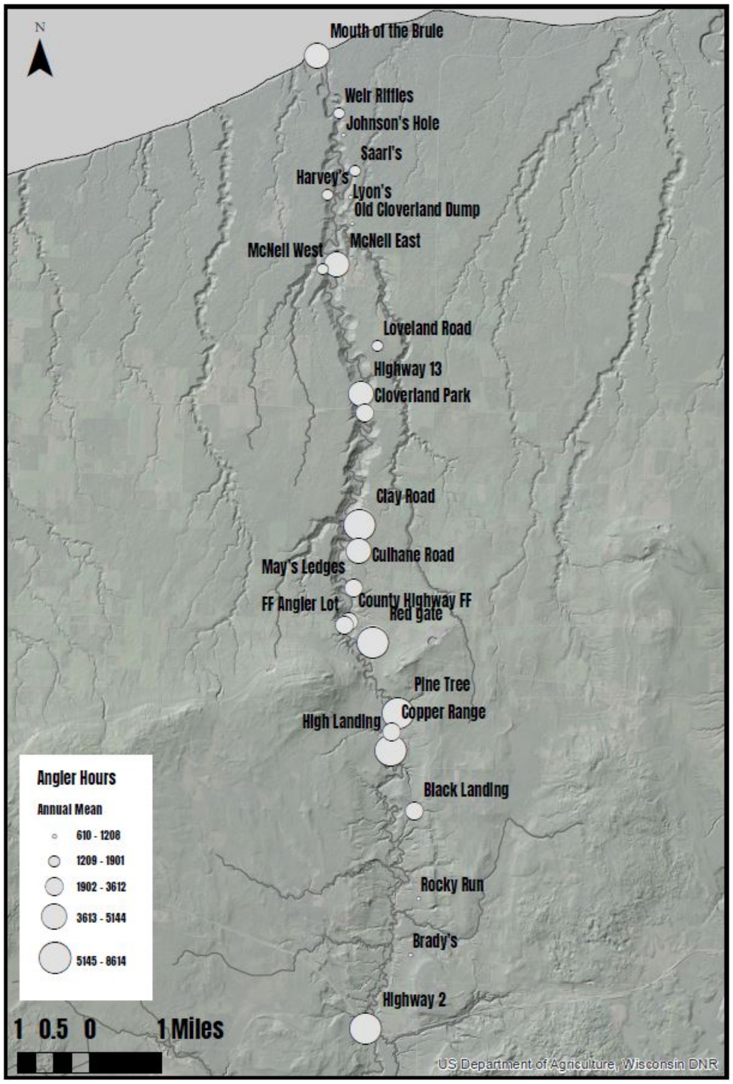


Figure 8. Angler pressure distribution: hours total.

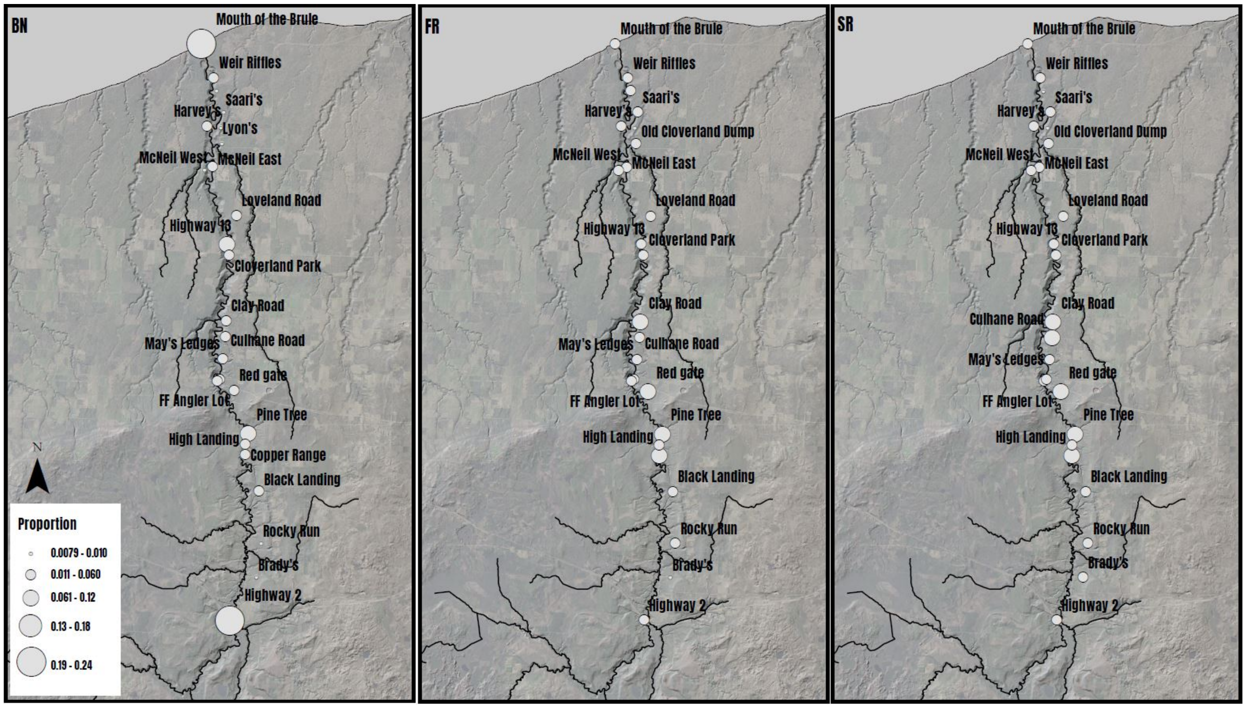


Figure 9. Angler pressure distribution: hours by strata.

Mean angler trip length was estimated at 2.9 hours (S.D. = 2.0, n = 23, 937). Trip length varied significantly among run strata (**Fig. 10**; Dunn Test, P <0.0001 on all comparisons) and differences were greatest between the Brown Run period and Spring and Fall Run periods (Mean ±1SD, Brown Run = 2.2 ±1.7, Fall Run = 2.9 ± 2.0, Spring Run = 3.0 ± 2.1). Based on mean trip length, we estimated that anglers took 31,912 and 29,184 trips in the 2016-2017 and 2017-2018 run periods, respectively.

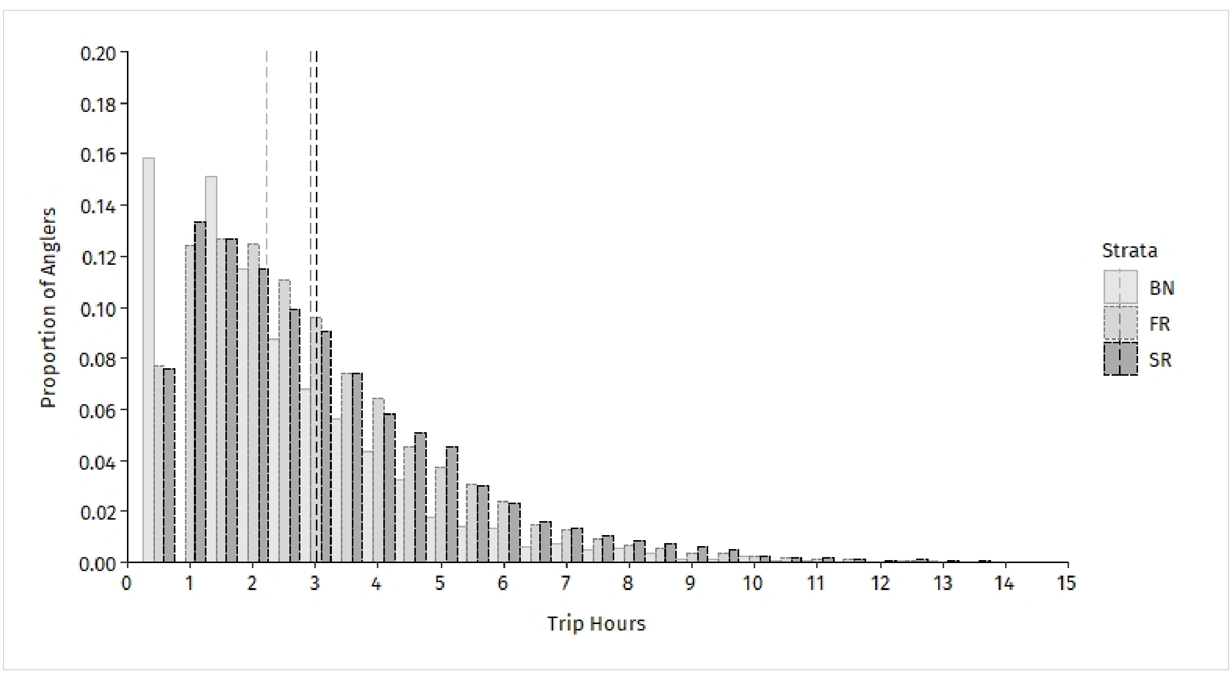


Figure 10. Angler trip length, by strata.

CATCH AND HARVEST

Total angler catch of adult steelhead and Brown Trout were high, estimated at 5,623 and 6,240 adult steelhead during the 2016-2017 and 2017-2018 run years, respectively (**Fig. 11**). These estimates approached the adult steelhead abundance estimate in 2016-2017 (90% of the total run) and exceeded it in 2017-2018 (114% of the total run). In total, anglers caught 1,219 and 2,315 adult Brown Trout in 2016-2017 and 2017-2018, respectively. These estimates were 30 and 63% of the total adult, lake-run Brown Trout abundance in 2016-2017 and 2017-2018, respectively. Anglers caught 100 and 343 Coho Salmon, or four and eight percent of the total Coho Salmon run in 2016-2017 and 2017-2018, respectively. Anglers also caught 28 and 53 Chinook Salmon in 2016-2017 and 2017-2018, respectively, or six percent and 12% of the total Chinook Salmon run. Steelhead catch was greatest during Fall or Spring Run strata, with considerably fewer fish caught during the Brown Run stratum (**Fig. 12**). Brown Trout catches were greatest in the Fall Run period during the 2016-2017 run period and similar among strata during the 2017-2018 run period. Chinook and Coho catches occurred only during the Brown Run or Fall Run strata.

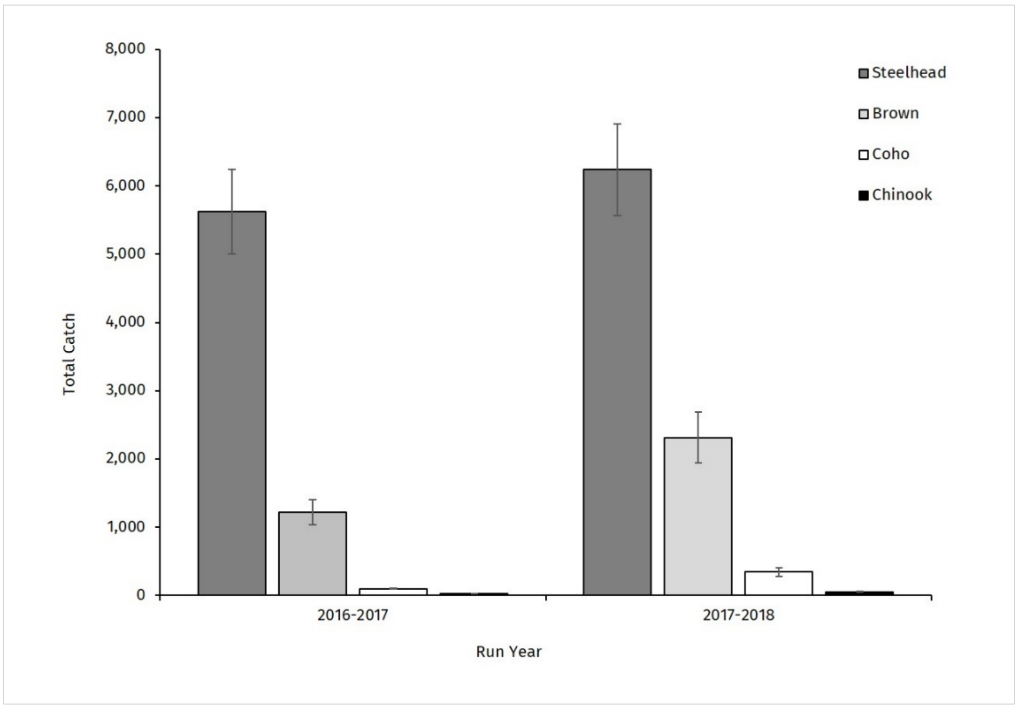


Figure 11. Angler catch by run year.

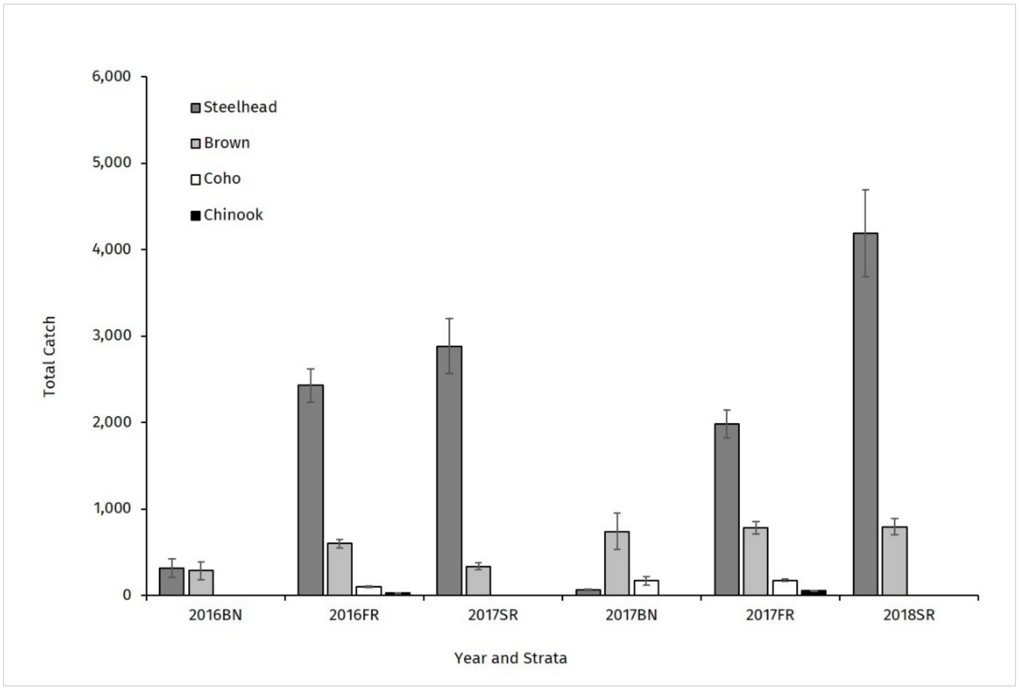


Figure 12. Angler catch by year and strata.

The average steelhead catch rate was 0.09 fish/hr. (i.e., one fish per 11 hours). The highest steelhead catch rates occurred during the Spring Run stratum (mean = 0.15 fish/hr.), followed by the Fall Run (mean = 0.066 fish/hr.), and the Brown Run (mean = 0.034 fish/hr. **Table 4**). Lake-run Brown Trout catch rate was 0.024 fish/hr. (i.e., one fish per 42 hours), on average, and the rates varied among strata 0.014 to 0.037 fish/hr for Brown Run in 2016 and Brown Run in 2017, respectively (**Table 4**). Coho and Chinook Salmon catch rates were low across all three run periods (<0.0067 fish/hr.) and 0 for the Spring Run. Putative resident Brook and Brown Trout catch rates were greatest during the Brown Run stratum (Brook Trout = 0.071 fish/hr., Brown Trout = 0.15 fish/hr.) and lower during the remaining run strata (Brook Trout = 0.0033 – 0.0059 fish/hr., Brown Trout = 0.057 - 0.073 fish/hr.).

Table 4. Average angler catch-per-hour of adult lake-run Brown Trout, steelhead, Coho and Chinook Salmon during the 2016-2018 creel survey on the lower Bois Brule River.

			CATCH PER HOUR			
RUN YEAR	**YEAR**	**STRATA**	**Brown**	**Steelhead**	**Coho**	**Chinook**
2016-2017	2016	BN	0.014	0.043	0.000	0.000
2016-2017	2016	FR	0.020	0.075	0.003	0.004
2016-2017	2017	SR	0.017	0.124	0.000	0.000
2017-2018	2017	BN	0.037	0.012	0.018	0.003
2017-2018	2017	FR	0.022	0.058	0.006	0.009
2017-2018	2018	SR	0.033	0.172	0.000	0.000

Angler caught and released steelhead were generally smaller than those measured passing the fishway window at the sea lamprey barrier (**Fig. 13**, K-W test, P <0.0001; mean ± 1 S.D., fishway = 22.0 ± 4.4, caught and released = 20.1 ± 5.0). Fish greater than 22 inches were under-represented in the angler catch, relative to the adult lake-run population in the river, while fish less than 22 inches were over-represented in angler catch. Harvested and measured fish ranged from 26 to 27 inches, though also included 15-inch fish.

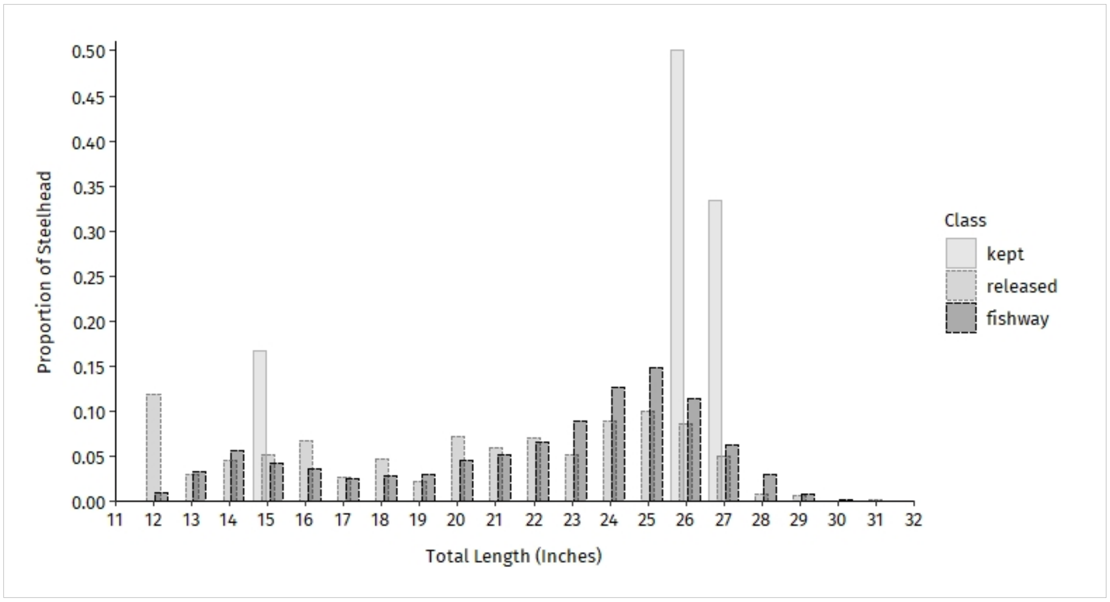


Figure 13. Steelhead length distribution, 2016-2018: fishway video records and angler caught.

Distributions of angler caught and released and harvested lake-run Brown Trout and those measured passing the fishway were substantially different (**Fig. 14**). While the population passing the fishway window exhibited a normal distribution, with a single mode at 23 inches, caught and released fish exhibited a right skew, with fish less than 19 inches generally over-represented in angler caught and released fish. The distribution of angler harvested fish was bimodal, with fish from 16 to 18 inches and 26 to 27 inches over-represented in angler harvest, relative to the river's adult lake-run population.

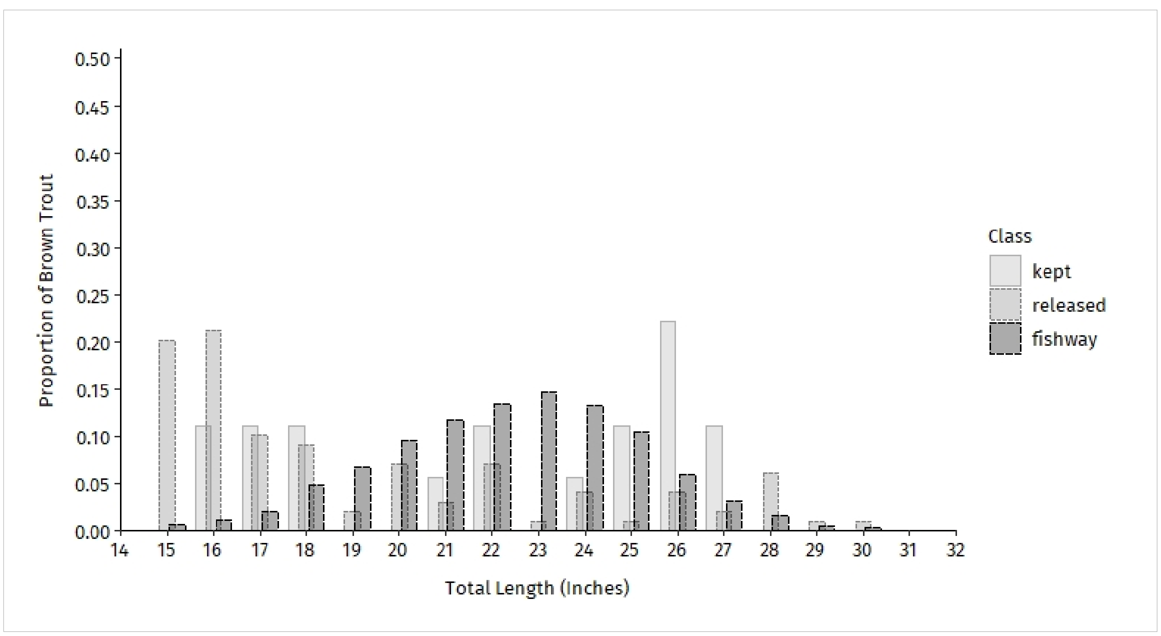


Figure 14. Brown Trout length distribution, 2016-2018: fishway video records and angler caught.

Anglers also caught salmonids that were either juveniles or putative residents. Juvenile steelhead made up the largest portion of the catch of salmonids in this group, with anglers catching 23,269 fish and 7,976 fish in 2016-2017 and 2017-2018, respectively (**Fig. 15**). Putative resident Brown Trout were also a component of the catch, with anglers catching 760 fish and

853 fish in 2016-2017 and 2017-2018, respectively. Brook Trout and Coho Salmon were less common, and no catches of juvenile Chinook Salmon were reported. Harvest of juvenile or resident salmonids was low, occurred only in the 2016-2017 run year, and was composed of putative resident Brown and Brook Trout (**Fig. 16**).

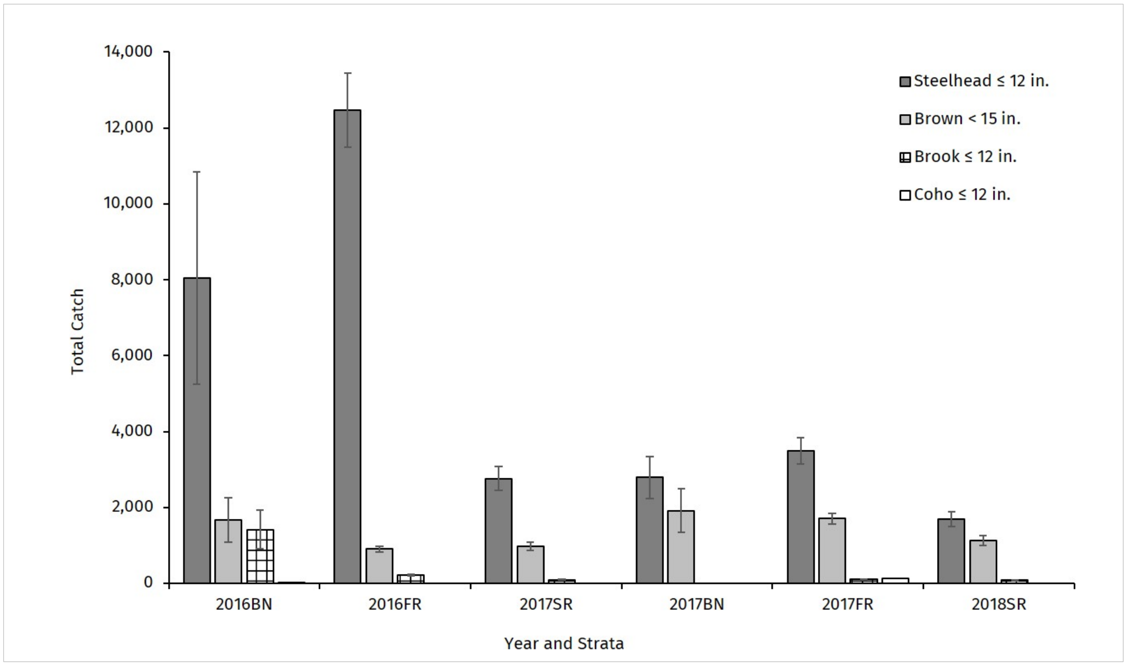


Figure 15. Juvenile salmonids catch by year and strata.

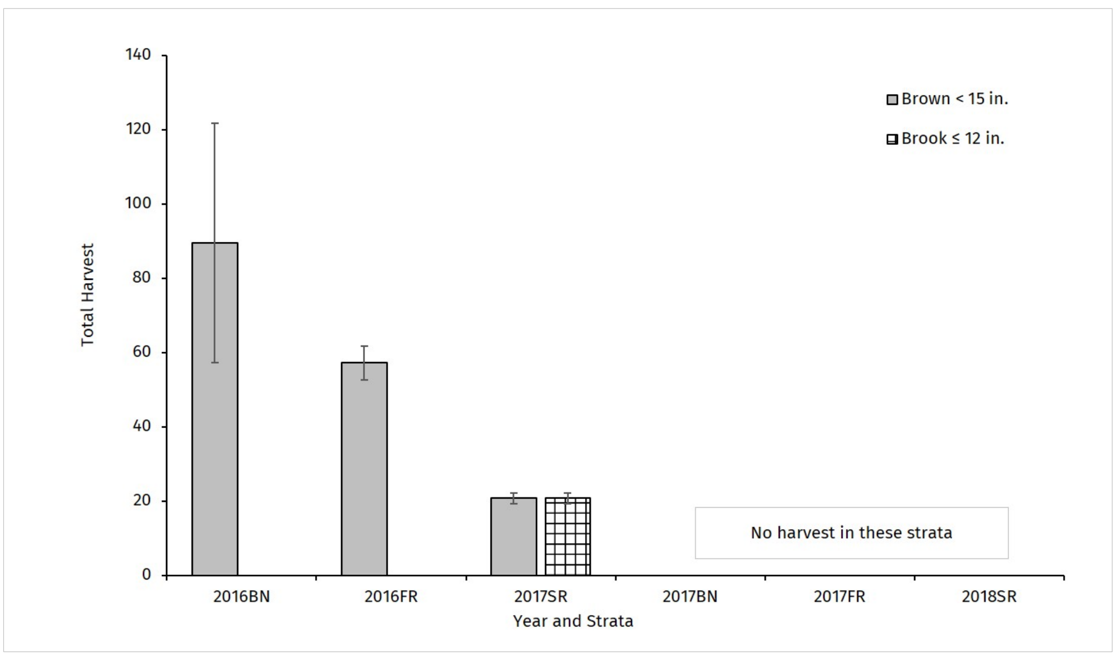


Figure 16. Harvest of juvenile putative and resident Brown Trout and Brook Trout.

In contrast to the high catch, anglers did not commonly harvest fish from the lower river. Only 43 of the 1,168 completed trip interviews (3.6%) included anglers who harvested fish. Based on upper 95% confidence limits, steelhead total harvest in both run years was less than or marginally exceeded 200 fish (**Fig. 17**). Of those, up to 34 were sub-legal (**Fig. 13**). Based on the abundance of adult migratory fish counted at the lower fishway (**Table 5**), exploitation of steelhead was 3% in both years. Harvest of other adult migratory salmonids was similarly low, with upper 95% confidence limit estimates never exceeding 350 fish (**Fig. 17**) and exploitation ranging from 3 to 12% (**Table 5**). Steelhead and Brown Trout harvest were greatest during the Fall Run stratum (**Fig. 18**). Coho and Chinook Salmon harvest was greatest during the Brown or Fall Run stratum.

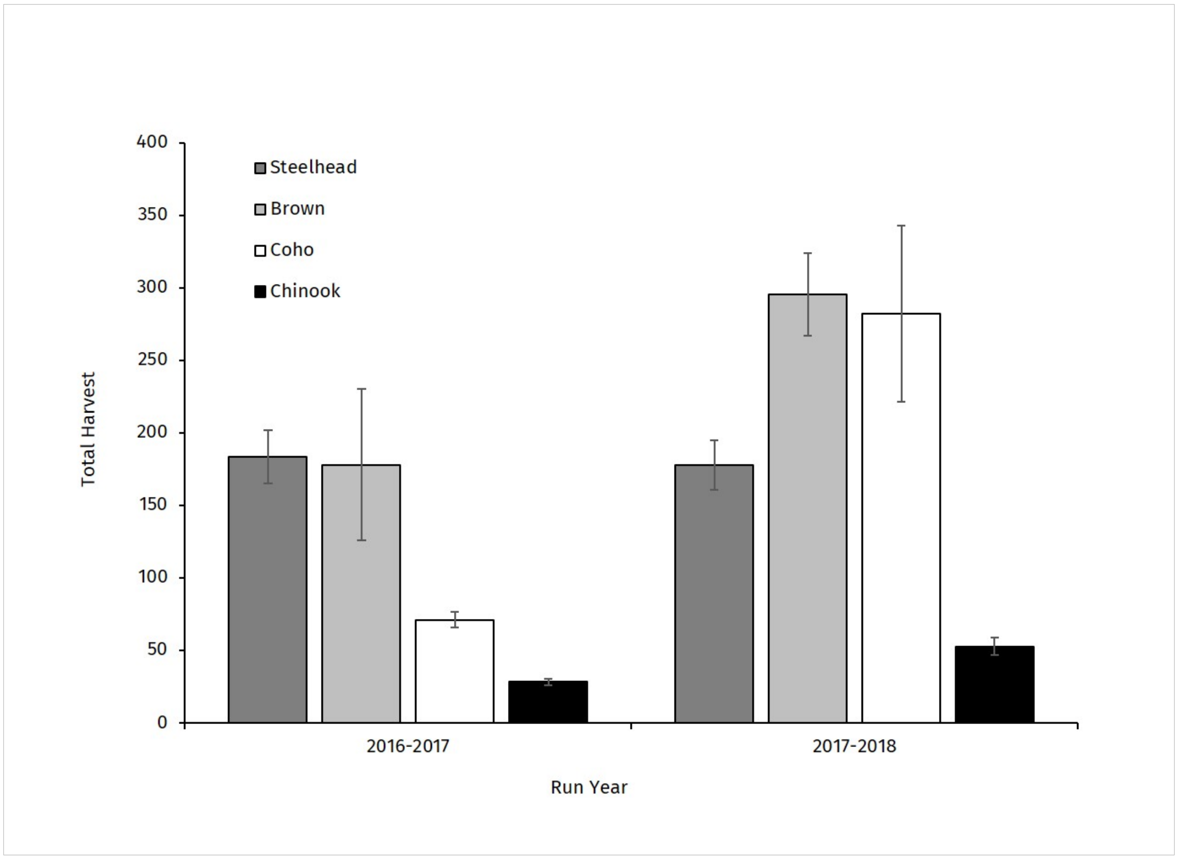


Figure 17. Angler harvest by run year.

Table 5. Abundance and exploitation rates, in parenthesis, of adult lake-run salmonids passing the lower Bois Brule sea lamprey barrier. Exploitation rates based on total harvest from the 2016-2018 creel survey.

RUN YEAR	COHO	CHINOOK	BROWN	STEELHEAD	BROOK TROUT
2016-2017	2323 (3%)	447 (6%)	4079 (4%)	6268 (3%)	1
2017-2018	4482 (6%)	450 (12%)	3634 (8%)	5469 (3%)	1

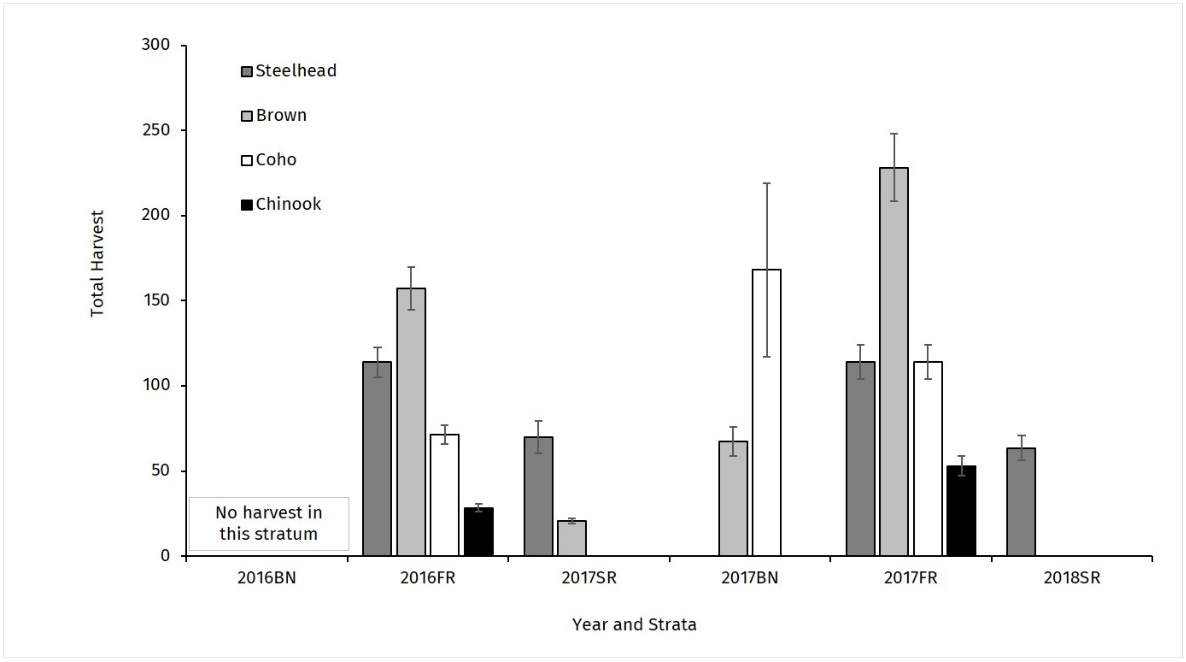


Figure 18. Angler harvest by strata.

Average steelhead harvest rate was low, at 0.0037 fish per hour (i.e., one fish harvested per 274 angler hours, **Table 6**). The greatest harvest rate occurred during the spring run period (mean = 0.0055 fish per hour), followed the fall (mean = 0.0033 fish per hour) and no harvest was documented during the Brown Run strata. Brown Trout harvest rates were similarly low, ranging from 0 to 0.007 fish per hour (**Table 6**) and was greatest during Brown or Fall Run. Salmon harvest only occurred during Brown or Fall Run and averaged 0.006 fish per hour during those strata.

Table 6. Average number of adult lake-run Brown Trout, steelhead, Coho and Chinook Salmon harvested per hour during the 2016-2018 creel survey on the lower Bois Brule River.

			HARVEST PER HOUR			
RUN YEAR	YEAR	STRATA	Brown	Steelhead	Coho	Chinook
2016-2017	2016	BN	0.001	0.000	0.000	0.000
2016-2017	2016	FR	0.005	0.005	0.003	0.004
2016-2017	2017	SR	0.004	0.003	0.000	0.000
2017-2018	2017	BN	0.007	0.000	0.018	0.003
2017-2018	2017	FR	0.004	0.002	0.004	0.008
2017-2018	2018	SR	0.000	0.008	0.000	0.000

TRAIL CAMERAS AND IN-PERSON CREEL

Where both methods were deployed, angler pressure estimated from trail cameras was similar to the in-person creel. Of the major strata, we only identified marginal differences in the Fall Run stratum in 2016 and 2017, based on 95% confidence intervals (**Fig. 19**). However, the difference between the nearest 95% confidence limit estimates from the in-person creel and the trail camera estimates were small (i.e., between 191 and 300 angler hours, or around 1% of the total estimated angler hours for each stratum). When evaluated by run year, no significant difference was evident between angler pressure estimates (**Fig. 20**). The two methods had markedly different costs with the cameras nearly 43% less than the in-person creel. This was reflected in both the cost of supplies and the cost of labor. Labor costs were predominantly associated with time needed to review the camera photographs (648 hours) and time to conduct the creel survey (i.e., visiting angler access points and interviewing anglers: 2,064 hours).

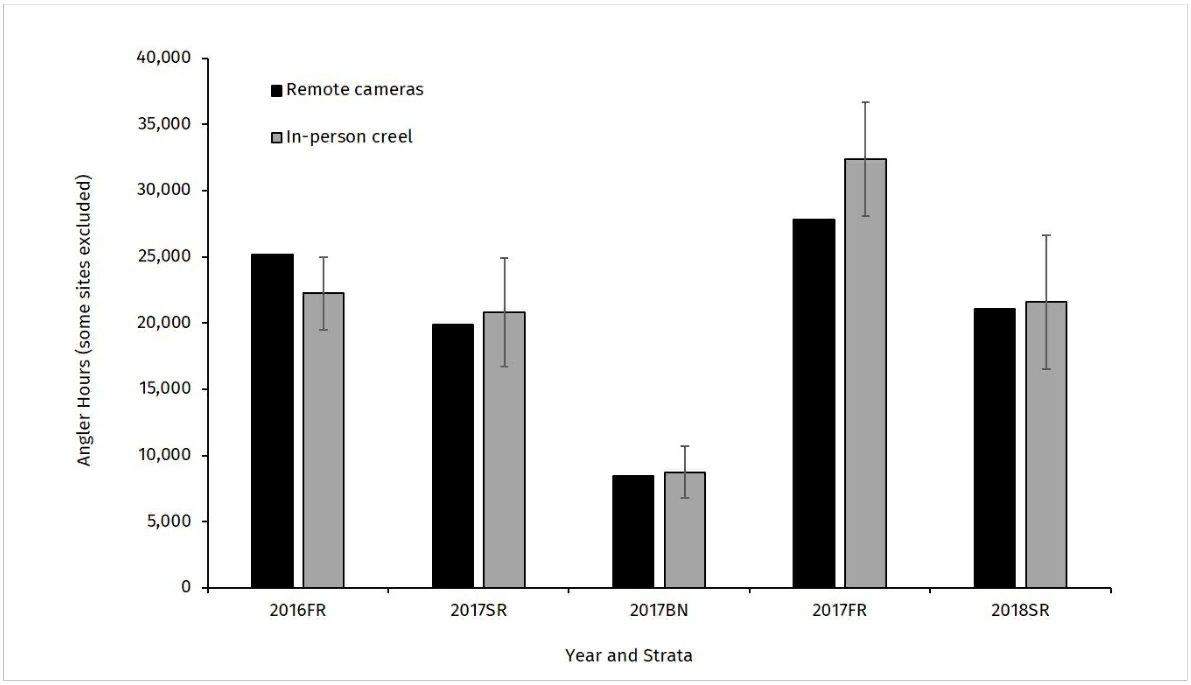


Figure 19. Angler pressure by creel and cameras, by strata.

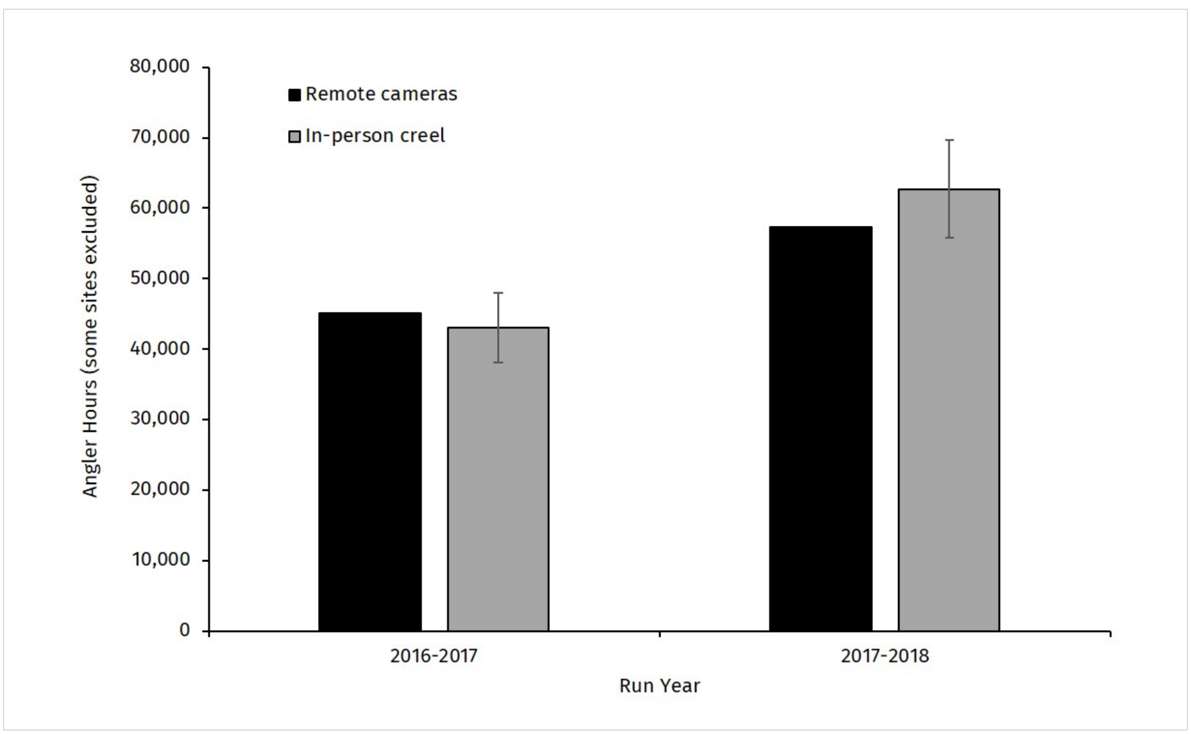


Figure 20. Angler pressure by creel and cameras, by year.

Angler trip length estimated from arrival and departure times from trail cameras were significantly shorter than trip length reported from creel interviews (**Fig. 21**, K-W test, P <0.0001; mean trip hours ±1 S.D., cameras = 2.9 ± 2.0, creel = 3.5 ± 4.0). Trip length based on cameras and creel interviews exhibited right-skewed distributions and overlapping ranges.

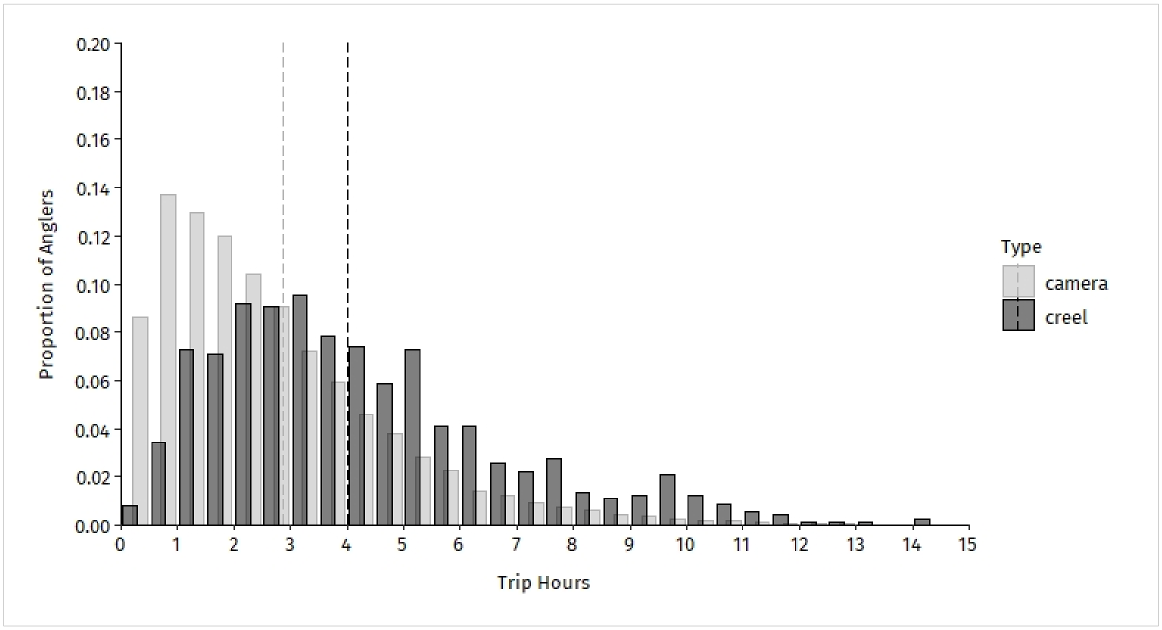


Figure 21. Angler trip length, creel vs. camera.

The trail cameras had vehicle detection rates nearing 100% across all sites. The probability of cameras detecting a vehicle at least once as it passed the camera on its way to and from the angler lot was 99% on average (minimum and maximum 95% confidence limits = 96% - 99%; **Table 7**). The probability of the camera detecting a vehicle on both departure and arrival was 91%, on average.

Table 7. Number of vehicles (n) detected at each angler access point, detection probabilities and 95% confidence limits for remote cameras, by site, during the 2016-2018 lower Brule River creel survey.

SITE NAME	N	DETECTION PROBABILITY	95% LL	95% UL
Bachelor's	2578	0.968	0.963	0.974
Black Landing	1955	0.994	0.992	0.996
Brady's Hole	1002	0.998	0.996	0.999
Copper Range/Coop Park	4866	0.974	0.971	0.978
Loveland Road/Drew's	1002	0.997	0.995	0.998
CTH FF Angler Lot	2451	0.981	0.976	0.984
Harvey's	1173	0.997	0.996	0.998
High Landing	3977	0.995	0.993	0.996
Johnson's	530	0.998	0.995	0.999
Lyon's	620	0.993	0.988	0.996
Mays Ledges	2723	0.999	0.998	0.999
McNeil's East	2232	0.988	0.985	0.990
McNeil's West	774	0.982	0.974	0.987
Mouth of Brule	5301	0.986	0.984	0.988
Old Cloverland Dump	623	0.998	0.996	0.999

Pine Tree	6281	0.992	0.991	0.993
Red Gate	4137	0.974	0.971	0.978
Rocky Run	970	0.984	0.978	0.989
Saari's	1022	0.994	0.991	0.996
Town Park	1765	0.989	0.986	0.992
Weir Riffles	1128	0.999	0.997	0.999

ANGLER POPULATION AND RESIDENCY

Anglers who participated in creel interviews were residents of Wisconsin, Minnesota and several other states, primarily male, and between 16 and 64 years of age (**Table 8**). Forty-nine of Wisconsin's 72 counties were represented in the angler population. The male to female ratio varied among the strata, with men outnumbering women nearly 7:1 during the Brown Run stratum and 21:1 during the Fall Run stratum. Flies were the most used bait/tackle for all strata, though an equal number of anglers used artificial lures during the Brown Run stratum. Most Wisconsin anglers lived in Douglas County (Brown Run = 37.6%; Fall Run =37.8%; Spring Run = 43.8%). The second most represented Wisconsin county was Sawyer County during the Brown Run stratum (10.3%) and Barron County during the Fall Run (7.0%) and Spring Run (8.3%) strata (**Table 9**). Minnesota county of residence was not recorded during creel interviews.

Table 8. Sex, age and gear type used (maximum of 2) reported by anglers during creel interviews by stratum. Number of anglers (percent of total) are reported.

		BN	FR	SR
SEX	Male	199 (87.7%)	782 (95.4%)	644 (94.6%)
	Female	28 (12.3%)	38 (4.6%)	37 (5.4%)
AGE	<16	14 (7.1%)	3 (0.4%)	9 (1.3%)
	16-64	152 (77.2%)	650 (86.8%)	609 (90.8%)
	65+	31 (15.7%)	96 (12.8%)	53 (7.9%)
BAIT/TACKLE (MAX 2)	Flies	66 (29.7%)	487 (59.0%)	412 (60.0%)
	Artificial Lures	66 (29.7%)	115 (13.9%)	86 (12.5%)
	Live Bait	37 (16.7%)	71 (8.6%)	59 (8.6%)
	Artificial Lures, Live Bait	31 (14.0%)	69 (8.4%)	25 (3.6%)
	Flies, Artificial Lures	11 (5.0%)	48 (5.8%)	64 (9.3%)
	Flies, Live Bait	11 (5.0%)	35 (4.2%)	41 (6.0%)

Table 9. Wisconsin county of residence reported by anglers during creel interviews, by strata. Number of anglers (percent of total) are reported for the top ten counties. All other counties were combined (other).

COUNTY	BN	FR	SR
Douglas	44 (37.6%)	119 (37.8%)	116 (43.8%)
Barron	2 (1.7%)	22 (7.0%)	22 (8.3%)
Bayfield	5 (4.3%)	7 (2.2%)	11 (4.2%)
Dane	4 (3.4%)	21 (6.7%)	10 (3.8%)
Dunn	0	11 (3.5%)	3 (1.1%)
Eau Claire	5 (4.3%)	11 (3.5%)	9 (3.4%)
Polk	2 (1.7%)	7 (2.2%)	11 (4.2%)
Sawyer	12 (10.3%)	9 (2.9%)	18 (6.8%)
St. Croix	5 (4.3%)	19 (6.0%)	9 (3.4%)
Washburn	4 (3.4%)	7 (2.2%)	15 (5.7%)
Other	34 (29.1%)	82 (26.0%)	41 (15.5%)

In the 2016–2017 creel survey year, vehicles with Wisconsin license plates were most frequently observed during the Brown Run stratum whereas those with Minnesota license plates were the majority during the Fall Run and Spring Run (pre- and post-North Shore opener; **Fig. 22**). Minnesota plates declined nearly 6% on both weekdays and weekends following the North Shore ice-out. In the 2017–2018 year, Wisconsin plates were the majority weekdays during the Brown Run stratum, but Minnesota plates were the majority on weekends. Minnesota plates were the majority on both day types during the Fall Run and pre-North Shore Spring Run, but Wisconsin license plates were the majority post-North Shore. Minnesota plates declined by 21.3% on weekdays and 10% on weekends following the 2018 North Shore ice-out.

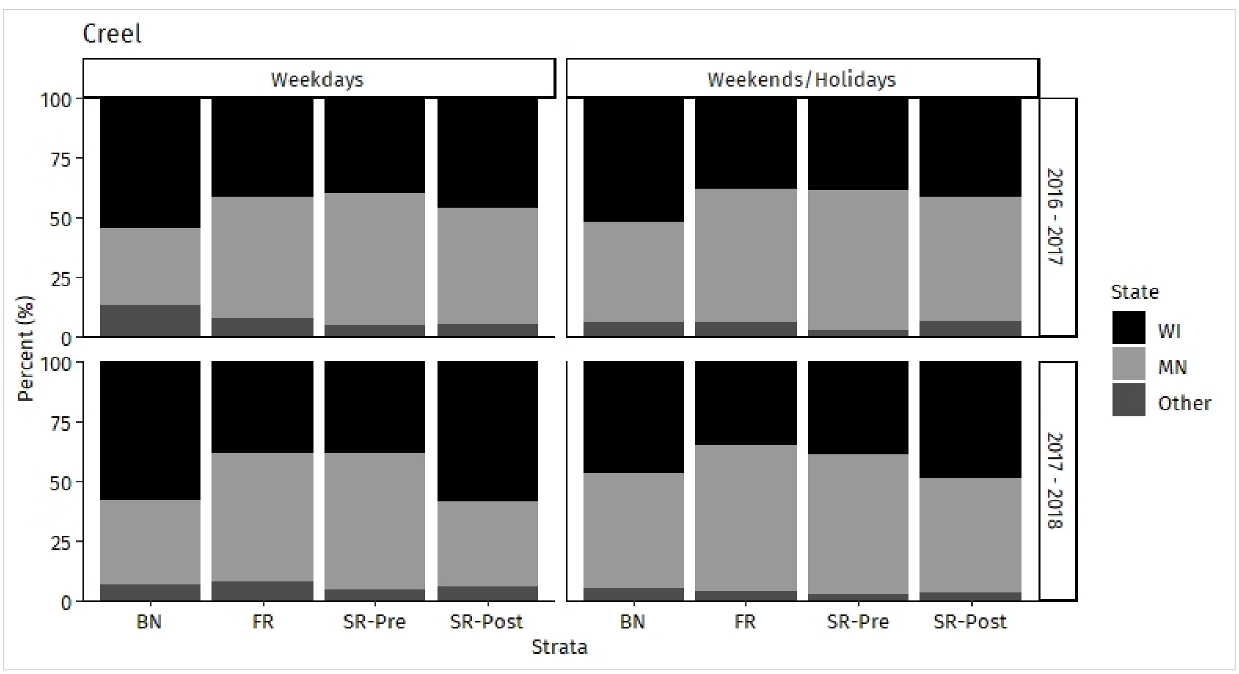


Figure 22. State of residency (percent of total) observed from creel vehicle counts for the 2016-2017 and 2017-2018 lower river surveys. Percentages are divided by strata and the SR stratum is further divided into pre- and post-North Shore ice-out.

In the 2016–2017 camera survey year, Minnesota plates were the majority during the Fall Run stratum, whereas Wisconsin plates were the majority during the Spring Run (pre- and post-North Shore; **Fig. 23**). Minnesota plates only declined by 0.9% on weekdays during the spring but declined more on weekends (5%) after ice out on the North Shore. In the 2017–2018 survey year, Wisconsin plates were most frequently observed during the Brown Run and on weekdays during the Fall Run whereas Minnesota plates were the majority on weekends. Wisconsin plates were the majority observed on weekdays pre-North Shore and both day types post-North Shore. Minnesota plates were the majority on weekends pre-North Shore and declined by 10.1% on weekdays and 10% on weekends in spring 2018 after ice out.

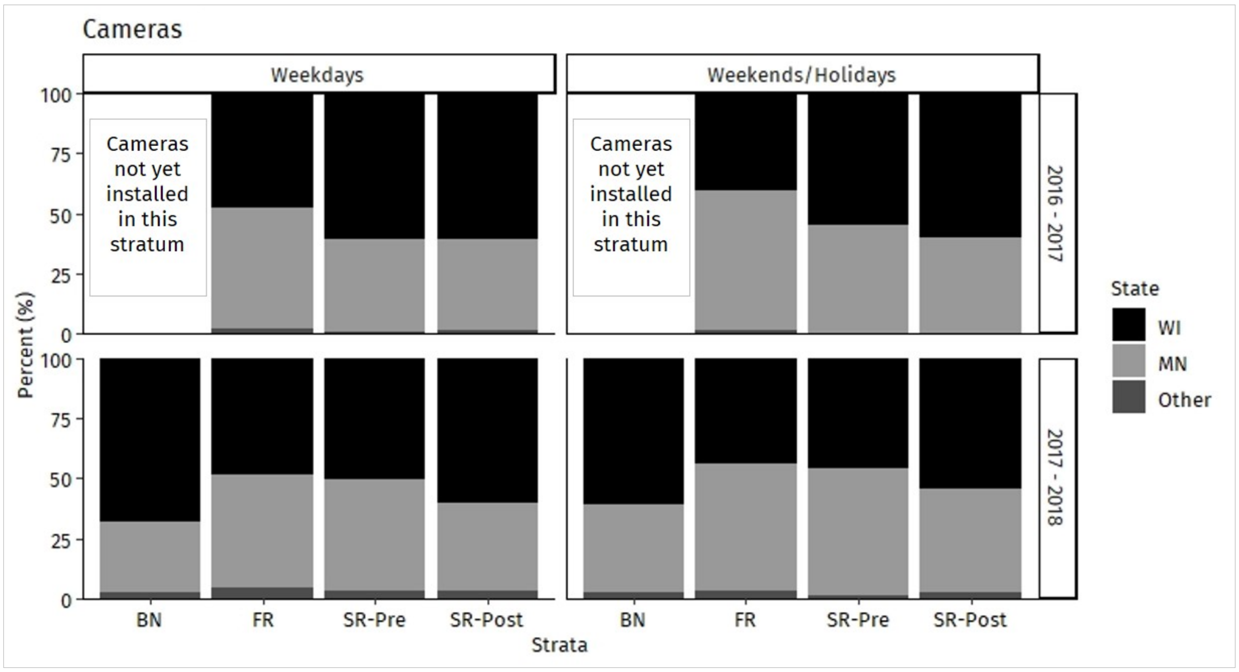


Figure 23. State license plates (percent of total) recorded by trail cameras for the 2016-2017 and 2017-2018 lower river surveys. Percentages are broken up by strata and the SR stratum is further divided into pre- and post-North Shore ice out.

ANGLER QUESTIONNAIRE

The questionnaire response period was 63 contiguous days (June 13, 2018 through August 15, 2018). Of the 532 anglers who agreed to participate in the survey, 261 provided responses, which yielded a 49.1% overall return rate: 55.6% (35 of 63) for paper edition and 48.2% (226 of 469) for electronic edition. Nearly 30% (80 of 271) of the anglers who did not respond, did not receive the survey due to potential email address transcription errors at the time of the survey or had obsolete email addresses at the time the questionnaire was distributed. An additional two anglers had moved and did not provide a forwarding address.

All responses including raw numbers and percentages for each question are tabulated in **Appendix 6**. Most respondents were male (98.8%). The highest percent (23.3%) were between the ages of 30 and 39, with an average age of 47. The youngest and oldest respondents were 20 and 87, respectively. The highest percent were Minnesota residents (55.8%), followed by Wisconsin (38.8%). The most common county of residence was St. Louis (MN; 18.3%), followed by Hennepin (MN; 13.7%) and Douglas (WI; 12%).

FISHING THE LOWER RIVER 2016-2018

Anglers primarily targeted steelhead (73.7%). October was the most often-fished month during fall 2016 (70%) and fall 2017 (71.9%). April was the most-often fished month during spring 2017 (83.8%) and spring 2018 (77.4%). July and August were only fished by approximately 2.0% of respondents during each year. The highest percent of anglers fished between five and 10 days for each season. One angler spent 120 days on the lower river during 2017, the maximum reported. Of all anglers combined, 83% fished between Highway 2 and Highway FF.

The highest percent of respondents reported they would never use centerpin (82.3%) or spinning/casting gears (54.3%), whereas 60.9% always use fly fishing gear. Most respondents reported they never use live bait (58.4%) or artificial lures (52%), whereas 58% always use flies. The highest percent of respondents traveled between 101 and 200 miles one-way to reach the lower river (30.2%), with an overall average one-way mileage of 124 miles. Local anglers (1–10 miles one-way) comprised 22.1% of the total, the second highest proportion of anglers. The maximum one-way distance traveled was 1,050 miles.

Most respondents were either somewhat or very satisfied (79.3%) with their fall 2016 – spring 2018 fishing experiences on the lower river, whereas 11.3% indicated they were either somewhat or very dissatisfied. Of the respondents who expressed dissatisfaction, 65.5% had fished the lower river for 10 or more years. The highest percent of respondents slightly agreed the following statements affected their dissatisfaction: “There are too many anglers” (44.4%) and “I don’t catch many fish” (32%), whereas the highest percentage of respondents strongly disagreed that the following were reasons for their dissatisfaction: “There are too many non-anglers” (45.3%), “The daily bag limit is too low” (68.1%), “The regulations are complicated” (55.9%), and “The regulations are restrictive” (57.6%). Most respondents were somewhat or very satisfied with the availability and quality of access points (92.9%).

YOUR HISTORY ON THE LOWER RIVER

The average respondent had fished the lower river for 18 years, though the number of years was broad (**Fig. 24)**. Nearly half of the respondents (47.7%) had fished the lower river for 10 years or less; 3.5%, 3.9% and 5.1% fished for the first time in 2018, 2017 and 2016, respectively. The earliest year any of the respondents fished the lower river was 1950. Most respondents (57.1%) indicated the number of days spent fishing the lower river has remained the same over the past decade. Of the 33 respondents who indicated the number of days has decreased, 54.5% also indicated the number of fish they catch has decreased, which was different than the overall majority who responded the number of fish they catch has remained the same.

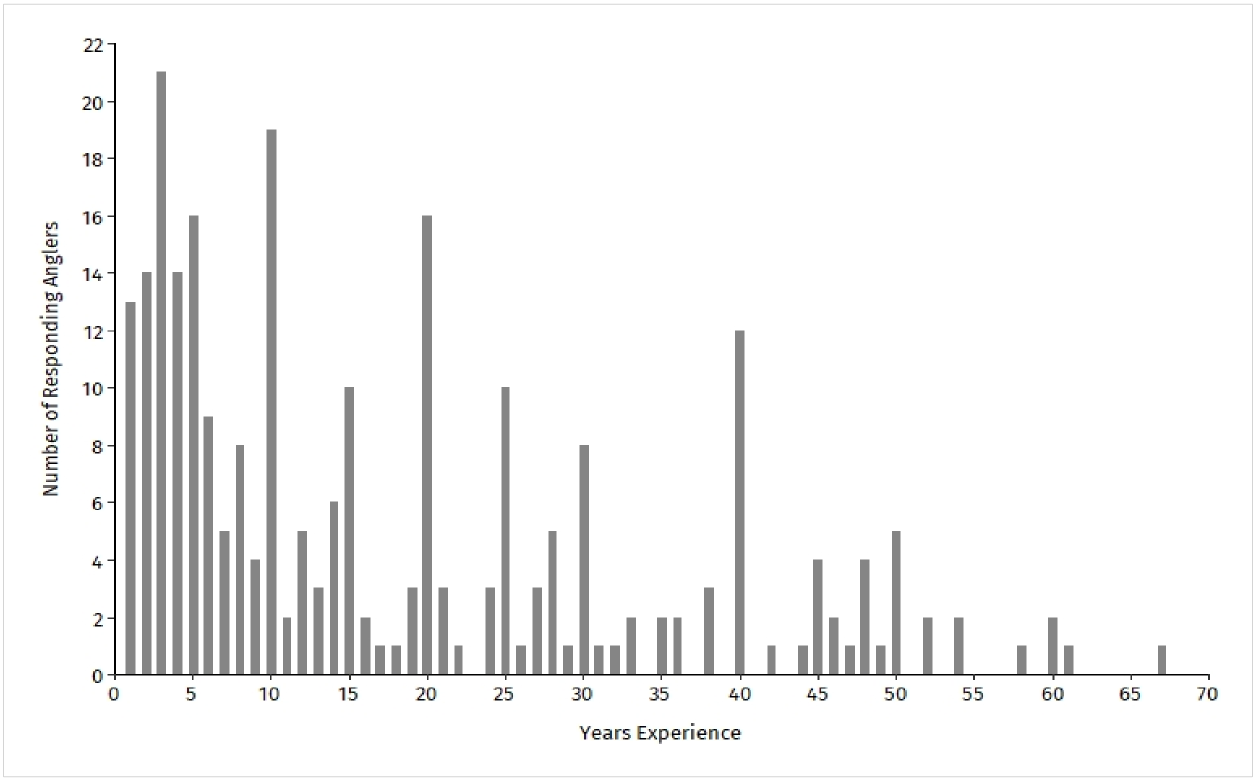


Figure 24. Years of experience fishing the lower river reported by questionnaire respondents.

When asked about the importance of the lower river as a fishing destination, 64.1% of respondents indicated it is one of their most important fishing destinations, half of which travelled an average of 126 miles one-way. Nearly 80% of respondents also fished other Great Lakes tributaries, and 77.7% of respondents fished other trout streams or rivers in Wisconsin (77.7%). Among these anglers, over half said that the lower river was somewhat or much better. Most respondents reported that the number of fish they caught (59%), the average size of fish they caught (71.7%), the water quality (86.8%) and the overall management of the river (80.4%) had remained stable since they began fishing the lower river. Over half of respondents (59.5%) reported crowding from other anglers has increased. These majority opinions were the same regardless of each angler's years of experience.

Since they began fishing the lower river, most anglers indicated the trout fishery has remained about the same (52.1%), though many anglers with greater than 45 years of experience (n = 22) perceived the trout fishery has probably worsened. Overall, anglers who indicated the trout fishery had worsened had been fishing the Brule River for an average of 31 years, which was higher than the average for the entire respondent population (18 years). In this specific group, anglers who indicated the trout fishery had worsened cited too much fishing pressure (25.9%), lower trout populations (16.7%) and fewer large steelhead (15.7%) as the most influential factors. Overall, anglers who indicated the trout fishery had improved cited more catch-and-release (C&R) being practiced (41.2%), improved fishing regulations (9.9%), higher trout populations (9.9%) and improved trout habitat (9.2%) as the most influential factors. Forty-seven percent of anglers specifying a worsened trout fishery were Wisconsin residents, 47% were Minnesota residents and 5.9% were other. Forty-five percent of anglers specifying an improved trout fishery were Wisconsin residents and 55% were Minnesota residents.

REGULATIONS AND FISH CAUGHT

Two hundred and twenty-seven respondents (87%) reported to have successfully caught a steelhead on the lower river sometime during the 10-year period of 2008 to 2018. On average, the longest steelhead caught by respondents was 27 inches (**Fig. 25**), and the maximum length reported was 39 inches. One hundred and sixty respondents (71%) reported the longest steelhead they had caught was longer than 26 inches. The average number of years of experience was 3.5 years for anglers who had not successfully caught a steelhead, compared to the 18-year mean reported by all anglers. Many anglers who had not successfully caught a steelhead were either neutral (37.5%) or somewhat satisfied (34.4%) regarding DNR management of the lower river, and somewhat (43.8%) or very (21.9%) satisfied with their 2016-2018 fishing experiences.

Two hundred and ten respondents (80.5%) indicated they had successfully caught a Brown Trout on the lower river sometime during the 10-year period of 2008 to 2018; the average length of the longest Brown Trout caught was 22.9 inches, with a maximum length of 40 inches (**Fig. 25**). One hundred and three respondents (39.5%) indicated they had successfully caught a Coho Salmon sometime from 2008 to 2018. The average length of the longest salmon caught was 24.6 inches, with a maximum length of 41 inches (**Fig. 25**). The average steelhead length considered to be a "trophy" was 29.1 inches, with a maximum of 40 inches, whereas the average Brown Trout length considered to be a "trophy" was 27 inches, with a maximum of 40 inches (**Fig. 26**). The average salmon (Chinook or Coho) length considered to be a "trophy" was 30.3 inches, with a maximum of 45 inches (**Fig. 26**).

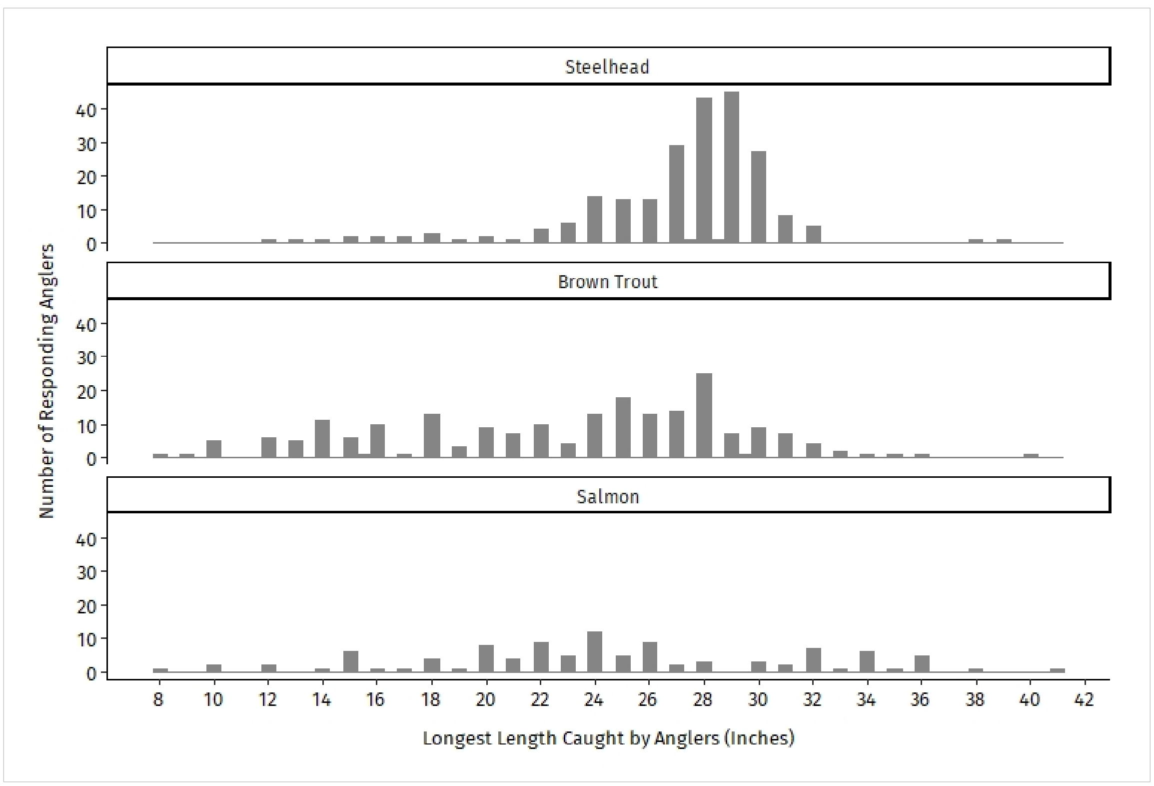


Figure 25. Lengths of longest steelhead, Brown Trout and combined salmon caught by questionnaire respondents fishing the lower river from 2008 to 2018.

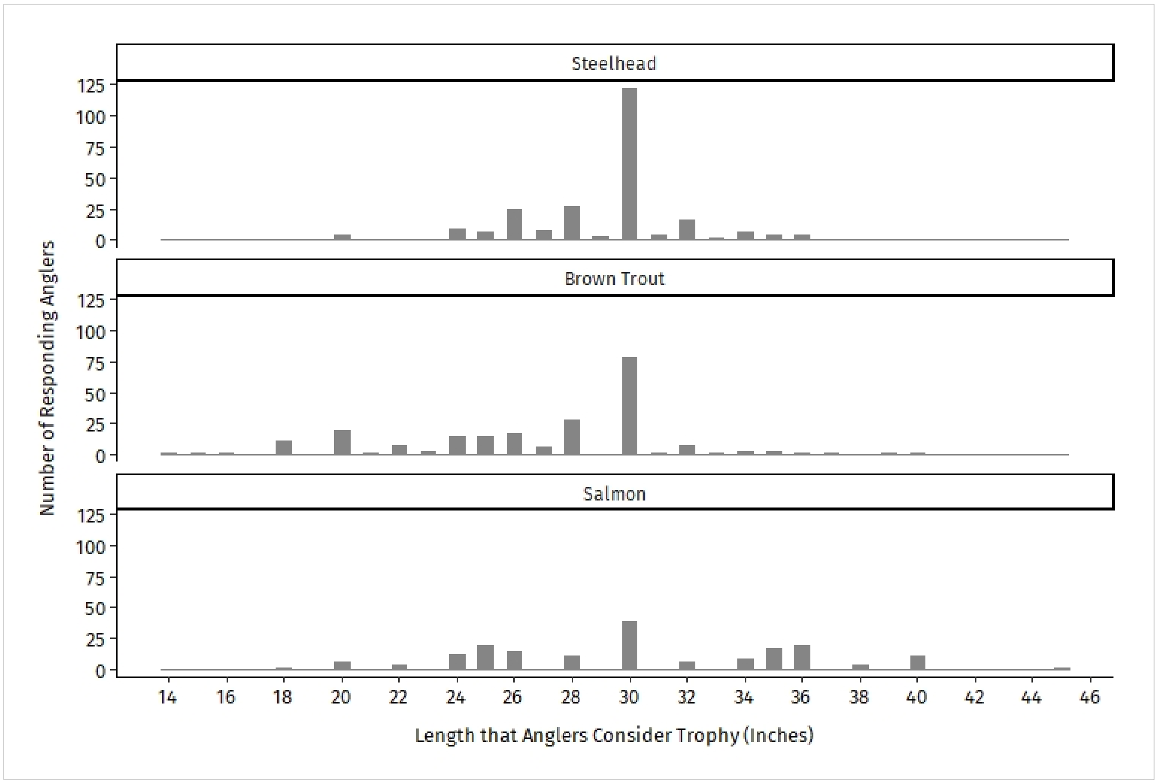


Figure 26. Lengths of Steelhead, Brown Trout and salmon considered as "trophy" by questionnaire respondents.

When asked about their C&R of legal-sized trout and salmon, 64.1% of respondents released all legal-sized trout and salmon, whereas 24.2% released some and kept others and 2.7% kept all legal-sized trout and salmon. Most respondents never (83.8%) or rarely (11.4%) kept fish for taxidermy, and 46.2% always or often kept for consumption. Fifty-five percent of respondents indicated their C&R had remained about the same, whereas 34.3% had increased and 10.8% had decreased C&R during the years they fished the lower river.

When asked their opinion of the daily bag limit of five trout and salmon, 42.1% of anglers were either somewhat or very satisfied, 29% were neutral and 29% were either very or somewhat dissatisfied. Seventy-one percent of anglers who always kept legal fish were very or somewhat satisfied with the daily bag limit and 31.4% anglers who released all legal fish felt neutral, the majority opinion. Regarding the bag limit for Brown Trout (two ≥15 inches), 47.3% of anglers were either somewhat or very satisfied, 25.8% felt neutrally and 27% were either somewhat or very dissatisfied. Opinions regarding the one steelhead (≥26 inches) bag limit were more varied; 33.6% of all anglers were very satisfied and 24.6% were very dissatisfied. Anglers who released all legal fish were mostly very dissatisfied (34.6%) or very satisfied (29.6%) regarding the steelhead bag limit, whereas 42.9% of anglers who kept all legal fish were very satisfied, 28.6% felt neutrally and 28.6% were somewhat dissatisfied.

The highest percent of respondents were very satisfied (27.5%) or neutral (26.7%) regarding the 10-inch minimum length on Brown Trout. Similarly, majority respondents were very satisfied (34.6%) or neutral (34.2%) regarding the 12-inch minimum length on salmon. Respondents were most divided on their opinions of the steelhead minimum length (26 inches); 33.2% were very satisfied and 23% were very dissatisfied. Again, respondents who released all legal fish were mostly very dissatisfied (31.1%) or very satisfied (29.8%) regarding the 26-inch minimum, whereas respondents who kept all legal fish were either somewhat dissatisfied (71.4%) or very satisfied (28.6%). The highest percent of respondents indicated the current season structure was very satisfactory for both the spring (39.5%) and fall (39.6%).

Most respondents were somewhat satisfied with the overall DNR management of the lower river (38.2%), whereas others were very satisfied (27.4%) and neutral (20.8%). Only 4 of the 35 respondents who were either somewhat or very dissatisfied with overall DNR management did not catch a legal-sized trout/salmon. Twenty-three of the dissatisfied respondents indicated they released all legal-sized trout and salmon (65.7%), whereas one dissatisfied respondent kept all legal fish. When completing a trip on the lower river and not having hooked a fish, most respondents thought "fish were there, but I did not hook them" (60.2%), followed by "fish were not there because they were elsewhere in the river" (24.2%), and lastly "fish were not there because they were too low in abundance" (15.6%).

More than half of the respondents indicated three useful criteria for gauging fish runs on the lower river: personal angling success (67.8%), DNR fishway counts (57.5%) and reports from other anglers (51.3%). Respondents who used DNR fishway counts traveled an average of 118.3 miles one-way (minimum 0.5 mile, maximum 1,050 miles), similar to the overall average of 124 miles. Seventy percent of anglers that used DNR fishway counts indicated October was their most-fished fall month and 82.9% indicated April was their most-fished spring month. Most respondents (86.2%) indicated the steelhead run contributed to their decision to fish the lower river, which preceded other reasons: history of the river (52.1%), location (49%), accessibility (44.4%), family/social tradition (34.9%) and popularity of the river (11.5%). The most frequent other factor listed was the beauty and scenery of the river (8.8%).

The highest percentages of responses to the open-ended section (Section III, Question 15) related to (favored) C&R (17.2%) and noted the river's scenic quality (17.2%). Anglers who favored C&R regulations had various suggestions including extended seasons for C&R, steelhead only C&R, all species C&R, certain river sections C&R and the entire river C&R. Among these 17% who favored C&R regulations, mostly were very dissatisfied with the following regulations: 26-inch minimum on steelhead (70.4%), one steelhead over 26 inches (79.1%), daily bag of five trout and salmon (51.2%), two Brown Trout over 15 inches (51.2%), 10-inch minimum on Brown Trout (57.3%) and 12-inch minimum on salmon (40.9%). One hundred percent of anglers who commented in favor of C&R strongly disagreed with the statement "the daily bag limit is too low." Half of the anglers (50%) who were very dissatisfied with the DNR management of the lower river mainly did so in favor of C&R regulations. In addition to the C&R and associated extended season comments, the open-ended section featured the various suggestions: implement more restrictive bag limits; increase the minimum lengths of all species, particularly steelhead; require barbless and/or single hooks; increase stocking; do not stock; address eroding clay river banks; and promote appropriate fish handling techniques. One open-ended comment cautioned that Section I Question 6 could have skewed answers toward fly fishing, as the responses would include anglers who use fly fishing equipment with monofilament line for yarn flies and spawn bags that "traditional" fly anglers (e.g., those who use fly line and spey rods) would not consider fly fishing. The open-ended section also found anglers who said they caught more fish over the years, and those who said they caught fewer fish over the years.

Discussion

The 2016-2018 lower river creel survey estimated angler pressure, harvest and catch with motion-detection trail cameras and in-person angler interviews, while the companion angler questionnaire identified perceptions and opinions that have not been documented in nearly

25 years. Our use of remote trail cameras as vehicle counters was new for Wisconsin and therefore subject to a rigorous internal DNR review and approval process, primarily because of privacy concerns. Our final survey design addressed those concerns by limiting camera use to state-owned property. The survey was among other remote camera surveys in the United States and Canada where fisheries management and research agencies have gauged angler pressure in various fisheries (Smallwood et al. 2012; Janssen et al. 2014; Olsen and Wagner 2014; Greenberg and Godin 2015; Aku et al. 2016; Hining and Rash 2016; Zorn et al. 2018).

ANGLER PRESSURE

The lower river continued to experience heavy angler pressure, as it has for many years, and exceeded the pressure observed in other regional rivers and streams (Peterson 2017; Toshner and Manz 2008; Toshner et al. 2016). The nearly 70,000 angler hours during the fall and spring reflects the tradition of steelhead fishing for which the lower river is known (O'Donnell 1945; Brasch 1950; Daly 1954; Niemuth 1970; Swanson 1974; Scholl et al. 1984; and DuBois and Pratt 1994). No other months in each of those seasons were more heavily fished than October and April, both of which experienced the peak steelhead runs of each season (DNR files; Scholl et al. 1984). Pressure was highest in the middle section of the lower river, known for many years for its wadability and accessibility. The comparable angler pressure estimates between 2016-2017 and 2017-2018 suggested that weather and river conditions had no effect on angler pressure, despite the colder air temperatures, higher river flow and later ice-out in the 2017-2018 survey year.

The present survey found nearly equivalent pressure to that in 1990 (68,140 hours) when comparing steelhead season to steelhead season (i.e., spring and fall), with expectedly higher pressure beyond the steelhead season (12,000 to 18,000 hours) since the 1990 survey did not extend beyond the steelhead season. Pressure in the present survey was more comparable to the pressure in 1986 (81,856 hours) but noticeably lower than that in 1978-1979 (132,847 hours), as reported in DuBois and Pratt (1994). Though not necessarily correlated, the observed decrease in pressure paralleled the considerable change in angler practices from harvest to C&R. For example, the present survey documented nearly 200 harvested steelhead, which was nearly 11 times lower than the 2,159 harvested in 1990 and 55 times lower than the 11,015 harvested in 1978-1979. This shift toward reduced harvest was also observed by Mitro et al. (2014) in their public meeting questionnaire relative to Wisconsin's statewide trout fishing and inland trout management program.

Angler pressure along the 24.5-mile length of the lower river was 19.3 and 19.7 angler hours per mile per day. These are two of the highest angler pressure estimates in Wisconsin when compared to 19 other stream and river salmonid creel surveys completed in the state over the past 55 years (mean = 7.4 hour/mile/day; DNR files). Most angler-hours were expended during the fall, followed by the spring and lastly the summer (Brown Run stratum), which was a shift from the 1990 and 1978-1979 surveys that found higher pressure during spring. Additionally, angler trips were longer during fall and spring, coincident with these peak seasons of the steelhead migration (DNR files), but still nearly 45 to 60 minutes shorter than those documented in 1990 and in 1978-1979. Though anglers took more trips in the present survey (average 30,508) than in the 1978-1979 survey (average 17,792), they spent less time per trip.

CATCH AND HARVEST

Total catches (i.e., numbers of fish caught by anglers relative to the numbers of fish counted by the DNR at the fishway) were high for lake-run steelhead and Brown Trout, more so than for Coho and Chinook Salmon. Further, high catch was also observed for putative resident salmonids and lake-run juveniles (i.e., smolts), particularly steelhead that aggressively feed and prepare for habitation in Lake Superior or as river residents. High catch is not unusual in the lower river, as Pratt and Blust (1991) reported a total catch of 6,861 steelhead, which was 84.9% of all steelhead counted (8,078) at the fishway in 1990 (DNR files). Anglers have noticed previous hooking wounds or hooks from previous anglers (i.e., break-offs), indicative of repeat-catch, and Barnhart (1989) and Nelson et al. (2005) have empirically documented repeat steelhead catch in British Columbia rivers and streams. Anecdotal angler observations and published peer-reviewed studies have also shown repeat-catch of putative resident, albeit non-Pacific, salmonids in C&R/no-harvest fisheries in the western United States (Schill et al. 1986) and in Japan (Tsuboi and Morita 2004). Carline et al. (1991) found total Brown Trout catch was 1.3 to 6.4 times the estimated population size in an eastern United States stream. Askey et al. (2006), commented that riverine fishes must act readily to catch prey or otherwise forfeit that prey with downstream currents.

High catches noted in the present survey and in peer-reviewed studies indicate how susceptible a fish population is or can be to overharvest. Pratt and Blust (1991) explained this following the 1990 lower river creel survey. Without regulations and C&R, anglers could harvest most, if not all, of a migratory run (or resident population), which over time, would reduce the population's size conceivably to the point of collapse. C&R fishing is not without its consequences, however. Though individual fish are not immediately removed from the population in C&R fishing, they can be removed through delayed mortality or sub-lethal effects of hooking, playing/fighting, handling and release. DuBois and Dubielzig (2004) found less than 4% hooking mortality in salmonids ≤16 inches in the upper river, regardless of hook type (e.g., treble, single with or without barb). An extensive body of hooking and post-release mortality literature was summarized by Hühn and Arlinghaus (2011), who found that, on average, the highest mortality for Rainbow Trout mainly less than 16 inches was 17.1% among various environmental conditions and terminal tackle.

Twardek et at. (2018) specifically studied adult steelhead using radio telemetry in the Bulkley River, British Columbia and found a gradual increase in post-release mortality from the fall season (4.5% within three days following release) to winter (6%) to over-winter (13 to 25%) among all study methods combined (i.e., fly fishing, spin fishing and centerpinning). Overall, the study noted the sensitivity of steelhead to excessive air exposure times during handling and release and suggested that time should not exceed 10 seconds. Hooking and post-release mortality of adult steelhead in the lower river has not been quantified, and its potential influence on numbers of returning adults are indeterminable from the fishway counts. However, the noted published studies could be used by lower river anglers to consider the degree of steelhead mortality that potential exists under the current regulations and frequency of C&R. To some extent, a shift in steelhead age structure can occur, as shown by Risley and Zydlewski (2011) for Brook Trout, but no evidence currently exists for an overall impact to the steelhead population. Population-level studies of C&R mortality are lacking, overall, in recreational fisheries (Kerns et al. 2012).

An adult Coho Salmon. Credit: Wisconsin DNR.

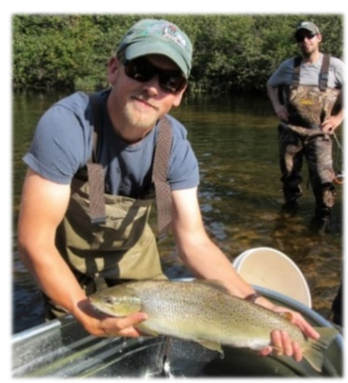
Repeat-catch of Coho and Chinook Salmon was expectedly lower due to their lower abundances and lower encounter probabilities consistent with their life history strategies. Both salmon species are semelparous (i.e., spawn only once after a single tributary migration before dying) and more urgently move through river corridors and access their spawning grounds than steelhead and Brown Trout that are iteroparous (i.e., spawn more than once after several tributary migrations before dying).

Steelhead overwinter in the river to spawn in the spring, whereas Brown Trout spawn in late-fall and often overwinter prior to returning to Lake Superior, thus making both species more likely to be encountered by anglers, perhaps repeatedly.

Steelhead harvest was markedly lower in the present survey than in previous surveys, likely reflective of C&R among anglers and more restrictive harvest regulations. For example, two-thirds of questionnaire respondents in the present survey said they practice C&R and one-third of questionnaire respondents said their C&R has increased. DuBois and Pratt (1994) cited various changes to fishing regulations and commented on increased C&R, while Pratt and Blust (1991) noted 53.7% of anglers who caught steelhead voluntarily released them in spring 1990 and 45.3% did so in fall 1990. Angler unease regarding overharvest and the support of reduced daily bag limits on the lower river were evident nearly a decade before that (Scholl et al. 1984). Concerns persisted in other Wisconsin trout fisheries, as Hunt (1981) observed voluntary release prior to the institution of special regulations (minimum length limit of 13 inches, daily bag limit of one trout and use of artificial flies or lures only) in his study of Race Branch in St. Croix County, WI; voluntary release was coincident with a high proportion of fly-fishing anglers. Concerns for overharvest went well-beyond Wisconsin, as Barnhart (1989) referenced a regulation change on Michigan's Au Sable River in 1949 that included an increased size limit and reduced bag limit to permit trout to spawn at least once. Further, he mentioned more restrictive regulations in several wild cutthroat trout streams in Idaho intended to reduce angling mortality. Outside the United States, Hooton (2001) remarked on the concerns for steelhead overharvest in his summary of terminal gear usage for steelhead in British Columbia.

Notwithstanding the prevalence of C&R and extant harvest regulations, an estimated 34 sub-legal steelhead were harvested from the lower river from 2016 to 2018. This is not necessarily unexpected, as sublegal harvest has also occurred in Lake Superior (Zunker 2018). Reasons could vary from deliberately choosing not to comply with regulations or keeping injured fish, to inadvertent misidentification (e.g., where a steelhead would be kept when it was thought to be a salmon). Though these have not been quantitatively assessed on the lower river, their occurrence prompts the need for continued enforcement and improving fish identification. In addition to DNR efforts, anglers could promote their stewardship by sharpening their identification skills and knowledge as well as sharing that knowledge with other anglers, particularly when fishing.

Putative resident fish (i.e., presumed stream-only individuals) such as Brook Trout and Brown Trout were occasionally harvested in the lower river fishery, though we could not reliably estimate exploitation due to lack of abundance data. The few Brook Trout that passed the fishway were coaster/coastal forms that can attain 20 inches in length (DNR files) and are generally more associated with river mouths near Lake Superior (Schreiner et al. 2008). No Brook Trout of this size were documented in the creel survey, and the few harvested Brook Trout were only caught well-upstream from the fishway.



DNR fisheries biologist and coauthor, Kirk Olson, holds a lake-run Brown Trout. Credit: Wisconsin DNR.

Salmon and Brown Trout harvest was expectedly higher than steelhead, due to various factors as lower minimum length limits than steelhead, preference as food fish, or combinations of these or other factors. Salmon and Brown Trout have been regular components of the Lake Superior recreational fishery harvest (Zunker 2018). In the lower river, Brown Trout harvest rates were highest during the Brown

Run or Fall Run strata (i.e., summer into fall seasons) despite similar catch rates in the spring, the time of year when Brown Trout are in their emaciated, post-spawn condition as they out-migrate to Lake Superior following the fall spawning and overwintering seasons.

CATCH RATE

Steelhead catch rates were variable among strata and highest during the Spring Run, a comparable pattern to findings by Pratt and Blust (1991) for the spring and fall runs in 1990. Relative to spring season catch rates in previous lower river creel surveys, the present survey's spring season average of one fish per 6.8 hours of fishing was the highest. It was also within the range of catch rates reported by Peterson (2018) for Minnesota's North Shore streams. The present survey's average fall season catch rate of one fish per 15.1 hours of fishing was at the higher end of the range of the previous eight fall DNR creel surveys during that timeframe; only the 1973 and 1990 creel surveys reported higher catch rates (one fish every 11.4 and 12.6 hours of fishing, respectively) (Swanson 1974; Pratt and Blust 1991).

Catch rates for other salmonids also varied among strata and relative to the 1990 survey. For example, Brook Trout and Brown Trout catch rates were considerably higher in the present survey, most likely attributable to the differences between the lengths of the creel survey periods. The present survey began in mid-July to include the Brown Trout run that typically begins during this time, whereas the 1990 survey specifically targeted the spring and fall steelhead runs. Coho and Chinook Salmon had much lower catch rates than steelhead and Brown Trout in the present survey, and these could illustrate the overwhelming angler emphasis on steelhead. Only 0.8% of questionnaire respondents and 1.0% of interviewed anglers indicated they mainly fished for Coho Salmon.

Catch rates can be challenging to interpret, as river conditions, angler skill, fish behavior and fish abundance are among the numerous factors that can independently and/or jointly affect catch rates. Pitman et al. (2018) showed increased catch rates with increased steelhead abundance and cited other studies with similar trends, but also cited studies where catch rates remained high as the population declined, a phenomenon known as hyperstability (Erisman 2011), which can lead to the perception of high abundance when catch rate is high. The opposite phenomenon hypostability (or hyperdepletion) exhibits catch rates that decrease more rapidly than abundance (Hicks 2016); this can give the perception that the abundance is low because catch rate is low. The degree to which hyper or hypostability exists in the lower river are neither known nor within the scope of the present survey. They are noted here to preclude misconceptions about any direct relationship between catch rates and abundance, as the relationship can be misleading due to changes in factors other than abundance, non-linearity, etc. (Maunder and Punt 2004; Maunder and Aires-Da-Silva 2008). For example, a comparison of the catch rates in the present survey to lower river fishway counts (i.e., abundance) yields variable outcomes. Steelhead catch rate during spring was higher in the present survey than in 1990, though fishway counts were higher in spring 1990 (Wisconsin DNR 2018). On the other hand, catch rate during fall was lower in the present survey than in 1990, though the fishway count was higher in fall 1990. The low catch rates for salmon can reflect the urgency of these fishes to rapidly ascend the river to spawn, as previously explained for the low incidence of repeat-catch. Salmon that ascend in September upstream of U.S. Highway 2, which is outside the creel survey area, would also not be encountered and included in the creel survey.

Detecting changes and increasing understanding of the catch rate-abundance relationship on the lower river could be improved by a more frequent creel survey schedule (e.g., every 10 years). Aside from catch rate and abundance, fishway counts indicate that adult steelhead abundance fluctuates annually, typically from 3,500 to 8,500 individuals, likely in response to short and long-term variations in environmental conditions of the lower river and Lake Superior. Other than strays from other state jurisdictions (i.e., remnant Minnesota Kamloops), lower river steelhead sustain themselves exclusively through natural reproduction.

MINNESOTA NORTH SHORE SPRING SEASON COMPARISON

The lower river is within 90 minutes' drive of several of Minnesota's North Shore tributaries to Lake Superior, which are also popular regional destinations for steelhead anglers. From the time of spring thaw and extending through late-May, the Minnesota DNR conducts annual creel surveys on 17 North Shore tributaries (Peterson 2017). The 2017 North Shore spring creel ran from April 5 to May 19 (45 days) and estimated 38,573 hours of angler pressure (857 hours per day) for all tributaries. The lower Bois Brule River on its own experienced nearly 28,000 angler-hours in 2017, which surpassed the combined 12,708 angler-hours in 2017 on the Sucker River and Lester River, both located near the population centers of Duluth and Superior. In 2018, the North Shore tributaries experienced lower-than-average angler pressure, while still within the range typically observed on the North Shore (Peterson 2018). The spring 2017 and 2018 creel surveys on the lower Bois Brule River had little change in pressure.

Aside from the differences in overall fishing pressure, the findings suggest that the timing of ice-out on the North Shore can influence angler pressure on the lower river. For example, pressure declined on the lower river following North Shore ice-out. In the 2016-2017 survey year, the numbers of Minnesota license plates on the lower river declined nearly 6% during weekdays and weekends following North Shore ice-out, and those declines were more marked in the 2017-2018 survey year (21.3% on weekdays and 10% on weekends). The North Shore tributaries experienced a period of prolonged ice cover in 2018 (Peterson 2018).

North Shore Rainbow Trout fishing regulations are intended to rehabilitate the wild steelhead population in Minnesota waters of Lake Superior and tributaries, an effort that began in in 1992 after documented declines in wild steelhead numbers in the 1980s (Schreiner 2003). A one steelhead over 28 inches regulation was in effect from 1992 to 1997, after which a no-harvest regulation was imposed (Goldsworthy et al. 2017) and continues in effect today with support by Minnesota DNR's Lake Superior Advisory Group (Peterson 2018). Harvest opportunities are limited only to Kamloops Rainbow Trout, a hatchery-reared strain identified with a clipped adipose fin; the bag limit is three and minimum length is 16 inches. Peterson (2018) noted that 25-40% of Kamloops caught each spring were voluntarily released.

TRAIL CAMERAS AND IN-PERSON CREEL

Trail cameras and the in-person creel survey produced similar angler pressure estimates, except in the two Fall Run strata when the differences were marginal. Thus, either method can be used to document angler pressure on the lower river. Trail cameras are extremely beneficial and reliable as a stand-alone method to document the popularity of a recreational fishery, whether relative to time (i.e., weekends, seasons) or space (i.e., other close-proximity fisheries). Information regarding popularity can be invaluable to fishery managers regarding safety and maintenance needs associated with a recreational fishery. While helpful from the perspective of time spent fishing, angler pressure does not specifically define catch and harvest, both of which are critical to understanding how anglers influence a sport fish population and its potential integration with other fishes within the overall community. Camera surveys require a concurrent in-person creel survey to estimate catch and harvest rates and anglers per vehicle, though one study employed voluntary telephone reporting (Hining and Rash 2016). This type of reporting might be possible for the lower river; a pilot or feasibility study would be useful to determine angler interest and reliability in reporting catch and harvest. Additionally, Pollock et al. (1994) cautioned that telephone and diary surveys can be biased from recollection of catch and rounding and species identification errors. Undoubtedly, the use of cameras in the present survey incited additional learning opportunities and challenges: missing data, detection efficiency and photograph processing, all of which required staff attention and reconciliation. To some extent, these are not unusual, as missing data and detection efficiency also challenged van Poorten et al. (2015) in their use of time-lapse cameras. In the present survey, an eight-day period of record was lost from the camera at the Mouth after it was found destroyed beyond recovery, likely from a gunshot. This was the only instance during the two-year survey that a camera was vandalized and in this instance was beyond repair.

Several studies have emphasized camera placement (Smallwood et al. 2012; Greenberg and Godin 2015; Hining and Rash 2016), particularly relative to motion-detection. Though we considered this prior to the study and achieved an average detection of 91%, our placements exhibited lower detection efficiency at angler access points with long, straight approaches (e.g., Clay Road and Mouth) compared to those with short, narrow approaches (e.g., May's Ledges and Weir Riffles), likely a function of vehicle speeds inherently influenced by these configurations. The placements also regularly detected stray movements by branches, shadows, etc., which produced thousands of images and triggered labor-intensive photograph review. A fixed-interval (e.g., one-hour) photographic record such as that by Greenberg and Godin (2015) could be used to reduce the photographic record and subsequent review, though it would occur at the expense of accuracy of the angler pressure estimates due to the need to extrapolate angler hours. Overall detection efficiency relative to vehicle speeds could be improved with speed control devices such as speed bumps.

The trail cameras and the in-person creel survey differed markedly in their cost and time requirements, though the methods produced similar angler pressure estimates. The approximate 43% offset (savings) by the cameras was mainly due to the lower cost of labor, despite the relatively high number of labor hours (648) to review the photographs. Even with the combined hours (160) to inspect and maintain the cameras, the cameras required 2.6 times fewer hours than the in-person creel survey (2,064) that gathered the same information. This comparison omits the catch and harvest data that cannot be collected with the cameras, and thus the value of solely using trail cameras would be expectedly less when catch and harvest are needed. Our reported time and cost of operating the trail cameras was exclusive to the motion-detection operating mode and as such, the cost reflects a relative maximum. Operating the cameras with a discrete time interval, for example one hour, would considerably decrease the cost by reducing the time needed to review the photographs. This, however, would reduce the precision in the angler pressure estimates due to the lower likelihood of encountering the vehicles at their arrival and departures that are otherwise captured by the cameras in motion-detection mode. These are important trade-offs to consider when planning camera-based surveys. Regardless, the trail cameras were shown to be a reliable stand-alone tool to document angler pressure; using them offers considerable cost savings when this information, alone, is desired by fishery managers.

ANGLER DEMOGRAPHICS AND RESIDENCY

Lower river anglers in the creel survey were heavily represented by males between the ages of 16 and 64, with 47 being the average age. This is not unusual, as males particularly in their 40s commonly pursued steelhead in Lake Erie tributaries in Ohio (Kayle 2011) and Lake Erie tributaries in New York (Markham 2016). In fact, Kelch et al. (2006) found the typical age of steelhead anglers to be 46; males were predominant. On the lower river, female anglers ranged from 4.6 to 12.3% of all anglers, which was proportionately higher than females noted in creel surveys by Kayle (2011) and Markham (2016).

Minnesota's St. Louis County anglers represented the highest proportion of anglers on the lower river, followed by Hennepin County, also in Minnesota. Douglas County was third, though only 1.7% lower than Hennepin County. St. Louis and Hennepin counties, respectively, contain the population centers of Duluth and Minneapolis-St. Paul, indicative of the lower river's attraction to anglers who live in high population centers whose local natural resources are unrivalled to the lower river. Angler residency among all strata was approximately one-half Wisconsin residents and one-half Minnesota residents, a shift from the two-thirds Wisconsin residency observed by Scholl et al. (1984).

In Wisconsin, Douglas County anglers markedly exceeded all other counties, and Wisconsin anglers were more frequently recorded with the trail cameras than through the in-person creel survey. Most Wisconsin residents were from Douglas County and therefore had shorter travel times and a higher likelihood of being recorded by the trail cameras that operated 24 hours per day, seven days per week. Though Wisconsin anglers accounted for more pressure during the Brown Run stratum, their numbers were lower than Minnesota anglers on weekdays and weekends during the Fall Run and pre-North Shore Spring Run. This indicates that most Minnesota anglers pursue steelhead, which is also evident throughout the questionnaire. As such, Minnesota residents make more time to travel during the steelhead run on weekdays as well as weekends. Wisconsin anglers outnumbered Minnesota anglers following the North Shore Spring Run, for the same reason: reduced travel times to North Shore streams compared to the lower river. The number of Minnesota anglers decreased at least 10% on weekdays and weekends following the 2018 North Shore ice out. This pattern was not reciprocated by Wisconsin anglers on the North Shore, as Minnesota anglers comprised 93.4% of all anglers interviewed during 2017 and Wisconsin anglers comprised only 4.7% (Peterson 2017). Aside from the Wisconsin-Minnesota comparison, the relatively high proportion of lower river non-resident anglers (i.e., Minnesota) demonstrated little interest in supporting any increases in non-resident license fees. The current annual non-resident license fee is $50 plus the $10 trout stamp fee required to fish for trout and salmon. Both the non-resident and resident license fees have provided important funding for fisheries work across the state, including the Bois Brule River.

ANGLER QUESTIONNAIRE

The 49.1% response rate was lower than anticipated, given angler enthusiasm for the questionnaire at the time of the creel interviews. This response rate was also much lower than the 74% response observed for a 1992 Bois Brule River angler questionnaire by Dubois and Stoll (1993). Nevertheless, the responses came from anglers of many different ages, years of experience fishing the lower river, residency, etc. to reasonably represent the lower river angling community. The 49.1% response was not atypical for data usage in other surveys. For example, Slagle et al. (2010) used a similar distribution to Ohio's Lake Erie tributary anglers and documented a 61.1% response rate. Their survey, however, included routine follow-up at various time intervals over an 18-week period since initial angler contact during the creel survey. Gigliotti and Henderson (2015) found a 20 to 66% response rate for Internet and mail surveys among various age groups in a South Dakota Department of Game, Fish, and Parks study that examined alternative approaches to creel surveys. Nearly 25 years prior, Sztramko et al. (1991) accepted a 43 to 64% response rate to represent full angler participation in a Lake Erie angler diary survey. Response rates in future lower river questionnaires could be improved, however, by reducing potential transcription errors when recording contact information (Barrett et al. 2017) and maintaining contact with participants, depending on when the questionnaires are distributed (van der Hammen et al. 2016).

FISHING THE LOWER RIVER 2016-2018

DNR fisheries biologist and lower river creel project manager, Paul Piszczek holds a steelhead. Credit: Wisconsin DNR.

The angler questionnaire corroborated many of the findings of the in-person creel survey and trail cameras. Specifically, the lower river continued among sport anglers to be most popular for steelhead fishing, with the months of October and April and the segment from Highway 2 to Highway 13 as the most popular times and areas to fish. Indeed, numerous anglers were opportunistic and fished for any species offered, but not to the extent that anglers pursued steelhead. The lower river has a long-standing reputation as a premier regional recreational fishery, whether through spoken lore or documented studies, and its anglers have over the years changed the way they pursue, capture and use the fish. Further, they expressed varied reasons for their fishing success, or lack thereof. Most felt the fish were there and were not hooked, or that fish were elsewhere, a likely outcome due to the nature of fishing and the movements of migratory fish. 15.6% of anglers noted that low abundance was the reason they did not hook a fish, implying that if fish were there, the anglers would catch them.

C&R and fly fishing, not necessarily in combination, were more common than harvest, spinning gear, and centerpinning gear, also not necessarily in combination. Mirroring the national and global movement of C&R (Jones 1984, Thurstan et al. 2018), the reported increase in C&R followed a trend also documented by DuBois and Stoll (1993). Similarly, fly fishing's growth was evident on the lower river, as 60.9% of anglers in the present questionnaire said they fly fished compared to the 19% in 1992 (DuBois and Stoll 1993). While the trend of increased fly fishing was also noted throughout the United States (RBFF 2019), surveys by Markham (2016) and Kayle (2011) found less incidence of fly fishing compared to spinning gear in other Great Lakes steelhead tributaries. Nonetheless, fly fishing is not without its impacts to fish. Chiaramonte et al. (2018), for example, found that longer fight/play times associated with fly fishing over other equipment can lead to excessive stress on individuals, though the study found only negligible population-level affects.

The lower river is known for its solitude perhaps as much as its crowds, and irrespective of angler years of experience, many anglers felt crowded (by other anglers and not non-anglers). This can understandably detract from angler experiences, particularly those who prefer to fish alone, in small groups, or those who catch too few fish. Crowding was also noted over 25 years ago (DuBois and Stoll 1993; Scholl et al. 1984). Dissatisfaction with any fishery resource could be based on inadequacy of opportunity, particularly the lack of catching fish (Spencer 1993) or too few fish (Markham et al. 2016). Mostegl's (2011) literature review of angler satisfaction noted the various types of anglers and their differences relative to the term "satisfaction." For example, while some anglers associated satisfaction specifically to catch (e.g., high satisfaction due to high catch), other anglers' low catch did not correlate to negative satisfaction. Lower river anglers generally indicated higher satisfaction with lower river fishing if harvest opportunities decreased and minimum length limits increased, particularly for steelhead, citing that the existing regulations are too liberal rather than too conservative. The current 26-inch limit was implemented in 1993 following the 1990 creel survey to allow mature steelhead to spawn at least once prior to being subject to harvest.

The lower river's regional and local appeal were reflected both in the distance anglers traveled and the numbers of days spent fishing. Anglers overall were satisfied with their fishing experience and the public access points along the lower river, which included town and county roads as well as many DNR-maintained parking areas within the Brule River State Forest. Anglers dissatisfied with their experiences had fished the river for at least a decade and thus drew from more varied experiences and conditions of the river and Lake Superior, both of which can affect fishing experiences over time.

If questionnaire respondents used catch rates as gages for the condition of the trout fishery over time, their perceptions were partially consistent with the conditions over the past 25 years, as 52.1 % of questionnaire respondents indicated the trout fishery has remained about the same. In contrast, however, were the perceptions of some anglers with more than 45 years' experience, who indicated the trout fishery had probably worsened. Perceptions can be challenging to interpret, particularly over the course of time. For example, Pitcher (2001), explained that each generation often experiences a shifting baseline in the abundance, size-structure and diversity of fisheries, remembering fish to be bigger and fishing to be better in the "good old days." Further, a phenomenon known as "telescoping bias" refers to the inaccurate memories of events regarding how recently and frequently events occurred (Bradburn et al. 1994), and this has been identified as a problem with angler creel surveys (Andrews et al. 2018). Anglers who indicated the trout fishery had worsened had fished the lower river an average of 31 years. These time periods would have extended back to the mid-1970s through late-1980s when catch rates were lower, often only half as those of the present survey. Further, anecdotal accounts of fishing being "better" in the 1970s was not necessarily reflected in the catch rates of that time.

YOUR HISTORY ON THE LOWER RIVER

Lower river anglers were more experienced than they were novice relative to their years of fishing, both on the lower river and around the Great Lakes region. Anglers were generally consistent relative to the number of days they spent fishing the lower river over the years, though two times more anglers noted they increased their number of days on the river than decreased. Angler recruitment was relatively stable on the lower river, according to the numbers of first-time anglers documented in this survey. This contrasts the White River in neighboring Bayfield County and Timber Coulee Creek in Vernon County, WI (nearly 200 miles south of the lower Bois Brule River), both of which experienced low angler recruitment and an older angler group (Toshner et al. 2016; DNR files). The U.S. Fish and Wildlife Service (2010) has also reported a nation-wide decrease in numbers of trout anglers. Providing opportunities for both novice and expert anglers will continue to be a priority for DNR Fisheries, and future questionnaires will be important for monitoring angler recruitment into the future.

Many anglers began fishing the lower river within the last 30 years. More anglers, however, started fishing prior to 1989 than after 2015 and therefore have a more long-term perspective of the lower river. Overall, the years that anglers first fished the lower river were distributed relatively evenly from 1990 through 1999, 2000 through 2009 and 2010 through 2015. This 25-year period in the lower river's history as a sport fishery saw fluctuating steelhead numbers at the fishway (e.g., lows during the 1990s and highs during the 2000s; Wisconsin DNR 2018), a dramatic increase in the minimum legal length limit (from 12 inches to 26 inches beginning in 1993; DuBois and Pratt 1994), stocking that had ended in 2002 (DNR files) and several flood events (e.g., over 1,700 cubic feet per second in spring 2001; U.S. Geological Survey 2018).

Through this, anglers had mixed perceptions of the fishery, where some said the fishery remained the same whereas others said it changed. Of anglers who either perceived the fishery as worse or improved, more said it was worse; 13 of these had over 45 years' experience and of those 13, three cited fewer larger steelhead. These anglers would also have fished from the early-mid 1960s into the 1970s, a time of substantial fish community changes in Lake Superior, particularly regarding prey availability, predator stocking, predator-prey interactions and prey-prey interactions (Swenson and Heist 1981; MacCallum and Selgeby 1984; Busiahn 1985; Conner et al. 1993; Bronte et al. 2003).

Quantitative Lake Superior steelhead studies during the 1960s and 1970s are lacking, though Conner et al. (1993) studied food habits of Lake Superior trout and salmon in the 1980s and found steelhead consumed only invertebrates, particularly terrestrial insects, which contrasted the piscivory exhibited by Chinook and Coho Salmon. A subsequent quantitative discussion is therefore not possible regarding steelhead survival, growth and mortality in Lake Superior and how these impacted angler perceptions in and contemporary data from the lower river. For general comparison, Busiahn (1985) noted that older, and presumably larger, Lake Trout exhibited the highest reductions in length-at-age. In other words, the early 1980s were a time when larger Lake Trout were found to be smaller than the larger Lake Trout in previous years. However, of note are the average and maximum steelhead lengths reported in lower river creel surveys back to 1949, as described in the subsequent paragraphs. Interestingly, the differing age groups somewhat contradicted one another in their perceptions of a worsened versus improved fishery. Older anglers cited lower trout populations and younger anglers cited higher trout populations. Anglers who perceived a worsened fishery were evenly split between Wisconsin and Minnesota residency, whereas anglers who perceived an improved fishery were generally from Minnesota. Clearly, perceptions of the fishery were highly variable among anglers and therefore indicative of the need for quantitative fishery surveys to objectively describe the fishery resource and justify management decisions.

The average length of steelhead caught in the present survey (20.1 inches) was within the range of average lengths reported among all creel surveys since 1949. Pratt and Blust (1991) found 21.6 inches in 1990, while surveys from 1962, 1963 and 1964 documented 21.3, 19.9 and 21.1 inches, respectively (Niemuth 1970). Brasch (1950) reported an average of 19 inches. The highest and lowest of the range of average lengths were found in the 1970s (18.1 inches in 1978-1979 and 22.8 inches in 1973). The apparent absence of trends in average lengths of angler-caught adult steelhead over the years likely reflects the variability in Lake Superior's environmental, forage and other conditions that affect growth.

REGULATIONS AND FISH CAUGHT

Lower river anglers were, overall, successful in catching steelhead, particularly larger legal steelhead, and one-third of anglers reported catching steelhead less than 26 inches. These lengths were consistent with the range of steelhead observed at the fishway during and beyond the creel period (DNR files), and the range anglers generally considered to be a trophy. The longest lengths for Brown Trout were generally similar to steelhead, except that nearly 15% of respondents who considered trophy Brown Trout from 18 to 20 inches, which may have been relative to resident Brown Trout. Salmon lengths were typically in the 20 to 26-inch range and 32 to 36-inch range, the smaller range likely more reflective of Coho Salmon than Chinook Salmon, as Chinook over 30 inches are more common than Coho Salmon of that length (DNR files). In contrast, the few respondent perspectives regarding the *maximum* length of a trophy (40, 40 and 45 inches, respectively, for steelhead, Brown Trout and salmon) are neither regular catches by angling, nor observed in any DNR surveys in the lower river; perhaps these characteristics are what some anglers define as a true trophy.

DNR fisheries biologist and coauthor, Ericka Massa, holds a Chinook Salmon. Credit: Wisconsin DNR.

A 39-inch steelhead, a 40-inch Brown Trout and a 41-inch salmon were reported caught by anglers from 2008 to 2018, and though fish of these lengths are not necessarily common in the Great Lakes (Thompson et al. 2008; Palla 2009; Paoli 2018), the Pacific Northwest (Gates and Boersma 2011; Chulik et al. 2017) and far-northwest Pacific Ocean (Dronova and Spiridonov 2008), Chinook Salmon up to 44 inches have been reported from Lake Michigan (Legler et al. 2019). Maxima found in all previous lower river surveys were markedly lower: 32.0-inch steelhead, 26.5-inch Brown Trout, 30-inch Chinook Salmon and 26.3-inch Coho Salmon during the 1990 creel (DNR files); 29.9-inch steelhead, 25.0-inch Brown Trout, 26.7-inch Coho Salmon (Scholl et al. 1984); slightly less than 32-inch steelhead (Niemuth 1970); slightly more than 32-inch Brown Trout (Niemuth 1967) and 30-inch steelhead (O'Donnell 1945). Swanson (1974), however, recorded 35 harvested Chinook Salmon that averaged 40 inches long, though he also documented 70 Coho Salmon that averaged 20.5 inches long. Niemuth (1970) delivered a similar discussion of steelhead sizes, with a comparison to the west coast (Sacramento River system), apparently due to angler perception and expectations of the lower river relative to more and larger fish in the 1960s.

Opinions regarding the current regulations were well-mixed between the satisfied and dissatisfied responses. For example, whereas some anglers were satisfied with the one steelhead over 26 inches, five trout and salmon in total or fall season dates, others were dissatisfied with those same regulations, particularly the anglers who favored C&R. Overall, however, anglers were more satisfied than dissatisfied with the regulations, except for steelhead minimum length, where views were nearly split between satisfied and dissatisfied. The pattern could simply reflect a greater angler emphasis on steelhead management compared to other salmonids. The opinions, themselves, may relate to anglers preferring a higher minimum length and more C&R, as was found in the open-ended comments section of the questionnaire. No substantial differences relative to satisfaction were evident for Brown Trout or salmon length limits, except for anglers who kept all legal fish; all were satisfied with the regulations.

The season structure was also satisfactory to most anglers, despite marginal differences with those who were dissatisfied. The mixed response to any regulations is common among many sport fisheries, whether coldwater, warmwater or marine (Markham 2016; Responsive Management 2006; Rubio et al. 2014; Toshner and Manz 2008), and not necessarily unexpected for the lower river. Although anglers are unified in their purpose in the fall and spring, that is to pursue steelhead, they hold varying opinions regarding regulations. Indeed, the DNR has different regulations for different applications among different resources, and how those regulations are selected and implemented depends on the views of anglers in addition to quantitative fisheries surveys. The mixed opinions in the present survey imply that the existing regulations sufficiently maintain an action-oriented, multi-species coldwater fishery that provides harvest opportunities, uniquely sustained through natural reproduction and a rare trait anywhere in the Great Lakes and North America. This is not to say that the regulations could not be modified with intents to bolster fish conservation, production or angling opportunities beyond that which exists with the current regulations. Any changes would be considered using quantitative fishery survey data and angler input, such as from DNR fishway counts and information exchanged among anglers, both of which were used by anglers to gauge lower river salmonid runs.

The angler questionnaire provided valuable insight to the opinions and perceptions of lower river anglers. Despite the unstructured format of the open-ended questions section, many of the comments paralleled one another, particularly those that supported C&R fishing for steelhead. Aesthetics, history, location and accessibility were also noted, along with family and social traditions. For several anglers the beauty and scenery of the area overshadowed other attributes such as the fishery being “wild,” its trophy potential, river water quality and Coho and Brown Trout runs. Aside from these comments, others were more individualized and variable (e.g., implement more restrictive bag limits; increase the minimum lengths of all species, particularly steelhead; require barbless and/or single hooks; increase stocking; do not stock; address eroding clay river banks; and promote appropriate fish handling techniques). This reflected a relatively diverse angling community, though unified by steelhead, regarding what was important in the management and pursuit of migratory fishes in the lower river.

Conclusion

The lower Bois Brule River sport fishery experienced high angler pressure and catch, but low harvest and strong incidence of C&R and fly fishing. Anglers targeted steelhead more than any other salmonid, and pressure on the species was higher in the fall than the spring. Total catch either approached or exceeded the respective total runs and thus demonstrated the species’ vulnerability to harvest without the protective regulations and C&R fishing that are currently in place and commonly practiced. Brown Trout, Chinook Salmon and Coho Salmon catches were markedly lower than steelhead, but were more commonly harvested than steelhead, albeit with low overall harvest.

St. Louis and Hennepin counties in Minnesota were the first and second-most represented angler residences; Douglas County, Wisconsin was third in overall angler numbers, though only slightly less than that of Hennepin County. Angler recruitment was stable compared to the declines observed in other popular coldwater sport fisheries in Wisconsin. Angler pressure and resource popularity were effectively monitored with trail cameras, whose placement and settings were important relative to post-processing workload. Angler experiences varied on the lower river, from those who first fished the river in 2016-2018 to those who first fished in 1950. Though crowding was a common concern, anglers were overall satisfied with the lower river fishery and its management.

The apparent lack of trends in the average lengths of angler-caught adult steelhead over the past 70 years likely reflects Lake Superior's influence on growth through variable environmental, forage and other conditions. Our survey did not indicate the need for regulation changes at this time, though future routine creel surveys and angler questionnaires, coupled with quantitative fisheries surveys, are necessary to manage this unique local and regionally esteemed resource sustained principally through natural reproduction.

Management Recommendations

A. **REGULATIONS:** Maintain the current early and extended seasons from the last Saturday in March to Nov. 15. Maintain the current daily bag limit of five trout and salmon in total, only two of which may be Brown Trout over 15 inches and only one of which may be a Rainbow Trout. Maintain current minimum length limits of 8 inches for Brook Trout, 10 inches for Brown Trout, 12 inches for Coho and Chinook Salmon, and 26 inches for Rainbow Trout.
B. **PROPAGATION:** Manage all salmonids for self-sustainability through natural reproduction.
C. **SPECIES:** Focus management priorities on steelhead.
D. **CREEL SURVEY:** Conduct a lower river creel survey (downstream from U.S. Highway 2) every 10 years utilizing a combined camera and creel clerk approach. Focus the survey on steelhead and include provisions such as probabilistic methods to document pressure, catch and harvest of other salmonids (e.g., Brook Trout, Brown Trout and Coho Salmon) during the mid-summer to early fall seasons. Install trail cameras in select angler access points, particularly those with high angler use (e.g., Pine Tree, High Landing and Red Gate) that can increase the sample sizes for calculating angler pressure. Program the cameras either for motion-detection or discrete interval according to the needs, funding and staff capacity for the survey. Consider the work of McCormick and Meyer (2017), who suggested a minimum of 30 days to collect sufficient data for representative calculations of angling effort, catch and harvest. Conduct the creel survey five days per week: all weekends and holidays, and on three randomly selected weekdays (one of which would include the holiday).
E. **ANGLER QUESTIONNAIRE:** Distribute an angler questionnaire concurrent with the recommended 10-year interval creel survey, consistent with the present survey. Use the same questions and questionnaire structure to document changes in angler attitudes over time. Also, explore alternatives to increase response rates, such as incentive programs, timing of questionnaire distribution, entry of email or mailing addresses using a tablet.
F. **PUBLIC OUTREACH:** Periodically distribute fish identification materials such as pocket cards to anglers, update identification materials on the DNR Bois Brule River website and develop newspaper articles regarding fish identification.
G. **ENFORCEMENT:** Work with DNR Brule River State Forest rangers and other Lake Superior area conservation wardens to continue and increase, when practicable, patrol of the lower river, including all lower river angler access points.

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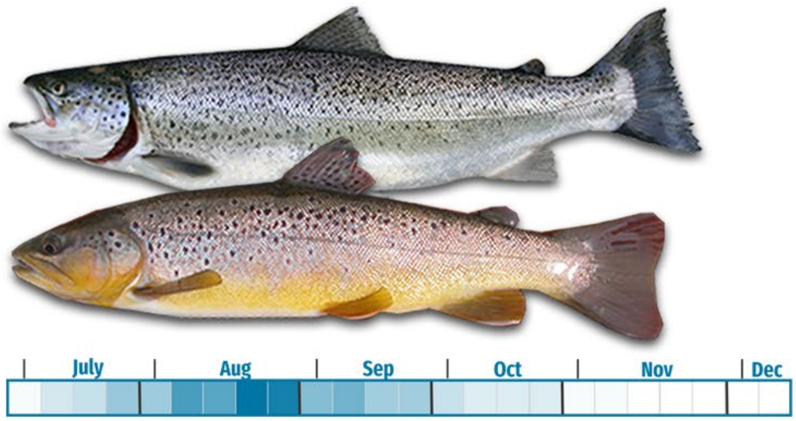
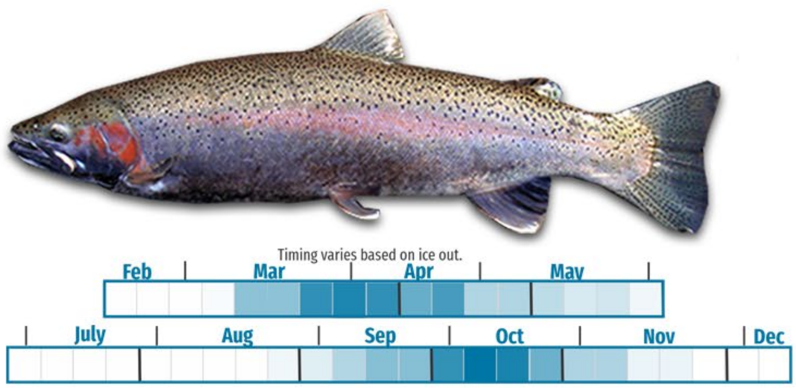
Appendix 1: Common Trout and Salmon of the Lower Bois Brule River

Common trout and salmon of the Lower Bois Brule River
(and the best time to fish them throughout the year)



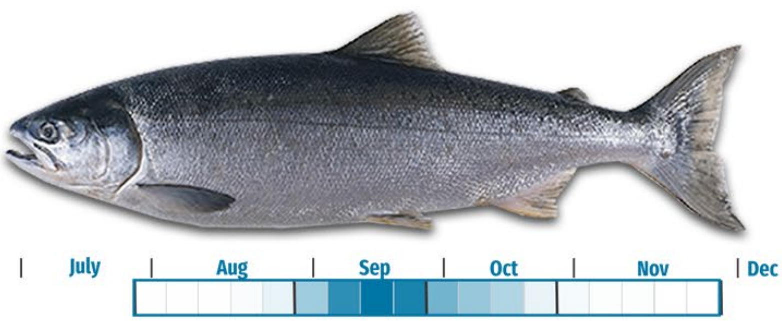
Brown trout
Salmo trutta

Lake-run form
Length range: 15 to 35 inches
Average length: 22 inches
Spawning migration: Fall
Spawning season: Fall



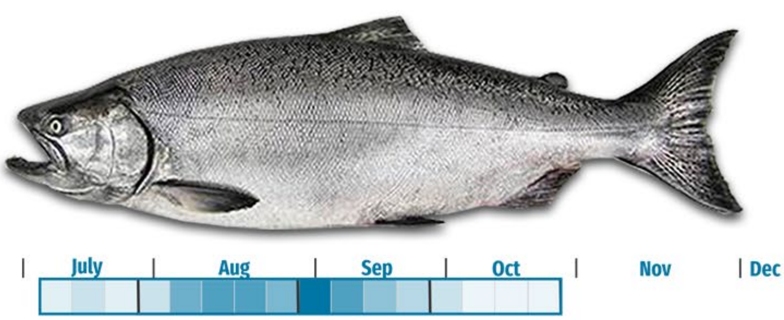
Rainbow trout Steelhead
Oncorhynchus mykiss

Lake-run (Steelhead) form
Length range: 12 to 32 inches
Average length: 22 inches
Spawning migration: Fall
Spawning season: Spring



Coho salmon
Oncorhynchus kisutch

Length range: 10 to 29 inches
Average length: 20 inches
Spawning migration: Fall
Spawning season: Fall



Chinook salmon
Oncorhynchus tshawytscha

Length range: 11 to 38 inches
Average length: 27 inches
Spawning migration: Fall
Spawning season: Fall

Appendix 2: Creel Clerk Time Allotments

LOOP	SITE #	ANGLER LOT	ASSIGNED MINUTES
1	1	Mouth of the Brule	17
	2	Weir Riffles	33
	3	Johnson's Hole	17
	4	Saari's	33
	5	Lyon's	17
	6	Old Cloverland Dump	33
	7	McNeil East	66
	8	McNeil West	83
	9	Harvey's	33
2	1	Cloverland Park	5
	2	Highway 13	49
	3	Loveland Road	11
	4	Clay Road	102
	5	Culhane Road	22
	6	May's Ledges	65
	7	Red Gate	65
	8	Highway FF	11
	9	FF Angler Lot	43
3	1	Highway 2	14
	2	Brady's	38
	3	Rocky Run	43
	4	Black Landing	81
	5	High Landing	86
	6	Coop Hole	43
	7	Pine Tree	110

Appendix 3: Creel Survey Interview Form

Wisconsin Department of Natural Resources	CREEL SURVEY INTERVIEW FORM	Sheet No. ______

DATE: (mm/dd/yy)	Access Point:	Loop (1 - 3)	1. ☐ Weekday
__ __ / __ __ / __ __	Clerk:		2. ☐ Weekend/Holiday

Party Type and Trip Length Information
(Interview all fishing and non-fishing parties)

1)*Fishing was from:
1. ☐ Wading 3. ☐ Not Fishing
2. ☐ Canoe

2)*Number in Party Today: ___ ___

3)*The Angler was a: 1. ☐ Driver
2. ☐ Passenger 3. ☐ No Vehicle

Number of Anglers/Vehicle: _____

4)*Time Started Fishing/Left Landing: __ __ : __ __
(military time)

5)*Time of Interview/Ended Fishing __ __ : __ __

6)*Hours spent on non-fishing activities:
-i.e. shore lunch/camping (hh:mm) __ __ : __ __

7)* Completed Fishing: 1. ☐ YES 2. ☐ NO

8) Sex: 1. ☐ Male 2. ☐ Female

9) Age: 1. ☐ Under 16
2. ☐ 16-64 3. ☐ 65& Over

10) Angler Residence: 1. ☐ WIS. 2. ☐ Non-Resident
Distance (Miles) 1. ☐ 0-25
2. ☐ 26-50 3. ☐ Over 50

WIS. County Code or Non-Resident State: ___ ___

11)*Bait/Tackle used (maximum of two):
1. ☐ Fly 2. ☐ Artificial lures
3. ☐ Live Bait
5. ☐ Other:

12) Angler was guided: 1. ☐ YES 2. ☐ NO

13)* CATCH AND HARVEST INFORMATION

SPECIES AND % OF TIME FISHED FOR:	NUMBER CAUGHT:	NUMBER KEPT:
Steelhead:________		
Brown Trout:________		
Coho ___________		
Chinook __________		

14)*Length, Weight, and Tagging Information (harvested fish)
(Lengths to the nearest one-tenth of an inch & Weight in grams)

Species	Length	Weight	Tag No.	Fin Clip

Species Codes: Brown trout - BrnT; Steelhead/Rainbow Trout - RbT; Coho Salmon - Coho; Chinook Salmon - Chin; Pink Salmon - Pink; Brook Trout - BrkT;

Fin Clip Codes: Adipose-AD, Top Caudal-TC, Bottom Caudal-BC, Left Ventral-LV, Right Ventral-RV, Left Pectoral-LP, Right Pectoral-RP.

15) Voluntary Angler Contact Information:

NAME:

ADDRESS:

EMAIL:

PHONE:

COMMENTS:

*Mandatory Info.

Appendix 4: Creel Survey Trail Camera Specifications

- Model: Bushnell Trophy Cam HD 12MP
- 32 low-glow infrared LEDs with an 80-ft. night vision flash
- 0.3-second trigger programmable for intervals between one and 60 seconds
- Removable anti-reflective device and black LED lights
- Video capabilities: one- to 60-second 780p resolution clips
- Multi-image mode: one to three photos per trigger
- Weatherproof construction
- Master Lock Python Compatible
- True one-year battery life; four or eight AA batteries
- 32GB SD card slot
- Web belt and 1/4"-20 socket
- Compatible with external power
- Temperature range between -5°F and 140°F
- 5.5"H x 4"W x 2.8"D

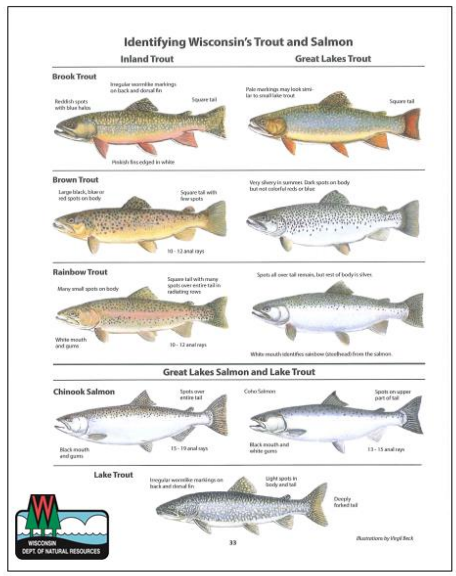
Appendix 5: Creel Survey Trail Camera Use Notification

ANGLER CREEL SURVEY

LOWER BOIS BRULE RIVER

(U.S. Highway 2 downstream to mouth)

CREEL SURVEY
WISCONSIN DEPARTMENT OF NATURAL RESOURCES



CAMERAS MAY BE IN USE AT THIS PARKING AREA

Appendix 6: Angler Questionnaire Survey Results

2016-2018 Lower Bois Brule River Angler Questionnaire Results

The Lower Bois Brule River is defined as downstream/north of US Highway 2 (*i.e., between Lake Superior and USH 2*).

Please read each question carefully and follow the instructions on how to record your answers.

SECTION I: FISHING THE LOWER BOIS BRULE FROM FALL 2016 – SPRING 2018

1. *Please choose the species you targeted when fishing the Lower Brule River from Fall 2016- Spring 2018.*

SPECIES	PERCENT (%)	NUMBER
I mainly fished for Steelhead.	73.7%	n = 191
I mainly fished for Brown Trout.	3.1%	n = 8
I mainly fished for Brook Trout.	0%	n = 0
I mainly fished for Salmon (Coho, Chinook).	0.8%	n = 2
I mainly fished for all species, with no preference for what I would catch.	22.4%	n = 58

2. *What area of the Lower Brule River did you fish most often from Fall 2016-Spring 2018?*

RESPONSE	PERCENT (%)	NUMBER
From Highway 13 downstream to mouth	16.8%	n = 43
From Highway FF downstream to Highway 13	44.9%	n = 115
From Highway 2 downstream to Highway FF	38.3%	n = 98

3. *What month did you most often fish the Lower Brule River in Fall 2016 and Fall 2017?*

MONTH	FALL 2016		FALL 2017	
July	0.9%	n = 2	1.3%	n = 3
August	1.4%	n = 3	0.4%	n = 1
September	18.8%	n = 40	16.5%	n = 37
October	70%	n = 149	71.9%	n = 161
November	8.9%	n = 19	9.8%	n = 22

4. *What month did you most often fish the Lower Brule River in Spring 2017 and Spring 2018?*

MONTH	SPRING 2017		SPRING 2018	
March	10.7%	n = 21	11.5%	n = 24
April	83.8%	n = 165	77.4%	n = 161
May	5.6%	n = 11	11.1%	n = 23

5. *During Fall 2016-Spring 2018, about how many days did you spend at least part of the day fishing the Lower Brule River?*

DAYS	FALL 2016		2017		SPRING 2018	
0	14.9%	n = 39	8%	n = 21	22.2%	n = 58
1-2	9.6%	n = 25	8%	n = 21	14.9%	n = 39
3-4	16.9%	n = 44	12.3%	n = 32	21.5%	n = 56
5-10	32.2%	n = 84	37.2%	n = 97	25.7%	n = 67
>10	26.4%	n = 69	34.5%	n = 90	15.7%	n = 41
Average # Days	9		12		6	
Max # Days	70		120		70	

6. *Please indicate how often you fish for trout on the Lower Brule River using the following gear. Fly fishing includes spey and switch.*

	NEVER	RARELY	SOMETIMES	OFTEN	ALWAYS
Spinning/	54.3%	11%	11.4%	11.9%	11.4%
Casting	n = 119	n = 24	n = 25	n = 26	n = 25
Fly Fishing	13.2%	4.1%	7%	14.8%	60.9%
	n = 32	n = 10	n = 17	n = 36	n = 148
Centerpin	82.3%	1%	4%	7.1%	5.6%
	n = 163	n = 2	n = 8	n = 14	n = 11

7. *Please indicate how often you fish for trout on the Lower Brule River using the following methods. Live bait includes night crawlers, waxworms, eggs/spawn.*

	NEVER	**RARELY**	**SOMETIMES**	**OFTEN**	**ALWAYS**
Live Bait	58.4%	10.6%	11.5%	15%	4.4%
	n = 132	n = 24	n = 26	n = 34	n = 10
Artificial	52%	13%	15.7%	14.8%	4.5%
	n = 116	n = 29	n = 35	n = 33	n = 10
Flies	9%	4.5%	7.3%	21.2%	58%
	n = 22	n = 11	n = 18	n = 52	n = 142

8. *How many miles one-way did you typically travel to reach your fishing location on the Lower Brule River during Fall 2016- Spring 2018.*

MILES	**PERCENT (%)**	**NUMBER**
1 – 10 miles	22.1%	n = 57
11 – 20 miles	5%	n = 13
21 – 50 miles	18.2%	n = 47
51 – 100 miles	11.2%	n = 29
101 – 200 miles	30.2%	n = 78
>200 miles	13.2%	n = 34
Average # miles	124	
Max # miles	1050	

9. Overall, how satisfied were you with your Fall 2016-Spring 2018 fishing experiences on the Lower Brule River?

RESPONSE	**PERCENT (%)**	**NUMBER**
Very Satisfied	41.2%	n = 106
Somewhat Satisfied	38.1%	n = 98
Neutral	9.3%	n = 24
Somewhat Dissatisfied	8.2%	n = 21
Very Dissatisfied	3.1%	n = 8

10. Please indicate your satisfaction with the availability and quality of the access points to the Lower Brule River.

RESPONSE	**PERCENT (%)**	**NUMBER**
Very Satisfied	67.8%	n = 173
Somewhat Satisfied	25.1%	n = 64
Neutral	5.1%	n = 13
Somewhat Dissatisfied	1.6%	n = 4
Very Dissatisfied	0.4%	n = 1

11. Your satisfaction with fishing on the Lower Brule River may have been influenced by some of the following. To what extent do you disagree or agree that each of the following statements affected your satisfaction with fishing the Lower Brule River.

RESPONSE	STRONGLY AGREE		SLIGHTLY AGREE		NEITHER		SLIGHTLY DISAGREE		STRONGLY DISAGREE	
There are too many anglers	14.7%	n = 38	44.4%	n = 115	25.5%	n = 66	11.6%	n = 30	3.9%	n = 10
There are too many non-anglers	2%	n = 5	5.1%	n = 13	31.6%	n = 81	16%	n = 41	45.3%	n = 116
I don't catch many fish	10.4%	n = 27	32%	n = 83	21.6%	n = 56	17.8%	n = 46	18.1%	n = 47
I catch too many small fish	2.3%	n = 6	12.8%	n = 33	35%	n = 90	22.6%	n = 58	27.2%	n = 70
I don't catch enough trophy fish	10.5%	n = 27	22.2%	n = 57	28.6%	n = 73	15.2%	n = 39	23.4%	n = 60
The daily bag limit is too low	1.6%	n = 4	1.6%	n = 4	16.7%	n = 43	12.1%	n = 31	68.1%	n = 175
The regulations are complicated	2%	n = 5	9%	n = 23	17.2%	n = 44	16%	n = 41	55.9%	n = 143
The regulations are restrictive	1.2%	n = 3	6.6%	n = 17	19.8%	n = 51	14.8%	n = 38	57.6%	n = 148

SECTION II: YOUR HISTORY ON THE LOWER BRULE RIVER

1. How many years have you been fishing the Lower Brule River?

YEARS	PERCENT (%)	NUMBER
1 – 2 years	10.5% (5% – 1 year)	n = 27 (13 – 1 year)
3 – 5 years	19.8%	n = 51
6 – 10 years	17.4%	n = 45
11 – 20 years	19%	n = 49
21 – 30 years	13.6%	n = 35
31 – 40 years	8.9%	n = 23
>40 years	10.9%	n = 28
Average # years	18	
Max # years	67	

2. Which type of salmonid do you typically fish for on the Lower Brule River?

SALMONID	PERCENT (%)	NUMBER
Brook Trout	0.4%	n = 1
Brown Trout	3.6%	n = 9
Steelhead	76.3%	n = 193
Salmon (Coho, Chinook, etc.)	1.6%	n = 4
All species/No preference	18.2%	n = 46

3. *In what year did you first fish the Lower Brule River?*

YEAR	PERCENT (%)	NUMBER
2018	3.5%	n = 9
2017	3.9%	n = 10
2016	5.1%	n = 13
2010 – 2015	23.8%	n = 61
2000 – 2009	21.5%	n = 55
1990 – 1999	15.2%	n = 39
1980 – 1989	9%	n = 23
1970 – 1979	10.5%	n = 27
Before 1970	7.4%	n = 19
Average year	1999	
Earliest year	1950	

4. *In the past 10 years (2008-2018), how many years have you fished the Lower Brule River?*

YEARS	PERCENT (%)	NUMBER
<3 years	15.1%	n = 39
3 – 4 years	12.4%	n = 32
5 – 6 years	12.8%	n = 33
7 – 8 years	7%	n = 18
9 – 10 years	52.7%	n = 136

5. *During the 10-year period from 2008 to 2018, in general would you say the number of days in a year you fish the Lower Brule River has been increasing, decreasing or staying about the same?*

RESPONSE	PERCENT (%)	NUMBER
Increasing	28.1%	n = 63
Decreasing	14.7%	n = 33
Staying about the same	57.1%	n = 128

6. *How important is fishing the Lower Brule River to you in comparison to all your other fishing destinations? Would you say that fishing the Lower Brule River is:*

RESPONSE	PERCENT (%)	NUMBER
My most important fishing destination	22.8%	n = 59
One of the most important fishing destinations	61.4%	n = 159
No more important than any other of my fishing destinations	13.1%	n = 34
Less important than most of my other fishing destinations	2.3%	n = 6
Not at all important to me as a fishing destination	0.4%	n = 1
I do not fish any other waters	0%	n = 0

7. *Do you fish other Great Lakes Tributaries?*

RESPONSE	PERCENT (%)	NUMBER
Yes	77.7%	n = 202
No	22.3%	n = 58

8. *How does fishing the Lower Brule River compare to other Great Lakes tributaries?*

RESPONSE	PERCENT (%)	NUMBER
Much better	29.3%	n = 61
Somewhat better	31.3%	n = 65
About the same	23.1%	n = 48
Somewhat worse	12.0%	n = 25
Much worse	4.3%	n = 9

9. *In the past 3 years have you fished other rivers or streams for trout in Wisconsin?*

RESPONSE	PERCENT (%)	NUMBER
Yes	77.7%	n = 202
No	22.3%	n = 58

10. Compared to other trout rivers or streams in Wisconsin would you say the fishing quality on the Lower Brule River is:

RESPONSE	PERCENT (%)	NUMBER
Much better	23%	n = 49
Somewhat better	34.7%	n = 74
About the same	28.2%	n = 60
Somewhat worse	13.1%	n = 28
Much worse	0.9%	n = 2

11. In the years that you've fished the Lower Brule River, how would you say each of the following has changed?

RESPONSE	INCREASING	REMAINING STABLE	DECREASING
Number of fish I catch	17.6% (n = 45)	59% (n = 151)	23.4% (n = 60)
Average size of fish I catch	11.8% (n = 30)	71.7% (n = 182)	16.5% (n = 42)
Water quality	5.1% (n = 13)	86.8% (n = 223)	8.2% (n = 21)
Crowding from other anglers	59.5% (n = 153)	38.1% (n = 98)	2.3% (n = 6)
Overall management of the river	9% (n = 23)	80.4% (n = 205)	10.6% (n = 27)

12. In the time you have been fishing the Lower Brule River, the trout fishery has:

RESPONSE	PERCENT (%)	NUMBER
Definitely improved	5.1%	n = 13
Probably improved	13.2%	n = 34
Remained about the same	52.1%	n = 134
Probably worsened	23%	n = 59
Definitely worsened	6.6%	n = 17

13. *Your answer to the previous question may have been influenced by various factors.* ***If you checked worsened in question 12, please check 2 boxes in the Worsened column, if you checked improved in question 12, please check 2 boxes in the Improved column.***

WORSENED	PERCENT (N)	IMPROVED	PERCENT (N)
Too much fishing pressure	25.9% (n = 79)	Reduced fishing pressure	3.1% (n = 4)
Other anglers keeping too many fish	13.8% (n = 42)	More catch and release being practiced	41.2% (n = 54)
Ineffective or detrimental regulations	3.3% (n = 10)	Improved fishing regulations	9.9% (n = 13)
Loss of trout habitat	5.9% (n = 18)	Improved trout habitat	9.2% (n = 12)
Water quality becoming worse	3.6% (n = 11)	Improved water quality	2.3% (n = 3)
Lower trout population levels	16.7% (n = 51)	Higher trout populations	9.9% (n = 13)
Higher water temperatures	2% (n = 6)	Cooler water temperatures	2.3% (n = 3)
Fewer large steelhead	15.7% (n = 48)	More large steelhead	6.1% (n = 8)
Fewer large Brown Trout	6.6% (n = 20)	More large Brown Trout	8.4% (n = 11)
Poor fish management (excluding regs)	3.9% (n = 12)	Improved fish management (excluding regs)	6.1% (n = 8)
Increase in other predators (such as otter)	2.6% (n = 8)	Decrease in other predators (such as otter)	1.5% (n = 2)

SECTION III: REGULATIONS AND THE FISH YOU CATCH

1. *How many inches long was the largest steelhead, Brown Trout and salmon that you caught from 2008 to 2018 from the Lower Brule River?*

Longest steelhead

INCHES	PERCENT (%)	NUMBER
12 – 15	2.2%	n = 5
16 – 20	4.4%	n = 10
21 – 23	4.8%	n = 11
24 – 26	17.6%	n = 40
27 – 28	32.2%	n = 73
29 – 30	32.2%	n = 73
31 – 32	5.7%	n = 13
>32	0.9%	n = 2
Average length	27	
Max length	39	

Longest Brown Trout

INCHES	PERCENT (%)	NUMBER
8 – 11	3.3%	n = 7
12 – 15	13.3%	n = 28
16 – 19	13.3%	n = 28
20 – 23	14.3%	n = 30
24 – 26	21%	n = 44
27 – 30	26.7%	n = 56
31 – 32	5.2%	n = 11
>32	2.9%	n = 6
Average length	22.9	
Max length	40	

Longest salmon (Coho & Chinook)

INCHES	PERCENT (%)	NUMBER
8 – 11	2.9%	n = 3
12 – 15	8.7%	n = 9
16 – 19	6.8%	n = 7
20 – 23	25.2%	n = 26
24 – 26	25.2%	n = 26
27 – 30	7.8%	n = 8
31 – 33	9.7%	n = 10
>33	13.6%	n = 14
Average length	24.6	
Max length	41	

2. *How many inches long would a steelhead, Brown Trout or salmon in the Lower Brule River need to be for you to consider it a "trophy" fish?*

Longest steelhead

INCHES	PERCENT (%)	NUMBER
<20	0.4%	n = 1
20 – 22	2.1%	n = 5
23 – 25	6.2%	n = 15
26 – 28	24.7%	n = 60
29 – 31	53.1%	n = 129
32 – 34	9.9%	n = 24
35 – 36	3.3%	n = 8
>36	0.4%	n = 1
Average length	29.1	
Max length	40	

Longest Brown Trout

INCHES	PERCENT (%)	NUMBER
<18	1.3%	n = 3
18 – 20	13.8%	n = 31
21 – 23	4.9%	n = 11
24 – 26	20.9%	n = 47
27 – 29	15.1%	n = 34
30 – 32	38.2%	n = 86
33 – 35	3.6%	n = 8
>35	2.2%	n = 5
Average length	27	
Max length	40	

Longest salmon (Coho & Chinook)

INCHES	PERCENT (%)	NUMBER
<20	0.6%	n = 1
20 – 22	5.3%	n = 9
23 – 25	18.3%	n = 31
26 – 28	14.8%	n = 25
29 – 31	22.5%	n = 38
32 – 34	8.3%	n = 14
35 – 37	21.3%	n = 36
>37	8.9%	n = 15
Average length	30.3	
Max length	45	

3. *Think about the legal sized trout and salmon you caught from the Lower Brule River during Fall 2016- Spring 2018. Would you say that you released all legal trout and salmon, released some and kept others, or kept all legal trout and salmon from the Lower Brule River?*

RESPONSE	PERCENT (%)	NUMBER
I did not catch a legal sized trout/salmon	9%	n = 23
I released all legal sized trout/salmon	64.1%	n = 164
I released some legal sized trout/salmon and kept others	24.2%	n = 62
I kept all legal sized trout/salmon	2.7%	n = 7

4. *If you keep fish, do you do so for consumption?*

RESPONSE	PERCENT (%)	NUMBER
Never	28.2%	n = 64
Rarely	14.5%	n = 33
Sometimes	11%	n = 25
Often	4.8%	n = 11
Always	41.4%	n = 94

5. *If you keep fish, do you do so for taxidermy?*

RESPONSE	PERCENT (%)	NUMBER
Never	83.8%	n = 191
Rarely	11.4%	n = 26
Sometimes	4.4%	n = 10
Often	0.4%	n = 1
Always	0%	n = 0

6. *In the years that you've been fishing the Lower Brule River, would you say that your catch-and-release fishing of legal sized trout and salmon has:*

RESPONSE	PERCENT (%)	NUMBER
Definitely increased	23.1%	n = 58
Probably increased	11.2%	n = 28
Remained about the same	55%	n = 138
Probably decreased	7.2%	n = 18
Definitely decreased	3.6%	n = 9

7. *What is your overall impression of the current daily bag limit of 5 trout and salmon total with a daily bag limit of 2 Brown Trout ≥ 15 inches and 1 steelhead ≥ 26 inches?*

5 Trout and Salmon:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	28.2%	n = 71
Somewhat Satisfied	13.9%	n = 35
Neutral	29%	n = 73
Somewhat Dissatisfied	15.5%	n = 39
Very Dissatisfied	13.5%	n = 34

2 Brown Trout ≥ 15 inches:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	30.6%	n = 77
Somewhat Satisfied	16.7%	n = 42
Neutral	25.8%	n = 65
Somewhat Dissatisfied	13.1%	n = 33
Very Dissatisfied	13.9%	n = 35

1 Steelhead ≥ 26 inches:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	33.6%	n = 86
Somewhat Satisfied	9.8%	n = 25
Neutral	20.7%	n = 53
Somewhat Dissatisfied	11.3%	n = 29
Very Dissatisfied	24.6%	n = 63

8. *What is your overall impression of the current length limit regulations for each species?*

Brown Trout, 10-inch minimum length limit:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	27.5%	n = 70
Somewhat Satisfied	14.5%	n = 37
Neutral	26.7%	n = 68
Somewhat Dissatisfied	14.5%	n = 37
Very Dissatisfied	16.9%	n = 43

Steelhead, 26-inch minimum length limit:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	33.2%	n = 85
Somewhat Satisfied	13.7%	n = 35
Neutral	18.8%	n = 48
Somewhat Dissatisfied	11.3%	n = 29
Very Dissatisfied	23%	n = 59

Salmon, 12-inch minimum length limit:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	34.6%	n = 88
Somewhat Satisfied	13%	n = 33
Neutral	34.3%	n = 87
Somewhat Dissatisfied	7.9%	n = 20
Very Dissatisfied	10.2%	n = 26

9. *What is your overall impression of the current season structure? Open harvest season downstream of USH 2 - last Saturday in March through November 15*

Spring:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	39.5%	n = 100
Somewhat Satisfied	22.1%	n = 56
Neutral	20.2%	n = 51
Somewhat Dissatisfied	10.7%	n = 27
Very Dissatisfied	7.5%	n = 19

Fall:

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	39.6%	n = 101
Somewhat Satisfied	20.8%	n = 53
Neutral	17.6%	n = 45
Somewhat Dissatisfied	13.7%	n = 35
Very Dissatisfied	8.2%	n = 21

10. What is your overall satisfaction with DNR management of the Lower Brule River fishery?

RESPONSE	PERCENT (%)	NUMBER
Very Satisfied	27.4%	n = 71
Somewhat Satisfied	38.2%	n = 99
Neutral	20.8%	n = 54
Somewhat Dissatisfied	10.4%	n = 27
Very Dissatisfied	3.1%	n = 8

11. What criteria do you use or rely on to gauge the fish runs on the Lower Brule River? ***(Please check all that apply)***

☐Own angling success ☐Reports from other anglers ☐Other
☐DNR fishway count ☐Social media or other websites

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
Own angling success	67.8%	n = 177
DNR fishway count	57.5%	n = 150
Reports from other anglers	51.3%	n = 134
Social media or other websites	24.1%	n = 63

If you answered other, please elaborate in the space provided:

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
USGS data/stream flow/water level	4.2%	n = 11
Weather	1.9%	n = 5
Fish sightings	1.5%	n = 4
Rainfall	1.5%	n = 4
Water temperature	1.1%	n = 3
Water condition	0.8%	n = 2

Size-structure of fish	0.4%	n = 1
Lunar cycle	0.4%	n = 1
Ice out at the mouth	0.4%	n = 1

12. *When you complete a fishing trip on the Lower Brule River and do not hook any fish, do you think:*

RESPONSE	PERCENT (%)	NUMBER
Fish were not there because they were elsewhere in the river	24.2%	n = 62
Fish were not there because they were too low in abundance	15.6%	n = 40
Fish were there, but I did not hook them	60.2%	n = 154

13. *What factors contribute to you fishing the Lower Brule River over other fisheries?* ***(Please check all that apply)***

☐Steelhead Run ☐History of the River ☐Family/Social Tradition
☐Location ☐Accessibility ☐Popularity of the Brule River ☐Other

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
Steelhead run	86.2%	n = 225
History of the river	52.1%	n = 136
Family/social tradition	34.9%	n = 91
Location	49%	n = 128
Accessibility	44.4%	n = 116
Popularity of the Brule River	11.5%	n = 30

If you answered other, please elaborate in the space provided:

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
Beauty/scenery	8.8%	n = 23
Quality fishery/trophy potential	1.5%	n = 4
Wild steelhead fishery	1.1%	n = 3
Stream size/variety of water types (pools, riffles, runs, etc.)/stream flow	1.1%	n = 3

Seclusion	1.1%	n = 3
Brown Trout run	1.1%	n = 3
Water quality	0.8%	n = 2
Wildlife	0.8%	n = 2
Fishing with friends	0.8%	n = 2
The challenge/the fight	0.8%	n = 2
Clients request to fish there	0.4%	n = 1
Coho run	0.4%	n = 1
Timing of steelhead run	0.4%	n = 1
Other fish (walleye, northern, smallmouth bass)	0.4%	n = 1

14. Are you a member of any angling or conservation groups (i.e., Trout Unlimited)?

RESPONSE	PERCENT (%)	NUMBER
Yes	45.9%	n = 117
No	54.1%	n = 138

Please list all that apply:

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
Trout Unlimited (all chapters)	32.2%	n = 84
Brule River Sportsmen's Club	12.3%	n = 32
Lake Superior Steelhead Association	8.8%	n = 23
Fly Fishers International	1.5%	n = 4
Backcountry Hunters & Anglers	1.5%	n = 4
Minnesota Steelheader	1.1%	n = 3
North Shore Steelhead Association	1.1%	n = 3
American Fisheries Society	0.8%	n = 2
Brule River Skagit Casters	0.8%	n = 2
Sierra Club	0.8%	n = 2
Greater Lake Superior Foundation	0.8%	n = 2

Izaak Walton League	0.8%	n = 2
Saint Paul Fly Tiers	0.8%	n = 2
Ruffed Grouse Society	0.8%	n = 2
Pheasants Forever	0.8%	n = 2
Brule River Rats Stewardship Council	0.8%	n = 2
Wisconsin Wildlife Federation	0.8%	n = 2
River Alliance of Wisconsin	0.4%	n = 1
Bois Brule Manifesto Group	0.4%	n = 1
The Nature Conservancy	0.4%	n = 1
Ducks Unlimited	0.4%	n = 1
Delta Waterfowl	0.4%	n = 1
Hawkeye Fly Fishing Association	0.4%	n = 1
Helen Shaw Fly Fishers	0.4%	n = 1
West Fork Sportsman's Club	0.4%	n = 1
Muskies Inc.	0.4%	n = 1
Native Fish Society	0.4%	n = 1
League of Conservation Voters	0.4%	n = 1
Michigan Steelheaders	0.4%	n = 1
Great Lakes Fisheries Commission	0.4%	n = 1
American Rivers	0.4%	n = 1
Environmental Defense Fund	0.4%	n = 1
Anglers of the Au Sable	0.4%	n = 1
Rocky Mountain Elk Foundation	0.4%	n = 1
Montana Wildlife Federation	0.4%	n = 1
United Northern Sportsmen	0.4%	n = 1
Minnesota Deer Hunters Association	0.4%	n = 1
Eau Galle-Rush River Sportsman's Club	0.4%	n = 1
Wisconsin Smallmouth Alliance	0.4%	n = 1
Wild Steelhead Coalition	0.4%	n = 1

Wild Steelheaders United	0.4%	n = 1

15. Please share any additional comments that you have on the Lower Brule River fishery in the space below:

RESPONSE	PERCENT OF ALL RESPONDENTS (261)	NUMBER
Enact catch-and-release only regulations (entire river; sections; extended season)	17.2%	45
Love the river; general satisfaction	17.2%	45
Extend fall season; extend spring season; open year-round	7.3%	19
Bag limits are too generous; enact more strict regulations; maintain strict regulations	6.9%	18
River etiquette; litter; access concerns	5.7%	15
No live bait; Artificial only	5.7%	15
Increased angling pressure; increased crowding	5%	13
Fishery getting worse; lower numbers of fish; small sizes of fish	4.2%	11
Increase Brown Trout minimum length	3.8%	10
Habitat concerns; erosion; beaver control	3.4%	9
Fly fishing only (entire river; sections; extended season)	3.1%	8
No treble hooks; barbless hooks only	2.7%	7
Fish handling concerns; minimize release mortality	2.7%	7
More warden presence desired; observations of illegal activities	2.7%	7
Protect females; protect redds	2.7%	7
Coaster Brook Trout rehabilitation	2.3%	6
Increase out of state license fees; out of state angler practices	2.3%	6
Increase steelhead minimum length	2.3%	6
Lake Superior trolling; charters; boating concerns	1.9%	5
No stocking	1.9%	5
Resume stocking	1.9%	5
Continue DNR Fish counts; more DNR research needed	1.1%	3

Concern for youth interest	0.4%	1
No night fishing	0.4%	1
Concern for bass abundance impacting smelt	0.4%	1
Increase salmon minimum length	0.4%	1

These last few questions will help us compare your answers to those of other Lower Brule River anglers.

1. *In which state and county is your primary residence located?*

STATE	PERCENT (%)	NUMBER
Minnesota	55.8%	n = 144
Wisconsin	38.8%	n = 100
Iowa	1.2%	n = 3
Michigan	1.2%	n = 3
Tennessee	0.8%	n = 2
Illinois	0.4%	n = 1
Indiana	0.4%	n = 1
Montana	0.4%	n = 1
North Carolina	0.4%	n = 1
Nebraska	0.4%	n = 1
Texas	0.4%	n = 1

COUNTY (STATE)	PERCENT (%)	NUMBER
St. Louis (MN)	18.3%	n = 44
Hennepin (MN)	13.7%	n = 33
Douglas (WI)	12%	n = 29
Ramsey (MN)	5.4%	n = 13
Dakota (MN)	4.1%	n = 10
Dane (WI)	2.9%	n = 7
Anoka (MN)	2.9%	n = 7
Carlton (MN)	2.1%	n = 5

Eau Claire (WI)	2.1%	n = 5
Polk (WI)	2.1%	n = 5
Washington (MN)	2.1%	n = 5
Barron (WI)	1.7%	n = 4
Bayfield (WI)	1.7%	n = 4
Sawyer (WI	1.7%	n = 4
Carver (MN)	1.2%	n = 3
Chippewa (WI)	1.2%	n = 3
Dunn (WI)	1.2%	n = 3
Marathon (WI)	1.2%	n = 3
St. Croix (WI)	1.2%	n = 3
Brown (WI)	0.8%	n = 2
Chisago (MN)	0.8%	n = 2
Lake (MN)	0.8%	n = 2
Rusk (WI)	0.8%	n = 2
Taylor (WI)	0.8%	n = 2
Walworth (WI)	0.8%	n = 2
Washburn (WI)	0.8%	n = 2
Ashland (WI)	0.4%	n = 1
Beltrami (MN)	0.4%	n = 1
Calumet (WI)	0.4%	n = 1
Cass (MN)	0.4%	n = 1
Cero Gordo (IA)	0.4%	n = 1
Clare (MI)	0.4%	n = 1
Clay (MN)	0.4%	n = 1
Crow Wing (MN)	0.4%	n = 1
Dallas (IA)	0.4%	n = 1
Fergus (MT)	0.4%	n = 1
Fond du Lac (WI)	0.4%	n = 1

Freeborn (MN)	0.4%	n = 1
Iron (WI)	0.4%	n = 1
Itasca (MN)	0.4%	n = 1
Kenosha (WI)	0.4%	n = 1
Kent (MI)	0.4%	n = 1
La Crosse (WI)	0.4%	n = 1
Lincoln (WI)	0.4%	n = 1
Mille Lacs (MN)	0.4%	n = 1
Milwaukee (WI)	0.4%	n = 1
Monroe (WI)	0.4%	n = 1
Montgomery (TX)	0.4%	n = 1
Morrison (MN)	0.4%	n = 1
Ozaukee (WI)	0.4%	n = 1
Portage (WI)	0.4%	n = 1
Rutherford (TN)	0.4%	n = 1
Saint Joseph (IN)	0.4%	n = 1
Sarpy (NE)	0.4%	n = 1
Shawano (WI)	0.4%	n = 1
Sheboygan (WI)	0.4%	n = 1
Stearns (MN)	0.4%	n = 1
Wake (NC)	0.4%	n = 1
Waukesha (WI)	0.4%	n = 1
Will (IL)	0.4%	n = 1
Winnebago (WI)	0.4%	n = 1
Wood (WI)	0.4%	n = 1
Wright (MN)	0.4%	n = 1

2. What is your age?

AGE	PERCENT (%)	NUMBER
<20	0	n = 0
20 – 29	14.3%	n = 37
30 – 39	23.3%	n = 60
40 – 49	19.0%	n = 49
50 – 59	17.8%	n = 46
60 – 69	18.2%	n = 47
70 – 79	7%	n = 18
>79	0.4%	n = 1
Average age	47	
Max age	87	

3. Are you:

GENDER	PERCENT (%)	NUMBER
Male	98.8%	n = 253
Female	1.2%	n = 3

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.