Trout Fishery Evaluation for Southwest Montana Fish, Wildlife & Parks

2026 Interim Report

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Executive Summary

Southwest Montana supports some of the most popular trout fisheries in the U.S. However, brown and rainbow trout abundances have declined to near historic low abundances in many mainstem river sections throughout much of the upper Missouri River Basin. Low trout abundances coupled with fish health concerns and increased recreational use led to the need to better understand the major limiting factors in the Beaverhead, Big Hole, Madison, and Ruby fisheries and characterize overall recreational use on those rivers. The specific goals of the combined efforts are to 1) quantify the proportions of mainstem trout originating in tributaries, 2) identify important spawning and rearing habitats throughout each of the major drainages, 3) identify how environmental conditions and angling affect adult trout survival, and 4) develop methods to estimate the quantity of use by different recreational user groups, and apply these methods on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers. These efforts were separated into four distinct studies, three of which are being conducted by graduate students and professors at Montana State University. The fish health study is being completed by Montana Fish, Wildlife & Parks with assistance from a collaborative workgroup that includes external partners.

Otoliths from brown and rainbow trout were collected from fish captured in the Beaverhead, Big Hole, and Ruby rivers as part of an otolith microchemistry study to determine natal origins of mainstem fish. Juvenile sampling completed in select tributaries and mainstem sections revealed young-of-year (YOY) trout abundances that ranged from nearly 0 to 3600 YOY/km. Mainstem sections ranged from nearly 0 YOY/km in several areas to over 10,000 YOY/km in the Hildreth Section of the Beaverhead River.

The adulty mortality study entails tagging adult brown and rainbow trout captured during long-term sampling efforts on the four main rivers. The use of external reward and internal passive transponder tags provides the ability to estimate angler capture, external tag retention, angler reporting rate, and adult fish mortality. Nearly 25,000 brown and rainbow trout were tagged during 2024 and 2025. Reported angler capture for brown trout and rainbow trout were highest in the Ruby River (0.37) and the Clark Canyon section of the Beaverhead River (0.36), respectively.

Fish health efforts assessed prevalence of head necrosis and fungal infections during sampling efforts. Tissue and blood samples were collected from moribund fish and a select number of seemingly healthy fish during sampling events. The primary infectious cause of the head lesions and presumed fungal infections remain unknown. Less than 1% of the adult trout and whitefish captured during 2025 spring and fall surveys efforts exhibited clinical signs of head necrosis or fungal lesions. No juvenile trout captured during 2025 sampling efforts for the natal origins and recruitment study showed signs of either infection.

On-site interviews, postcard surveys, and vehicle counts were used to characterize recreational use along the four main rivers along with the upper Yellowstone River starting in 2025. About 290,000 individual recreationalists totaling about 1,250,000 hours were estimated across all five

rivers between March 1 and September, 2025. The Madison River consistently had the highest number of recreationists per month. Nearly 450,000 capture events by anglers were estimated to have occurred during the same time. Harvest was minimal throughout the sampling period with less anglers reporting a harvest fish on < 1% of recreational trips. Fly fishing was the dominant activity across all rivers during most periods.

Project Background and Objectives

Trout fisheries in Montana are valued at more than $750 million/year (Lewis 2018) representing more than 20% of tourism spending in Montana (Grau 2018). Southwestern Montana, including the upper Missouri and Yellowstone basins, supports some of the most well-known rainbow trout *Oncorhynchus mykiss* and brown trout *Salmo trutta* fisheries in the world and provide a significant portion of the statewide economic benefits to the economy (Cline et al. 2022). Between 1983 and 2017, total fishing pressure doubled from 0.8 million angler-days to 1.7 million angler-days (Cline et al 2022). Nonresident angling in the most popular rivers, including those in SW Montana, increased up to 1,600% during this time (Cline et al 2022). In addition to angling, these rivers also experience other types of water-based recreation such as rafting, kayaking, inner-tubing, and sight-seeing, though these other kinds of use are not quantified. Of concern is the observation that the rainbow and brown trout populations in sections of the Beaverhead, Big Hole, Madison, and Ruby rivers have declined to near historic lows in recent years. This, along with public concerns about the number of people recreating on the rivers and how that affects the quality of the experience and the aquatic resources, points to the immediate need for a comprehensive study of juvenile trout recruitment, adult trout survival, river recreation, and fish health in this part of the state.

The purpose of this project is to determine the natal origins of fish in the mainstem rivers, quantify the levels and causes of adult trout mortality, better understand the prevalence and causes of head necrosis and fungal infections observed primarily in brown trout and mountain whitefish *Prosopium williamsoni*, and to develop methods to accurately estimate the amount and type of recreational uses on rivers. These studies will directly inform management approaches to ensure trout population conservation while providing ample recreational opportunity. Our specific goals are to 1) quantify the proportions of mainstem trout originating in tributaries, 2) identify important spawning and rearing habitats throughout each of the major drainages, 3) identify how environmental conditions and angling affect adult trout survival, and 4) develop methods to estimate the quantity of use by different recreational user groups, and apply these methods on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers.

Natal Origins and Recruitment.—This research is focused on determining the recruitment dynamics of juvenile (young-of-year and age-1) brown and rainbow trout across spatial and temporal scales in the Big Hole, Beaverhead, and Ruby watersheds. In recent years, population surveys conducted by Montana Fish, Wildlife & Parks (FWP) have found decreasing abundances of adult brown and rainbow trout across these three highly valuable fisheries. Population modeling has revealed a recent decline in age-2 recruitment underlying the observed decrease in adult abundance. Recruitment of fish to the juvenile life stage may mediate age-2 population dynamics due to bottlenecks in production and survival of fish through early life stages. Despite the importance of juvenile recruitment for regulating adult abundances, little work has been done in Southwest Montana to investigate juvenile fish production and survival across watersheds.

This project aims to leverage both lab and field methods to investigate the processes driving juvenile trout recruitment. Otolith microchemistry analysis will determine natal origins and relative production of juveniles from main stem and tributary sites in cohorts produced in the past ~8 years. Additionally, data from contrasting flow years will allow an analysis of how broad climate trends influence relative production of juveniles across the landscape. Analysis of age and growth from otoliths will provide an understanding of interannual growth and size at age relationships linked to environmental conditions through time. Age and growth analysis will pair synergistically with microchemistry analysis by providing information on how interannual growth and size at age differs between cohorts produced in years of varying climate conditions across the landscape. In the field, extensive juvenile abundance surveys and redd counts at both tributary and main stem sites will be paired with in-situ habitat data collection. This data will allow an understanding of how environmental variables mediate juvenile trout abundances and recruit per spawner relationships across tributary sites within and between watersheds. In addition, successive Fall and Spring abundance estimates will allow a coarse estimation of overwintering survival in tributaries and main stem sites. The synergistic use of field and lab methodologies will provide a holistic understanding of many of the factors limiting the production and survival of juvenile trout across temporal and spatial scales. This work will therefore enhance the understanding of factors limiting the abundance of adult trout across these highly valuable fisheries.

The objectives of this study are to 1) determine natal origins and relative production of juvenile trout across watersheds by conducting otolith microchemistry, 2) build age and growth relationships through otolith aging and measurement methods, and 3) obtain estimates of juvenile abundance in tributary and main stem field sites, estimate spawner densities, and quantify habitat features associated with varying abundance. This work will enhance FWP's understanding of adult trout population declines in Southwest Montana by elucidating the complex dynamics of juvenile trout recruitment. The results of this study have the potential to reveal management strategies that could enhance the survival and production of juvenile trout to bolster adult trout populations. Additionally, this work could inform management of other trout fisheries in Montana and assist in developing methods that can be employed throughout the state to monitor juvenile recruitment.

Adult Mortality.—Montana supports some of the nation's most well-known and highly regarded coldwater fisheries. High angler and commercial guide use combine to generate $1.1 billion per year in expenditures (Sheehan et al. 2025). Southwestern Montana, including the upper Missouri and upper Yellowstone River basins, supports some of the most well-known rainbow and brown trout fisheries in the world and provides significant benefits to the state economy.

Trout fisheries in southwest Montana have high fish densities and high angler catch rates, which result in popular fisheries. Increasing angling pressure combined with decreasing river discharge and increasing water temperatures have caused concern for southwest Montana trout fisheries. Total coldwater fishing pressure in Montana has increased dramatically over the last 60 years, including non-resident pressure increases of up to 1,600% in some sections of the most popular rivers (Cline et al. 2022). In addition to increases in angling pressure, southwestern Montana has warmed at twice the global rate over the last century (Pederson et al. 2010), and trout exhibit higher angling and natural mortality rates at elevated water temperatures (Boyd et al. 2010; Jiang et al. 2021). Concern was heightened when Montana Fish, Wildlife & Parks estimates for trout abundance in this region had declined to near historic lows. Declines in trout abundances raised concern among fisheries managers, commercial outfitters, business owners, and angling stakeholders. Projected declines in trout abundance could reduce economic input from trout angling by 30% (Cline et al. 2022).

Adult mortality of trout is a mechanism that could be responsible for the observed declines in trout abundance in southwest Montana. Our research aims to better understand the mechanisms that influence fishing and natural mortality. Many studies define fishing mortality as harvest only; however, the importance of incorporating catch-and-release mortality is becoming more apparent (Kerns et al. 2012). Catch-and-release mortality can vary widely depending on location, water temperature, species, and gear type (Taylor and White 1992; Muoneke and Childress 1994). The combination of increased angling pressure coupled with higher post-release mortality rates at high water temperatures could cause catch-and-release angling to be a large component of total mortality.

The research described in this annual report was conducted in the Beaverhead, Ruby, Big Hole, and Madison rivers. These rivers were traditionally managed to maximize angler opportunity. However, restrictions on season lengths, terminal gear, and creel limits have been introduced in response to fish abundance declines. Observed declines in the fish abundances in these rivers, coupled with the economic importance of trout fisheries in Montana, pointed to the immediate need for a comprehensive study of mortality sources of adult trout in southwest Montana.

The purpose of this project is to determine the causes of adult mortality in the upper Missouri River basin, and the specific objective is to quantify how environmental conditions and angling affect adult trout survival. This study will provide insight into the major factors contributing to adult trout mortality. This will allow managers to prioritize management actions that have the biggest influence on trout abundance.

Fish Health.—Brown and rainbow trout populations on the Beaverhead, Big Hole, and Ruby rivers exhibited population declines in recent years and are near historically low abundances in many long-term sampling sections. While factors such as low flows and high water temperatures contributed to those declines (Keleher and Rahel 1996; Williams et al. 2007; Jaeger and Bateman 2016; Kovach et al. 2016), notable signs of disease have also been apparent during the same time span. Two discernable afflictions, which will be referred to as "Head Necrosis" and "Fungal Infection", have been seen in brown trout, rainbow trout, mountain whitefish, and white suckers in the upper Jefferson River basin, and garnered noteworthy public and media attention. The underlying causes of these conditions is unknown, but hypotheses include increased susceptibility to disease because of unfavorable environmental conditions or growing pressures of novel disease introduction via new infections agents or water contaminants.

The Big Hole Fish Health Workgroup was created to understand risk factors and underlying relationships influencing fish health in the upper Jefferson Basin. Because the complex dynamics of the system with multiple stressors (e.g., water quantity and quality, climate, fishing pressure). The Workgroup consists of biological expertise at multiple levels from molecular to population and includes a comprehensive list of fish health experts, histopathologists, water quality specialists, microbiologists, fish physiologists, and fish biologists with FWP, Montana State University (MSU), the Washington Animal Disease Diagnostic Laboratory at Washington State University (WADDL), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS). In May of 2024, a proposal was made by the workgroup for a study aimed at improving the understanding of overall fish health including the etiology (primary cause), prevalence, limiting factors, and population-level effects of the two infections among fish populations in the upper Jefferson River basin. This was framed in conjunction with several joint FWP-MSU studies including assessments of juvenile and adult trout mortality as well as a comprehensive characterization of river recreation.

Case Definitions

Head Necrosis: This disease condition is characterized by the loss of epithelium primarily only on the dorsal half of heads (Figure 1). Lesions are typically depressed and white to light gray in color but can extend to the nares and laterally to the jaw line. Mild cases may include lesions smaller than 1 cm and be found on otherwise apparently healthy individuals. Severe cases are found on moribund or dead fish and involve deep lesions that cover and deform much of the head. Reports of Head Necrosis on brown trout and mountain whitefish began around 2019 primarily in the Big Hole and Beaverhead rivers with occasional reports in other mainstem rivers in the upper Missouri River basin. Cases of Head Necrosis appear to peak during early summer, and anecdotally, the frequency of cases appears to correlate with low flows and high water temperatures. However, infections have been observed in the spring prior to stressful flows or water temperatures.

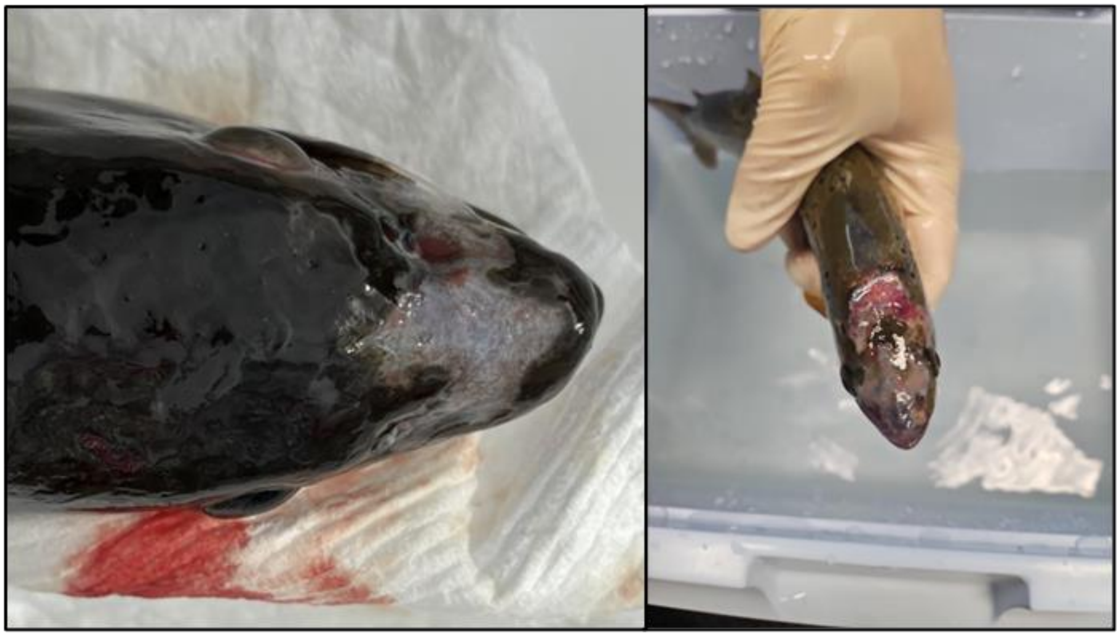


Figure 1. Mountain whitefish (left) and brown trout (right) with head necrosis.

Fungal Infections: This disease condition is characterized by raised, circular lesions, ranging in color from white to light brown (Figure 2). Lesions can be found on the head, body, and fins of infected fish. In most cases, these are attributed to Fungal Infections that are considered ubiquitous and assumed to be a secondary, opportunistic pathogens that colonize the skin. Subsequent infections may be a consequence of unidentified primary stressors, including trauma or pathogens. Mild cases may consist of small (0.5 cm), isolated fungal lesions on the fins or body of otherwise apparently healthy fish, whereas severe cases may involve large (25-50 cm) lesions that cover much of the body and result in death. Fungal Lesions have been observed on fish throughout Montana and neighboring states, but severe cases have been more commonly reported among brown trout in the fall and among rainbow trout in the spring.

Figure 2. Adult brown trout with severe fungal infection.

River Recreation.—Coldwater fisheries in Montana are valued at more than $1 billion/year (Sheehan et al. 2025). Southwestern Montana, including the upper Missouri and upper Yellowstone River basins, supports some of the most well-known rainbow trout and brown trout fisheries in the world and provides a significant portion of the statewide economic benefits to the economy. Total fishing pressure doubled from 0.8 million angler-days to 1.7 million angler-days between 1983 and 2017, and nonresident angling in the most popular rivers, including those in southwest Montana, increased up to 1,600% (Cline et al. 2022). In addition to angling, the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers also experience other types of water-based recreation such as rafting, kayaking, inner-tubing, and sight-seeing. However, non-angling recreational use has not been fully quantified. Owing to increases in all recreational use and the lack of non-angling use data, public concerns exist about the number of people recreating on the rivers and how that affects the quality of the experience and the aquatic resources. The objective of this research is to develop methods to estimate the quantity of use by different recreational user groups, and apply these methods on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers.

Methods

Natal Origins and Recruitment.—To date, 575 pairs of otoliths have been obtained from brown and rainbow trout across the Big Hole, Beaverhead, and Ruby Rivers. Rainbow trout otoliths were only collected from the Big Hole River. Most of the otoliths originate from fish collected in 2024 and the remainder originate from fish collected in 2020 and 2025 (Table 1). An additional 10 pairs of otoliths were collected from adult brown trout sampled in Grasshopper Creek to confirm natal origins and assess connection with the main stem Beaverhead River.

The 423 otoliths collected from 2020 and 2024 were fully prepared for microchemistry analysis in early 2025. Preparation for microchemistry analysis includes transverse cutting of otoliths, mounting cut otolith segments onto microscope slides, and sanding and polishing to improve visibility of annuli. Each otolith was imaged under a high-powered microscope to support subsequent age and growth analyses.

In February 2025, all 423 otoliths from 2020 and 2024 were analyzed using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) at Oregon State University. Transects were run from the core to the edge of each otolith to quantify 87Sr:86Sr ratios. Additionally, identical transects were run for elemental concentrations. These data will be paired with watershed-specific water chemistry measurements to assign natal origins and quantify relative juvenile production across years and basins.

Post-processing of microchemical data is currently underway, including data QA/QC, alignment of otolith transects with growth increments, and integration with water chemistry data. These analyses will provide spatially explicit estimates of natal origin and allow assessment of how juvenile production varies among tributaries, main stem habitats, and contrasting hydrologic conditions.

Table 1. Distribution of otolith sample sizes for each river basin and year of collection. Rainbow trout were only collected from the Big Hole in 2024 and 2025.

River	**Species**	**Year**	**Sample Size**
Big Hole	Brown trout	2020	55
Big Hole	Brown trout	2024	82
Big Hole	Brown trout	2025	33
Big Hole	Rainbow trout	2024	63
Big Hole	Rainbow trout	2025	27
Beaverhead	Brown trout	2020	70
Beaverhead	Brown trout	2024	72
Beaverhead	Brown trout	2025	92
Ruby	Brown trout	2020	54
Ruby	Brown trout	2024	27
Total			**575**

In the Summer of 2023, water samples were collected across the Big Hole, Beaverhead, and Ruby River watersheds and sent for isotopic and elemental analysis. Analysis of water samples was completed in Summer 2024 and the data was received. Ongoing work is now focused on integrating these data with otolith microchemistry results to assign natal origins and quantify relative juvenile production across watersheds.

Initial preparation has begun to develop spatially continuous isoscapes models to characterize variation in isotopic and elemental signatures across the river networks. Integrating both isotopic and elemental tracers within a unified spatial framework represents a novel analytical advancement that will substantially improve the resolution and confidence of natal origin assignments and understand habitat changes through time.

As part of the otolith processing workflow, all otoliths processed for microchemistry analysis have been imaged and aged to support the development of age and growth relationships for trout across the study watersheds. High-resolution images were used to identify annuli and measure increment widths, allowing for estimation of individual age and annual growth patterns. These measurements provide the foundation for evaluating variation in growth rates among cohorts, species, and river systems.

Age and growth analyses are currently underway and will be used to quantify interannual variability in growth and size-at-age across contrasting environmental conditions. These data will also be integrated with otolith microchemistry to link growth trajectories with natal origin and habitat use. Together, these analyses will provide insight into how environmental conditions and spatial context influence early-life growth, survival, and recruitment dynamics across the Big Hole, Beaverhead, and Ruby River systems.

Fall juvenile trout abundance sampling has now been completed for two consecutive years across the Big Hole, Beaverhead, and Ruby River drainages. During the 2024 and 2025 Fall field seasons, juvenile trout abundance estimates were obtained from seven tributary sites in the Big Hole drainage, four in the Beaverhead drainage, and four in the Ruby drainage (Table 2). Tributary sites were selected based on access through private land or public land, the presence of brown and rainbow trout, and representation of habitat and geomorphic variation. Abundance estimates were carried out using the 3-pass depletion method in 200-250 meter sample reaches. All age classes of trout were netted during sampling, allowing age-class-specific abundance estimates. Abundance estimates for juvenile (young of year) brown and rainbow trout have been calculated for each site using a Bayesian modeling approach and were corrected for reach length and expressed in juvenile trout per kilometer.

Table 2. *Tributary sampling sites for brown and rainbow trout abundance estimates.*

Basin	Site	Coordinates
Big Hole	Cherry Creek	45.60029, -112.69822
Big Hole	Trapper Creek	45.62320, -112.69548
Big Hole	Camp Creek	45.64728, -112.63559
Big Hole	Moose Creek	45.70382, -112.71761
Big Hole	Canyon Creek	45.69934, -112.75333
Big Hole	Deep Creek	45.90206, -113.11085
Big Hole	Wise River	45.76203, -112.96606
Beaverhead	Cox Creek	45.49855, -112.33354
Beaverhead	Stone Creek	45.34251, -112.53572
Beaverhead	Blacktail Creek	45.22357, -112.63746
Beaverhead	Grasshopper Creek	45.23199, -113.07490
Ruby	Wisconsin Creek	45.48649, -112.30292
Ruby	Mill Creek	45.46089, -112.28524
Ruby	Silver Springs Creek	45.40074, -112.19112
Ruby	Alder Creek	45.36014, -112.11962

In addition to tributary samples, estimates of juvenile trout abundance were obtained from four main stem sites in each of the Big Hole, Beaverhead, and Ruby Rivers using mark-recapture in both field seasons. Main stem sample sites were located at FWP Fishing Access Sites (FAS) or on private land and were distributed along a longitudinal gradient throughout each basin (Table 3). One additional site on the Big Hole River (Maidenrock FAS) was added in Fall 2025. In the Ruby River, the Barnosky site was substituted for the Morse site in Fall 2025 to improve spatial coverage of sampling. Bank margins along a single side of river were electroshocked for 200-250 meters and only juvenile trout were netted. All netted juveniles were marked with a passive integrated transponder (PIT) tag or an upper caudal clip and then released. Sites were revisited 7-8 days after marking and the same reach was electroshocked again. Juvenile abundance estimates were obtained using the proportion of recaptured fish during the second pass following the Peterson method. Abundance estimates were assumed to be equal for each riverbank and therefore were multiplied by two and were then corrected to juveniles per kilometer.

Table 3. Mainstem sampling sites for juvenile abundance estimates.

Basin	Site	Coordinates
Big Hole	Browns Bridge FAS	45.54467, -112.69304
Big Hole	Salmon Fly FAS	45.62416, -112.68565
Big Hole	George Grant FAS	45.77867, -112.84958
Big Hole	Jerry Creek FAS	45.78493, -112.91422
Big Hole	Maidenrock FAS	45.70449, -112.74442
Beaverhead	Ten Mile	45.21492, -112.66625
Beaverhead	Poindexter FAS	45.18348, -112.68915
Beaverhead	Pipe Organ FAS	45.06586, -112.80249
Beaverhead	Hildreth	45.02726, -112.84448
Ruby	Silver Springs FAS	45.41448, -112.20769
Ruby	Barnosky	45.40629, -112.19949
Ruby	Morse	45.45456, -112.28223
Ruby	Alder Bridge FAS	45.31948, -112.11750
Ruby	Vigilante FAS	45.26060, -112.09970

In Spring 2025, follow-up electrofishing surveys were conducted at all tributary and main stem sites to estimate overwinter survival of juvenile brown trout (Figure 3). Methods and sampling sites were identical to Fall survey locations. These paired fall-spring surveys provide an initial assessment of early-life survival and will support evaluation of how habitat conditions and environmental variability influence juvenile persistence and recruitment across watersheds. When more fish were observed in Spring 2025 than Fall 2024, survival estimates are >1.0 which is indicative of significant migration of individuals into the study site between seasons. Grasshopper Creek was the only site sampled in Fall 204 and not sampled in Spring 2025.

For two consecutive years, redd counts were conducted across 14 tributary sites from late November to early December to determine brown trout spawner abundances. Stone Creek was not surveyed due to high turbidity and low water visibility during Fall 2024 and 2025. Survey reaches encompassed 1-2 km and were limited by private landowner access and availability of public land. During each survey, redds were counted independently by two readers and counts were corrected to redd per kilometer.

Continuous temperature measurements at 10-minute intervals are being actively collected from each tributary site using Onset data loggers. Loggers were deployed in each site from July to September 2024. Year-round temperature data was unattainable in every site due to animal interference with data loggers.

Discrete discharge measurements were taken opportunistically at tributary sites from March through December. Average Summer flows across sites were calculated using discrete measurements collected from July-September of 2024 and 2025. Discharge was not collected in the Wise River but will be available in the future using USGS data. In June of 2025, continuous water level and temperature loggers were installed at all tributary sites to provide continuous discharge and temperature time series across the study period. These loggers were more robust to animal interference and will ensure reliably continuous temperature and flow data moving forward. Analysis of continuous flow data across sites is forthcoming. Future plans for habitat data collection include on-site habitat surveys and geospatial analysis of tributary habitat features that will further characterize site specific characteristics.

Adult Mortality.—We used external reward and passive integrated transponder (PIT) tags to estimate angler capture of fish, external tag retention, and angler reporting. Rainbow trout and brown trout were sampled using electrofishing by Montana Fish, Wildlife & Parks (MFWP) in the MFWP long-term monitoring sections in the Beaverhead, Ruby, Big Hole, and Madison rivers. Annual tagging started in spring 2024, except on the upper Madison where tagging began in autumn 2024. Two additional sections outside of the MFWP long-term monitoring sections were also sampled in the Beaverhead River. All sampled fish were tagged with a PIT tag in the dorsal sinus (Biomark model GPT-12; 12.5 × 2.12 mm). In spring 2024, nine of every ten fish were also tagged with an external T-bar tag advertising an entry into a raffle drawing (Hallprint Inc. T-bar; 55 mm; blue). Tags with a raffle entry read "PRIZE CLIP TAG CALL XXX-XXX-XXXX." About 250 fish with external tags advertising a $100 reward were tagged on the Beaverhead, Ruby, Madison, and Big Hole rivers (Hallprint Inc. T-bar; 55 mm; yellow). These tags read "$100 CLIP TAG CALL XXX-XXX-XXXX." Starting in autumn 2024, all fish were tagged with an external tag. Additionally, 300 fish were tagged with two external T-bar tags to estimate tag retention. Additional fish were tagged in the Big Hole River in autumn 2025.

Recapture runs were conducted by MFWP to assess external tag retention and tag additional fish. Recapture runs occurred about one week after the initial tagging event. Captured rainbow trout or brown trout were inspected for tags and previously untagged fish were tagged. No high-value reward tags were used during recapture runs. Recaptures were recorded and retention of external tags was noted. Beginning in 2025, recaptured fish that had lost their external tag(s) were retagged.

Anglers who caught a tagged fish were instructed to remove the external tag(s) and report it in which case they would receive either a $100 reward or be entered into a prize raffle. Anglers could report external tags to the phone number on the tag, a reporting website, or MFWP. Anglers were asked to report the fish species, tag number(s), date and location caught, if the fish was released, if the tag(s) was removed, gear type, and if the fish showed signs of disease. Anglers who did not remove the tag(s) were also eligible for a reward and were instructed to remove tags in the future. Raffle drawings were done throughout the year, with anglers entered into the first drawing held after they reported their fish. A larger winter raffle included everyone who caught a raffle-tagged fish. Anglers who caught $100 reward fish were mailed a pre-paid gift card.

To better identify when mortality occurred, MFWP conducted additional electrofishing recapture runs in the autumn of 2024 and 2025, except in the upper Madison River where recapture runs occurred in spring 2025. Data from the 2025 upper Madison River spring recapture run are currently being processed and are not included in this report. Low flows prevented sampling some sections. A target recapture probability was set at 0.2 to verify fish survival and better estimate mortality (i.e., attempt to recapture 20% of the fish originally tagged). Personnel from MFWP recorded every trout captured. If a fish had a PIT tag, its number was recorded along with if it had an external tag. Some fish were identified as having a small amount of the external-tag filament protruding from the body. These fish were identified as having had the tag clipped off by an angler.

Two methods were used to estimate immediate external-tag retention (Type I). The first method compared the number of recaptured fish during the immediate electrofishing recapture run that had retained their tag(s) to the number of marked fish that were recaptured. A binomial regression was used for fish tagged with a single external tag, and a multinomial regression was used for fish tagged with two external tags. The second method compares the proportions of fish tagged with two external tags that were reported as caught by anglers with either one or two tags. The likelihood of a double-tagged fish retaining one or two tags was conditional on the fish having not lost both tags because fish that have lost two tags are unobservable using this method.

The angler reporting rate of tagged fish was estimated using two methods. The first was the high-value reward method, which is common in fisheries (Pollock et al. 2001). This method compares the proportions where different monetary rewards elicit tag reports by anglers. We assumed that a $100 tag would elicit 100% reporting, whereas a raffle tag would not. The angler reporting rate was estimated by comparing the proportion of $100 and raffle tags reported by anglers. We modeled number of fish reported as caught by anglers of a given reward value as the result of a binomial trial with a size equal to the number of fish of that reward value tagged. The probability of a tag being reported as caught is the product of the proportion of tagged fish caught and the angler reporting rate. We also estimated the angler reporting rate based on the number of tags that MFWP recaptured with angler-clipped tags that were reported as caught by anglers to the total number of fish recaptured with clipped tags. We did not estimate a reporting rate for $100 tags using this clipped-tag method because of limitations imposed by low sample size. The angler reporting rate from the clipped-tag method was estimated as proportion of clipped-tag fish that were reported as caught. Upper and lower 95% confidence limits were estimated by multiplying the standard error of the proportion by 1.96.

We estimated the proportion of fish caught by anglers within the calendar year of tagging for each river and species using a binomial regression. Angler non-reporting was corrected for using the high-value reward method. Fish tagged in the upper Madison River were excluded from this assessment, as insufficient time has passed since the 2025 tagging to allow meaningful comparison with 2024 data. We assumed external-tag loss was negligible. Due to the short time series and need for additional electrofishing recapture events we did not incorporate natural mortality into these estimates.

We used a Bayesian approach to estimate angler reporting (high-value reward method), tag retention (both methods), and the proportion of tagged fish caught by anglers. For these analyses, priors were designed to be uninformative. R package cmdstanr was used to generate posterior estimates from program Stan (Gabry et al. 2023); 95% credible intervals were derived from the posteriors. Model outputs were inspected for divergent transitions, and convergence was assessed using the $\hat{R}$ statistic and visually inspecting the trace plots. Models were run for 10,000 iterations using a 5,000 iteration warm up. Samples were not thinned.

Fish Health.—<u>*Disease Prevalence: Long-term Monitoring*</u>
Annual trout monitoring in the Beaverhead, Big Hole, lower Madison, and Ruby rivers occurred in the spring using mark-recapture efforts (Vincent 1971; Figure 3). Two sections in the upper Madison River were sampled in the fall. Channel width and complexity dictated the number of mark and recapture runs needed to provide reliable population estimates. Three mark and recapture runs were needed on the Madison River. The Big Hole River required two mark and recapture runs whereas 1-day mark and recapture efforts were sufficient on the Beaverhead and Ruby rivers. Sampling was conducted by mobile-anode electrofishing using a 3500-watt generator, leach type rectifying box, and a modified fiberglass drift boat. A straight or continuous DC wave current was used between 1000 to 1800 watts. Fish within the field were drawn to the boat, netted, and deposited into a live car. Fish were anesthetized, measured (mm) and weighed (gm), marked with a small identifying fin clip or implanted with a PIT and/or t-bar tag, and released. Fish exhibiting Head Necrosis and Fungal Infections were noted and staff provided gross descriptions of external abnormalities, including severity and proportion of the body affected, which were also captured with pictures.

Long-term monitoring sections typically sampled in the spring were also sampled in the fall with a single-pass electrofishing effort through each section. Captured fish were evaluated for PIT and t-bar tags before the sampling crews completed the same fish health process described above.

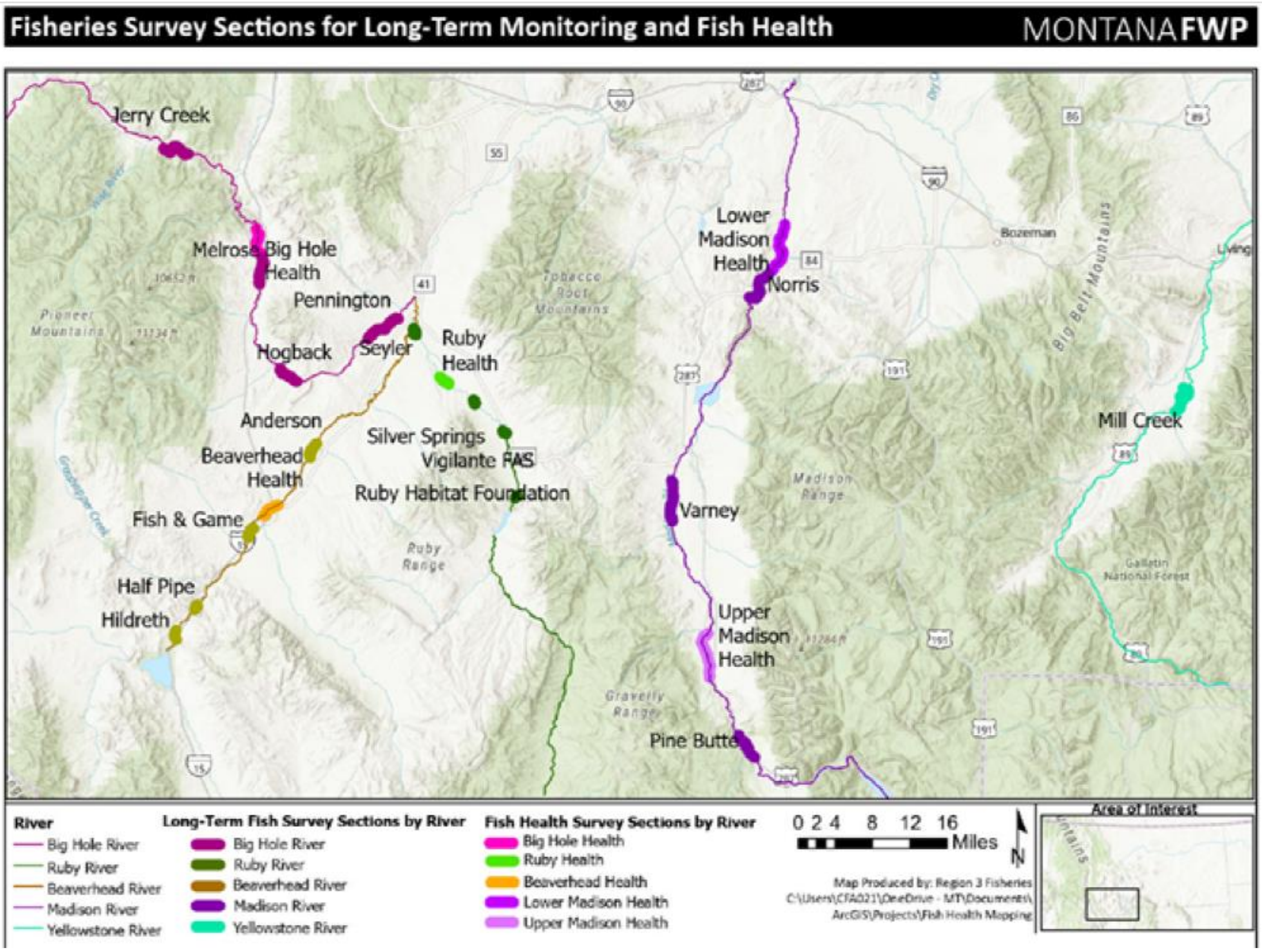


Figure 3. Long-term and fish health survey sections on the Beaverhead, Big Hole, Madison, Ruby, and Yellowstone rivers in southwestern Montana.

<u>Fish Health Sampling</u>

To develop a baseline for fish health on each river, tissue samples were collected from apparently healthy fish captured in target rivers (Beaverhead, Big Hole, and Ruby rivers). Samples were also collected from the Madison River (Figure 3), which has lower prevalences of Head Necrosis or Fungal Infections and relatively stable trout populations. Samples were collected from brown trout, rainbow trout, and mountain whitefish during spring efforts via one-pass drift boat mobile anode electrofishing (Table 1). Length (mm), weight (gm), presence of hook scars, and clinical signs of the two infections were recorded for captured fish. Diseased fish captured during those efforts were kept in separate aerated holding tanks from healthy fish until tissue sample were collected. Live fish were euthanized using an overdose of MS-222. Fish that died shortly after capture were placed on ice until tissue samples were collected immediately following daily electrofishing efforts. Location, date, species, sex, length (mm), weight (gm), photographs of both sides of fish including closeups of any lesions, and gross descriptions of observed lesions were collected for each specimen.

Table 4. Tissue sampling methodology for brown trout, rainbow trout, and mountain whitefish captured during 2025 fish health sampling efforts in the upper Missouri River basin.

Analysis Tool	Target Tissues	Purpose	Preservation
Histology	Lesioned skin (if applicable), healthy skin, gut/cloaca, gills, liver, kidney, spleen, gonad, heart	Identify cellular, tissue, or organ changes that may indicate etiology	Fixed in 10% Formalin
16S/18S/ITS Metagenomics	Swabs of lesions (if applicable), healthy skin, gut/cloaca, gills, liver	Screen for presence and relative abundance of bacterial and eukaryotic genera	RNA Later
Next-generation sequencing	Lesioned skin (if applicable), healthy skin, gut/cloaca, gills, liver, kidney, spleen	High-resolution sequencing to identify known or unknown species of bacteria, viruses, or eukaryotes	DNA/RNA Shield
Contaminant assays	Muscle, gonads, liver, blood & plasma	Measure concentrations of various contaminants in body tissues, including heavy metals, organic and chemical contaminants, toxins, etc.	Frozen
Bacterial and viral culture	Lesioned skin (if applicable), kidney, spleen, blood	Grow and isolate bacteria or virus cultured from infected tissues	Frozen

Prevalence of Diseased Fish: Juvenile Sampling

Juvenile trout were sampled between August and September in select 200-500-m sections of tributaries using backpack electrofishing in the Beaverhead, Big Hole and Ruby rivers as a part of a recruitment study being conducted by MSU (Figure 4). Sites were selected based on the presence of trout and representation of common habitat features and geomorphology. All salmonids were netted, measured, and weighed before being released. Fish displaying Head Necrosis or Fungal Infections were noted.

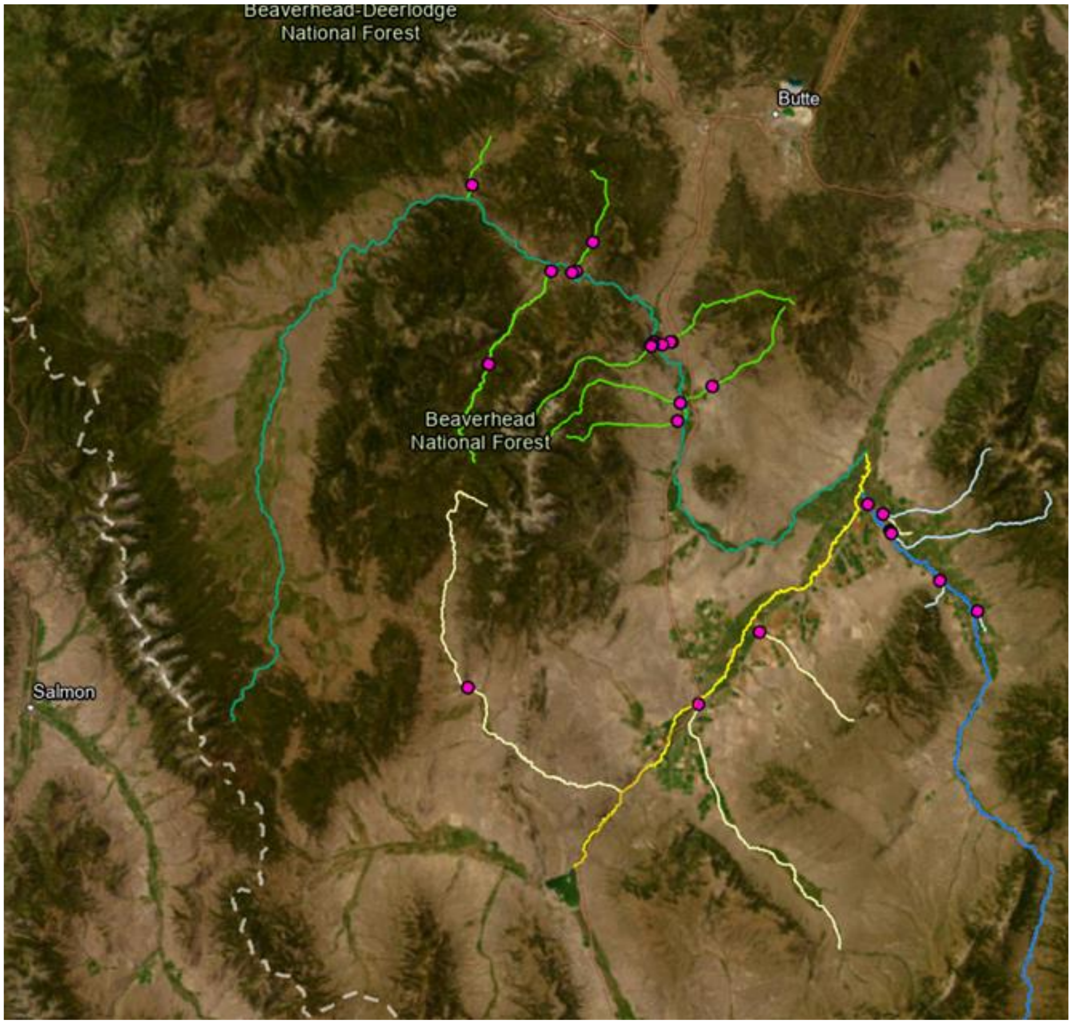


Figure 4. Juvenile sampling reaches (pink dots) by Montana State University in tributaries (light shades) of the Beaverhead (yellow), Big Hole (green), and Ruby (blue) rivers.

Fish Health Floats

Weekly fish health floats were conducted on the Beaverhead, Big Hole, and Ruby rivers starting in early June, whereas floats on the Madison River occurred biweekly. Floats occurred in sections that overlapped fish health sampling sections (Figure 1). When possible, floats were conducted on consecutive days to minimize environmental variability. The same path was used on each float to keep the scope of habitat covered consistent. Inside bends of the rivers where water velocities were often the slowest were targeted because of the increased likelihood moribund and dead fish would be deposited in those habitats. Only one round of floats was conducted in the month of September. Priority was given to the Beaverhead and Big Hole rivers when staff capacity was limited.

Beaverhead River: 7.5-mile section from Poindexter Slough FAS to Selway Park.

Big Hole River: 9-mile section from BLM Maiden Rock to Salmon Fly FAS, which includes three diversion dams. At the first two diversions, the watercraft would be beached on the main river and the irrigation channel would be inspected on foot to locate moribund and dead fish.

Madison River: 8.5-mile section from the Palisades River Fishing Access Site to McAtee Bridge. The watercraft would remain on river right during the duration of each float to maintain consistency.

Ruby River: 7-mile section from Duncan District Road to Lewis Lane.

Reports of Moribund and Dead Fish

To increase documentation of diseased fish or fish kills, as well as create more opportunities to obtain samples from clinical specimens, reporting from anglers, outfitters, and natural resource staff was encouraged. Before the start of the 2024 fishing season, almost 50 outfitters in SW Montana were informed of the FWP-MSU studies and provided contact information for FWP staff whom they could report moribund and dead fish. When possible, FWP staff responded to reports to collect tissue samples from moribund fish and document details of dead fish.

River Recreation.— We adapted and employed a river recreational use survey from creel surveys commonly employed in recreational fisheries management (Pollock et al. 1994; Malvestuto 1996; McGlennon and Kinloch 1997; Bernard et al. 1998; Armstrong and Hyder 2013). Our river recreational use survey had four primary components: on-site in-person interviews, postcard surveys, vehicle counts, and trail camera counts of people and watercraft (Appendices A, B, C, D, E, F, G, H and I). The four components were developed and adapted from recreational fisheries management creel survey techniques.

Surveyors (i.e., creel clerks) were randomly assigned a sub-section (i.e., spatial stratum) of river and traversed the entirety of the area by automobile stopping at fishing access sites and other recreational locations to administer in-person interviews. We included all Montana Department of Fish, Wildlife & Parks (MTFWP) fishing access sites (FAS) and high-use non-FAS locations (e.g., Bureau of Land Management accesses, roadside pullout locations) in our surveys. Surveyors travelled predetermined and standardized routes between each survey location to avoid any spatial or temporal biases. In-person interviews collected information including site (e.g., waterbody, FAS location), demographic and party information (e.g., ZIP code, party number, group type), recreational activity information (e.g., effort in hours, primary activity), fish catch information (e.g., total caught and released, harvested), and experience-evaluation information (e.g., recreational experience expectation, perception, and importance ratings) (see Appendix D for the full survey).

Surveyors distributed postcard surveys among all unoccupied automobiles and to recreationists intercepted prior to their trip's completion. For example, vehicles parked at FAS locations and riverside pullout locations and recreationists who had not started their recreational activity received postcard surveys. Postcard surveys had either a mail-in option that included pre-paid postage or a non-mail-in option that required drop-off at designated drop boxes at FAS locations. Postcard surveys and in-person interviews collected similar information (see Appendices B and C for full surveys).

Vehicle counts were obtained by the bus-route time interval count method to estimate total recreational pressure (Appendix A; Pollock et al. 1994). Surveyors counted parked vehicles (used for estimation of pressure) while administering surveys (i.e., in-person and postcard surveys) at each sampling location. Surveyors recorded the total time they sampled a particular access site and the total time a vehicle was observed at each access site.

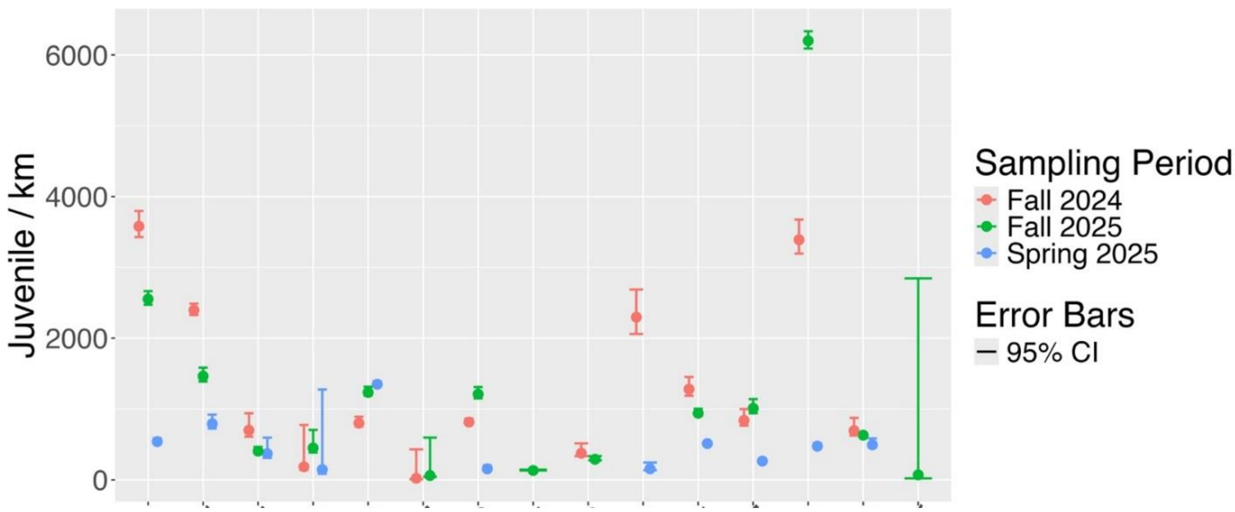
Single trail cameras were placed between all major access sites throughout each river and used as an alternative method to estimate recreational pressure through counts of individuals and watercraft. Trail cameras were deployed at the beginning of each river's sampling season and programmed to passively collected images once every 20 seconds. Trail cameras were oriented perpendicular to the directional flow of the river and aimed to capture the entire river bankfull width within each single image. Images were later processed using free, open-source, Artificial Intelligence software (Van Lunteren 2023) to count the number of individual recreationists and watercraft present in each image.

Total recreational use, number of recreationists, and catch were estimated using the above methods following protocols outlined in Pollock et al. (1994). Estimates of satisfaction were calculated following the expectations-perception-importance (EPI) formula outlined in Latu and Everett (2000). In short, recreationists were asked to evaluate their expectations, perceptions (reality of trip experiences), and relative importances of four trip characteristics. Respondent expectations were subtracted from their perceptions and multiplied by their importance for each aspect and summed across all aspects to estimate trip satisfaction. We adapted and collapsed the discrete categories used by Latu and Everett (2000) to only three; expectations were not met, expectations were met, expectations were exceeded.

Results

Natal Origins and Recruitment.—Every tributary site contained juvenile brown trout while only some sites contained juvenile rainbow trout (Figure 5). Despite the presence of trout at every site, juvenile abundance estimates at some tributaries were unattainable due to the catch of juveniles being too low for effective abundance estimates. Every main stem site contained juvenile brown trout while only some sites contained juvenile rainbow trout (Figure 6). Spawner densities varied across tributary sites, and readers did not differ significantly in their counts. Therefore, redds per kilometer are expressed as an average across the two readers (Figure 8).

A



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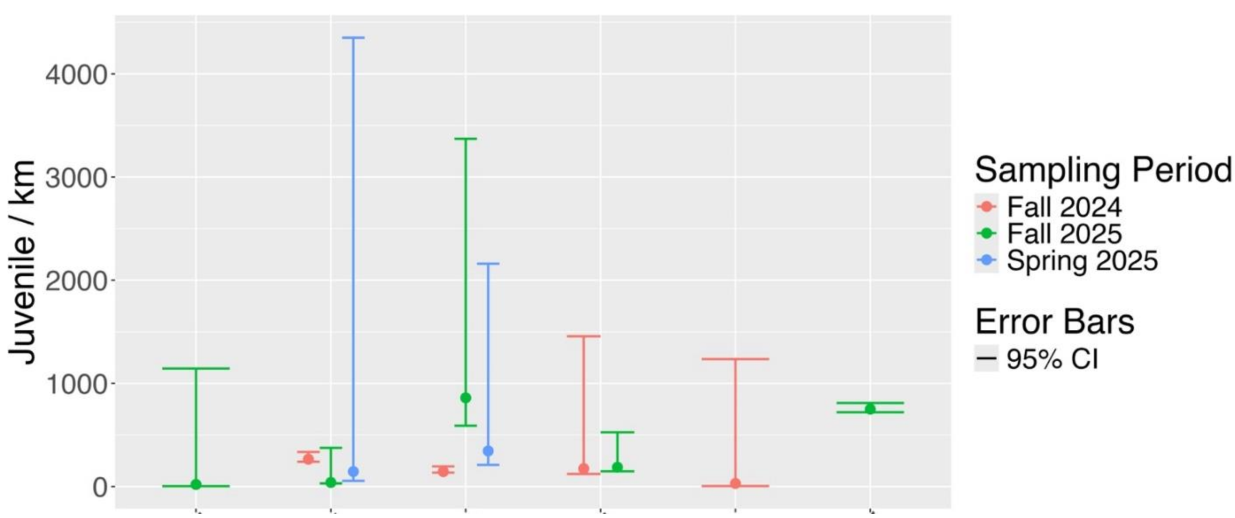
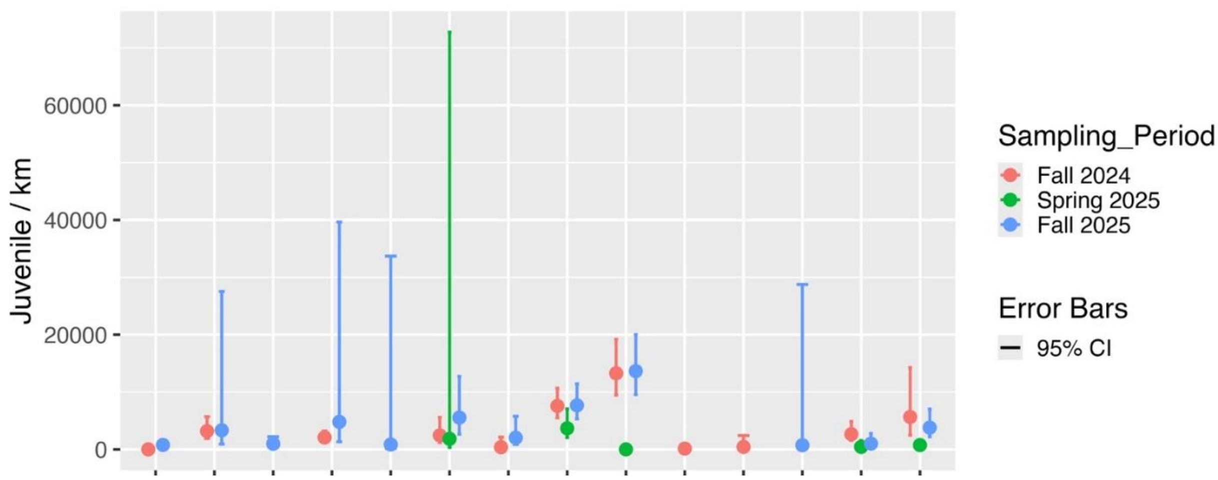


Figure 5. Estimates of juvenile brown trout abundance (panel A) and rainbow trout abundance (panel B) in tributary sites calculated using Bayesian methods and standardized per kilometer. Points represent abundance estimates, and bars represent 95% credible intervals.

A



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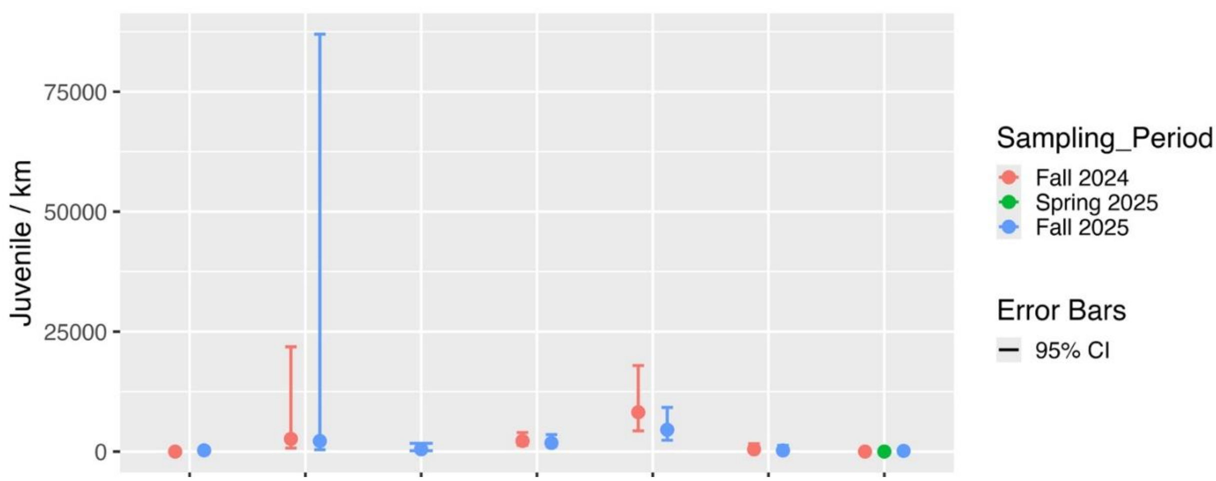

Figure 6. Estimates of abundance (± 95% CI) of juvenile (YOY) brown trout (panel A) and rainbow trout (panel B) in mainstem sites, calculated using the Peterson method and standardized per kilometer. Points represent abundance estimates, and bars represent 95% confidence intervals.

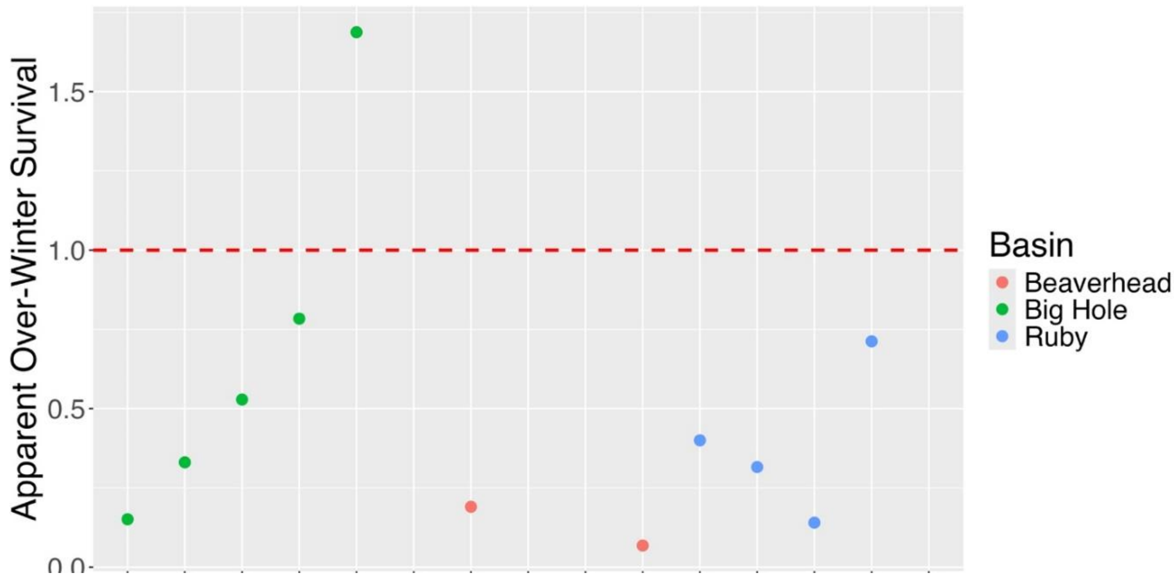

Figure 7. Apparent over-winter survival of juvenile brown trout in tributary sites, colored by basin. The horizontal red line represents 100% survival.

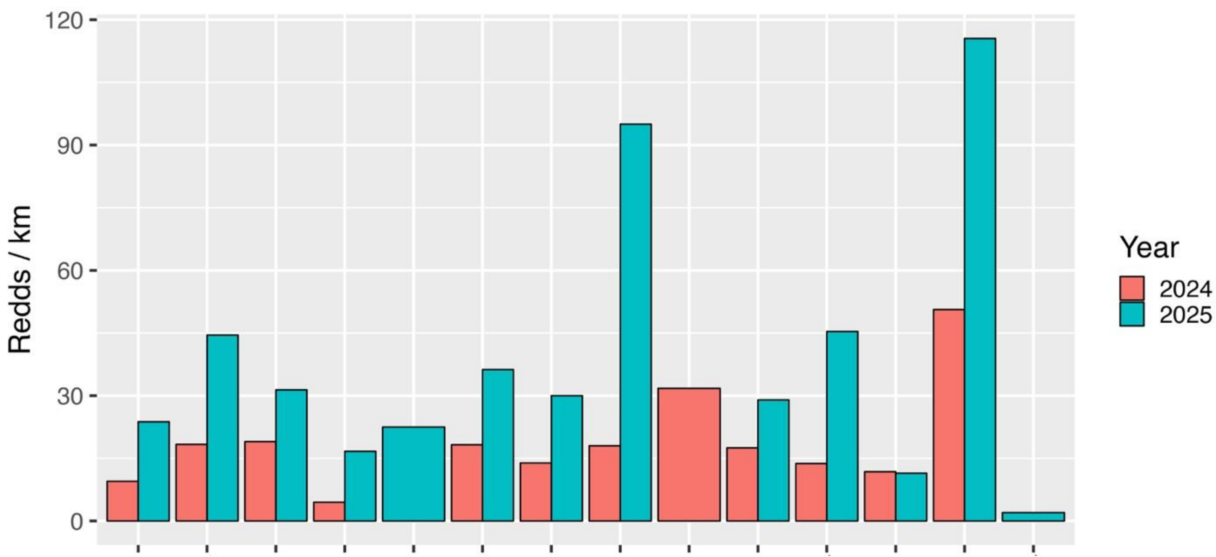

Figure 8. Average redds per kilometer at each of the surveyed tributary sites across Fall 2024 (red) and Spring 2025 (blue).

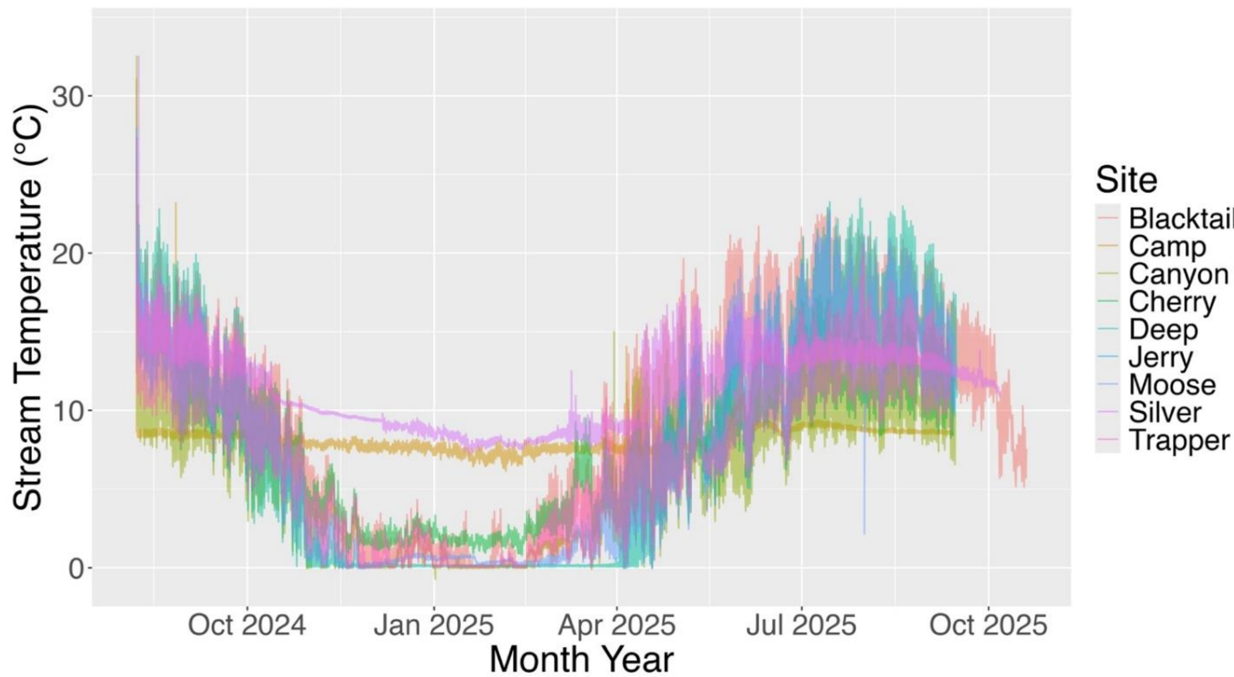

Figure 9. Continuous temperature (°C) collected at nine of the fifteen tributary sites from the start of the study period until Fall 2025.

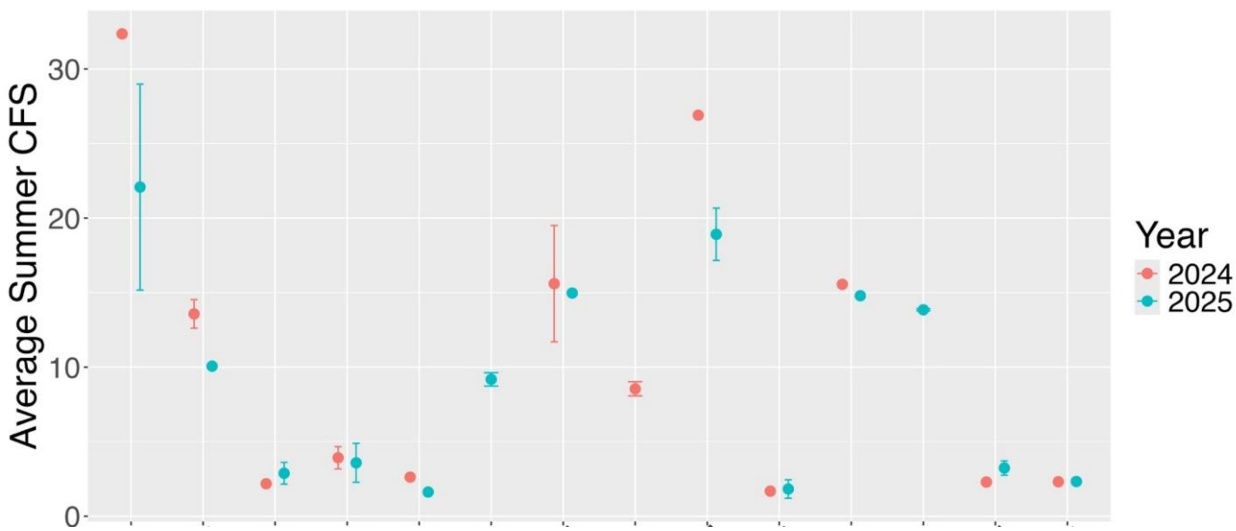

Figure 10. Average Summer flow (cubic feet per second, CFS) collected at fourteen of the fifteen tributary sites across Summer 2024 (red) and Summer 2025 (blue).

Adult Mortality.—The number of fish tagged varied among years, sections, and rivers (Tables 5-9). Totals of 15,787 brown trout (LL) and 9,197 (RB) rainbow trout were tagged across all rivers and sections. The number of tagged brown trout varied from 40 to 1,541 fish per section. Numbers of tagged rainbow trout in a section varied from 0 to 1,293. We determined that a minimum of thirty tagged fish is needed to reliably estimate the proportion of fish caught by anglers and proportion of fish recaptured during electrofishing. This threshold was met everywhere for brown trout and was met for rainbow trout in all sections of the Big Hole, lower Madison, and upper Madison rivers. Fewer than thirty rainbow trout were tagged in four sections of the Beaverhead River, and all sections of the Ruby River.

The proportion of raffle-reward-tagged fish that were caught by anglers varied among year, river, and section (Tables 10-14). Sections on the Beaverhead and Ruby rivers that did not meet the thirty fish threshold were excluded from comparison. Angler reported capture for brown trout within the year of tagging was highest in the Vigilante section of the Ruby River (0.37) and lowest was in the Pine Butte section of the upper Madison (0.02). For rainbow trout, angler reported capture was highest in the Clark Canyon section of the Beaverhead River (0.36) and lowest in the Pine Butte section of the upper Madison (0.02). Anglers reported releasing the majority fish caught (Tables 15-19). Most anglers reported catching their fish using flies; however, lure use exceeded 10% in multiple sections (Table 20). The proportion of fish reported as caught with bait was low everywhere.

The proportion of fish tagged with $100 tags that were reported as caught by anglers was higher than for those tagged with raffle tags across all rivers (Table 21). Estimated angler tag reporting using the high-value reward method was 0.68 (CI 0.59-0.78). Biologists identified 623 fish as having their tags clipped off by anglers, 311 of which were reported as caught by an angler. The estimated reporting rate (0.49, CI 0.45-0.54) using the clipped-tag method was lower than using the high-value reward method.

The estimated proportion of fish caught by anglers within the year of tagging was similar for both tagging years in most rivers (Figures 11 and 12). However, the proportion of fish caught in the Beaverhead River decreased for both species in 2025. We found no difference between years for both species in the Big Hole, lower Madison, or Ruby rivers. Estimated proportions of fish caught were similar between species within each section and year, except for rainbow trout on the Ruby River, where uncertainty was high.

We had mixed results meeting our electrofishing recapture probability of 0.2. The recapture probability was exceeded on several sections of the Beaverhead and Ruby rivers; however, some sections were below 0.2. Recapture runs on the Big Hole in spring 2025 had higher recapture probabilities than autumn 2024. Recapture probabilities were consistently low on the Madison River sections.

Tag retention estimates from electrofishing recaptures were generally similar among rivers (Table 22), although tag retention in the Madison River was slightly lower than in the Big Hole and Beaverhead rivers. Tag retention estimated from angler tag returns of double-tagged fish was lower for the Madison River than the Ruby River (Table 23). Tag retention estimates from anglers catching double-tagged fish were lower than estimates from electrofishing recaptures.

Table 5. Proportion of Beaverhead River PIT-tagged fish recaptured during subsequent electrofishing efforts. Section refers to the original tagging location. Year is the year fish were tagged, N_t is the number of fish tagged, and N_m is the number of fish tagged during the marking run. S and A indicate recapture during seasons of spring (S) and autumn (A), and 24 and 25 represent recapture in 2024 and 2025. Dashes indicate no recaptures because no fish were available to be tagged, or because a recapture run was not conducted. Asterisks indicate fewer than 30 fish were tagged in these sections; results in these sections should be interpreted with caution.

					Proportion recaptured			
Section	Species	Year	N_t	N_m	S 24	A 24	S 25	A 25
Anderson	Brown trout	2024	277	165	0.21	0.25	0.28	-
		2025	461	269	-	-	0.30	-
	Rainbow trout	2024	*0	*0	-	-	-	-
		2025	*1	*0	-	-	-	-
Clark Canyon	Brown trout	2024	79	79	0.01	0.06	0.25	0.08
		2025	116	116	-	-	0.00	0.13
	Rainbow trout	2024	61	61	0.00	0.07	0.23	0.03
		2025	170	170	-	-	0.00	0.05
Fish and Game	Brown trout	2024	498	306	0.34	0.07	0.28	0.09
		2025	535	330	-	-	0.24	0.09
	Rainbow trout	2024	*9	*4	*0.25	*0.00	*0.00	*0.00
		2025	*10	*7	-	-	*0.29	*0.00
Half Pipe	Brown trout	2024	393	232	0.14	0.05	0.10	0.03
		2025	471	244	-	-	0.13	0.07
	Rainbow trout	2024	*12	*6	*0.17	*0.08	*0.08	*0.00
		2025	*12	*7	-	-	*0.14	*0.00
Hildreth	Brown trout	2024	532	273	0.22	0.12	0.31	0.10
		2025	681	443	-	-	0.20	0.13
	Rainbow trout	2024	86	43	0.21	0.08	0.37	0.09
		2025	110	68	-	-	0.35	0.10
Poindexter	Brown trout	2024	296	210	0.30	0.26	0.30	0.15
		2025	594	297	-	-	0.37	0.08
	Rainbow trout	2024	*3	*0	-	*0.00	*0.67	*0.33
		2025	*3	*1	-	-	*0.00	*0.33

Table 6. Proportion of Big Hole River PIT-tagged fish recaptured during subsequent electrofishing efforts. Section refers to the original tagging location. Year is the year fish were tagged, N_t is the number of fish tagged, and N_m is the number of fish tagged during the marking run. S and A indicate recapture during seasons of spring (S) and autumn (A), and 24 and 25 represent recapture in 2024 and 2025. Dashes indicate no recaptures because no fish were available to be tagged, or because a recapture run was not conducted.

					Proportion recaptured			
Section	Species	Year	N_t	N_m	S 24	A 24	S 25	A 25
Hogback	Brown trout	2024	388	180	0.11	0.02	0.21	-
		2025	525	312	-	-	0.21	-
	Rainbow	2024	186	75	0.13	0.03	0.12	-
	trout	2025	278	137	-	-	0.13	-
Jerry	Brown trout	2024	527	285	0.26	0.03	0.17	0.02
		2025	858	455	-	-	0.17	0.03
	Rainbow	2024	574	289	0.22	0.04	0.13	0.02
	trout	2025	645	321	-	-	0.14	0.05
Melrose	Brown trout	2024	407	200	0.21	0.05	0.28	0.04
		2025	528	294	-	-	0.23	0.05
	Rainbow	2024	233	123	0.15	0.06	0.17	0.04
	trout	2025	242	139	-	-	0.28	0.03
Pennington	Brown trout	2024	479	291	0.13	-	0.22	-
		2025	562	359	-	-	0.22	-
	Rainbow	2024	184	89	0.11	-	0.20	-
	trout	2025	234	147	-	-	0.14	-

Table 7. Proportion of Ruby River PIT-tagged fish recaptured during subsequent electrofishing efforts. Section refers to the original tagging location. Year is the year fish were tagged, N_t is the number of fish tagged, and N_m is the number of fish tagged during the marking run. S and A indicate recapture during seasons of spring (S) and autumn (A), and 24 and 25 represent recapture in 2024 and 2025. Dashes indicate no recaptures because no fish were available to be tagged, or because a recapture run was not conducted. Asterisks indicate fewer than 30 fish were tagged in these sections; results in these sections should be interpreted with caution.

					Proportion recaptured			
Section	Species	Year	N_t	N_m	S 24	A 24	S 25	A 25
Habitat Foundation	Brown trout	2024	286	200	0.4	0.24	0.20	0.10
		2025	140	97	-	-	0.24	0.15
	Rainbow trout	2024	*2	*1	*0	*0	*0	*0
		2025	*0	*0	-	-	-	-
Seyler	Brown trout	2024	47	29	0.21	0.04	0.09	-
		2025	40	26	-	0.00	0.19	-
	Rainbow trout	2024	*0	*0	-	-	-	-
		2025	*0	*0	-	-	-	-
Silver Springs	Brown trout	2024	113	61	0.3	0.15	0.23	0.10
		2025	89	61	-	-	0.13	0.12
	Rainbow trout	2024	*0	*0	-	-	-	-
		2025	*3	*2	-	-	*0.00	*0.67
Vigilante	Brown trout	2024	317	221	0.39	0.32	0.6	0.31
		2025	141	111	-	-	0.56	0.36
	Rainbow trout	2024	*29	*14	*0.5	*0.21	*0.38	*0.14
		2025	*14	*10	-	-	*0.70	*0.21

Table 8. Proportion of lower Madison River PIT-tagged fish recaptured during subsequent electrofishing efforts. Section refers to the original tagging location. Year is the year fish were tagged, N_t is the number of fish tagged, and N_m is the number of fish tagged during the marking run. S and A indicate recapture during seasons of spring (S) and autumn (A), and 24 and 25 represent recapture in 2024 and 2025. Dashes indicate no recaptures because no fish were available to be tagged, or because a recapture run was not conducted.

					Proportion recaptured		
Section	Species	Year	N_t	N_m	S 24	A 24	S 25
Norris	Brown trout	2024	443	203	0.13	0.02	0.11
		2025	397	232	-	-	0.09
	Rainbow trout	2024	636	335	0.15	0.02	0.09
		2025	803	490	-	-	0.13

Table 9. Proportion of upper Madison River PIT-tagged fish recaptured during subsequent electrofishing efforts. Section refers to the original tagging location. Year is the year fish were tagged, N_t is the number of fish tagged, and N_m is the number of fish tagged during the marking run. A indicates recapture during Autumn, and 24 and 25 represent recapture in 2024 and 2025. Dashes indicate no recaptures because no fish were available to be tagged, or because a recapture run was not conducted.

					Proportion recaptured	
Section	Species	Year	N_t	N_m	A 24	A 25
Pine Butte	Brown trout	2024	809	434	0.05	0.08
		2025	856	516	-	0.09
	Rainbow trout	2024	984	537	0.04	0.06
		2025	1138	688	-	0.07
Varney	Brown trout	2024	1541	906	0.07	0.07
		2025	1054	571	-	0.09
	Rainbow trout	2024	1290	758	0.04	0.04
		2025	946	538	-	0.08

Table 10. Proportion of Beaverhead River raffle-tagged fish that were reported as caught by anglers. Section refers to the original tagging location. Asterisks indicate fewer than 30 fish were tagged in these sections; results in these sections should be interpreted with caution.

Section	Species	Tagging year	Number tagged	Proportion reported in 2024	Proportion reported in 2025
Anderson	Brown trout	2024	251	0.04	0.01
		2025	486	-	0.06
	Rainbow trout	2024	*0	-	-
		2025	*1	-	*0.00
Clark Canyon	Brown trout	2024	69	0.26	0.04
		2025	131	-	0.20
	Rainbow trout	2024	58	0.36	0.03
		2025	182	-	0.20
Fish and Game	Brown trout	2024	451	0.26	0.01
		2025	633	-	0.10
	Rainbow trout	2024	*8	*0.25	0.00
		2025	*10	-	*0.30
Half Pipe	Brown trout	2024	351	0.13	0.04
		2025	491	-	0.08
	Rainbow trout	2024	*12	*0.08	*0.17
		2025	*12	-	*0.08
Hildreth	Brown trout	2024	435	0.23	0.02
		2025	794	-	0.11
	Rainbow trout	2024	73	0.23	0.04
		2025	133	-	0.11
Poindexter	Brown trout	2024	269	0.21	0.06
		2025	639	-	0.07
	Rainbow trout	2024	*3	*0.33	*0.00
		2025	*3	-	*0.00

Table 11. Proportion of Big Hole River raffle-tagged fish that were reported as caught by anglers. Section refers to the original tagging location.

Section	Species	Tagging year	Number tagged	Proportion reported in	
				2024	2025
Hogback	Brown trout	2024	351	0.06	0.02
		2025	562	-	0.07
	Rainbow trout	2024	172	0.09	0.01
		2025	289	-	0.03
Jerry	Brown trout	2024	410	0.07	0.03
		2025	887	-	0.08
	Rainbow trout	2024	454	0.11	0.03
		2025	670	-	0.09
Melrose	Brown trout	2024	377	0.15	0.03
		2025	576	-	0.11
	Rainbow trout	2024	200	0.13	0.02
		2025	264	-	0.10
Pennington	Brown trout	2024	431	0.07	0.02
		2025	602	-	0.04
	Rainbow trout	2024	166	0.04	0.01
		2025	245	-	0.03

Table 12. Proportion of Ruby River raffle-tagged fish were reported as caught by anglers. Section refers to the original tagging location. Asterisks indicate fewer than 30 fish were tagged in these sections; results in these sections should be interpreted with caution.

				Proportion reported in	
Section	Species	Tagging year	Number tagged	2024	2025
Habitat Foundation	Brown trout	2024	259	0.05	0.01
		2025	144	-	0.06
	Rainbow trout	2024	*2	*0.5	*0.00
		2025	*0	-	-
Seyler	Brown trout	2024	45	0.07	0.00
		2025	40	-	0.05
	Rainbow trout	2024	*0	-	-
		2025	*0	-	-
Silver Springs	Brown trout	2024	102	0.03	0.03
		2025	85	-	0.11
	Rainbow trout	2024	*0	-	-
		2025	*3	-	*0.33
Vigilante	Brown trout	2024	236	0.36	0.06
		2025	231	-	0.37
	Rainbow trout	2024	*29	*0.55	*0.03
		2025	*18	-	*0.28

Table 13. Proportion of lower Madison River raffle-tagged fish that were reported as caught by anglers. Section refers to the original tagging location.

				Proportion reported in	
Section	Species	Tagging year	Number tagged	2024	2025
Norris	Brown trout	2024	402	0.27	0.01
		2025	249	-	0.26
	Rainbow trout	2024	574	0.28	0.01
		2025	857	-	0.24

Table 14. Proportion of upper Madison River raffle-tagged fish that were reported as caught by anglers. Section refers to the original tagging location.

Section	Species	Tagging year	Number tagged	Proportion reported in	
				2024	2025
Pine Butte	Brown trout	2024	724	0.02	0.05
		2025	884	-	0.02
	Rainbow trout	2024	886	0.02	0.06
		2025	1171	-	0.02
Varney	Brown trout	2024	1363	0.04	0.06
		2025	1087	-	0.03
	Rainbow trout	2024	1154	0.03	0.04
		2025	979	-	0.04

Table 15. Number and proportion fish reported as released or harvested in the Beaverhead River by section. Reported catches for which anglers did not indicate harvest or release were excluded. Asterisks indicate that fewer than 30 fish were reported as either harvested or released; results in these sections should be interpreted with caution.

Section	Species	Number reported	Proportion	
			Released	Harvested
Anderson	Brown trout	40	1.00	0.00
Clark Canyon	Brown trout	47	1.00	0.00
	Rainbow trout	58	0.98	0.02
Fish and Game	Brown trout	186	1.00	0.00
	Rainbow trout	*4	*0.75	*0.25
Half Pipe	Brown trout	94	0.97	0.03
	Rainbow trout	*4	*1.00	*0.00
Hildreth	Brown trout	211	0.98	0.02
	Rainbow trout	35	1.00	0.00
Poindexter	Brown trout	118	0.90	0.10
	Rainbow trout	*1	*1.00	*0.00
Total	Brown trout	696	0.97	0.03
	Rainbow trout	102	0.98	0.02

Table 16. Number and proportion fish reported as released or harvested in the Big Hole River by section. Asterisks indicate that fewer than 30 fish were reported as harvested or released; results in these sections should be interpreted with caution.

			Proportion	
Section	Species	Number caught	Released	Harvested
Hogback	Brown trout	67	0.99	0.01
	Rainbow trout	*23	*0.87	*0.13
Jerry	Brown trout	120	0.99	0.01
	Rainbow trout	131	0.97	0.03
Melrose	Brown trout	134	0.98	0.02
	Rainbow trout	56	0.96	0.04
Pennington	Brown trout	59	0.97	0.03
	Rainbow trout	*15	*0.93	*0.07
Total	Brown trout	380	0.98	0.02
	Rainbow trout	225	0.96	0.04

Table 17. Number and proportion of fish reported as released or harvested in the Ruby River by section. Asterisks indicate that fewer than 30 fish were reported as harvested or released; results in these sections should be interpreted with caution.

			Proportion	
Section	Species	Number caught	Released	Harvested
Habitat Foundation	Brown trout	*24	*0.96	*0.04
	Rainbow trout	*1	*1.00	*0.00
Seyler	Brown trout	*4	*0.75	*0.25
Silver Springs	Brown trout	*15	*0.93	*0.07
	Rainbow trout	*1	*1.00	*0.00
Vigilante	Brown trout	203	1.00	0.00
	Rainbow trout	*22	*0.95	*0.05
Total	Brown trout	246	0.98	0.02
	Rainbow trout	24	0.96	0.04

Table 18. Number and proportion fish reported as released or harvested in the lower Madison River by section tagged.

			Proportion	
Section	Species	Number caught	Released	Harvested
Norris	Brown trout	231	0.95	0.05
	Rainbow trout	376	0.98	0.02

Table 19. Number and proportion fish reported as released or harvested in the upper Madison River by section tagged.

			Proportion	
Section	Species	Number caught	Released	Harvested
Pine Butte	Brown trout	77	0.95	0.05
	Rainbow trout	92	0.96	0.04
Varney	Brown trout	172	0.99	0.01
	Rainbow trout	118	0.99	0.01
Total	Brown trout	249	0.98	0.02
	Rainbow trout	210	0.98	0.02

Table 20. Proportion of external-tagged fish that were reported as being caught with a fly, lure, or bait. Reported captures for which anglers did not indicate gear type were excluded. Asterisks indicate that gear type was reported for fewer than 30 fish in these sections; results in these sections should be interpreted with caution.

			Proportion of reports		
River	Section tagged	Number reported	Fly	Lure	Bait
Beaverhead	Anderson	40	0.78	0.22	0.00
	Clark Canyon	104	0.97	0.03	0.00
	Fish and Game	190	0.91	0.09	0.01
	Half Pipe	99	0.90	0.07	0.03
	Hildreth	246	0.97	0.02	0.01
	Poindexter	118	0.81	0.18	0.01
	Total	**797**	**0.91**	**0.08**	**0.01**
Big Hole	Hogback	90	0.86	0.14	0.00
	Jerry	252	0.89	0.11	0.00
	Melrose	191	0.96	0.04	0.01
	Pennington	74	0.86	0.12	0.01
	Total	**607**	**0.90**	**0.09**	**0.00**
Lower Madison	Norris	610	0.95	0.04	0.01
Upper Madison	Pine Butte	169	0.88	0.10	0.02
	Varney	290	0.96	0.04	0.00
	Total	**459**	**0.93**	**0.06**	**0.01**
Ruby	Habitat Foundation	*25	*0.92	*0.08	*0.00
	Seyler	*4	*0.75	*0.25	*0.00
	Silver Springs	*16	*0.81	*0.19	*0.00
	Vigilante	231	0.96	0.03	0.01
	Total	**276**	**0.94**	**0.05**	**0.01**

Table 21. Proportion of fish tagged with either a $100 or raffle-reward external tag that were reported as caught by anglers.

River	Sections	Species	Year	Reward	Number tagged	Proportion reported
Beaverhead	Hildreth	LL	2024	$100	50	0.46
				raffle	435	0.26
Big Hole	Jerry	LL	2024	$100	27	0.22
				raffle	410	0.10
		RB	2024	$100	22	0.18
				raffle	454	0.15
Ruby	Vigilante	LL	2024	$100	50	0.50
				raffle	236	0.42
Lower Madison	Norris	LL	2025	$100	185	0.32
				raffle	249	0.26
Upper Madison	Varney	LL	2024	$100	30	0.20
				raffle	1363	0.10
		RB	2024	$100	20	0.15
				raffle	1154	0.07
		LL	2025	$100	50	0.08
				raffle	1087	0.03

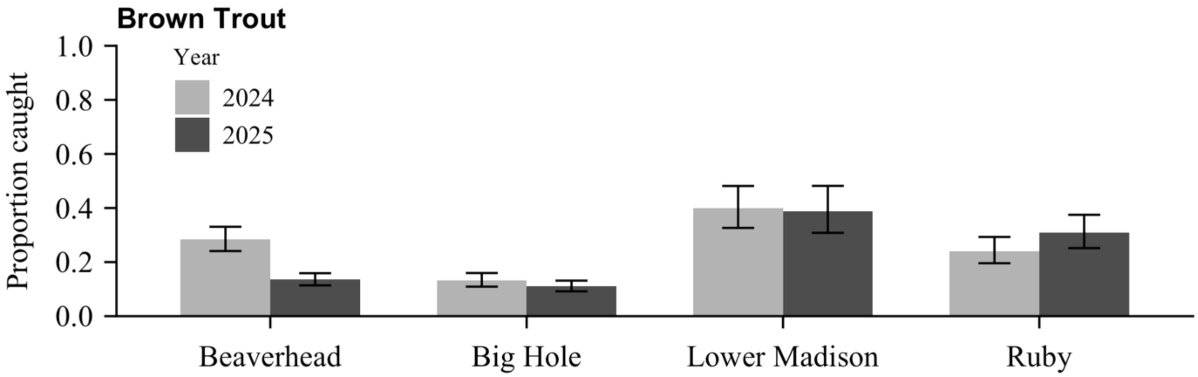

Figure 11. Estimated proportion of brown trout caught by anglers within the calendar year of tagging. Error bars represent the lower and upper limits of the 95% credible interval.

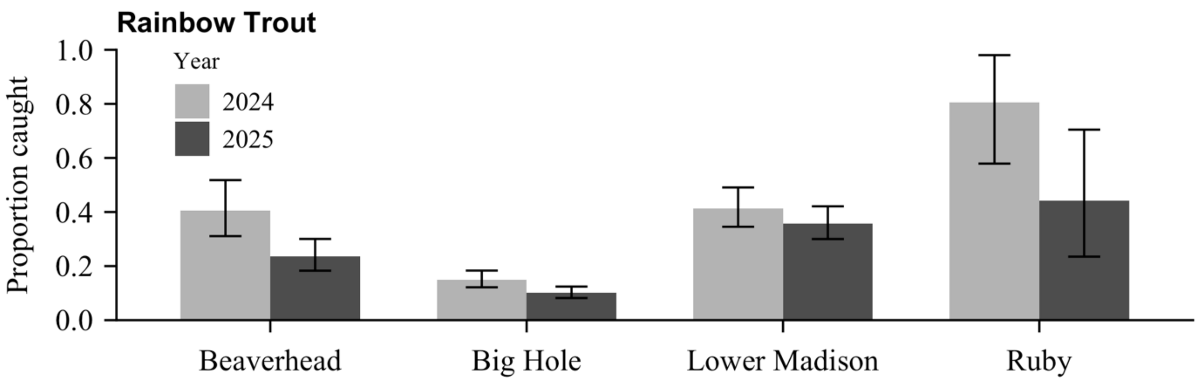

Figure 12. Estimated proportion of rainbow trout caught by anglers within the calendar year of tagging. Error bars represent the lower and upper limits of the 95% credible interval.

Table 22. Estimated immediate tag retention from electrofishing recapture for each river. Number of tags is the number of external tags fish received. The upper and lower bounds on the 95% credible interval are L95 and U95.

River	Number recaptured	Number of tags	Retained two tags	Retained one tag	Retention	L95	U95
Madison	553	1	-	531	0.96	0.95	0.97
	25	2	25	0			
Ruby	210	1	-	207	0.98	0.96	0.99
	61	2	59	0			
Beaverhead	690	1	-	685	0.99	0.98	1.00
Big Hole	583	1	-	581	1.00	0.99	1.00

Table 23. Numbers of angler reported double-tagged fish that retained two or one tag(s) when reported as caught by an angler and estimated immediate tag retention by river. The upper and lower bounds on the 95% credible interval are L95 and U95.

River	Retained two tags	Retained one tag	Retention	L95	U95
Madison	22	24	0.64	0.52	0.74
Ruby	53	20	0.84	0.77	0.89

Fish Health.—*Prevalence of Sick Fish: Long Term Monitoring*

Prevalence of Head Necrosis and Fungal Infections were between 0-1% for brown and rainbow trout in most sections (Table 24). High prevalence of rainbow trout with Fungal Infections in the Half Pipe Section of the Beaverhead River may be attributed to low abundances of rainbow trout within the section, which resulted in relative high prevalence estimates because of only a single infected rainbow trout that was captured in the mark and recapture runs. Prevalence of Fungal Infections for brown trout, the dominant salmonid in Half Pipe, was lower (0-1%). High prevalence of brown trout with Head Necrosis in the Ruby Habitat Foundation and Silver Spring sections of the Ruby River may also be attributed to low abundances of trout within the section, which resulted in relative high prevalence estimates because of a few individuals encountered during the recapture runs. Lower prevalences of Head Necrosis (0-2%), were seen during the marking runs, when twice as many fish were handled compared to the recapture runs. The most clinical fish observed in one day was during the Hildreth marking run the Beaverhead River, where 14 individuals were encountered, which composed 2.2% of the total trout caught that day. The number of individuals displaying Head Necrosis and Fungal infections in this section increased noticeably in this section, though many more fish were handled in 2025 compared to 2024.

The number of trout handled during spring sampling on the Beaverhead and Big Hole rivers in 2025 increased from the previous year, with almost 1000 and 2000 more fish being inspected for disease on each river, respectively. Prevalence on the Big Hole River was lower in 2025 compared to 2024, as just 0.3% of over 4500 trout handled across all four sections exhibited signs of disease in 2025 compared to 0.9% of almost 3000 fish in 2024 (Table 25). Overall disease prevalence in the Beaverhead River increased from 0.9% of almost 2000 fish in 2024 to 1.5% of about 2700 fish in 2025. All sections other than Anderson saw some increases of Head Necrosis. In addition to disease prevalence increasing on the Ruby, the number of fish handled also decreased. Just shy of 800 fish were handled in 2024, 1.1% of which showed signs of disease. In 2025, 2.4% of the 720 fish displayed either Head Necrosis or Fungal Infections.
No longitudinal trends in disease prevalence were observed on any river and no differences were seen between mark and recapture runs on any of the sections. Prevalence of disease was even lower in the fall.

Table 24. Percentages of brown trout (LL) and rainbow trout (RB) > 8" (200 mm) captured during spring 2025 long-term sampling efforts that exhibited Head Necrosis (HN) or Fungal Infections (FI).

River	Section	Run	Captured		% LL (HN)	% RB (HN)	% All Trout (HN)	% LL (FI)	% RB (FI)	% All Trout (FI)
			LL	RB						
Beaverhead	Hildreth	Mark	555	88	2.5	0.0	2.2	0.0	2.8	0.3
		Recap	293	54	1.4	0.0	1.2	0.0	0.0	0.0
	Halfpipe	Mark	266	7	2.6	0.0	2.5	0.0	0.0	0.0
		Recap	243	6	4.9	0.0	4.7	0.8	16.7	1.2
	F&G	Mark	425	7	0.5	0.0	0.5	0.0	0.0	0.0
		Recap	248	4	0.4	0.0	0.4	0.4	0.0	0.4
	Anderson	Mark	322	0	0.0	0.0	0.0	0.0	0.0	0.0
		Recap	217	1	0.0	0.0	0.0	0.0	0.0	0.0
Big Hole	Jerry Creek	Mark 1	273	224	0.0	0.0	0.0	0.0	0.0	0.0
		Mark 2	259	146	1.2	0.0	0.7	0.0	0.0	0.0
		Recap 1	246	174	0.0	1.1	0.5	0.0	0.0	0.0
		Recap 2	214	201	0.0	0.0	0.0	0.0	0.0	0.0
	Melrose	Mark 1	208	102	0.0	0.0	0.0	0.0	0.0	0.0
		Mark 2	157	64	0.6	0.0	0.4	0.0	0.0	0.0
		Recap 1	168	68	0.0	0.0	0.0	0.0	0.0	0.0
		Recap 2	134	57	0.0	0.0	0.0	0.0	0.0	0.0
	Hogback	Mark 1	158	58	0.0	0.0	0.0	0.0	0.0	0.0
		Mark 2	205	93	0.5	0.0	0.3	0.0	0.0	0.0
		Recap 1	136	77	0.0	0.0	0.0	0.0	0.0	0.0
		Recap 2	128	82	0.0	0.0	0.0	0.0	0.0	0.0
	Pennington	Mark 1	285	100	0.7	1.0	0.8	0.0	0.0	0.0
		Mark 2	127	68	1.6	0.0	1.0	0.0	0.0	0.0
		Recap 1	138	58	0.7	0.0	0.5	0.0	0.0	0.0
		Recap 2	126	51	0.0	0.0	0.0	0.0	0.0	0.0
Ruby	Vigilante	Mark	266	18	0.4	0.0	0.3	0.4	0.0	0.3
		Recap	70	6	0.0	0.0	0.0	0.0	0.0	0.0
	Ruby Habitat Foundation	Mark	138	0	2.2	0.0	2.2	2.2	0.0	2.2
		Recap	60	0	6.7	0.0	6.7	3.3	0.0	3.3
	Silver Springs	Mark	81	2	0.0	0.0	0.0	1.2	0.0	1.2
		Recap	34	1	8.8	0.0	8.6	0.0	0.0	0.0
	Seyler	Mark	30	0	0.0	0.0	0.0	0.0	0.0	0.0
		Recap	14	0	0.0	0.0	0.0	0.0	0.0	0.0

Table 25. Percentages of brown trout (LL) and rainbow trout (RB) > 8” (200 mm) captured during fall 2025 sampling efforts that exhibited Head Necrosis (HN) or Fungal Infections (IF). Sites arranged from upstream to downstream for each river. Lower sections of the Beaverhead, Big Hole, and Ruby rivers were not sampled.

River	Section	Captured		% LL (HN)	% RB (HN)	% All Trout (HN)	% LL (IF)	% RB (IF)	% All Trout (IF)
		LL	RB						
Beaverhead	CC Dam to Buffalo Bridge	70	52	0.0	0.0	0.0	0.0	0.0	0.0
	Hildreth	292	35	0.0	0.0	0.0	0.0	0.0	0.0
	Half Pipe	157	7	0.0	0.0	0.0	0.0	0.0	0.0
	Fish & Game	365	5	0.0	0.0	0.0	0.0	0.0	0.0
	Anderson	-	-	-	-	-	-	-	-
Big Hole	Jerry Creek			0.0	0.0	0.0	0.0	0.0	0.0
	FWP Maiden Rock	-	-	-	-	-	-	-	-
	Melrose			0.0	0.0	0.0	0.0	0.0	0.0
	Hogback	-	-	-	-	-	-	-	-
Madison	Pine Butte			0.0	0.0	0.0	0.0	0.0	0.0
	Varney			0.0		0.0	0.0	0.0	0.0
	Norris			0.0	0.0	0.0	0.0	0.0	0.0
Ruby	Vigilante	300	16	0.0	0.0	0.0	0.0	0.0	0.0
	Ruby Habitat Foundation	286	1	0.0	0.0	0.0	0.0	0.0	0.0
	Silver Springs	143	8	0.0	0.0	0.0	0.0	0.0	0.0
	Seyler	-	-	-	-	-	-	-	-

Prevalence of Diseased Fish: Juvenile Sampling

Almost 5000 trout were sampled across 15 tributaries of the Beaverhead, Big Hole, and Ruby rivers (Table 26). No signs of Head Necrosis or Fungal Infections were observed.

Table 26. Number of brook trout (EB), brown trout (LL), and rainbow trout (RB) captured in 2025 during tributary sampling during Montana State University recruitment study. No fish exhibited signs of Head Necrosis or Fungal Infections.

Basin	Tributary	EB	LL	RB
Beaverhead	Blacktail Creek	0	96	0
	Cox Slough	0	251	0
	Stone Creek	0	81	0
Big Hole	Camp Creek	73	284	0
	Canyon Creek	133	78	245
	Cherry Creek	0	628	0
	Deep Creek	18	20	41
	Fish Trap Creek	21	7	1
	Moose Creek	0	138	18
	Trapper Creek	0	337	3
	Upper Wise River	60	7	267
Ruby	Alder Creek	0	1297	0
	Mill Creek	0	221	0
	Silver Springs Creek	0	154	82
	Wisconsin Creek	0	273	0

Fish Health Sampling

A primary infectious cause of the head lesions and presumed fungal infections remains uncertain. A variety of known viruses, bacteria, and other organisms commonly observed in fisheries and aquaculture settings elsewhere were detected in tissue samples; however, no patterns existed for any particular pathogen among healthy, moribund, or dead fish. Targeted testing of herpesvirus was incorporated into efforts in 2025. However, no evidence of eukaryotic viruses, including herpesvirus, were observed in PCR and metagenomic sequencing. Histological evaluations were completed on 58 fish captured in 2024: 25 brown trout, 18 mountain whitefish, 14 rainbow trout, and 1 white sucker. The head lesions were typically characterized by epidermal ulceration, variable inflammation, and dermal thrombi. However, the skin adjacent to and approaching the area of ulceration was inconsistent. No common signs of inflammation or other abnormalities were observed in the tissue samples collected from internal organs (liver, spleen, and kidney). Parasite loads were generally low and therefore not likely directly related to morbidity. Results from histological samples collected in 2025 are pending (Table 27).

Table 27. Tissue samples collected from brown trout (LL), rainbow trout (RB), and mountain whitefish (MWF) captured in fish health sections in 2025. Results are pending.

Date	**River**	**Healthy**	Moribund	**Location**
Apr 23	Ruby	2 LL, 2 MWF	2 LL, 2 MWF	Duncan District 45.44488, -112.27897
Apr 24	Big Hole	2 LL, 2 RB, 2 MWF	1 LL, 1 MWF	Maiden Rock 45.67625, -112.70702
Apr 25	Beaverhead	1 LL, 1 RB, 1 MWF	8 LL	Trash 45.22955, -112.64043
May 7	Madison	2 LL, 2 RB, 2 MWF	1 MWF	Palisades to Ruby Creek 45.03011, -111.67187
May 8	Madison	2 LL, 2 RB, 2 MWF	0	Damselfly 45.64638, -111.52247

Fish Health Floats

Beaverhead River: At least one dead fish was observed on most floats (Figure 13; Table 28). Floats that occurred before mid-July yielded fish that may have had head lesions, but due to decomposition was difficult to confirm. No samples were taken from any of these fish. One float was conducted outside of the designated fish health section, and before weekly floats began. This was conducted in response to a report of multiple dead fish near the Pipe Organ FAS. A 4-mile float took place from Henneberry to Grasshopper FAS, which yielded two dead brown trout, one of which was displaying a head lesion. No samples were taken from this fish due to advanced decomposition.

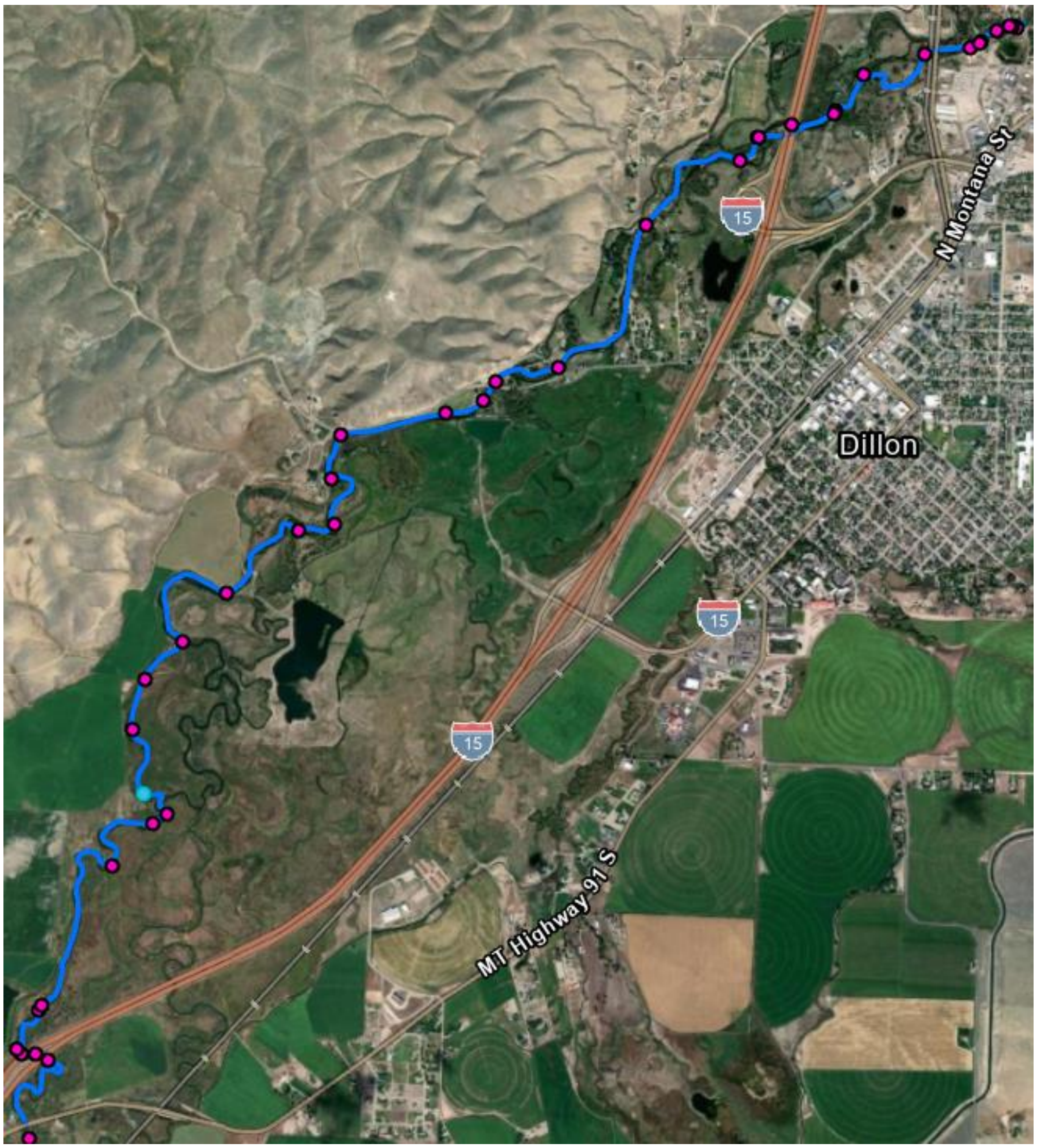

Figure 13. Beaverhead River fish health float (blue line) and locations of moribund and dead fish (pink circles).

Table 28. Beaverhead River float dates and observations.

Date	Float Within Fish Health Section?	Moribund Fish	Dead Fish	Location	Samples Collected?
5/02/2025	No	0	2 LL	45.06317, -112.80412 45.10108, -112.77857	No
6/16/2025	Yes	0	12 LL	45.20113, -112.67602 45.20389, -112.67725 45.23034, -112.63829 45.23218, -112.63672 45.23459, -112.62651 45.23465, -112.62685 45.23385, -112.62893 45.23356, -112.62962 45.21787, -112.65583 45.21621, -112.66076 45.21557, -112.66314 45.21435, -112.67008	No
6/26/2025	Yes	0	3 LL, 1 MWF	45.23463, -112.62711 45.22900, -112.64337 45.18701, -112.68841	No
6/30/2025	Yes	0	7 LL, 1 WS	45.23437, -112.62793 45.23380, -112.62899 45.23372, -112.63318 45.22962, -112.64115 45.22788, -112.64445 45.22472, -112.65044 45.20985, -112.67260 45.19641, -112.68046	No
7/7/2025	Yes	0	8 LL	45.18473,-112.68766 45.18500, -112.68944 45.18729, -112.68821 45.19665, -112.67831 45.20679, -112.67709 45.21229, -112.67053 45.21621, -112.66076 45.23025, -112.63837	No
7/18/2025	Yes	0	1 LL	45.19593, -112.68134	No
7/23/2025	Yes	0	1 LL	45.22897, -112.64328	No
7/30/2025	Yes	0	3 LL	45.18498, -112.68847 45.18514, -112.68973	No

				45.21022, -112.67024	
8/6/2025	Yes	0	0	-	-
8/12/2025	Yes	0	1 RB	45.20238, -112.67753	No
8/20/2025	Yes	0	0	-	-
8/26/2025	Yes	0	1 LL	45.18105, -112.68867	No
9/2/2025	Yes	0	1 LL	45.21710, -112.65998 45.19388, -112.68388	No

Big Hole River: At least one dead fish was observed on most floats (Figure 14;Table 29), but it was difficult to determine if any of those fish had head lesions because of decomposition. No tissue samples were collected. However, tissues samples were collected from a moribund brown trout with a head lesion found on July 8.

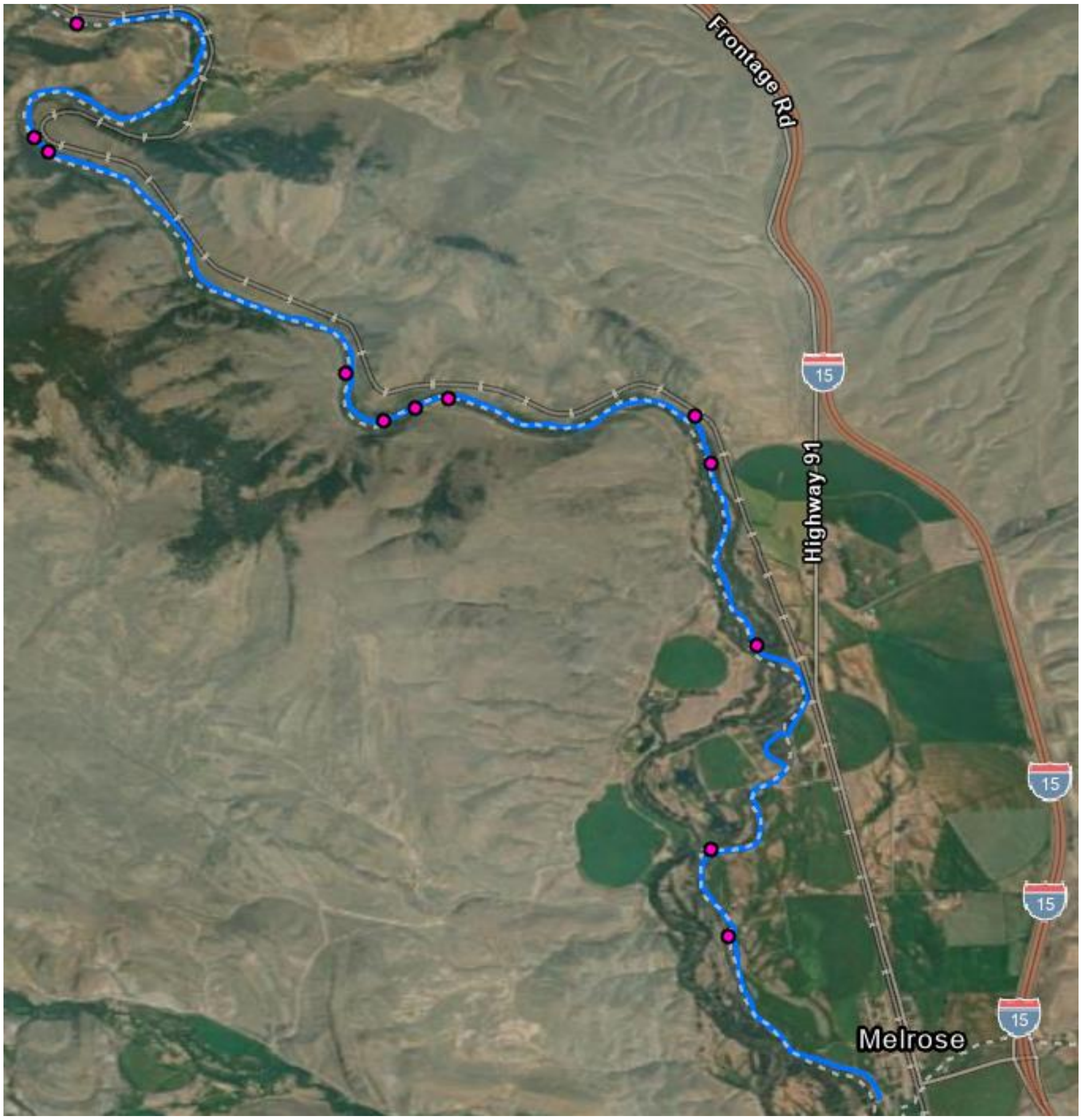

Figure 14. Big Hole River fish health float (blue line) and locations of dead fish (pink circles).

Table 29. Big Hole River float dates and observations. Asterisks indicate fish that samples were collected from.

Date	Float Within Fish Health Section?	Moribund Fish	Dead Fish	Location	Samples Collected?
6/20/2025	Yes	0	1 WS	45.67291, -112.69896	No
6/27/2025	Yes	0	1 LL, 1 MWF, 1 Ling	45.67634, -112.71471	No
7/2/2025	Yes	0	2 MWF	45.64506, -112.69891 45.67596, -112.72257	No
7/8/2025	Yes	1 LL	1 LL, 1 WS, 1 Ling	45.69640, -112.74773 45.67940, -112.72526 45.67693, -112.72024 45.63879, -112.69767*	From 1 moribund LL
7/17/2025	Yes	0	1 LL, 1 MWF	45.70458, -112.74472 45.67940, -112.72526	-
7/25/2025	Yes	0	0	-	-
8/1/2025	Yes	0	0	-	-
8/8/2025	Yes		0	-	-
8/13/2025	Yes	0	1 LL, 1 Ling	45.69540, -112.74670 45.67753, -112.71782	No
8/21/2025	Yes	0	1 LL	45.65983, -112.69558	-

Madison River: Two dead fish were found during fish health floats (Figure 15; Table 30), all of which were found in small side channels where water velocities were relatively slow. None of the fish displayed any lesions or fungus, so samples were not collected.

Figure 15. Madison River fish health float (blue line) and locations of dead fish (pink circles).

Table 30. Madison River fish health float dates and observations.

Date	Dead Fish	Location	Samples Collected?
6/19/2025	1 RB	45.04568 -111.67686	No
7/22/2025	0	NA	-
7/29/2025	1 LL	45.01319 -111.66265	No
8/14/2025	0	-	-
8/25/2025	0	-	-

Ruby River: Dead fish were seen during almost half of these floats (Figure 16; Table 31), and given the amount of decomposition that had occurred, it was difficult to determine if they displayed any clinical symptoms. As a result, no samples were taken from these fish.

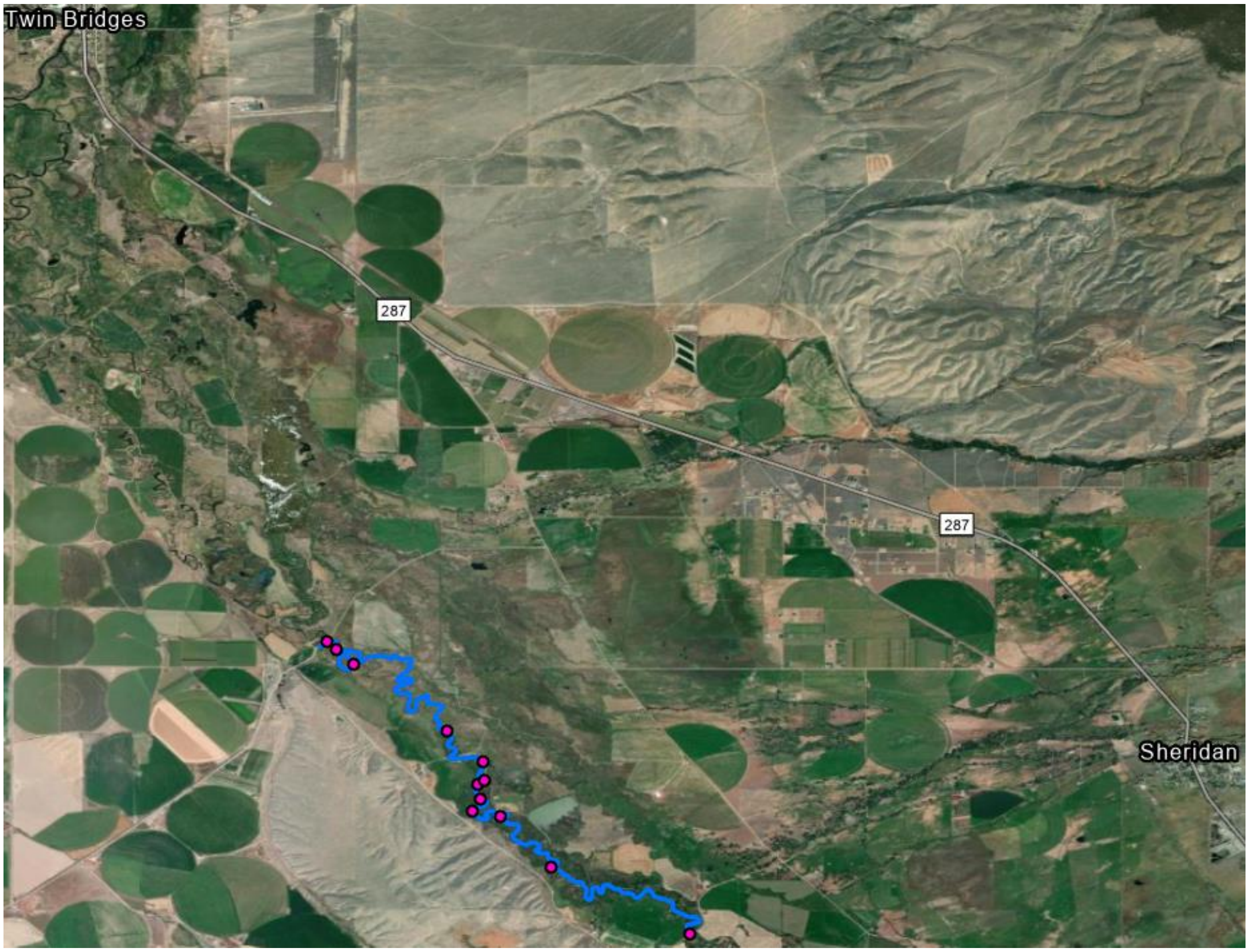

Figure 16. Ruby River fish health float (blue line) and locations of dead fish (pink circles).

Table 31. Float dates and observation for the Ruby River.

Date	Dead Fish	Location	Samples Collected ?
6/18/2025	3 WS	45.45189, -112.28317 45.45843, -112.28691 45.46646, -112.29826	No
6/25/2025	0	-	-
7/1/2025	1 LL, 1 WS	45.46920, -112.30146	No
7/9/2025	1 LL	45.45249, -112.28240	No
7/24/2025	3 WS, 1 MWF, 1 LL	45.44187, -112.27433 45.44816, -112.28051 45.44877, -112.28389 45.45476, -112.28259 45.4683, -112.30036	No
7/31/2025	1 MWF	45.43388, -112.25753	No
8/7/2025	0	-	-
8/22/2025	0	-	-
9/4/2025	0	-	-

Reports of Moribund and Dead Fish

Between March 19th and July 22nd, sixteen reports were received about moribund or dead fish (Figure 17). Eleven were of a single fish and five entailed multiple dead fish in a general location. Outfitters and anglers made most of the reports with several reported by FWP and TU employees. Reporting was highest between the last week of May and the first week of July. Of the eleven reports regarding specific fish, two resulted in the collection of quality tissue samples.

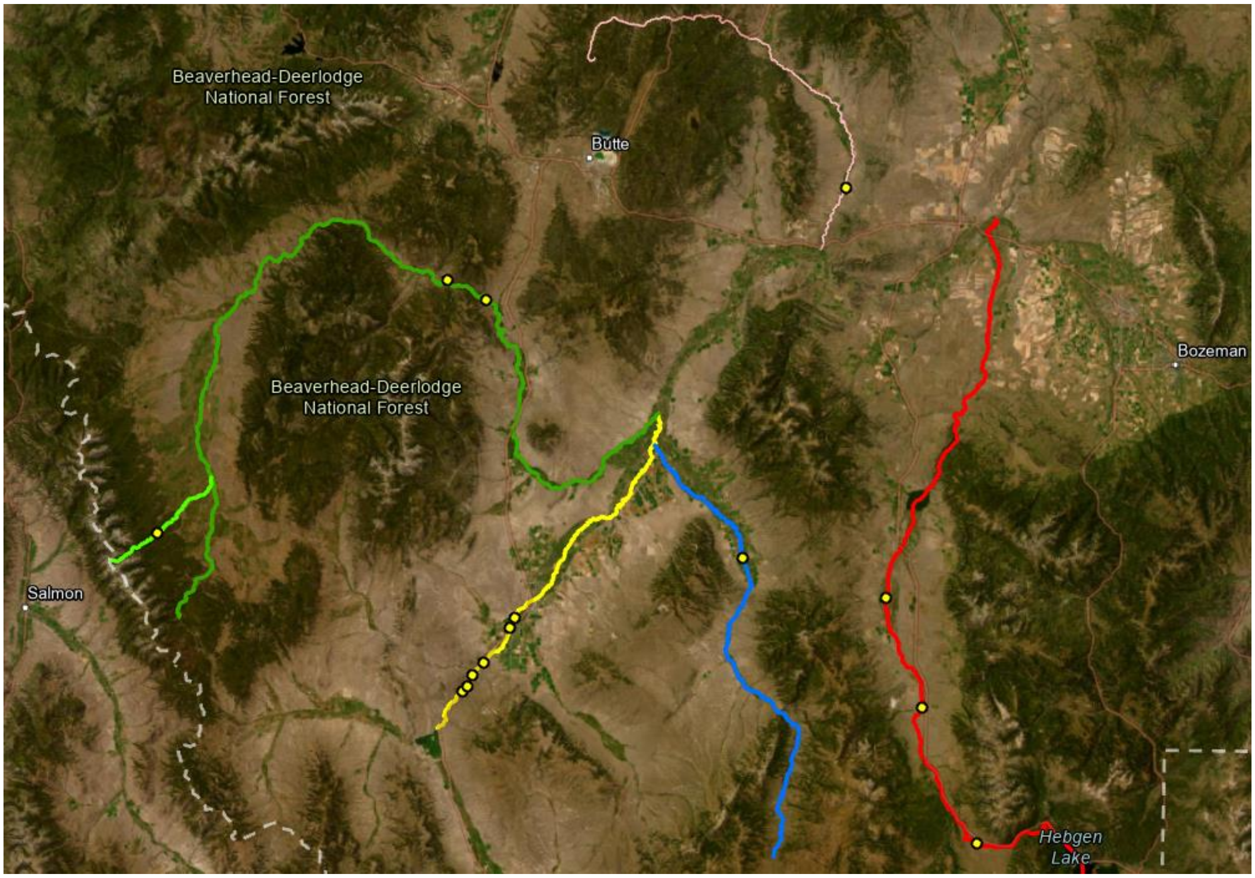

Figure 17. Reports of singular moribund or dead fish on the Beaverhead (yellow), Big Hole (green), Boulder (pink), Madison (red), and Ruby (blue) rivers in 2025. All reported fish (yellow dots) were brown trout other than a dace found on the Boulder River and a long nose sucker found on Miner Creek (light green).

River Recreation.—A total of 384 shifts (sampling days) was completed between March 1, 2025 and September 30, 2025. We distributed a total of 12,562 postcard surveys during the sampling period and a total of 1,510 completed postcards among the Big Hole (n = 220), Beaverhead (n = 81), Madison (n = 617), Ruby (n = 19), and Yellowstone (n = 573) rivers were returned (Table 32). A total of 1,463 in-person interview surveys were collected during the sampling period among the Big Hole (n = 234), Madison (n = 666), and Yellowstone (n = 563) rivers.

We estimated a total of about 1,250,000 recreational hours occurred among all five rivers between March 1 and September 30, 2025. The Madison River consistently had the greatest amount of recreational effort and the Ruby River consistently had the least throughout the sampling period (Figure 18). An estimated total of about 290,000 individual recreationists visited the five rivers between March 1 and September 30, 2025 The Madison River consistently had the highest number of individual recreationists per month and the Ruby River had the fewest throughout the sampling period (Figure 19).

We estimated a total of about 450,000 fish capture events occurred (i.e., the number of times fish were caught) among the five rivers over the entire 2025 study period. The greatest percent of fish caught was made up by brown trout in the Beaverhead (~84%), Big Hole (37%), and Ruby rivers (63%), rainbow trout in the Madison River (47%), and mountain whitefish in the Yellowstone River (45%). The Big Hole, Madison, and Yellowstone rivers observed the most capture events (i.e., times a fish was caught) throughout the sampling period (Figure 20). Harvest was minimal throughout the sampling period in all rivers; it occurred on <1% of recreational trips.

Disparities existed among gear use across the study systems (Figure 21). Fly fishing gear (i.e., both the rod type and bait type) was the most popular gear on all rivers. Barbless hook types were used more often than barbed hook types and the proportional use was similar among the Big Hole, Madison, and Yellowstone rivers. Most lures only had a single hook point but 2 lures per line (e.g., double nymph fly rigs) was the most dominant fishing style.

Table 32. Summary statistics, including number of in-person interviews collected, postcard surveys distributed, and complete postcard surveys returned for each river by month in 2025.

Waterbody	Month	In-person interviews (n)	Postcards distributed (n)	Postcards return
Beaverhead	May	0	97	14
	Jun	0	159	20
	Jul	0	198	26
	Aug	0	68	10
	Sep	0	52	11
Big Hole	Apr	28	170	34
	May	31	273	37
	Jun	104	668	106
	Jul	35	233	23
	Aug	24	83	12
	Sep	12	92	8
Madison	Mar	44	97	46
	Apr	38	311	67
	May	115	756	77
	Jun	167	1395	138
	Jul	118	1789	164
	Aug	68	922	61
	Sep	116	728	64
Ruby	Apr	0	21	3
	May	0	7	3
	Jun	0	14	2
	Jul	0	28	11
	Aug	0	6	0
	Sep	0	11	0
Yellowstone	May	98	215	23
	Jun	114	785	102
	Jul	89	1785	243
	Aug	142	1193	157
	Sep	120	406	48

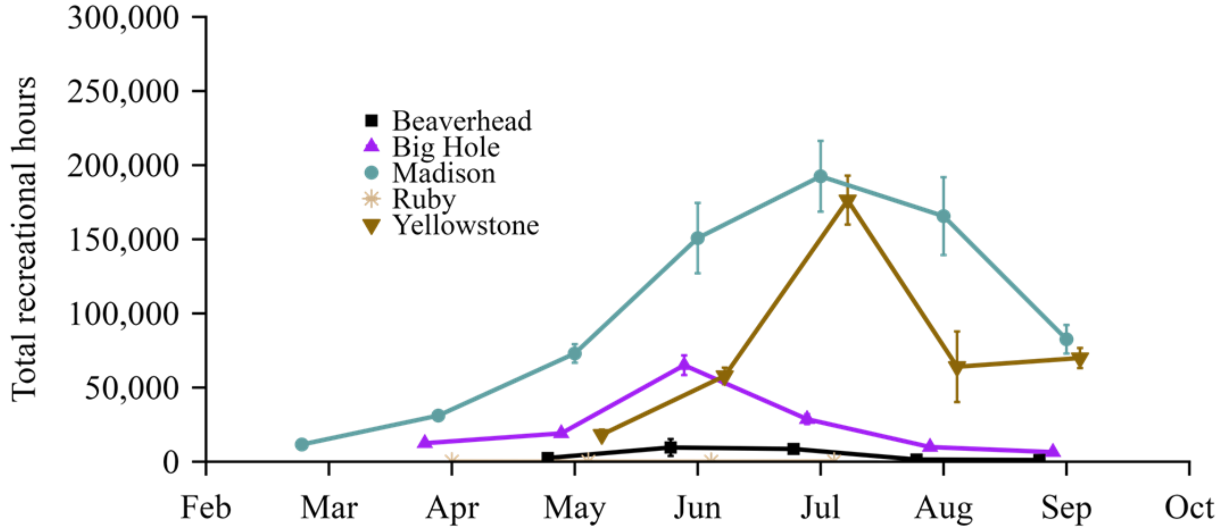

Figure 18. Total estimated monthly recreational use (hours, angling and non-angling combined) derived from survey data collected on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers, March–October 2025. Error bars denote 95% confidence intervals around point estimates. Symbol color and shape denote waterbody.

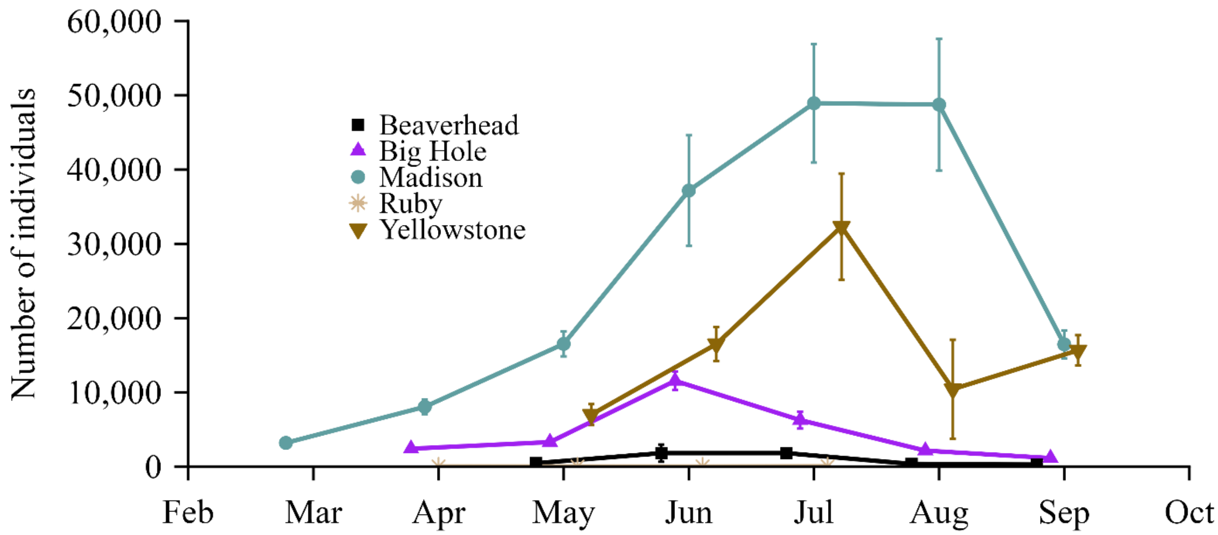

Figure 19. Total estimated monthly number of recreationists (angling and non-angling combined) derived from survey data collected on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers, March–October 2025. Error bars denote 95% confidence intervals around point estimates. Symbol color and shape denote waterbody.

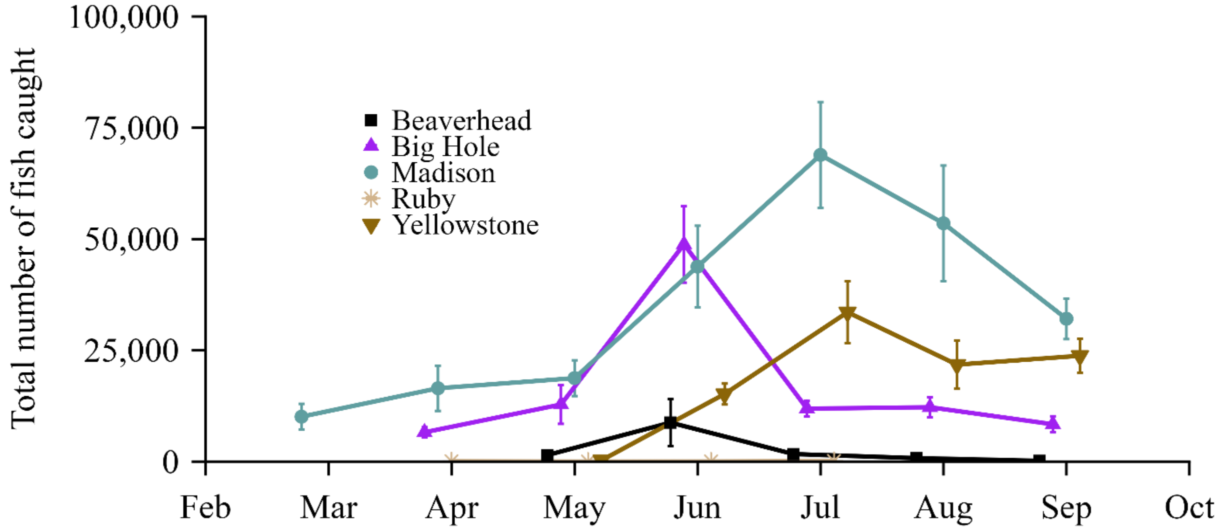

Figure 20. Total estimated monthly number of fish caught derived from survey data collected on the Beaverhead, Big Hole, Madison, Ruby, and upper Yellowstone rivers, March–October 2025. Error bars denote 95% confidence intervals around point estimates. Symbol color and shape denote waterbody.

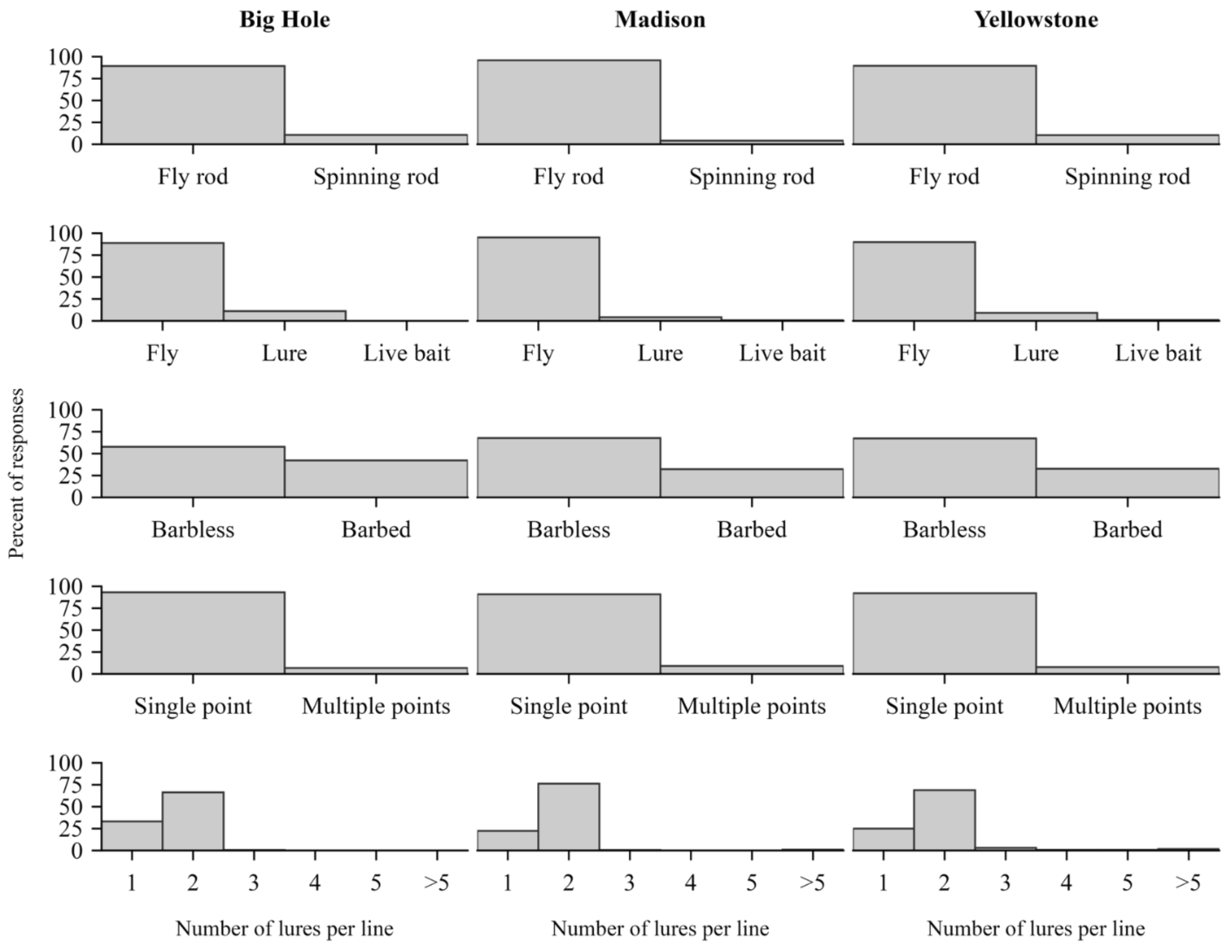

Figure 21. Percent uses of different gear types on the Big Hole, Madison, and Yellowstone rivers, derived from in-person interviews.

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