Upper Clark Fork Drainage Supplemental Data for the 2023 Statewide Fish Management Plan

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INTRODUCTION

The Upper Clark Fork River lies near the heart of western Montana flowing for over 120 miles in a northwesterly direction from its headwaters near Warm Springs to where it meets the Blackfoot River at Milltown, just east of Missoula. However, for the purposes of this report we will focus on the upper 55 miles of the Upper Clark Fork from the headwaters to Jens Road Bridge. Throughout its upper reaches, the Upper Clark Fork River meanders through agricultural lands used primarily for producing hay and pasturing livestock. The Upper Clark Fork Basin has a long history of human disturbance beginning in earnest in the mid 1800s when placer mining for gold began on many basin streams. By 1896, copper had become the target metal and mining and smelting operations near the town of Butte, located near the headwaters of the Clark Fork, were processing over 4,500 tons of copper ore per day (Luoma et al., 2008). By the turn of the 20th century, one of the largest smelters in the world was constructed in Anaconda, about 25 miles northwest of the mines in Butte. Mining and smelting activities in the Butte and Anaconda areas continued into the early 1980s. While some mining activity persists near Butte, most of the operations have now been completely shut down and abandoned. Nevertheless, the environmental consequences of over 100 years of mining activity in the Upper Clark Fork Basin have left their mark. Enormous amounts of fine material, mostly mine tailings, were released into the drainage, and were transported and deposited downstream throughout the river system. These tailings proved toxic to aquatic life and negatively altered the aquatic biological community of the upper river.

For years, the Upper Clark Fork River was considered void of fish, and it wasn't until efforts were made to try and retain some portion of the toxic tailings in the Warm Springs Treatment Pond System that water quality improved to a level where trout could begin to re-colonize the lower sections of the river, upstream of Missoula. However, by that time, most of the trout in the river were introduced species, including rainbow and brown trout. Brown trout have been shown to have a higher tolerance to metals and degraded habitat conditions than other trout species (Lipton et al., 1995; Woodward et al., 1995), and it is likely because of this that the species dominates the current trout community in much of the Upper Clark Fork River. While trout are common in the upper river today, past research has shown that trout populations are approximately one fifth of what is expected without contamination from mining wastes (Hillman et al., 1995).

The Clark Fork River from its headwaters to the former Milltown Dam site was designated a Superfund Priority site in 1986. While cleanup activities have been underway or completed for several years on Silver Bow Creek near Butte as well as at Milltown Dam near Missoula, active remediation work is still in progress on the mainstem Clark Fork River. Cleanup of metals-contaminated soils along the Upper Clark Fork River is expected to improve water quality and allow for more tolerable conditions for fish and other aquatic life.

There are several other factors that affect trout densities and habitat quality in the Upper Clark Fork. Irrigation withdrawal can have severe impacts on summer stream flows in the river upstream of Deer Lodge, especially during drought years. Historically, flows have been one of the main factors influencing brown trout population densities in the Upper Clark Fork River. In recent years, however, fish populations have remained at low levels regardless of flow conditions (Elam et al., 2021). Low flows also increase water temperatures to levels not suitable for trout. The upper thermal limit for Brown Trout is 19.0°C, above which growth rate approaches zero (Elliot 1994). During the summer months, temperatures routinely exceed 19°C in much of the Upper Clark Fork River for extended periods of time (Montana Department of Fish, Wildlife and Parks Unpublished Data). Riparian vegetation along the river also tends to be in rather poor condition from over a century of livestock use of lands adjacent to the stream as well as ongoing removal necessary to complete remedial activities.

Over the past 30 years, regular monitoring of trout populations in the Upper Clark Fork River has focused on the sampling of two primary sections. These sections include the pH Shack section near Warm Springs and the Williams-Tavenner Section located several miles downstream of Deer Lodge. All sampling has consisted of mark and recapture electrofishing during the spring (typically during the month of April) with a boat mounted electrofishing unit to obtain an estimate of the number of trout per mile of river. The following report summarizes the annual fish sampling activities completed on the Upper Clark Fork River for the period: 1998-2022.

METHODS

Fish Sampling

Trout populations in the Upper Clark Fork River were monitored with electrofishing completed bi-annually from 1996-2004 and annually from 2008-2021. Sampling was completed during the spring (typically during April). Population estimates were made using a mark and recapture technique. Fish were collected with the use of a boat (14-foot long aluminum drift boat) mounted electrofishing unit with fixed booms. The system was powered by a 5,000-watt generator and current was modified with a Smith-Root VVP-15 rectifying unit. Smooth direct current was used at all times. Crews consisted of two people, one controlling the boat and the other standing in the bow capturing fish with a dip net. Typically, estimates were made using two marking passes done on consecutive days with one or two recapture passes completed about one week later. The only exception to this was in 2009 and 2015 when only a single marking pass (and a single recapture pass) was made on each sample section. The reason for this was that upper river was sampled continuously in this year instead of at several distinct sections. Limited time only allowed for single passes to be made. All captured trout were identified to species, weighed, measured, given a small fin clip unique to the sampling section and day, and then released. In each sample reach, multiple stops were made to process fish and make sure fish were well distributed throughout the section.

Sample Reaches

Various sections of the Upper Clark Fork River have been monitored in the past, but the most consistent long-term monitoring has occurred at the pH Shack section (near Warm Springs) and the Williams-Tavenner section (downstream of Deer Lodge). Extra stream length was added to the Williams-Tavenner section in 2010 to increase the number of fish marked and improve capture efficiency. Estimates from the pH shack section generally represent trends present in the fishery upstream of Deer Lodge, while Williams-Tavenner generally represents the trends observed between Deer Lodge and Gold Creek.

Data Analysis

Data collected during these sampling efforts were summarized by sample reach and by year. Fishery data were summarized as the population estimate for the section (standardized to number of fish per mile). Population estimates were generated using a modified Peterson estimator provided in Montana Fish, Wildlife and Park's Fisheries Information System and is a standard method used for fish mark and recapture estimates. Estimates were only reported for brown trout greater than 175 mm (~7 in) in length at pH shack, due to low numbers and/or poor capture efficiency of other species and smaller size classes. We also estimated westlope cutthroat trout greater than 175 mm (~7 in) in length at Williams-Tavenner, however westslope cutthroat were not present in densities conducive to estimates in all years.

Angling Pressure

Creel surveys are collected using in-person interviews conducted by Montana Fish, Wildlife and Park staff. Creel surveys in the upper reaches of the Upper Clark Fork are conducted on the mainstem Clark Fork River between the confluence with the Little Blackfoot and Warm Springs, MT. Surveys in this reach have been conducted bi-annually since 2005, with an additional survey being done in 2020 to assess impacts of the COVID-19 pandemic. Surveys intend to capture the angling pressure (reported in angler days) for the summer season from May to September.

RESULTS

Population Estimates & Size Structure

pH Shack (Upstream of Deer Lodge)

The pH Shack Section is located just downstream of the confluence of Silver Bow Creek and Warm Springs Creek. Population levels vary from reach to reach in the Clark Fork River upstream of Deer Lodge, but the pH Shack section generally represents the trends in the populations upstream of Deer Lodge. The pH Shack section is immediately downstream of the Warm Springs Ponds discharge. The Warm Springs Ponds serve as a water treatment system for water flowing into them from historically heavily mine-polluted Silver Bow Creek. Despite being a treatment facility for metals laden water, the ponds are relatively shallow and tend to be biologically productive. Because of this, the discharge leaving the ponds is rich in nutrients. Aquatic insect abundance tends to be very high in the stream channel downstream of the discharge site, and fish density in this segment of the stream has generally been found to be the highest of any site sampled on the Upper Clark Fork River upstream of Deer Lodge.

Throughout much the 1980s, brown trout density in the pH Shack Section was estimated to be as high as 2,500 fish per mile (Hadley 2003). Upgrades were made to the ponds in the 1990's to make them more effective at treating Silver Bow Creek water. Since the modifications were made, trout populations have decreased in the pH Shack Section indicating that the modifications may have lessened the tail-water effect to some extent. Nevertheless, trout density tended to remain relatively high in the pH Shack section from the mid-1990s into the mid-2010's, with density averaging about 900 brown trout per mile (Figure 1). Starting in 2015 densities declined again and brown trout densities currently average 200 fish per mile (Figure 1). During this eight-year span numbers have ranged from 462 fish per mile to 73 fish per mile, with the last five years all being under 200 fish per mile (Figure 1).

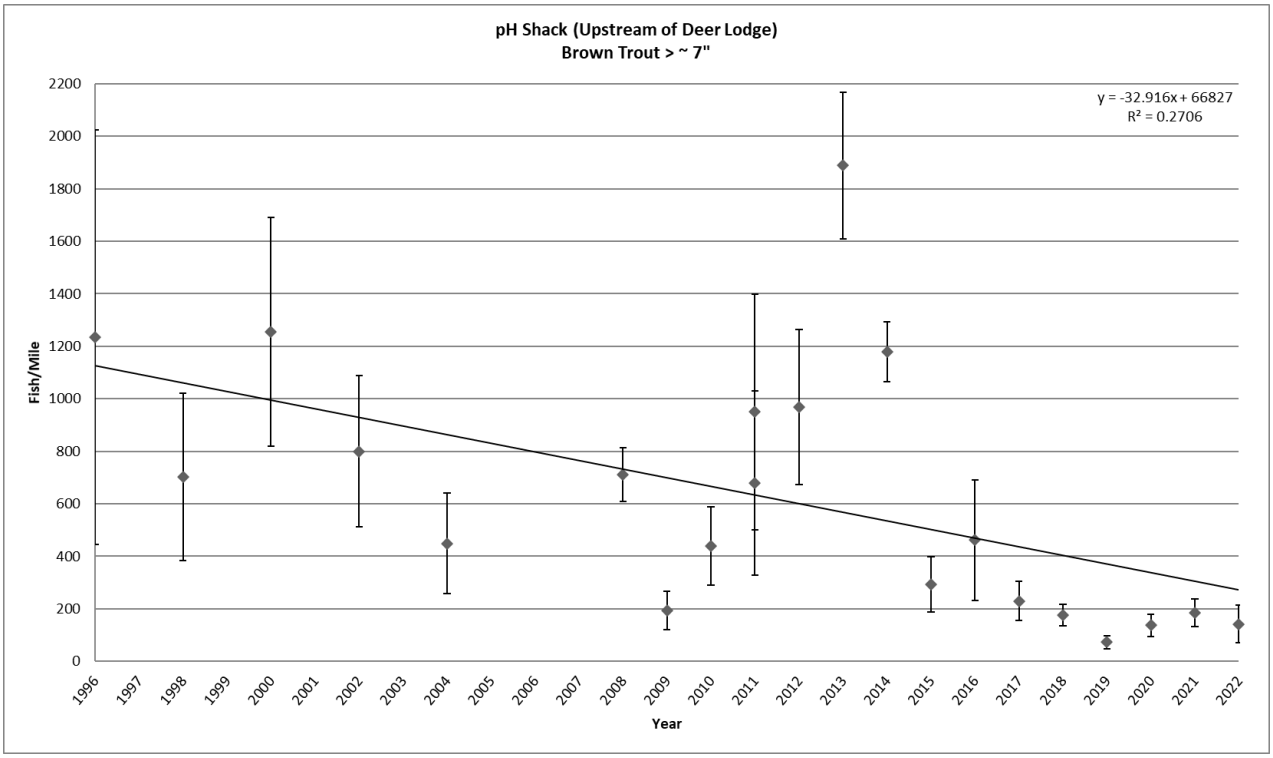

Figure 1. Brown trout population estimates reported in fish per mile for the pH Shack section on the Upper Clark Fork River.

Williams-Tavenner (Downstream of Deer Lodge)

The Williams-Tavenner Section is located 6 miles downstream of the town of Deer Lodge. Population levels have been historically more stable downstream of Deer Lodge. The Williams-Tavenner section is generally representative of population density and trend from Deer Lodge to Gold Creek, this section has also been sampled most consistently of the sections sampled downstream of Deer Lodge. Brown trout make up most of the trout fishery downstream of Deer Lodge but westslope cutthroat become more abundant. The presence of Westlope cutthroat trout downstream of Deer Lodge is likely due to better connectivity to spawning habitat and increased water quantity and quality.

Consistent monitoring at Williams-Tavenner using modern techniques began in the late 1990's and has continued to present. Brown trout densities have been stable to slightly increasing in the section over the period of record, with an average of 250 fish per mile (Figure 2). Brown trout estimates in 2013 and 2014 are noticeable outliers, with estimates of 535 and 620 fish per mile respectively. These values are likely due to strong recruitment from the 2011 year-class due to exceptional flows that year. Westslope cutthroat trout have been present at the Williams-Tavenner section throughout the period of record but are only present in estimable numbers in some years (Figure 2), and generally make up <10% of the trout population. Higher densities of westlope cutthroat trout can be associated with good flow years two to three years prior (i.e., 2011, 2018, 2019, 2020). High flow years likely allow for better out-migrating conditions from tributaries and higher survival for fish in the Clark Fork River mainstem.

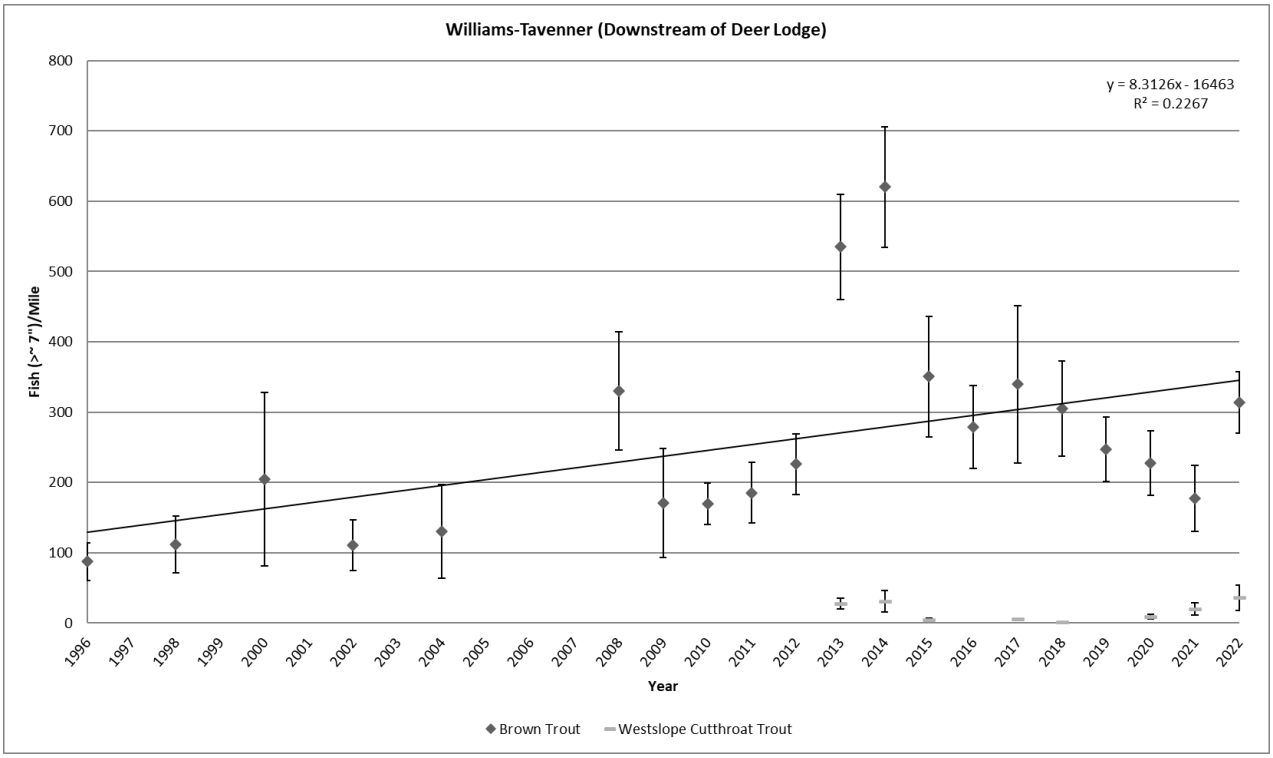

Figure 2. Brown trout and Westslope cutthroat trout estimates reported in fish per mile for the Williams-Tavenner section on the Upper Clark Fork River.

Angling Pressure

Creel surveys in the upper reaches of the Upper Clark Fork River began in 2005. Angling pressure has been highly variable from 2005 to present (Figure 3). However, the trend is nearly flat, angler days peaked in 2013 with 9,052, then declined to 3,552 in 2017, before steadily increasing to 7,496 in 2020 (Figure 3). Angling pressure has been steadily increasing since 2017, but it remains to be seen if this trend will continue or if it is part of the normal variability observed in the Upper Clark Fork, the 2020 data point is still within the part observed range.

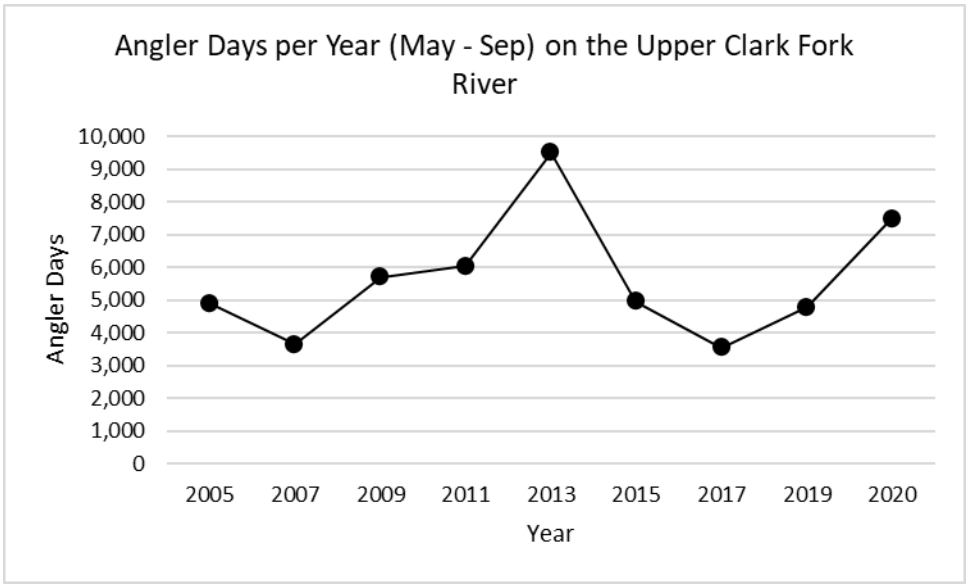

Figure 3. Summer angling pressure for the Upper Clark Fork River reach (Warm Springs to Little Blackfoot River confluence).

Discussion and Management Implications

Since the upgrades at Warm Springs Ponds, flows and associated variables were the main driver influencing fish populations upstream of Deer Lodge (Elam et al. 2021). Brown trout densities and recruitment were closely correlated to minimum flows observed in the river three years prior. Likely because high flows increase the quantity and quality of available habitat in the river and therefore increases survival. For instance, 2009 appears to be an extreme outlier in the dataset prior to 2015, but the population numbers were predicted with a basic flow model based on minimum flows from 2006 (Elam et al. 2021). Starting in 2015, the relationship between flows, recruitment, and population densities was poor. Predictive flows (three years prior to sample year) have varied, but there has been no correlation to population densities or recruitment. A historically good flow year occurred in 2018, but fish populations remained at historic lows in 2021 and 2022. The relationship between flows and population levels is well documented in flow impaired brown trout fisheries in Montana, other rivers, such as the Big Hole River, have been subject to similar declines.

Other than flows, there are many other variables that influence brown trout populations in the Upper Clark Fork (i.e., heavy metals, pH, dissolved oxygen, temperature, etc.), but none of these variables are known to have changed significantly since the brown trout population decline that started in 2015. There have been continued operational changes at the Warm Springs Ponds, most significantly a reduction in lime used to treat water in the ponds. However, this change has not resulted in any known degradation to water quality parameters important to brown trout, reducing liming has aimed to improve water quality and lower seasonally high pH. One notable change in the upper reaches of the Upper Clark Fork has been the ongoing remediation of the rivers banks and floodplain to remove heavy metals contamination. The remediation process involves the removal of the riverbank and some of the floodplain, these features are then built back using various techniques. This process began at the pH shack section in 2012 and has continued in various downstream reaches. About one third of the river mileage between Warm Springs and Deer Lodge has been remediated to date, and 2.5 miles immediately downstream of Deer Lodge. Due to the bank and floodplain reconstruction, habitat has been simplified in remediated reaches, vegetation and bank features that may have taken decades to form were removed and replaced. Short-term habitat simplification was an expected impact of remediation, and likely has some impact on brown trout densities. However, habitat simplification is not believed to be the sole or main variable responsible for brown trout population declines. Brown trout population declines have been documented throughout the Upper Clark Fork River upstream of Deer Lodge regardless of remediation activity as well as other southwest Montana rivers (Elam et al. 2021; Montana Department of Fish, Wildlife and Parks Unpublished Data). It should be noted that fish kills have been documented on the Upper Clark Fork River historically and several times in recent years. These fish kills are assumed to be associated with toxic runoff entering the river from the contaminated floodplain. Montana Fish, Wildlife and Parks staff have also observed dead and dying fish with symptoms consistent with Saprolegnia (fungus) on various occasions in the pH Shack section. Saprolegnia outbreaks have typically been relatively mild and resulted in very few observed dead fish. Fish kills related to heavy metals and fungus outbreaks on the Upper Clark Fork River may have an impact on fish populations, however, the documented fish kills have generally been limited to small areas and relatively few fish.

Angling related mortality from harvest or handling can be a significant population driver in fisheries that have harvest pressure, high capture frequency, or a combination of capture frequency with

environmental stressors. Data on capture frequency and angling pressure is limited on the Upper Clark Fork, but it does not appear to be a significant driver of trout populations. Downstream of Deer Lodge brown trout densities have remained stable through times of above and below average angling pressure. Upstream of Deer Lodge, brown trout densities are more variable and do not appear correlated to angling pressure. The relationship of trout numbers and angling pressure is inconsistent and contradictory to an influence of an angling effect. From 2005-2011 angling pressure was near average, as were trout numbers. From 2012 to 2014, trout numbers increased to above average as angling pressure also increased to a record level in 2013. Starting in 2015, angling pressure was at average levels, down from 2013, but have increased to above average in 2020. During this same time, trout numbers declined to historic lows. Creel surveys on other area rivers have shown anglers who harvest trout have a strong propensity to harvest trout greater than 12 inches (Peters and Spoon 1989). Over the past decade the average length of captured brown trout in the pH Shack section has increased from about 12 inches to around 14 inches (Gold Quiros et al. 2022). If harvest pressure was impacting the trout population, we would likely expect a decrease in average length because of angler tendency to harvest larger fish. Instead, the increase in average length appears to be due to declining recruitment of juvenile fish to the population (Elam et al. 2021). Also of note, the sampling section above Deer Lodge at pH Shack where trout numbers have declined dramatically is in the very short (2.5 miles) upper reach of the Clark Fork River that is catch-and-release. It is possible fish from this reach move downstream where they could be harvested, but it is unlikely harvest has any significant impact on trout densities in the pH Shack section given the regulations.

Brown trout densities in the Upper Clark Fork remain stable downstream of Deer Lodge and at historically low levels upstream. Current regulations are more restrictive upstream of Deer Lodge and do not appear to be responsible for brown trout population declines. It is not clear what is responsible for the decline. Based on the size structure of the population, declines appear to be related to decreased recruitment. Angling pressure and harvest are not generally thought to influence recruitment because juvenile fish are rarely caught or harvested, and adult numbers don't appear to vary with angling pressure changes. Therefore, current regulation appears to be appropriate. Montana Department of Fish, Wildlife and Park is currently collecting information to better understand recruitment in the Upper Clark Fork. Spawning and juvenile fish data are being collected and will be used to better understand what areas are important for spawning and rearing and if juveniles exist at a level that is comparable to reference waterbodies. This data will help inform which early life stage (i.e., spawning, rearing, sub-adult) is the bottleneck on recruitment. We have also partnered with the Montana Natural Resource Damage Program to evaluate where current recruitment is coming from using otolith michrochemistry. This data will be compared to a similar study completed before population declines to determine if individual sources (i.e., tributaries or mainstem) of fish recruitment have diminished. Continued monitoring of fish populations and the many variables that influence populations in the Clark Fork is essential, especially considering the many nuances and changes occurring in the Upper Clark Fork Drainage. The upper Clark Fork fishery is an indicator of the ecological wellbeing of the river and is socially and economically important.

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