Thompson Falls Hydroelectric Project
FERC Project No. 1869

Final Study Report
Fish Behavior Study 2023

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List of Abbreviations and Acronyms

~	approximately
%	percent
<	less than
>	greater than
°C	degrees Celsius
3D	three-dimensional
BO	Biological Opinion
CFD	computational fluid dynamics
cfs	cubic feet per second
FERC	Federal Energy Regulatory Commission
fish passage facility	Thompson Falls Upstream Fish Passage Facility
Flatiron FAS	Flatiron Ridge Fishing Access Site
fps	feet per second
FSR	Final Study Report
FWP	Montana Fish, Wildlife and Parks
FWS	U.S. Fish and Wildlife Service
HB	High Bridge
HVJ	high velocity jet
ILP	Integrated Licensing Process
ISR	Initial Study Report
Licensee	NorthWestern Energy
ladder	Thompson Falls Upstream Fish Passage Facility
MDL	Main Channel Dam Left
MDR	Main Channel Dam Right
MHz	megahertz
NorthWestern	NorthWestern Energy
PH	Powerhouse
PIT	passive integrated transponder
Project	Thompson Falls Hydroelectric Project
Scientific Panel	Thompson Falls Scientific Review Panel
study area	Zone of Passage
TAC	Technical Advisory Committee
TC	terms and conditions

Thompson Falls Project	Thompson Falls Hydroelectric Project
U.S.	United States
USGS	U.S. Geological Service
USR	Updated Study Report
vs.	versus
ZOP	Zone of Passage

Executive Summary

The Thompson Falls Hydroelectric Project (Thompson Falls Project or Project) is located on the Clark Fork River in Sanders County, Montana. Non-federal hydropower projects in the United States (U.S.) are regulated by the Federal Energy Regulatory Commission (FERC) under the authority of the Federal Power Act. The current FERC License expires December 31, 2025.

This *Fish Behavior Study – Final Study Report* (FSR) has been prepared consistent with the requirements of NorthWestern Energy's (NorthWestern, Licensee) Revised Study Plan, filed April 12, 2021, as approved in FERC's *Study Plan Determination for the Thompson Falls (P-1869-060) Hydroelectric Project* (FERC 2021) and FERC's *Determination on Requests for Study Modifications for the Thompson Falls Hydroelectric Project* (Modified Study Plan; FERC 2022) and FERC's *Determination on Study Modification Requests* (FERC 2023).

This Executive Summary provides an overview of the FSR and is intended to synthesize key points of the overall content. It is provided as a separate, stand-alone section to aid the reader's understanding of the contents of the FSR. The full FSR report begins on page 1-1 (Introduction).

Fish Behavior Study Background

The Project is located on the lower Clark Fork River near the town of Thompson Falls, Montana in Sanders County. Between 2009 and 2010, the Licensee constructed the Thompson Falls Upstream Fish Passage Facility (fish passage facility or ladder) along the right abutment of the Main Channel Dam designed to address upstream fish passage for the Bull Trout (*Salvelinus confluentus*), which has been listed as threatened by the U.S. Fish and Wildlife Service (FWS) under the Endangered Species Act.

Per the *Study Plan Determination* (FERC 2021), this study focused on Rainbow and Brown trout, which are important game fish in the study area and serve as surrogate species to better understand upstream fish passage efficacy for Bull Trout (Thompson Falls Scientific Review Panel [Scientific Panel] 2020).

The goal of this study was to evaluate upstream fish movement *via* radio telemetry[1] through the Project's zone of influence[2] which is defined by the Zone of Passage (ZOP) concept (FWS 2017). The ZOP concept defines discrete areas for analysis of the pathway fish use to move through the influence of the Project. These areas include far field, near field, fish passage facility entrance, internal fish passage facility, exit, and upstream. The ZOP concept provides a method to measure passage effectiveness and identify influences, (Project and non-project related), to upstream

[1] Radio telemetry uses individually coded tags which transmit radio waves which can be detected with receivers mounted on shore.
[2] Zone of Influence means an area within which there are positive or negative effects as a result of the Project.

passage effectiveness. This study focused on fish movement in the far field, near field, fish passage facility entrance and internal fish passage facility (study area).

Methods

The evaluation of fish behavior in the study area was conducted through radio telemetry. Fixed receivers were installed to continuously monitor the movement of tagged fish. Rainbow and Brown trout were collected, either *via* electrofishing or at the fish passage facility, anesthetized, and a radio tag inserted in the body cavity of each fish. The tagged fish were transported downstream to the Flatiron Ridge Fishing Access Site (Flatiron FAS), 4 miles downstream of the far field, and released. Mobile tracking was also used to define specific locations where the tagged fish were located in the study area.

The data were analyzed to determine the travel time between key locations in the study area, the proportion of fish that entered the ZOP, specific locations utilized by fish within the ZOP, seasonality of movement, and water depths where fish hold in the ZOP.

The results from the Hydraulic Conditions Study were also evaluated to assess how velocities in the ZOP may influence upstream fish passage.

Results

A total of 100 trout (Rainbow and Brown) were tagged over the 3 years of study. In 2021, seven Rainbow Trout and six Brown Trout were radio tagged in June, and three Brown Trout were radio tagged in late September and early October, for a total of 16 radio tagged trout. In 2022, 29 Rainbow Trout and eight Brown Trout were radio tagged in March, and 17 Brown Trout were radio tagged in September for a total of 54 trout tagged in 2022. In 2023, 30 Rainbow Trout were tagged in March and April, and their movements were monitored through July 31, 2023.

In 2021 and 2022, all but one radio tagged trout released at the Flatiron FAS were later detected in the ZOP. In 2023, 26 of 30 Rainbow Trout tagged and released at the Flatiron FAS were later detected in the ZOP.

Travel Time

Both Brown and Rainbow trout demonstrated an ability to travel upstream rapidly, reaching the far field from the Flatiron FAS as quickly as 1 hour, and finding the fish passage facility entrance from the near field in as quickly as an hour. Movement from the far field to the near field for both trout species ranged from an average of 1 to 4 weeks.

Travel time from the far field to the near field varied between the two trout species. Rainbow Trout spent approximately 5 to 6 days between their first entry into the far field and their first detection in the near field. Behavior of Brown Trout tagged in spring was different than Brown Trout tagged in fall. The average travel time between the far and near field for Brown Trout tagged in 2022 was 28.4 days for spring-tagged fish compared to 14.4 days for fall-tagged fish.

Rainbow Trout movement from the near field to the fish passage facility entrance was consistent between 2022 and 2023 tagged fish. In 2022, Rainbow Trout spent an average of 8.2 days (0.03-37.8 days) from their first detection in the near field until entering the fish passage facility. In 2023, Rainbow Trout spent an average of 5.4 days (0.9-13.9 days) from their first detection in the near field until entering the fish passage facility. Rainbow Trout movement to the near field and fish passage facility was concentrated to the spring months, March, April, and early May.

The travel time for spring-tagged Brown Trout from the far field to the fish passage facility entrance averaged 136 days, whereas Brown Trout tagged in September 2022 made the journey in an average of 0.08 day. It appears most of the radio tagged Brown Trout enter the fish passage facility during the fall months regardless of the individual fish's ability to navigate upstream to the near field earlier in the spring.

Movement Patterns

The two areas where Brown and Rainbow trout congregated the most were near the mouth of Prospect Creek and along the right side of the Main Channel Dam, near the upstream fish passage facility. Most fish move up the main section of the channel did not concentrate near the Original Powerhouse or the New Powerhouse, although some fish were detected for short periods of time in these locations before moving further upstream.

Rainbow Trout were observed utilizing many locations in the ZOP, however in the near field, Rainbow Trout concentrated within the Main Channel Dam Right (MDR) zone near the fish passage facility entrance during March and April. Rainbow Trout utilization of the Main Channel Dam area showed three Rainbow Trout in the Main Channel Dam Left (MDL) zone prior to moving to the MDR zone and greater use of the MDL zone prior to spill in 2023 than in 2022. Rainbow Trout presence in the ZOP was greatest during the spring months in both the far and near field before tapering off rapidly when runoff occurred in May and June and then with few detections into the summer and fall months.

There was no consistent holding area observed for Brown Trout in the ZOP during the spring and summer months. Peak activity in the ZOP and upstream movement into the fish passage facility occurred in the fall.

Fish Passage Efficiency

Over the 3-year study, 27 (41%) of the 66 radio tagged Rainbow Trout and 10 (29%) of 34 radio tagged Brown Trout were detected at the fish passage facility entrance. In 2022 and 2023, when fish collection occurred in March/April, detections of Rainbow Trout at the fish passage facility entrance were similar. Approximately 43 percent (in 2022) and 48 percent (in 2023) of radio-tagged Rainbow Trout were detected at the fish passage facility entrance. In 2021, when fish collection occurred in June, no Rainbow Trout entered the fish passage facility entrance. Detections of Brown Trout at the fish passage facility entrance were 33 percent in 2021 and 28 percent in 2022.

Internal ladder passage efficiency is calculated by the remote passive integrated transponder (PIT) tag array system located in the fish passage facility entrance and holding pool. Collectively over the multi-year study, 89 percent of Rainbow Trout entering the fish passage facility ascended to the holding pool, 93 percent in 2022 (13 of 14 Rainbow Trout) and 85 percent in 2023 (11 of 13 Rainbow Trout). For Brown Trout, approximately 60 percent of fish entering the fish passage facility ascended to the holding pool, 67 percent in 2021 (2 of 3 fish) and 57 percent in 2022 (4 of 7 fish).

Water Temperature in the ZOP

NorthWestern water temperature monitoring of the Clark Fork River upstream and downstream of the study area shows that water temperatures in the summer are warm throughout the Clark Fork River system. There is no difference in temperature upstream and downstream of the Project.

Water temperature data collected in conjunction with the telemetry study allowed NorthWestern to examine thermal profiles in the study area. NorthWestern collected temperature profile data in both 2021 and 2022 at three locations downstream of the Main Channel Dam: Prospect Hole, High Bridge, and Dollar Hole. In both years, all three sites showed distinct thermal stratification during the summer.

Fish Depth

During the summer months when the thermocline has been established, trout are more often found in deeper waters to access cooler water temperatures. During the spring and fall periods, trout are found primarily at shallower depths, but also venture into depths greater than those found in the summer months.

Fish Swimming Abilities and Computational Fluid Dynamics (CFD) Modeling

During the Hydraulic Modeling Study, two-dimensional modeling of spill discharge of 200, 2,000, 25,000, and 37,000 cubic feet per second (cfs) was conducted. The three-dimensional (3D) model was applied to the 2,000 and 37,000 cfs spill discharge.

The modeling showed that two locations (High Bridge and falls) present maximum velocities of 20 feet per second (fps) or greater at some flows, exceeding swimming abilities of local fish species. Based on the 3D modeling, the falls appear to be a challenging area for upstream fish passage during all flows. When spill is 37,000 cfs at the Main Channel Dam, both the High Bridge and the falls have a maximum velocity of 20 fps. However, in the two high flow scenarios, the velocities near the fish passage facility entrance remain 7.0 fps or less and appear to be accessible to local fish species. Although maximum velocity at the fish passage facility entrance exceeds 7.0 fps at low flows, these maximum velocities represent attraction flow for fish.

At the lower flows modeled (200 and 2,000 cfs), discharges from the fish passage facility produce a significant portion of the flow in near field and most of the flow path streamlines are concentrated near the entrance of the fish passage facility, resulting in fish attraction flow to the fish passage facility entrance. At the higher modeled flows (25,000 and 37,000 cfs), there are limited flow path streamlines from the upstream fish passage facility, as the flow is quickly mixed with turbulence

and flow from the radial gates. Velocities are relatively low (<5 fps) at the upstream fish passage facility, but the high velocity jet (HVJ) has limited influence on the resulting downstream velocity field.

Discussion

Effectiveness of Study Methodology

- The Scientific Panel recommended a minimum of 50 fish be used in the telemetry study. NorthWestern successfully radio-tagged 100 fish, exceeding the recommendations of the Scientific Panel.
- 95 percent of the 100 fish collected, tagged, and transported downstream for release at Flatiron FAS were later detected in the far field. These data indicate that handling or tagging mortality was low or none during the study, and also indicate that tagged fish were motivated to move upstream.
- The study methodology was effective in generating information on fish movement in the study area.

Fish Passage Conditions at Varying Flows

- The data indicate that during spill at the Main Channel Dam, the detection of fish in the ZOP was limited. Rainbow Trout were nearly absent from the ZOP once spill started at the Main Channel Dam, and for the remainder of the season. Brown Trout that were present in the ZOP during the spring appeared to leave the ZOP during spill, and then returned in the fall.
- Past telemetry studies conducted in the study area from 2004-2006 also found that few fish were present in the study area during the peak of spring runoff.
- Velocities through much of the High Bridge and falls areas exceed the swimming ability for fish during spring flows, likely impeding fish access to upstream locations. Accessible areas for fish to move upstream during high flow are limited to the margins and bottom of the channel.
- The falls and High Bridge areas are natural features of the Clark Fork River.
- While the telemetry data indicate that many fish leave the study area during high flow, a few fish remain and manage to find the fish passage facility. Fish are known to ascend the fish passage facility in limited numbers during high flows when spill is exceeding design capacity (>25,000 cfs spill).
- Velocities near the fish passage entrance are within fish swimming abilities at all flow scenarios. There are no apparent velocity barriers near the fish passage facility entrance that would limit fish movement to entering the fish passage facility.

- At modeled flows of 200 and 2,000 cfs, the flow path streamlines remain distinguishable near the fish passage facility entrance.
- As total spill increases and reaches 25,000 and 37,000 cfs, flow path streamlines from the fish passage facility entrance area are not as distinct and appear to be overwhelmed from flows at the radial gates and flow over the Main Channel Dam.

Location of Fish Passage Facility

The efficacy of the fish passage facility was noted during the development of study plans as a potential concern due to its location. The data collected during this study supports that the fish passage facility was correctly sited for the following reasons:

- Telemetry shows that fish enter the near field and preferentially select the right bank.
- The left side of the near field (MDL) is generally more turbulent and violent at various spill regimes at the Main Channel Dam.
- The results indicate that a fish passage facility located at the powerhouses or Dry Channel Dam would be less effective than the current passage facility location, as only small numbers of fish were detected in those areas, and only for a short duration, before making forays further upstream near the mouth of Prospect Creek, to the Main Channel Dam, or to the fish passage facility entrance.

Water Temperature Effects on Fish Migration

- River temperature may be a contributing factor limiting salmonid movement during July and August when Clark Fork River temperatures tend to peak. Summer water temperature is consistent throughout the Project (upper river, in Thompson Falls Reservoir, and in the river downstream of the Project), except for areas at the mouth of cooler tributaries.
- During the hot summer season, few radio tagged salmonids were recorded at the fish passage facility. Radio-tagged fish were not present in the near field, and relatively few were detected in the far field, during the period of high-water temperatures.
- Prospect Creek provides a cooler water source and creates an area more tolerable for salmonids in the summer. Although thermal stratification was observed at the 3 deep water locations downstream of the Main Channel Dam (Prospect Hole, High Bridge, and Dollar Hole), thermal conditions are likely more preferrable for salmonids at the Prospect Hole compared to the other 2 sites. This may explain observations of fish staying near the confluence of Prospect Creek during the summer compared to other areas in the ZOP.

Summary of Study Results

Fish behavior for both species was relatively similar from year to year. Both species appeared motivated to move upstream for spawning, Rainbow Trout in the spring (pre-spill) and Brown Trout in the fall.

Fish showed the ability to move quickly after release upstream of the Flatiron FAS and enter the ZOP. Peak movement of Rainbow Trout occurred in the spring prior to spill. Peak movement of Brown Trout occurred in the fall (post-spill) and prior to the fish passage facility closing for the season. Both species appeared to leave the ZOP during high flow periods.

CFD modeling and review of fish swimming abilities indicate velocity challenges near the High Bridge and through the natural falls during spill at the Main Channel Dam. Fish movement supported these findings and found few fish in the ZOP during periods of spill. Total fish captures at the upstream fish passage facility also decline during spill. The CFD model also revealed the area around the fish passage facility entrance maintains suitable velocities for fish to swim during spill, although there are limited flow path streamlines leading to the upstream fish passage facility. The flow is quickly mixed with turbulence and flow from the radial gates. Velocities are relatively low (<5 fps) at the upstream passage facility, but the HVJ has limited influence on the resulting downstream velocity field when spill reaches or exceeds 25,000 cfs (NorthWestern 2023c).

Fish were not commonly found at the outlets of the Original or New powerhouses and were most often detected moving up the middle of the main channel through the ZOP frequently utilizing the Prospect Creek confluence area for extended periods. Prospect Creek confluence provides an important area for fish to hold, whether fish are moving upstream to the fish passage facility or holding during warmer periods of the summer. A small fraction of radio-tagged fish moved upstream into Prospect Creek. The fish utilizing Prospect Creek during the spawning season generally left the ZOP after leaving Prospect Creek and did not continue to move upstream.

This study and existing fish passage facility data provide evidence that fish move upstream to the ZOP and can accomplish this quickly, and often continue to the near field preferring the MDR area near the fish passage facility entrance.

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1. Introduction

The Thompson Falls Hydroelectric Project (Thompson Falls Project or Project) is located on the Clark Fork River in Sanders County, Montana. Non-federal hydropower projects in the United States (U.S.) are regulated by the Federal Energy Regulatory Commission (FERC) under the authority of the Federal Power Act. The Project's current FERC License expires December 31, 2025. As required by the Federal Power Act and FERC's regulations, on July 1, 2020, NorthWestern Energy (NorthWestern, Licensee) filed a Notice of Intent to relicense the Thompson Falls Project using FERC's Integrated Licensing Process (ILP). Concurrently, NorthWestern filed a Pre-Application Document.

The ILP is FERC's default licensing process which evaluates effects of a project based on a nexus to continuing Project operations. In general, the purpose of the pre-filing stage of the ILP is to inform Relicensing Participants[3] about relicensing, to identify issues and study needs (based on a project nexus and established FERC criteria), to conduct those studies per specific FERC requirements which are included in FERC's *Study Plan Determination for the Thompson Falls (P-1869-060) Hydroelectric Project* (FERC 2021), issued May 10, 2021, and to prepare the Final License Application.

This *Fish Behavior Study – Final Study Report* (FSR) has been prepared consistent with the requirements of FERC's *Determination on Requests for Study Modifications for the Thompson Falls Hydroelectric Project* (FERC 2022) and FERC's *Determination on Study Modification Requests* (FERC 2023).

1.1 Fish Behavior Study Background

The Project is located on the lower Clark Fork River near the town of Thompson Falls, Montana in Sanders County. Between 2009 and 2010, the Licensee constructed the Thompson Falls Upstream Fish Passage Facility (fish passage facility or ladder) along the right abutment of the Main Channel Dam designed to address upstream fish passage for the Bull Trout (*Salvelinus confluentus*), listed as threatened by the U.S. Fish and Wildlife Service (FWS) under the Endangered Species Act.

The siting and design of the fish passage facility were determined through consultation between the Licensee and the Thompson Falls Technical Advisory Committee (TAC), which includes representatives of NorthWestern, Montana Fish, Wildlife and Parks (FWP), FWS, U.S. Forest Service, and Confederated Salish and Kootenai Tribes. After a multi-year study process, the decision to install a full height fish ladder was made by consensus at a TAC meeting held in

[3] Relicensing Participants includes local, state, and federal governmental agencies, Native American Tribes, local landowners, non-governmental organizations, and other interested parties.

October 2006 (GEI Consultants, Inc. 2007 [4]). In April 2007, the Licensee filed a Biological Assessment with FERC which included letters of support for the fish passage facility from FWS and FWP. In October 2008, the FWS released a Biological Opinion (BO) which included non-discretionary terms and conditions (TC). TC 1(a) states, "During 2009 and 2010, [the Licensee] will construct a fish passage facility (permanent fishway) to provide timely and efficient upstream passage at the right abutment of the Main Channel Dam, as agreed to by the FWS and through oversight of the TAC (as provided for in the interagency Thompson Falls Memorandum of Understanding)" (FWS 2008).

The upstream fish passage facility was constructed as specified in the BO and has operated seasonally since 2011. Over 40,000 fish, representing 16 species (plus 3 hybrids), including 23 Bull Trout have been recorded at the fish passage facility (NorthWestern *in progress*).

The goals and objectives of the fish passage facility were defined by the TAC. The TAC determined the highest priority for upstream fish passage are Bull Trout, followed by native species and non-native game fish such as Rainbow (*Oncorhynchus mykiss*) and Brown (*Salmo trutta*) trout. These goals and objectives have informed how the fish passage facility is operated (notch vs. orifice mode) and the seasonal timing of operation (March – October). Rainbow and Brown trout represent over 80 percent of the salmonids recorded at the fish passage facility over the last 12 years (NorthWestern 2023a).

Per TC 1-h in the BO (FWS 2008) and the License amendment approving construction of the fish passage facility (FERC 2009), NorthWestern, in collaboration with the TAC, organized the Thompson Falls Scientific Review Panel (Scientific Panel) to evaluate the fish passage facility, with emphasis on Bull Trout. The Scientific Panel identified a large volume of qualitative data gathered from the fish passage facility but noted a data gap when quantitatively evaluating the proportion of "motivated" fish entering the Zone of Passage (ZOP) and finding the fish passage facility entrance (Scientific Panel 2020). The ZOP was defined by the Scientific Panel as shown on **Figure 1-1**. The Scientific Panel specifically suggested NorthWestern, "…initiate two parallel studies [telemetry and hydraulic modeling] to assist in the determination of the fish passage facility's attraction [5] and entrance efficiency." (Scientific Panel 2020). This study was developed to address the Scientific Panel's recommendation for a telemetry study. The Hydraulic Conditions Study was performed in parallel, and results are partially reported here, with detailed results available in the *Hydraulic Conditions Study* – FSR (NorthWestern 2023b).

Following the recommendation of the Scientific Panel, and consistent with the FERC's *Study Plan Determination* (FERC 2021), this study focused on Rainbow and Brown trout. Rainbow and Brown trout are important game fish in the study area and serve as surrogate species to better understand upstream fish passage efficacy for Bull Trout (Scientific Panel 2020).

[4] Meeting notes from this meeting state that, "There was consensus that the right bank full height ladder was the preferred alternative. GEI engineers will begin final design on the right bank full height ladder."

[5] Attraction flow means the flow that discharges from the fishway that attracts upstream migrating fish.

1.2 Goals and Objectives of Study

The goal of this study is to evaluate upstream fish movement *via* radio telemetry[6] through the Project's zone of influence[7] which is defined by the ZOP concept (FWS 2017). The ZOP concept defines discrete areas for analysis of the pathway fish use to move through the influence of the Project. These areas include far field, near field, entry, internal fish passage facility, exit, and upstream (*see* **Figure 1-1** for ZOP concept and definitions). The ZOP concept provides a method to measure passage effectiveness and identify attributing causes and influences (Project and non-project related) to upstream passage effectiveness. This study focused on fish movement in the far field, near field, and fish passage facility entrance, as illustrated in Figure 1-1.

[6] Radio telemetry uses individually coded tags which transmit radio waves which can be detected with receivers mounted on shore.

[7] Zone of Influence means an area within which there are positive or negative effects as a result of the Project.

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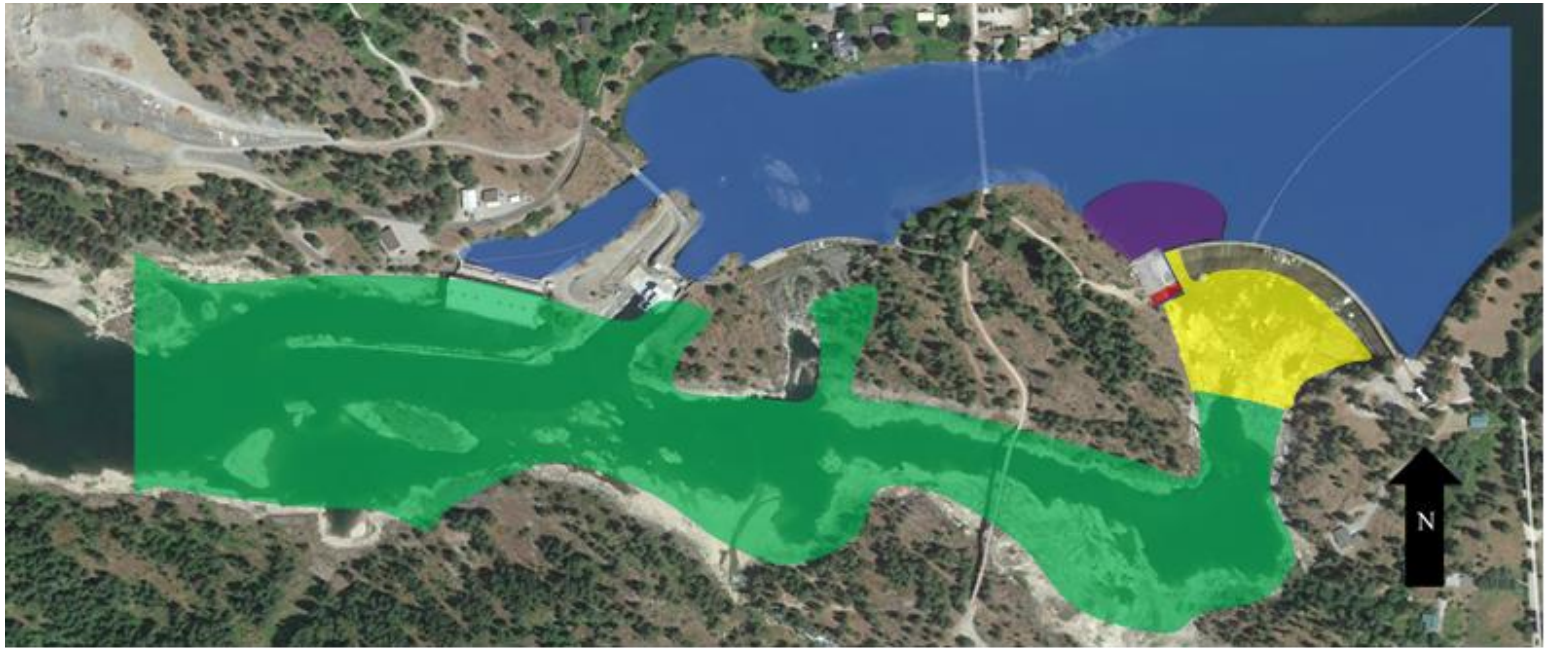
Figure 1-1. Study Areas as Defined by the Zone of Passage Concept



Notes:
Figure not to scale.
Far Field = Downstream of fish passage facility/dam where the Powerhouse and spill serve as primary attraction to migrating fish.
Near Field =In proximity to fish passage facility where fish passage facility attraction flow may lure fish to entrance.
Entry = Immediately downstream of entrance channel/gate where fish passage facility discharge dominates hydraulics/velocity field/fish behavior.
Internal Passage = Hydraulics, structure, and fish movement with the fish passage facility (i.e., entrance channel, pools, trap, exit channel).
Exit = Immediate upstream of the fish passage facility exit gate/exit channel where inflow into fish passage facility dominates hydraulics/velocity field/fish behavior.
Upstream = Beyond the influence of the fish passage facility into the reservoir/impoundment.
Source: Scientific Panel 2020.

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Initially, fish movement and behavior data from June through October 2021 (NorthWestern 2022b) and March through October 2022 were evaluated. The study continued into 2023 with an additional study season, March through July 2023.

Due to the limited battery life in the radio tags, separate groups of fish were monitored each year. For example, fish sampled and tagged in 2021 were monitored in 2021 and fish sampled and tagged in 2022 were monitored in 2022. Results from 2021 are summarized in detail in the *Initial Study Report, Fish Behavior* (ISR) (NorthWestern 2022b); results from the 2022 season are summarized in the *Updated Study Report, Fish Behavior* (USR) (NorthWestern 2023c), and results from the 2023 season are summarized in this FSR. The results from 2023 are compared to 2022 Rainbow Trout movements where appropriate, such as when the seasonal monitoring periods overlap.

This study evaluates what proportion of radio tagged fish enter the ZOP and find the fish passage facility entrance. The study measures the duration of time and pathway(s) of these movements during various flow conditions. This report does not evaluate movement of fish after entering the fish passage facility or details regarding internal fish passage ascents. Internal fish passage facility efficiency is evaluated *via* the remote passive integrated transponder (PIT)[8] arrays located in the ladder section of the fish passage facility; those data are reported in the 2021 Annual Report (NorthWestern 2022a), 2022 Annual Report (NorthWestern 2023a), and 2023 Annual Report (NorthWestern *in progress*) for each respective year. This study's primary objective is to assess the ability of fish to move upstream through the ZOP and find the fish passage facility entrance.

The USR (NorthWestern 2023c) includes a synthesis of upstream fish passage conditions downstream of the Main Channel Dam based on the swimming abilities of fish, as described in NorthWestern (2022b); modeled flow velocities, as described in NorthWestern (2022c and 2023b), and trout radio telemetry tracking data, as described in the USR (NorthWestern 2023c).

This FSR includes a synthesis of upstream movement patterns *via* radio telemetry tracking for the Rainbow Trout tagged in 2023.

[8] A PIT tag is a small radio transponder that contains a specific code, which allows individual fish to be assigned a unique 10- or 15-digit alphanumeric identification number. They are "passive" and do not require a battery, which allows them to be smaller and last the life of the fish.

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2. Methods

2.1 Overview of Approach

The evaluation of fish behavior in the study area was conducted through radio telemetry. Fixed receivers were installed at four locations in the study area to continuously monitor the movement of tagged fish. Then Rainbow and Brown trout were collected, anesthetized, and a radio tag inserted in the body cavity. The tagged fish were transported downstream to the Flatiron Ridge Fishing Access Site (Flatiron FAS), 4 miles downstream of the study area and released.

Data from the fixed receivers were downloaded and entered into a database for analysis. Mobile tracking was also used to define specific locations where the tagged fish were in the study area.

The data were analyzed to determine the travel time between key locations in the study area, the proportion of fish that entered the ZOP and specific locations within the ZOP, and areas where fish hold in the ZOP.

The results from the *Hydraulic Conditions Study* (NorthWestern 2023b) were also evaluated to assess how velocities in the ZOP may influence upstream fish passage.

Details of the study methodology are found in the following sections.

2.2 Study Area

In 2023, the study focused on evaluating Rainbow Trout movement from the Thompson Falls original powerhouse upstream to the fish passage facility entrance at the Main Channel Dam. This 0.75-mile section of the Clark Fork is further divided into the far field, near field, and fish passage facility entrance (*refer to* **Figure 1-1**). Brown Trout movement is studied and reported in the ISR (NorthWestern 2022b) and USR (NorthWestern 2023c).

NorthWestern developed a computational fluid dynamics (CFD) model of the area downstream of the Main Channel Dam to about 500 feet downstream of the High Bridge. High velocity locations noted in the CFD modeling were areas of particular focus, as they potentially possess challenging conditions for upstream fish passage. The location of the falls and the high velocity area downstream of the High Bridge are shown in **Figure 2-1**. The falls is a naturally occurring bedrock feature downstream of the Main Channel Dam (**Photos 2-1, 2-2,** and **2-3**).

In the ISR (NorthWestern 2022b), data were presented on thermal stratification at some of the deeper pools in the study area. These pools are known as the Dollar Hole, Prospect Hole, and High Bridge Hole (Figure 2-1). Thermal conditions in these pools were further investigated in 2022.

Fish movement was monitored in relationship to other prominent features of the study site, including the Dry Channel Dam, mouth of Prospect Creek, the new powerhouse, original (old) powerhouse, and wingwall (**Figure 2-1**).

Figure 2-1. Prominent Features of the Study Area

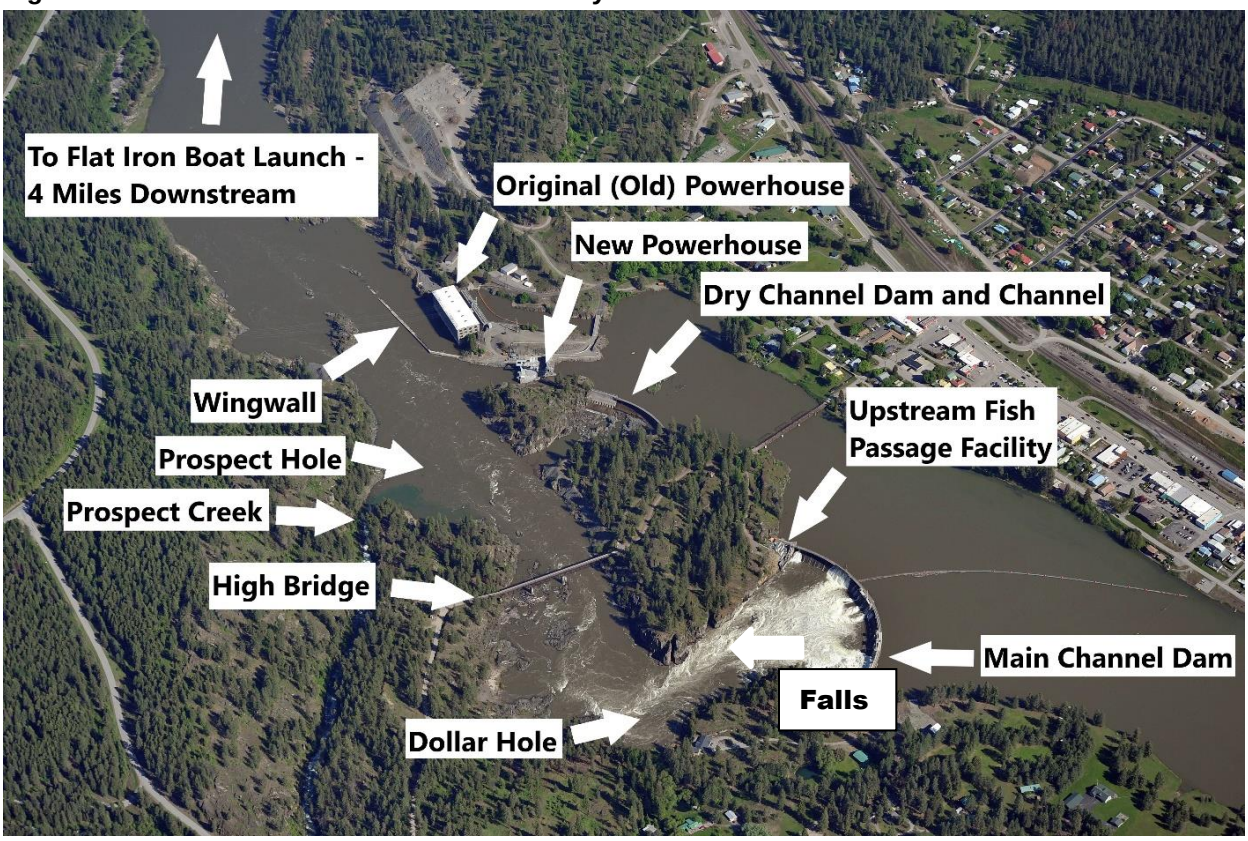

Photo 2-1. Clark Fork River at Thompson Falls, Prior to the Construction of the Thompson Falls Hydroelectric Project

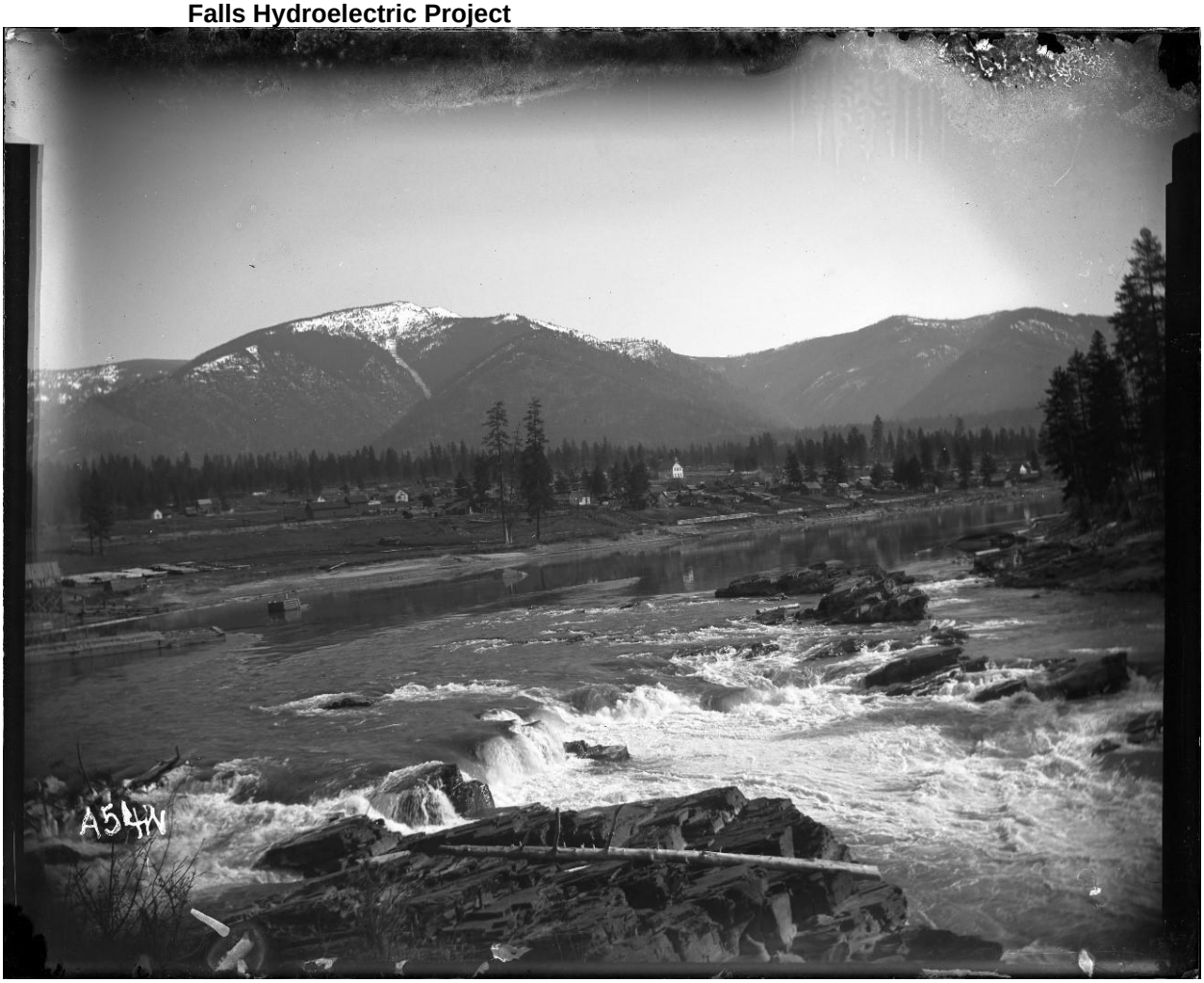

Photo courtesy of the University of Montana Mansfield Library

Photo 2-2. Looking Upstream at the Falls, Clark Fork River at Thompson Falls, Prior to the Construction of the Thompson Falls Hydroelectric Project

Photo courtesy of the University of Montana Mansfield Library

2.3 Tagging and Monitoring Equipment

Tagging equipment included full-duplex PIT and radio transmitter tags. PIT tags are detected by a remote antennae array system operating in the two fish passage facility entrances. Radio tags were monitored by four fixed receiver stations and one mobile receiver.

The location of the four fixed receiver stations and estimated detection zone in the study area are illustrated in **Figure 2-2**. The Powerhouse and High Bridge fixed receiver stations recorded fish presence in the far field and the Main Channel Dam Right (MDR) and Main Channel Dam Left (MDL) recorded fish presence in the near field. The fish passage facility entrance is located along the right abutment of the Main Channel Dam (Figure 2-2).

Each fixed station was set up with a Lotek SRX1200-D2 receiver along with a single 6-Element Yagi antenna, except for the Powerhouse, where two antennae were installed (**Figure 2-3**). The Powerhouse station had one 6-Element Yagi and one 4-Element Yagi antenna. The station on the left side of the MDL was installed along the south side of the radial gate to shield it from

duplicative detections with the right-side station (MDR). The Powerhouse and High Bridge stations were powered using a solar panel to charge a deep cycle battery, the two Main Channel Dam stations were powered by a deep cycle battery charged by permanent AC power.

Radio transmitters were MCFT3 series tags manufactured by Lotek Wireless. In 2022, MCFT3 tags were coded with frequency, 149.7 megahertz (MHz) and a unique code identification number. In 2023, MCFT3 tags were coded with frequency, 148.3 MHz and a unique code identification number. Radio tags were equipped with depth and activity sensors. A good faith effort was made to adhere to a 2 percent tag to body weight ratios (**Table 2-1**). Burst rates (length of time between transmissions) and battery life varied between the two sizes of tags (Table 2-1). In 2023, only the larger tags were implanted in the Rainbow Trout.

Table 2-1. Properties of Lotek MCFT3 Radio Tags, 2021-2023

Variable	2021		2022		2023
Frequency (MHz)	149.7		149.7		148.3
Tag Burst rate (seconds)	5	10	5	10	5
Tag weight (grams)	11	6.8	11	6.8	11
Minimum Fish Weight (grams)	550	340	550	340	550
Battery Life (months)	8	1.5	8	1.5	8
# Tags Deployed	13	3	37	17	30

Notes: # = number; MHz = megahertz

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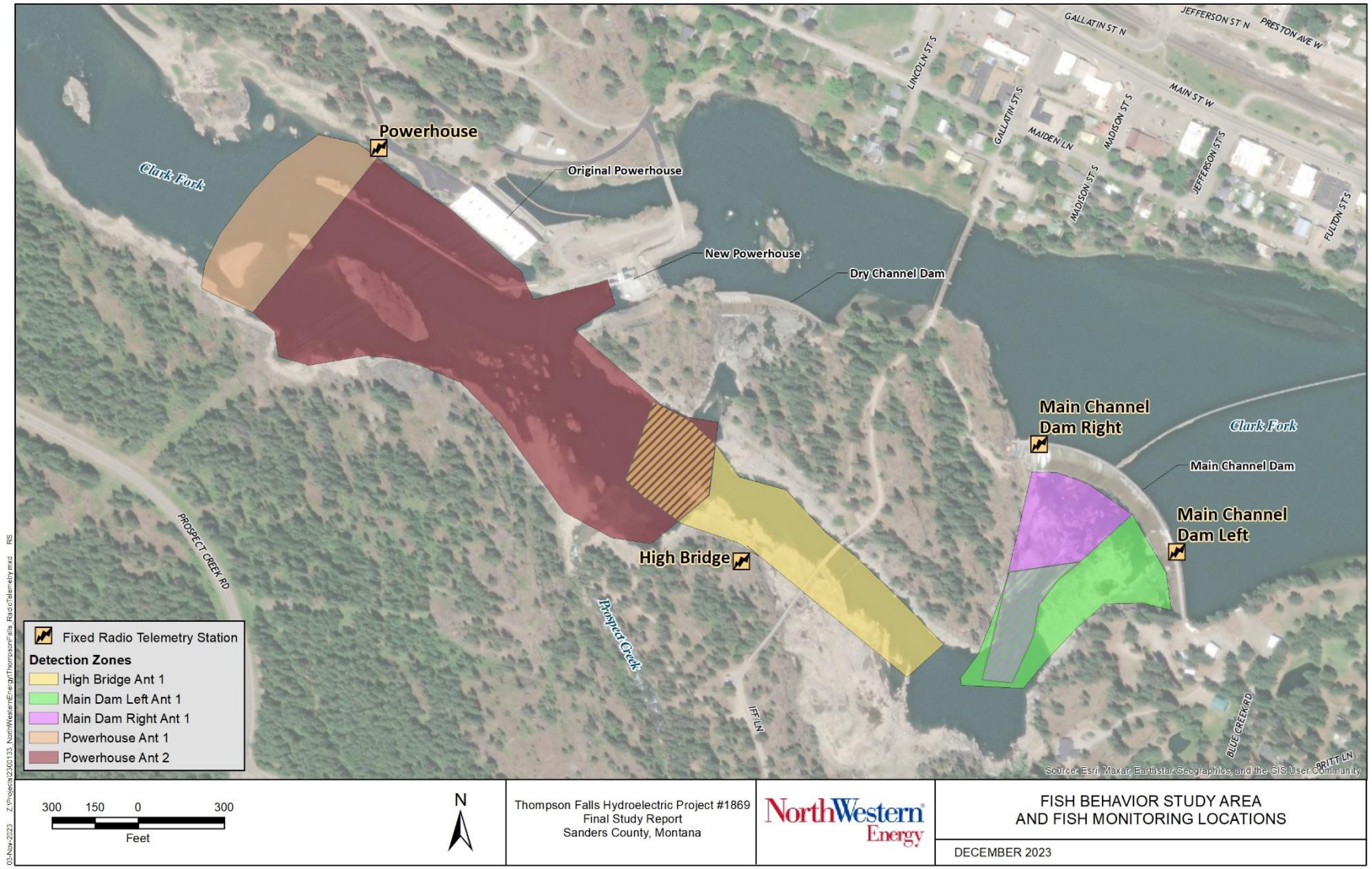
Figure 2-2. Fixed Station Locations and Detection Zones (2021-2023 Seasons)[9]



[9] Detections zones are approximate based on testing and data collection.

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2.4 Fish Collection

Fish collection sites included (1) the mainstem Clark Fork River upstream of the Thompson Falls Project, (2) the lower section of the Thompson River (downstream of the confluence with West Fork Thompson River), and (3) the fish passage facility. Boat mounted electrofishing was used in the Clark Fork River to collect trout of suitable size for radio tagging. Angling was attempted in the Thompson River in 2021, but no fish of suitable size were collected. No angling attempts were made in 2022. Fish collection was contingent on accessibility of the sampling areas and water temperature necessary to allow for acceptable recovery of fish post-surgery. Fish collection, radio-tagging and transport occurred when water temperature was less than or equal to 16 degrees Celsius (°C), a standard established in collaboration with FWP for this study.

Tagged fish were transported by vehicle in an aerated tank to the Flatiron FAS, approximately 4 miles downstream of the Thompson Falls Dam. The majority of fish collected in 2021, 2022, and 2023 were tagged and transported within a few hours of when each fish was captured. There were some exceptions to this when, in 2022 and 2023, four Brown Trout (2022) and 11 Rainbow Trout (2023) were collected *via* night electrofishing and held overnight before being tagged and released the following morning.

Radio tags were internally implanted through the intra-peritoneal (body cavity) following the methods described in Mizell and Anderson (2015). PIT tags (full duplex) were also implanted in each radio tagged fish in the muscle tissue ventral to the dorsal fin.

2.5 Training and Testing Procedures

On May 18, 2021, field crews received training and practiced radio tagging fish surgeries, including anesthetizing, surgery procedure, and recovery process for fish prior to transport and release.

Fixed receiver stations were installed, calibrated, and tested prior to fish collection activities in 2021, 2022, and 2023. Fixed receiver stations were tested to determine tag detection areas, and to ensure adequate power supply, data downloading, and quality assurance and quality control systems were in place. The zones of detection for each fixed station were determined by moving a submerged radio tag around the area and using the receiver to track when a signal was detected. Through trial and error with detections, associated signal strengths, and adjusting antenna positions, detection areas were determined for each fixed station. The zones of detection presented in **Figure 2-1** reflect the results obtained from testing and actual data collected (fixed station data correlated with manual data collection) during the season. A representative from the manufacturer, Lotek, was present in 2021, along with FWP and NorthWestern personnel to assist in setup and testing equipment.

2.6 Monitoring and Data Processing Procedures

The fixed telemetry stations recorded data continuously throughout the study season (June – October 2021; March – October 2022; and March – July 2023). Data from the fixed receivers were downloaded weekly. Because of the large volume of data being collected in 5- or 10-second intervals, a database was developed to store all the information and provide a method to query and process data.

Manual tracking consisted of an individual walking along the bank, within the near and far fields, with a Lotek SRX1200-MD1 receiver and an H antenna 150 MHz. Once a tagged fish was detected, its location was triangulated, and applicable information recorded using a standardized data sheet with a georeferenced grid that was uploaded into a geographic information system (commonly known as GIS).

The data were processed per consultation with Lotek. Fixed receiver data were filtered by a defined detection window to remove false detections. For example, an 11-gram MCFT3 tag is set on a 5-second transmission interval, the detection window requires a minimum of three detections per minute with a signal strength of 100 or greater. For the smaller 6.8-gram MCFT3 tag set on a 10-second transmission interval the smaller tag detection window required a signal strength of 100 or greater. Based on information provided by Lotek and review of the data, false detections were determined to be inconsequential for the smaller tags and supported the decision to modify the detection window criteria. For both tag sizes, a detection record that did not include a sensor (activity or pressure) was excluded from the analysis. False detections are often a result of environmental noise where a random noise or other factors produce a signal that is logged as a viable code. Areas around hydroelectric facilities with powerlines and operation of turbines and gates can increase the amount of environmental noise. The filters applied increase the confidence that detections are radio tagged fish of interest.

Manual radio telemetry monitoring efforts were implemented from June 3 through October 27, 2021; March 23 through October 26, 2022; and March 30 through July 31, 2023. The frequency of manual tracking depended on fish detections in the ZOP and varied from multiple times a week, to daily, or multiple times a day. The goal of the manual tracking was to confirm locations of fish and provide higher resolution of the location for an individual fish within the ZOP. Manual tracking extended from Flatiron FAS (release site) upstream to Thompson Falls Project.

2.7 Study Assumptions

NorthWestern designed the Fish Behavior Study to provide the most consistent comparison of data values (fish detection locations and associated meta data) within a study season. Certain assumptions were necessary to achieve this objective. The study assumes each radio-tagged fish transported downstream and released at the Flatiron FAS are motivated to return upstream. The Fish Behavior Study assumes all fish collected upstream of the Thompson Falls Dam in the mainstream Clark Fork River will express the same motivation to return upstream as the fish

collected at the Thompson Falls fish passage facility. As electrofishing data from the mainstem Clark Fork River show (NorthWestern 2017, 2019b, 2021, 2023a), the ability to capture fish, specifically salmonids, *via* electrofishing in the mainstem Clark Fork River is limited, thus the fish passage facility was included in the collection sites. This enables the study to include a reasonable sample size of Rainbow and Brown trout. The fish and wildlife agencies were consulted and agreed that this assumption and approach were appropriate.

The study evaluates what proportion of radio tagged fish enter the ZOP and find the fish passage facility entrance by assessing movement (duration of travel and pathways) of fish upstream through the ZOP. The study assumes if a fish entered the fish passage facility entrance, this movement through the ZOP is complete.

The study focused on the ability of fish to move upstream through the ZOP and does not include travel calculations of fish that may make multiple forays to the ladder. A fish returning downstream after being passed upstream may present different motivations and behavior in its movement pattern in the ZOP. For example, a fish returning downstream may have already moved into a tributary (e.g., Thompson River) and spawned. Thus, the motivation factors and condition of a fish returning downstream after already moving upstream through the ZOP may alter behavior and movement patterns in the ZOP. Moreover, fish that may make multiple trips to the ladder entrance may have gained knowledge, introduce biased behavior, present different fish condition based on previous experience that might bias results. Therefore, travel time (fixed station data) and pathway (mobile tracking) data are based on the information collected between the time of release at Flatiron FAS and detection in the fish ladder entrance. These boundaries provide consistent data collection for analysis without confounding factors (e.g., changes in fish behavior, fish condition) and support the initial study assumption fish are motivated to move upstream.

The method of data collection and analysis addresses the objectives of the study, which focused on pathway(s) and rate(s) of movement fish have through the ZOP and the ability to access the fish ladder entrance. The methodology was approved by FERC in its *Study Plan Determination* (FERC 2021). Further, the ZOP concept, telemetry and sample size components were consistent with the Scientific Panel conclusions.

2.8 Fish Behavior Data Analysis

Fish movement data were analyzed to assess fish behavior through a range of flow conditions. The telemetry monitoring efforts evaluated fish movement behaviors with emphasis on attraction efficiency[10] (FWS 2017) by assessing the following:

- Travel time from the far field to the near field.
- Travel time from the near field to the entrance of the fish passage facility.

[10] Attraction efficiency is a measure of the proportion of the (motivated) population that is successfully attracted to the fishway; typically measured as a percentage of the motivated population that enters the fishway (FWS 2017). For this study, attraction efficiency is defined as fish moving from the far field to the entrance of the fish passage facility.

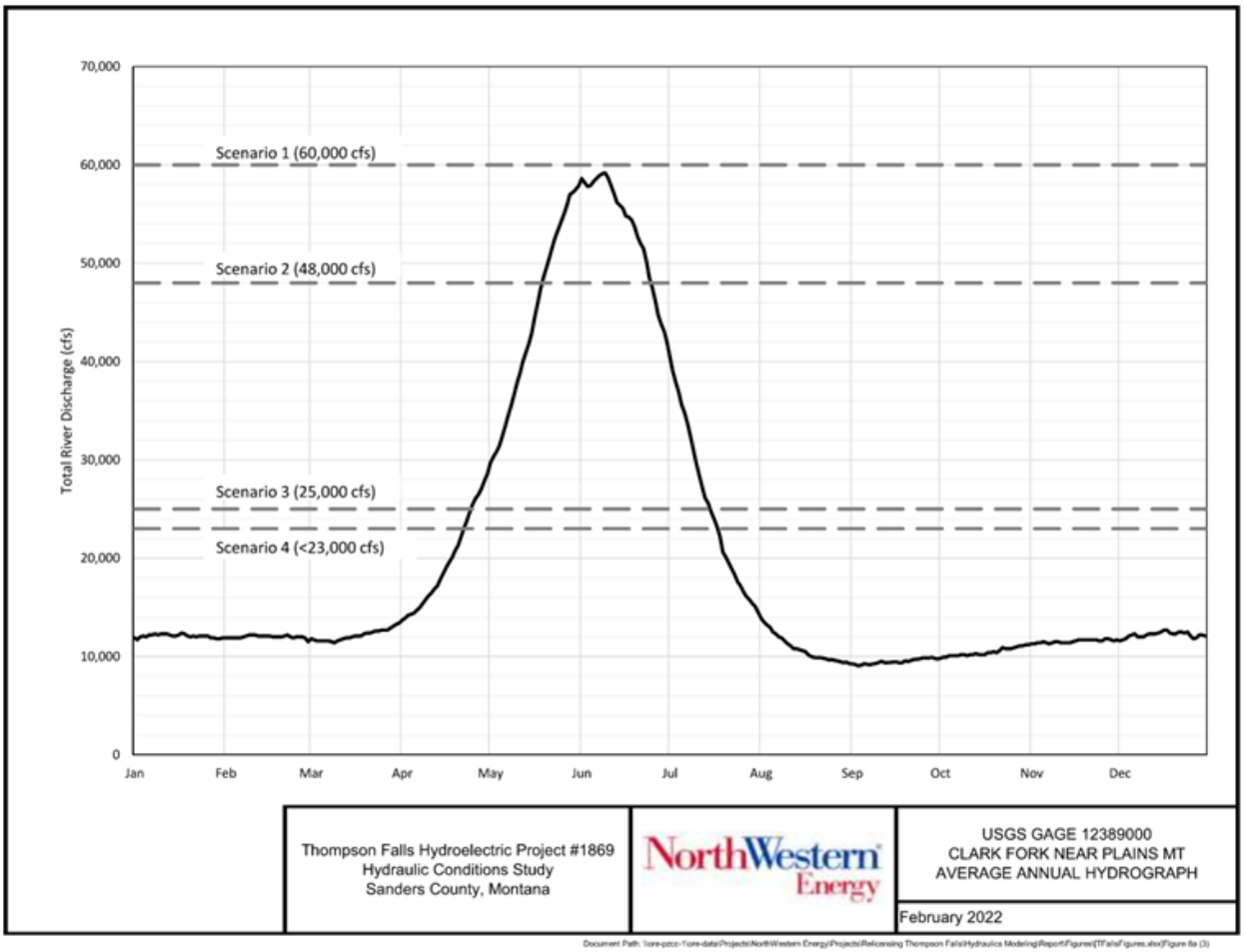
- Movement patterns (e.g., left bank, right bank) in the near field (Main Channel Dam area).
- Proportion of fish that enter the ZOP and locate the entrance of the fish passage facility entrance.
- Locations where fish hold within the ZOP.

2.9 CFD Modeling Data Analysis

A CFD model was developed for the existing Main Channel Dam and river approximately 500 feet downstream of the High Bridge using FLOW-3D software. Details of the CFD model development are provided in the FSR, Hydraulic Conditions Study (NorthWestern 2023b).

The Hydraulics Condition Study ISR (NorthWestern 2022c) provided an estimate of the hydraulic characteristics of the near field from the High Bridge upstream to the Main Channel Dam and the resulting flow depths, velocities, and flow patterns for four flows scenarios over the Main Channel Dam: Scenario 1: 37,000 cubic feet per second (cfs) spill; Scenario 2: 25,000 cfs spill; Scenario 3: 2,000 cfs spill; and Scenario 4: 200 cfs spill. **Figure 2-3** illustrates when these spill scenarios occur based on the average annual hydrograph for the Clark Fork River.

Figure 2-3. Average Annual Hydrograph



Note: U.S. Geological Service (USGS) Gage 12389000 Clark Fork River near Plains, Montana.

The Hydraulic Conditions Study – FSR (NorthWestern 2023b) includes three-dimensional (3D) simulations providing detailed results of the river channel hydraulics at two specific flows **(Table 2-2)**. Scenario 1 was total river flow of 60,000 cfs and spill flow at the Main Channel Dam of 37,000 cfs. Scenario 1 represents an intermediate flow during spill (within design capacity of the upstream fish passage facility). Scenario 3 was total river flow of 25,000 cfs and spill flow at the Main Channel Dam of 2,000 cfs**.**

Table 2-2. Flow Scenarios Utilized In 3D Simulations to Evaluate River Channel Hydraulics

Spill Scenario	Modeled Spill over Main Channel Dam (total river discharge, both in cfs)	Modeled Spill Represents	Representative Period When Modeled Spill is Observed	Dates Conditions Occurred in 2021, 2022
1	**37,000** (60,000)	Assess downstream flow conditions during the upper limit of Upstream Fish Passage Facility operations.	Spring Freshet. Average peak flow (60,000 cfs) typically occurs in May/June. Duration of flow at 60,000 cfs is brief (scale of hours/days).	June 5-6, 2021 June 7-10, 2022 June 29-July 2, 2022 Spill did not reach 37,000 cfs in 2023
3	**2,000** (25,000)	Assess downstream flow conditions at an intermediate typical flow rate.	Ascending and descending limb of hydrograph. Brief period (scale of hours).	May 2, 2021 June 28, 2021 May 6, 2022 July 19, 2022 May 2, 2023 June 16-25, 2023

Note: cfs = cubic feet per second
Source: NorthWestern (2022b)

This report utilizes the results of the CFD model (NorthWestern 2023b) to identify potential velocity obstacles under four flow scenarios from the High Bridge upstream to the Main Channel Dam. Two of the flow scenarios (*refer to* **Table 2-2**) were modeled in greater detail using 3D methods for higher resolution.

The 3D simulation evaluated the vertical velocity distributions of flow downstream of Main Channel Dam for each flow scenario. The simulated 3D flow velocity output was grouped in relation to fish swimming abilities from available published literature. Details of fish swimming abilities by species are provided in Section 3.4 of the ISR (NorthWestern 2022b).

Velocity gradients were delineated into three categories (**Table 2-3**) to best compile and illustrate fish swimming abilities (Section 3, **Table 3-7**). The three velocity categories are generalized and not intended to reflect the swim speed capabilities of a specific fish species. The three groups were:

1. Velocities of 7.0 fps or less, which encompasses the majority of the species swimming abilities for prolonged and burst speeds.
2. Velocities between 7.1 and 14.0 fps, the range of burst speeds for all the salmonid species.
3. Velocities exceeding 14.0 fps which is greater than all species prolonged and burst swimming abilities.

The modeled velocity output illustrates these three velocity groups to identify areas in the near field, and the far field between the High Bridge and Main Channel Dam, that could potentially present an obstacle to upstream fish passage.

Table 2-3. Velocity Categories, Grouped by Fish Swimming Abilities

Velocity Categories	Velocity Gradient (fps)
Most Species – Mix of Prolonged and Burst speeds	0-7.0
Many Species – Burst Speeds	7.1-14.0
Exceeds Burst Speeds	>14.0

Notes: > = greater than; fps = feet per second

The 3D model for a cross-section (or several cross-sections) provides a detailed assessment of the vertical distribution of flow velocities at the cross section. Based on the 3D modeling results, the percent of the cross-sectional area for each velocity category was calculated.

Cross-sections of the areas of concern or interest were evaluated for the approximate area available for fish to navigate based on the swimming abilities (prolonged and burst speeds) identified from the literature and presented in the ISR (NorthWestern 2022b). The cross-sections represent the portion of the area that appears to present the greatest velocities and potential obstacles for upstream fish movement. The configuration of each cross-section is delineated based on the mapping grid. In most instances, one line represents a cross-section for a specific site. At the fish passage facility, a vertical and horizontal cross-section were placed to evaluate velocities for fish approaching the fish passage facility entrance at different directions and provide a more descriptive depiction and assessment of velocities in the area. The falls area includes multiple segments to illustrate cross-sections when evaluating the 37,000 cfs spill scenario. Multiple segments were utilized to maintain precision of the model in an X or Y grid orientation, while attempting to evaluate a representative cross-sectional area of the falls location.

2.10 Variances from the FERC-approved Study Plan

There were no variances during the 2023 study season.

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3. Results

3.1 Fish Collection and Tagging

In 2021, spring fish collection occurred between June 2 and June 16 resulting in the tagging of 13 fish *via* electrofishing in the Clark Fork River. Water temperatures exceeded 16°C on June 17, halting fish collection efforts. Water temperatures declined in the fall, and three Brown Trout were radio tagged at the fish passage facility on September 29 and October 1. Fish tagged in the spring received an 11-gram MCFT3 tag and fish tagged in the fall received a 6.8-gram MCFT3 tag.

In 2022, spring fish collection occurred between March 16 and March 29 resulting in the tagging of 27 Rainbow Trout at the fish passage facility workstation and two Rainbow Trout *via* electrofishing in the Clark Fork River. All tagged fish received an 11-gram MCFT3 tag. Water temperatures declined in the fall, allowing for tagging of 17 Brown Trout (11 at the fish passage facility and 6 electrofishing upstream of the dam in the Clark Fork River) before the end of September. Brown Trout tagged in the fall received a 6.8-gram MCFT3 tag.

In 2023, spring fish collection occurred between March 24 and April 14 resulting in the tagging of 19 Rainbow Trout at the fish passage facility workstation and 11 fish *via* electrofishing the Clark Fork River upstream of Thompson Falls Dam. All tagged fish received an 11-gram MCFT3 tag. No Brown Trout were tagged in the 2023 study season.

A summary of the fish collection efforts for each study season (2021-2023), including collection method, collection location, species, and tag size is provided in **Table 3-1**. **Appendix A** provides more details regarding each sampling event, including method, location, water temperature, effort, total catch, and catch per unit effort and individual fish tagged, including species, total length, weight, radio tag number, and PIT tag number for each study year and season. Monitoring data from 2021, 2022, and 2023 indicated no immediate mortalities from surgery.

Table 3-1. Rainbow and Brown Trout Collection Summary (2021-2023)

Season & Year	Method	Location	RB	LL	MCFT3 Tag size (g)	Total # Fish
Jun '21	Electrofishing	Clark Fork River	7	6	11	13
Sep/Oct '21	Ladder[11]	Clark Fork River	-	3	6.8	3
2021 TOTAL			**7**	**9**		**16**
Mar '22	Ladder	Ladder	27	1	11	28
	Electrofishing	Clark Fork River	2	7	11	9
Sep '22	Ladder	Ladder	-	11	6.8	11
	Electrofishing	Clark Fork River	-	6	6.8	6
2022 TOTAL			**29**	**25**		**54**
Mar/Apr '23	Ladder	Ladder	19	-	11	19
	Electrofishing	Clark Fork River	11	-	11	11
2023 TOTAL			**30**	**-**		**30**
		GRAND TOTAL	**66**	**34**		**100**

Notes: g = grams; LL = Brown Trout; RB = Rainbow Trout

The following results in this report focus on Rainbow Trout. Brown Trout results are discussed and presented in the ISR and USR (NorthWestern 2022b, 2023c).

3.2 River Conditions 2021, 2022 and 2023

A summary of 2021, 2022, and 2023 mean daily streamflow in the Clark Fork River near Plains, Montana (USGS gage #12389000) and a daily water temperature reading at Thompson Falls Dam upstream fish passage facility are shown in **Figures 3-1, 3-2, and 3-3, respectively**. The red line depicted on the figures shows the threshold (23,000 cfs) for when spill occurs at the Main Channel Dam. During the non-spill period, NorthWestern released approximately 200 cfs from the upstream fish passage facility and from the Main Channel Dam to provide attractant flow for fish throughout the fish passage season.

The Project's combined capacity of the seven generating units is approximately 23,000 cfs. When river inflows exceed this capacity, spill is initiated at the Main Channel Dam spillway. The period of spill at the Main Channel Dam for each study season is provided in **Table 3-2** below. In all years, spring flows increased in May, but due to a cooler and wetter spring in 2022, in contrast to 2021 or 2023, the duration of high spring flows was longer (nearly double the other years), and the peak flow was greatest during the second study season. The timing and magnitude of peak spring flow varied among the study years. The timing varied from mid-May in 2023, to the 1st or 2nd week in June in 2021 and 2022, respectively.

Table 3-2. Summary of Spill, Streamflow Greater than 23,000 CFS at the Main Channel Dam (2021-2023)

Year	Start of Spill at Main Channel Dam	End of Spill at Main Channel Dam	Spill Duration (days)	Clark Fork River (@ Plains) Peak Flow (Date)
2021	May 2	June 30	59	59,700 cfs – June 6
2022	May 6	July 19	92	86,100 cfs – June 13
2023	May 2	June 23	53	55,900 cfs – May 19

Figure 3-1. Mean Daily Streamflow in the Clark Fork River near Plains (USGS #12389000), and Water Temperature Recorded at the Thompson Falls Fish Passage Facility (March 1 – October 29, 2021)

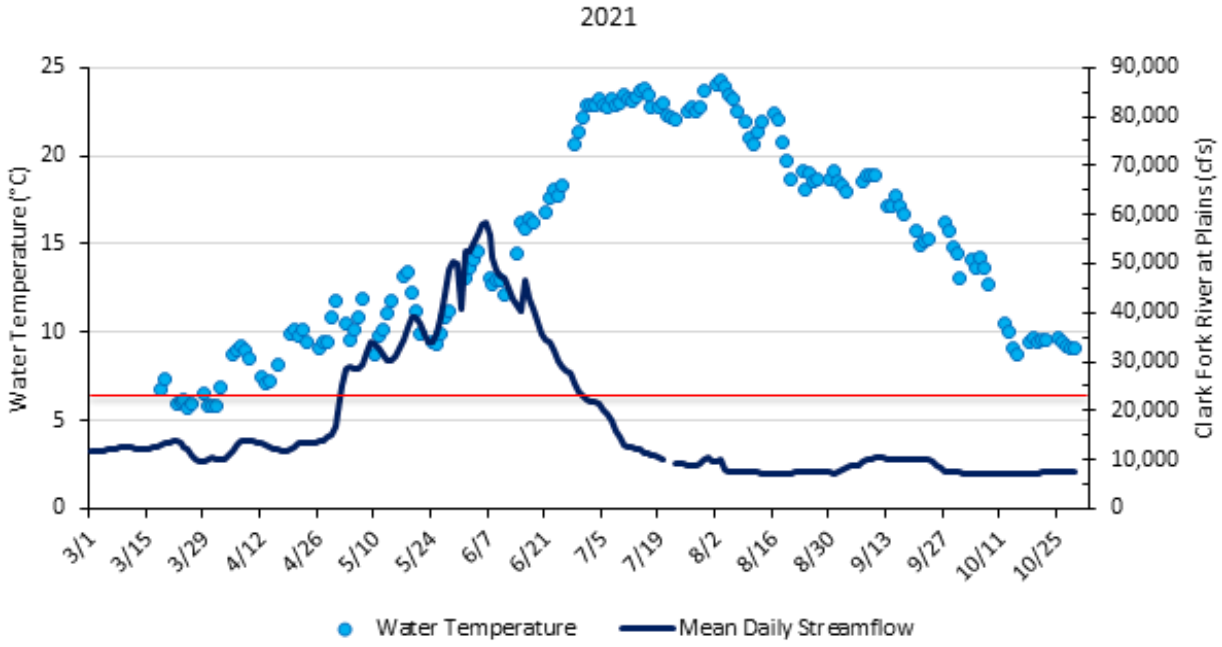


Figure 3-2. Mean Daily Streamflow in the Clark Fork River near Plains (USGS #12389000), and Water Temperature Recorded at the Thompson Falls Upstream Fish Passage Facility (March 1 – October 26, 2022)

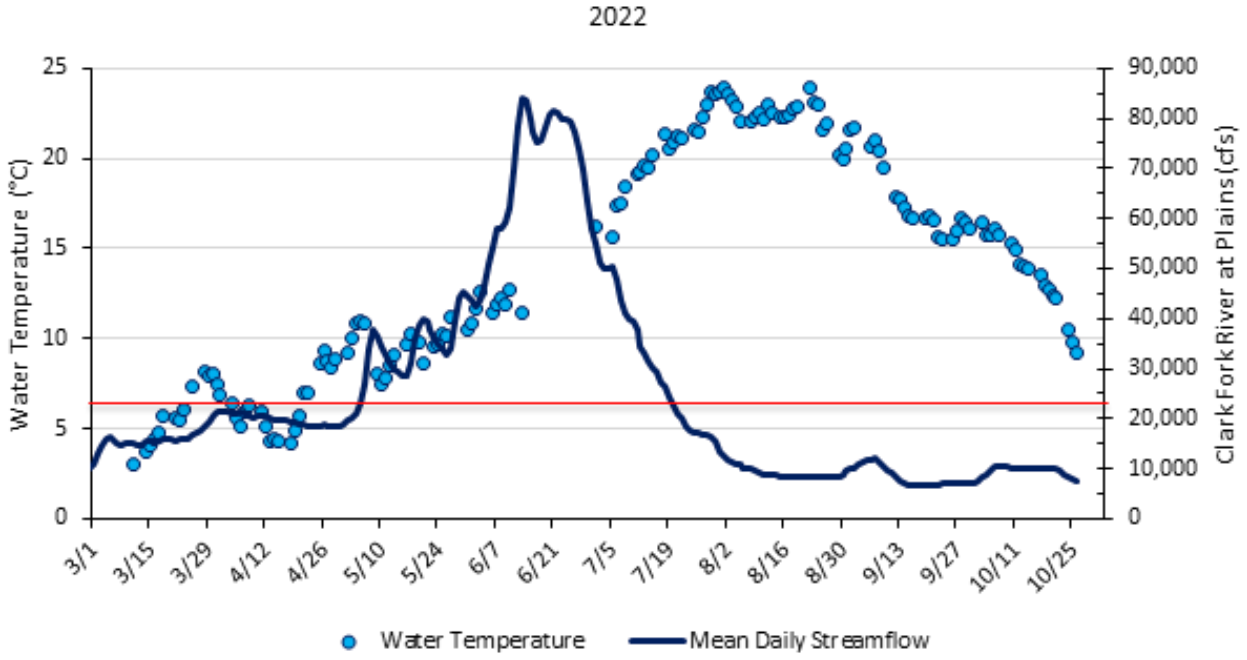
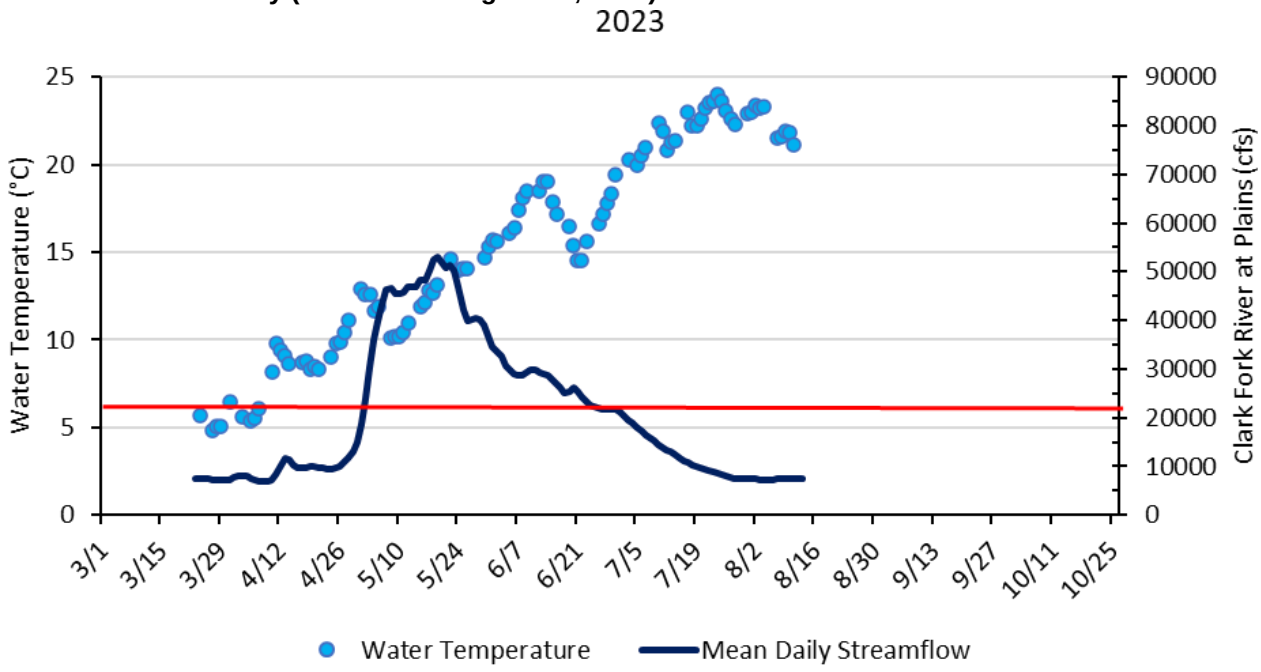


Figure 3-3. Mean Daily Streamflow in the Clark Fork River near Plains (USGS #12389000), and Water Temperature Recorded at the Thompson Falls Upstream Fish Passage Facility (March 13 – August 13, 2023).



3.3 Rainbow Trout Telemetry Results

A summary of the Rainbow Trout studied in 2021, 2022 and 2023, including the month and year of tagging total number radio tagged, percentage/number of radio-tagged fish detected in the far field, near field, fish passage facility entrance, and ascending the ladder is provided in **Table 3-3**.

Table 3-3. Summary of the Rainbow Trout Tagged and the Percentage (and number) of Fish Detected in the Far Field, Near Field, Ladder Entrance, and Ascending the Ladder (2021-2023)

Collection Time	Total Tagged	% (#) in Far Field	% (#) in Near Field	% (#) Ladder Entrance	% (#) Ladder Ascent
June '21	7	100% (7)	14% (1)	-	-
March '22	29	100% (29)	86% (25)	48% (14)	45% (13)
March and April '23	30	**87% (26)**	**63% (19)**	**43% (13)**	**37% (11)**
Grand Total	**66**	**94% (62)**	**68% (45)**	**41% (27)**	**36% (24)**

Notes: % = percentage; # = number of fish detected

Millions of records from the fixed receivers, representing movements of the 66 radio-tagged Rainbow Trout, were collected during the three study seasons. All 36 radio-tagged Rainbow Trout in 2021 and 2022 and 26 (of 30) radio-tagged Rainbow Trout in 2023 were detected entering the far field on fixed receivers. Collectively over the three study seasons, approximately 94 percent of the 66 tagged Rainbow Trout were detected by the fixed receivers in the near field.

In 2021, fish were collected for radio tagging in June during spring runoff in accordance with the FERC-approved study plan, thus no data on spring movement prior to that were collected. Early spring fish collection in 2022 (March) and 2023 (March and April) resulted in observations of Rainbow Trout migration throughout the study season.

During the 2021 season, no 2021-radio tagged Rainbow Trout were detected at the fish passage facility entrance or ascended the fish passage facility. However, one of the 2021 tagged Rainbow Trout entered the fish passage facility in March 2022.

In 2022, fish collection occurred in March, and 48 percent (14 of 29) of the 2022-radio tagged Rainbow Trout were detected at the fish passage facility entrance and 45 percent (13 of 29) ascended the fish passage facility. Additionally, two of the 2022-radio tagged Rainbow Trout ascended the fish passage facility in 2023.

In 2023, fish collection occurred in March and April, and 43 percent (13 of 30) of the 2023-radio tagged Rainbow Trout were detected at the fish passage facility entrance and 37 percent (11 of 30) ascended the fish passage facility (NorthWestern *In Progress*).

Rainbow Trout fish passage facility entries (2022-2023) occurred primarily in March and April (25 fish) with only two fish entering in May during this study.

Over the 3 years of study, 27 (41%) of the 66 radio tagged Rainbow Trout were detected at the fish passage facility entrance. Detections at the fish passage facility entrance were much higher in 2022 and 2023 than in 2021, with zero Rainbow Trout detected in 2021, 48 percent detected in 2022, and 43 percent detected in 2022.

3.3.1 *Capture Locations and Movement Results*

During the 3-year study, 20 Rainbow Trout were collected *via* night electrofishing in the Clark Fork River upstream of Thompson Falls Dam and 46 at the fish passage facility at Thompson Falls Dam (**Table 3-4**).

Most Rainbow Trout tagged and released downstream were motivated to move upstream and enter the ZOP, regardless of where they were initially tagged. However, Rainbow Trout collected and tagged at the fish passage facility appear to have a higher detection rate (98%) moving upstream into the ZOP than fish collected by electrofishing upstream of the Project in the Clark Fork River (84%). In addition, Rainbow Trout initially collected and tagged at the fish passage facility were over two times more likely to enter the near field and 5.4 times more likely to enter the fish passage entrance than Rainbow Trout initially collected and tagged *via* night electrofishing upstream in the mainstem Clark Fork River (Table 3-4).

One Rainbow Trout collected *via* night electrofishing in 2023 had a prior history of ascending the fish passage facility. Rainbow Trout #116 was tagged with a PIT tag when initially captured at the fish passage facility in March 2019. Rainbow Trout #116 also ascended the fish passage facility in March 2020 and March 2021. This fish's PIT tag was also detected in the Thompson River in 2020, 2021, 2022, and 2023. Rainbow Trout #116 was detected leaving the Thompson River March 22, 2023, before being captured by electrofishing in the Clark Fork River on March 27, 2023. Rainbow Trout #116 was then radio tagged and transported downstream for this study. Following the release of this fish at Flatiron FAS, it was detected in the far field of the ZOP in April until leaving the ZOP April 21.

Table 3-4. Rainbow Trout Collection Summary (2021-2023)

Season & Year	Method	Location	RB Tagged	Far Field	Near Field	Enter Ladder	Ascend Ladder
June '21	Electro-fishing	Clark Fork River	7	7	1	-	-
March '22			2	2	2	-	-
March '23			5	4	2	0	0
April '23			6	4	2	2	2
Total Electrofishing Clark Fork River 2021-2023 % (#)			**20**	**85% (17)**	**35% (7)**	**10% (2)**	**10% (2)**
March '22	Fish Passage Facility	Thompson Falls Dam	27	27	23	14	13
March '23			7	7	5	5	4
April '23			12	11	10	6	5
Total Ladder 2021-2023 % (#)			**46**	**98% (45)**	**83% (38)**	**54% (25)**	**48% (22)**
2021-2023 RB Grand Total % (#)			**66**	**94% (62)**	**68% (45)**	**41% (27)**	**36% (24)**

Notes: RB = Rainbow Trout

3.4 Travel Time

3.4.1 *Travel Time from Release Location to Far Field*

The distance from the release location, Flatiron FAS, to the far field is approximately 4 miles. Travel time from the release location to the far field was calculated by duration between the date and time an individual fish was released at Flatiron FAS and the first detection date and time by the fixed receiver in the far field. A summary of fish travel time, including minimum and maximum, mean, and median times for Rainbow Trout to travel from the Flatiron FAS to the far field is provided in **Table 3-5** (and **Appendix B**). In total, 94 percent (62 fish) of the Rainbow Trout radio tagged in the 3 years of study were detected entering the ZOP. The average travel time following release at the Flatiron FAS to the far field was approximately 6 days, with a range of 0.05 (~1.2 hours) to 42.1 days (~1.5 months).

Table 3-5. Summary of Travel Time from Release at Flatiron FAS to the Far Field (2021-2023)

Collection Time	# of Individual RB Detected in Far Field	Duration (days) Between Release and Detection in Far Field		
		Average	Median	Range
June '21	7	19.7	20	0.25 – 32.0
March '22	29	2.6	1.8	0.05 – 11.4
March and April '23	26	6.1	2.0	0.2 – 42.1
2021-23 RB Grand Total	**62**	**6.0**	**2.2**	**0.05 – 42.1**

In 2021, the 7-tagged Rainbow Trout were released at Flatiron FAS between June 2 and 14, and all fish were detected entering the far field of the ZOP. On average Rainbow Trout were detected entering the far field approximately 20 days (range <1-32 days) following release. The Rainbow

Trout were detected entering the far field (Powerhouse and High Bridge fixed station receivers) starting June 2 through July 6. During the month of June, flows in the Clark Fork River exceeded powerhouse capacity (*refer to* Table 3-2) at the Project (spill range was approximately 800 to 35,000 cfs).

In 2022, the 29-tagged Rainbow Trout were released at Flatiron FAS between March 16 and March 29, and all fish were detected entering the far field of the ZOP. On average, Rainbow Trout were detected entering the far field approximately 2.6 days (range 1 hour – 11.4 days) following release. The Rainbow Trout were detected entering the far field (Powerhouse and High Bridge fixed station receivers) starting March 19 through April 8. During this period there was no spill at the Project, the mean daily streamflow in the Clark Fork River (USGS gage #12389000) ranged from 15,600 to 21,300 cfs.

In 2023, the 30-radio tagged Rainbow Trout were released at Flatiron FAS between March 24 and April 17. Twenty-six fish were detected entering the far field of the ZOP. On average Rainbow Trout were detected entering the far field approximately 6.1 days (range 0.2 – 42.1 days) following release. Rainbow Trout were detected entering the far field (Powerhouse and High Bridge fixed station receivers) starting March 27 through May 9 with the majority (25 of 26) fish detected in the far field ZOP by April 23 (prior to spill). Spill at the Main Channel Dam began May 2 (*refer to* Table 3-2).

Rainbow Trout displayed a 2.2-day median travel time between Flatiron FAS and the first detection in the far field of the ZOP (~4 miles) which calculates to a sustained swim speed of approximately 2.7 fps. The fastest fish took approximately 1.2 hours to reach the far field, resulting in an estimated sustained swim speed of approximately 4.7 fps. These rates are within the range of prolonged swimming speeds (1.6–4.0 fps) and burst speeds (3.4–13.5 fps) documented in the literature for Rainbow Trout presented in the ISR (NorthWestern 2022b).

Details on all tagged fish, including date of transportation and release at Flatiron FAS boat launch, the first date detected in the far field, near field, and fish passage facility entrance, and the travel time between locations, are summarized in **Appendix B**.

3.4.2 *Travel Time from the Far Field to the Near Field*

Travel time from the far field to the near field is equal to the number of days between the last date a fish was detected at the Powerhouse or High Bridge station and first date the fish was detected at the MDR or MDL station. A summary of fish travel time, including minimum and maximum, mean, and median times for Rainbow Trout to travel from the far field to the near field is provided in **Table 3-6** (and Appendix B). Rainbow Trout demonstrated the ability to migrate upstream from the far field to the near field within hours.

During the 2021 study, one Rainbow Trout was detected in the near field approximately 5 weeks (36.6 days) after it was first detected in the far field, July 6, post-spill at the Main Channel Dam.

During the 2022 study, Rainbow Trout averaged about 1 week from their first detection in the far field and first detection in the near field. All movements into the near field were made in March and April prior to spill at the Main Channel Dam. The two Rainbow Trout not detected in the near field were later detected in Prospect Creek or downstream, outside of the study area.

During the 2023 study, Rainbow Trout averaged 4.8 days from their first detection in the far field and first detection in the near field. The majority (89% of 19 fish) of fish movements into the near field were made from March 30 through April 23 prior to spill at the Main Channel Dam (*refer to* Table 3-2). Two fish entered the near field during spill period on May 3 (~7,400 cfs spill) and May 12 (~23,800 cfs spill). Seven fish detected entering the far field between March 29 and April 23 were not detected in the near field, and only one of these fish continued upstream into Prospect Creek (detected *via* PIT Tag array system). The remaining four fish (of 30 radio-tagged) were not detected in the ZOP study area by the fixed station receivers or by manual detection methods.

Table 3-6. Rainbow Trout Travel Time (Days) from the Far to the Near Field (2021-2023)

Collection Time	Total # of RB Detected in Near Field	Rainbow Trout Travel Time from the Far to Near Field (Days)			
		Average	Min	Max	Median
June '21	1	36.6	-	-	-
March '22	25	7.3	0.08	32.7	4.9
March and April '23	19	4.8	0.04	18.9	3.0
Grand Total	**45**	**6.4**	**0.04**	**32.7**	**3.5**

Notes: # = number of fish detected in near field

3.4.3 *Travel Time from the Near Field to the Entrance of the Fish Passage Facility*

Travel time from the near field to the entrance of the fish passage facility is equal to the number of days between the date a fish is first detected by the MDL/MDR station and the date the fish is first detected by the PIT tag array in the fish passage facility entrance. A summary of the 2022 and 2023 study seasons, including the number of fish by species, the average, minimum and maximum travel time (in days) from the near field to detection at the fish passage facility is provided in **Table 3-7.**

In 2021, no Rainbow Trout were detected at the entrance of the fish passage facility.

In 2022, there were 14 Rainbow Trout detected at the entrance of the fish passage facility. The median travel time from first detection in the near field and first detection at the fish passage facility entrance for Rainbow Trout in 2022 was 1.8 days.

In 2023, there were 13 Rainbow Trout detected at the entrance of the fish passage facility. These Rainbow Trout represent two of 11 fish collected electrofishing and 11 of 19 fish collected at the

fish passage facility. The median travel time from the first detection in the near field and first detection in the fish passage facility entrance for Rainbow Trout in 2023 was 4.7 days.

Overall, the 27 Rainbow Trout detected at the entrance of the fish passage facility in 2022 and 2023 spent a median travel time of 3.3 days from the first detection in the near field and first detection in the fish passage facility entrance. Individual travel times are summarized in **Appendix B**.

Table 3-7. Summary of Radio-Tagged Rainbow Trout that Traveled from the Near Field to the Fish Passage Facility Entrance (2022-2023)

Collection Time	Total # RB Detected in Ladder Entrance	Rainbow Trout Travel Time from Near Field to Ladder Entrance (Days)			
		Average	Min	Max	Median
March '22	14	8.2	0.03	37.7	1.8
March and April '23	13	5.4	0.9	13.9	4.7
Grand Total	**27**	**6.9**	**0.03**	**37.7**	**3.3**

Notes: # = number of fish detected in ladder entrance; RB = Rainbow Trout

Internal Fish Passage Efficiency

Results and analysis of internal fish passage ascents are provided in the Thompson Falls Fish Passage Annual Reports (NorthWestern 2022c, 2023b, *in progress*) and Draft License Application (NorthWestern 2023d). These reports provide an overview of all PIT tagged fish detections and ascents at the fish passage facility. PIT tag remote-array antennae are located at the lower and upper entrances, lower pool 7 and pool 8, and the holding pool (the top pool 45) in the fish passage facility. The time between the last PIT tag entry array detection and first holding pool PIT equals the ascent time for fish to reach the top (holding pool).

Annual reporting from 2021 and 2022 of the PIT tagged Rainbow Trout documented approximately 80 percent of 92 PIT tagged Rainbow Trout (and hybrids) detected entering the ladder ascended to the top (holding pool) (NorthWestern 2022c, 2023b). In 2021, 25 PIT-tagged Rainbow Trout spent approximately 5.3 hours (median 2.7 hours) and in 2022, 47 Rainbow Trout spent approximately 6.4 hours (median 3.3 hours) ascending the ladder.

The radio telemetry study provides a sub-sample of data regarding internal ladder efficiency. Radio-tagged Rainbow Trout represent about one-third of the Rainbow Trout detected by the PIT tag array system in the fish passage facility. During the 2022 and 2023 study seasons, the data collected from the PIT tag array system indicate 89 percent of 27 radio-tagged Rainbow Trout detected entering the fish passage facility entrance migrated to the top holding pool. The 24 radio-tagged Rainbow Trout spent an average of approximately 3.5 hours (median 2.7 hours, range 0.9 to 9.4 hours) ascending the fish passage facility.

The median travel time to the top holding pool for the radio tagged Rainbow Trout was similar to the larger sample size of PIT-tagged fish entering the fish passage facility, while the average ascent time for radio-tagged Rainbow Trout was 1.8 to 1.9 hours faster than the PIT-tagged Rainbow Trout recorded ascending the ladder in 2021 and 2022.

3.5 Rainbow Trout Movement Patterns

Data collected with both the fixed receivers, and with manual tracking, were used to assess trout movement patterns. The two types of data provide complimentary information about fish behavior. Manual tracking data was the primary tool used to identify specific locations where fish are located and to analyze potential holding patterns or locations in the ZOP. Fixed receivers operate 24 hours a day and thus capture continuous fish movements in the far and near fields. Because manual tracking occurs over a relatively short period of time, representing one moment in time, manual tracking did not always locate all of the fish that were detected by fixed receivers, which operate continuously. Details of results of both manual tracking and fixed receivers are provided in the following sections for each species.

In 2022, manual tracking detected 23 of the 29 individual Rainbow Trout detected entering the ZOP by fixed station receivers. In 2023, manual tracking detected 18 of the 26 individual radio-tagged Rainbow Trout entering the ZOP detected by the fixed station receivers (**Figure 3-4**).

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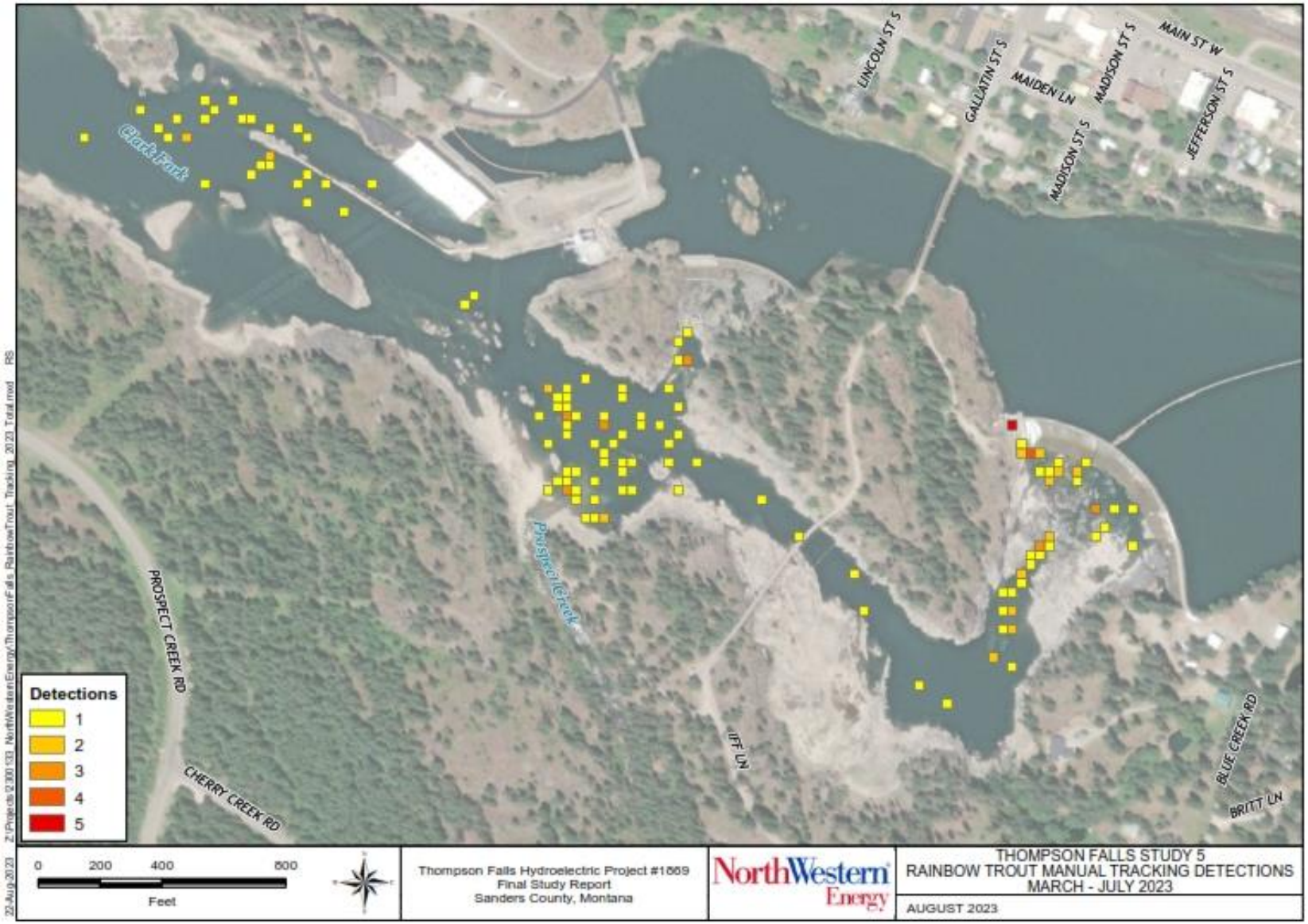
Figure 3-4. Manual Tracking of 18 Radio-Tagged Rainbow Trout in 2023



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In 2022 and 2023, the detection (by manual and fixed receivers) and presence of Rainbow Trout in the ZOP was greatest during the spring months (March and April) in both the far and near field before tapering off rapidly when runoff occurred (May and/or June) and then with few detections into the summer in both years and/or fall months in 2022 (**Figures 3-5 and 3-6**). In 2022 and 2023, approximately 43 to 45 percent, respectively, of the radio-tagged Rainbow Trout entered the fish passage facility between March and May.

Figure 3-5. Daily Detections of Rainbow Trout at the Fixed Station Receivers, Approximate Spill at the Main Channel Dam, and Water Temperature During the 2022 Study Season (March-October)

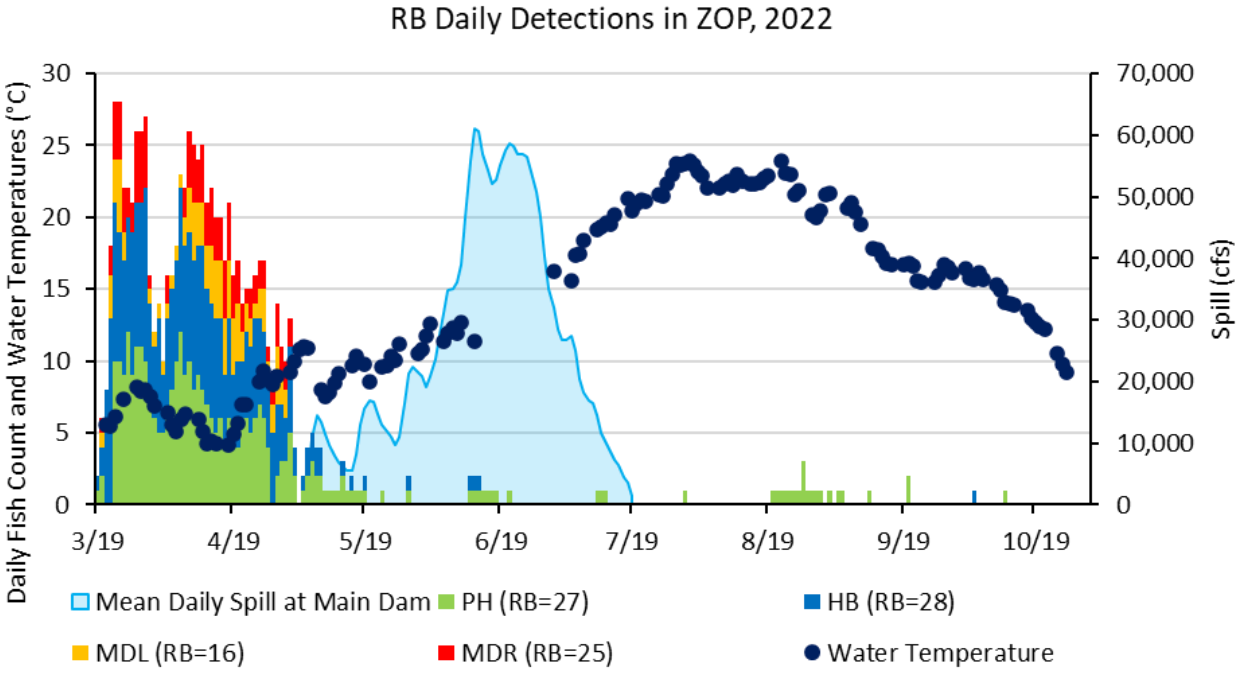
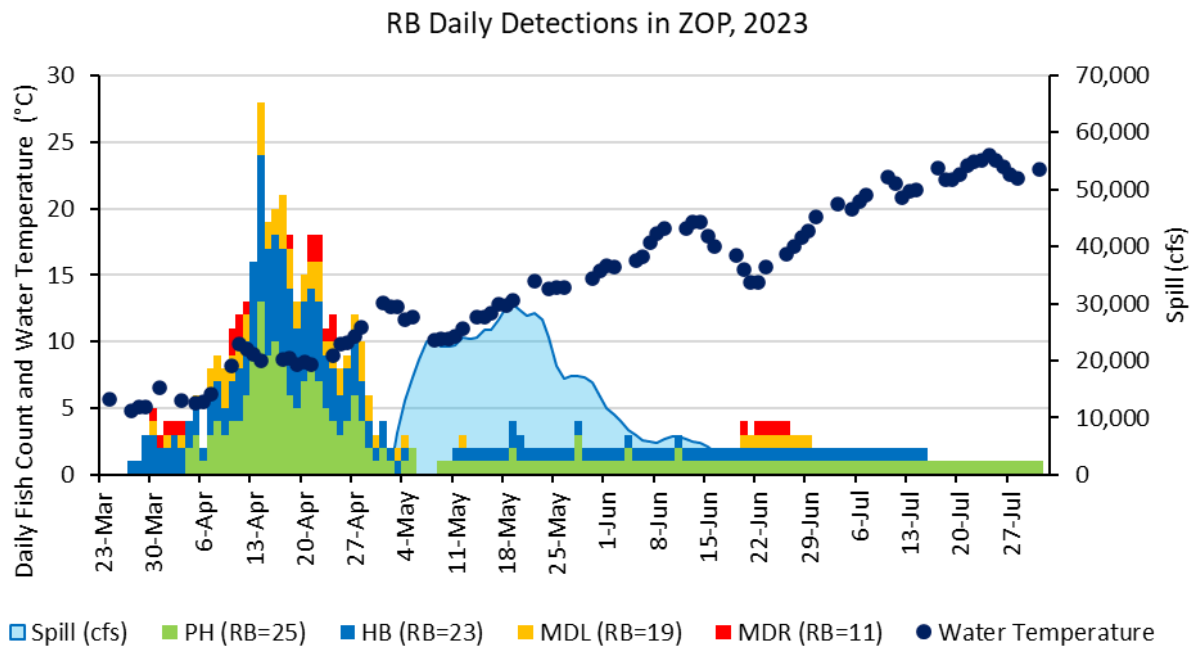


Figure 3-6. Daily Detections of Rainbow Trout at the Fixed Station Receivers, Approximate Spill at the Main Channel Dam, and Water Temperature During the 2023 Study Season (March-July)



A summary of the monthly manual tracking detections of Rainbow Trout is shown in **Table 3-8** for 2022 and **Table 3-9** for 2023. Similar movement patterns by Rainbow Trout were observed *via* manual tracking in 2022 and 2023. In 2022, 70 percent of the 23 fish manually detected in the ZOP moved into the near field and 61 percent (of 23) entered the fish passage facility entrance between March 23 and May 2 (NorthWestern 2023c). In 2023, 78 percent of the 18 fish manually detected in the ZOP moved into the near field and 72 percent (of 18) entered the fish passage facility entrance between March 24 and April 12. In 2023, there was also one Rainbow Trout detected in the near field in June. No radio-tagged Rainbow Trout were detected in the near field or fish passage facility in July in either 2022 or 2023.

Table 3-8 Monthly Summary of the Number of Individual Rainbow Trout Detected *via* Manual Tracking in the ZOP, 2022. Detections at the Ladder Entrance Represent a PIT Tag Recording. No Rainbow Trout were detected in the ZOP (August-October 2022).

Month 2022	Individual Rainbow Trout Detected *via* Manual Tracking		PIT Tag Array Detection	
	ZOP	Near Field	Ladder Entrance	Ascend Ladder
MAR	17	12	8	8
APR	12	10	4	4
MAY	5	2	2	1
JUN	1	-	-	-
JUL	-	-	-	-
Total[11]	**23**	**16**	**14**	**13**

Note: ZOP = Zone of Passage

Table 3-9 Monthly Summary of the Number of Individual Rainbow Trout Detected *via* Manual Tracking in the ZOP. Detections at the Ladder Entrance Represent a PIT Tag Recording. Study season ended July 31, 2023.

Month 2023	Individual Rainbow Trout Detected *via* Manual Tracking		PIT Tag Array Detection	
	ZOP	Near Field	Ladder Entrance	Ascend Ladder
MAR	2	-	1	1
APR	16	14	12	11
MAY	3	-	-	-
JUN	1	1	-	-
JUL	1	-	-	-
Total	**18**[12]	**15**	**13**	**12**

Note: ZOP = Zone of Passage

Manual tracking in 2022 and 2023 confirmed that the peak presence of Rainbow Trout in the ZOP and near field occurred during the spring months, March and April, prior to spill at the Main Channel Dam. The locations for the 2023 monthly detections (March – July) are illustrated in **Figure 3-7**. Note the data collection in the 2023 study season ended on July 31, 2023, consistent with the *Study Plan Determination* (FERC 2021). The locations of Rainbow Trout monthly detections from both study years (2022 and 2023), March through June are illustrated in **Figure 3-8.** No fish were detected in July 2022; thus, no illustrative comparison is provided in the figure.

[11] Total number of separate, individual Rainbow Trout. Monthly numbers do not add to total because some Rainbow Trout detected in more than 1 month.

[12] Total number of separate, individual Rainbow Trout. Monthly numbers do not add to total because some Rainbow Trout detected in more than 1 month.

The majority of manual fish tracking data for March are available from 2022, when data collection began March 21 vs. March 30 in 2023. Manual tracking data for March show fish moving up the main river channel with most detections in the falls and MDR zone in March.

In April most fish detections from 2023 remain in the falls, MDR and MDL zone as well as further downstream near the Original Powerhouse (**Figure 3-8**). In 2022, Rainbow Trout appeared to be slightly more dispersed with most detections remaining in the MDR zone and the addition of fish detections downstream at the mouth of Prospect Creek and two fish below the Dry Channel Dam.

In May individual fish detections in the ZOP were minimal (2 in 2023, 5 in 2022) and of the fish present in the ZOP, the majority were, near Prospect Creek, a few near the Dry Channel Dam, and a few by the wingwall near the Original Powerhouse (*refer to* Figure 3-8). In 2023, spill started at the Main Channel Dam on May 2, with peak spill around 30,000 cfs, and continued through the month of May.

Spill at the Dry Channel Dam is infrequent and only occurred for 1-year during the 3-year study (2021-2023). The Dry Channel Dam spilled for a total of 12 days between June 13 and 27, 2022 with spill flows ranging from approximately 2,600 to 6,500 cfs. No fish were detected in the area below the Dry Channel Dam during this time.

Three individual fish were manually detected in the channel downstream of the Dry Channel Dam in 2022 (2 fish) and 2023 (1 fish). In 2022, the fish detections of two individuals were prior to spill at the Main Channel Dam and in 2023 fish detections of one individual coincided with peak spill at the Main Channel Dam (~25,000 – 30,000 cfs). In 2022, one fish spent about 3 weeks in the Dry Channel Dam area in March and April before moving upstream and entering the fish passage facility in early May. The second fish (in 2022) was detected upstream in the MDR zone prior to a brief detection near the Dry Channel Dam at the end of March before leaving the ZOP in early May.

Figure 3-7 Monthly Manual Tracking of 18 Individual Rainbow Trout (March-July 2023). Number of Individual Fish Detected in the ZOP Each Month Provided.

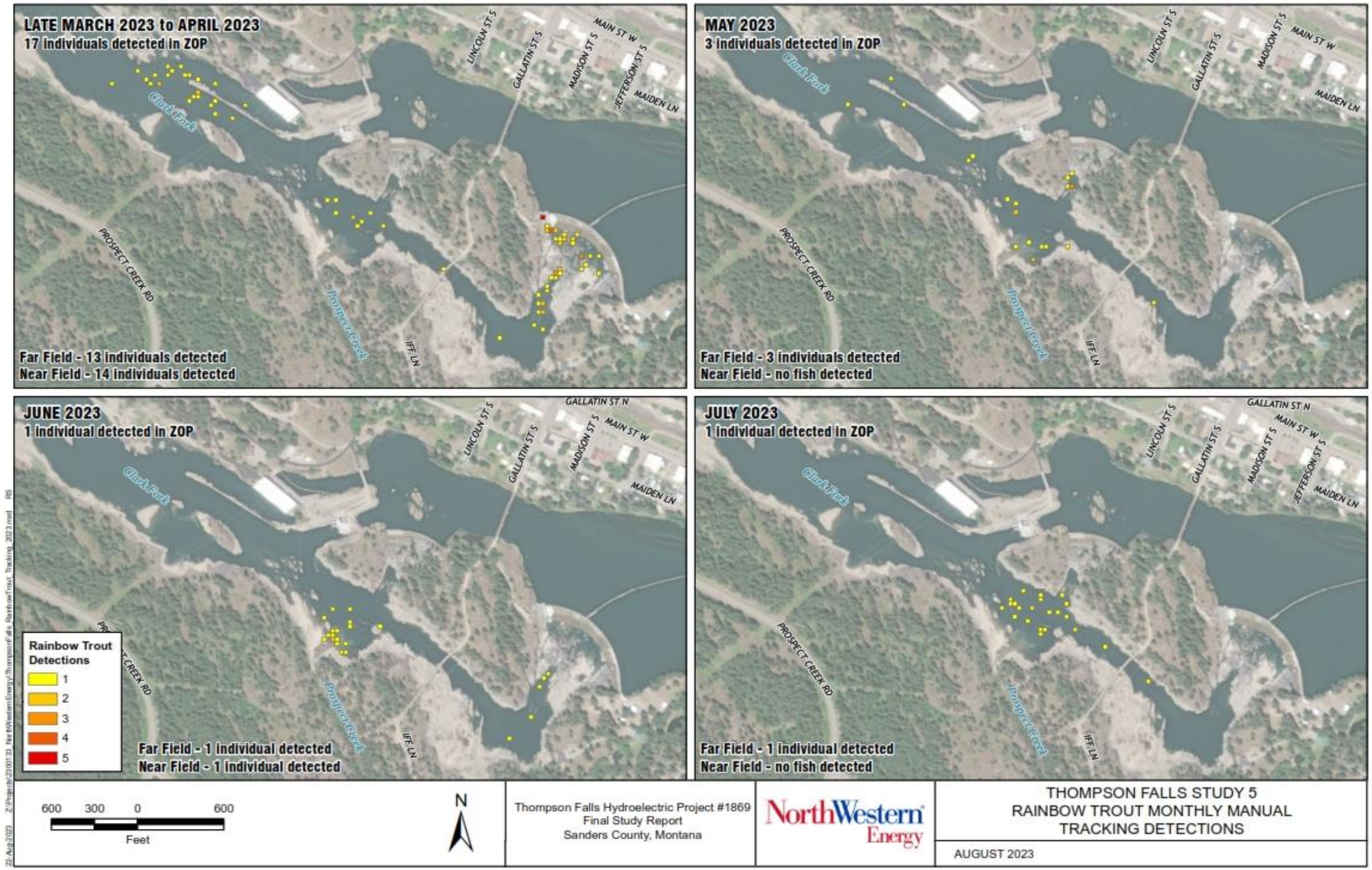
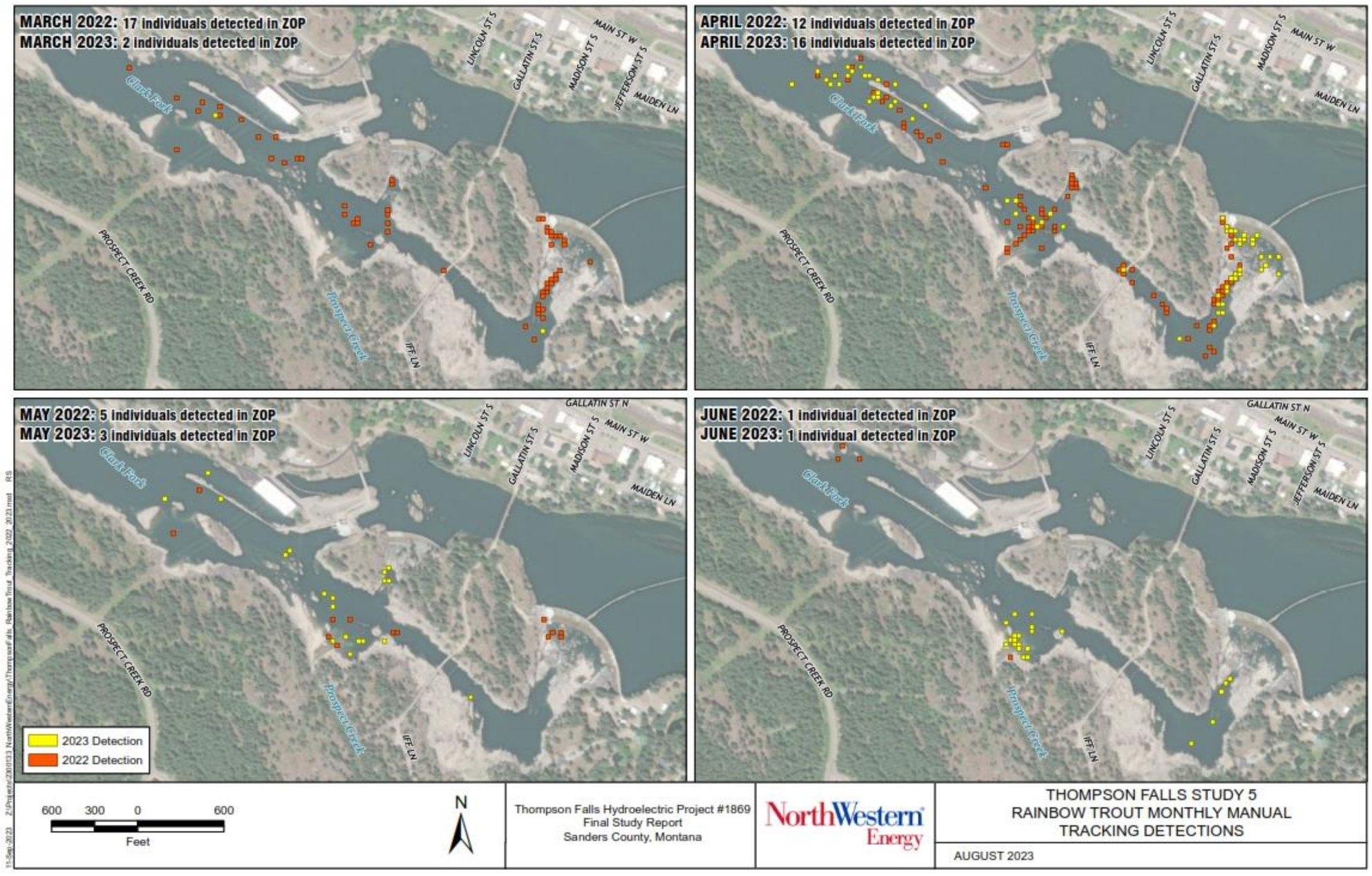


Figure 3-8 **Monthly Manual Tracking of 18 Individual Rainbow Trout (March-June 2022, 2023). No fish detect in ZOP in July 2022 Thus No Comparison is Provided. Number of Individual Fish Detected in the ZOP Each Month and Year Provided.**



In 2023, one individual fish was detected entering the near field during the spill period on May 12 (~25,000 cfs) before being manually detected downstream near the Dry Channel Dam between May 15 and May 19. This individual was detected across the main river channel around the outlet of Prospect Creek May 22 through June 21 before moving further upstream below the falls in late June when spill at the Main Channel Dam was declining from 1,300 to 300 cfs (June 22-23). In June, manual detection recorded one fish each study season. In June 2023, the Rainbow Trout observed near the Dry Channel Dam in mid-May approached the falls and remained in the confluence area of Prospect Creek before moving upstream to the area immediately downstream of the falls around June 22 and 23. Spill at the Main Channel Dam was around 11,600 cfs on June 1 and continued to decline daily to around 300 cfs on June 23 (and ended by June 24). In 2022 between June 2 and June 16, there was one individual Rainbow Trout detected in the far field after leaving the Prospect Creek drainage and observed near the Original Powerhouse before leaving the ZOP. During this period, spill at the Main Channel Dam quickly increased from 19,200 to over 61,000 cfs. Peak flow in 2022 was recorded on June 13.

In July, one individual Rainbow Trout was detected in the ZOP in 2023 and none were detected in the ZOP in 2022. The individual detected in July 2023 was the same individual fish detected in June. This Rainbow Trout remained in the ZOP through the study season (July 31) with 25 daily detections between the Prospect Creek and Dry Channel Dam outlets and mostly downstream of the High Bridge (*refer to* **Figure 3-7**).

Movement patterns in 2022 and 2023 showed Rainbow Trout either entered and ascended the fish passage facility during the spring, with a notable decline in detections in May and June. This decline continued through the remainder of the study season (*refer to* **Figure 3-8**).

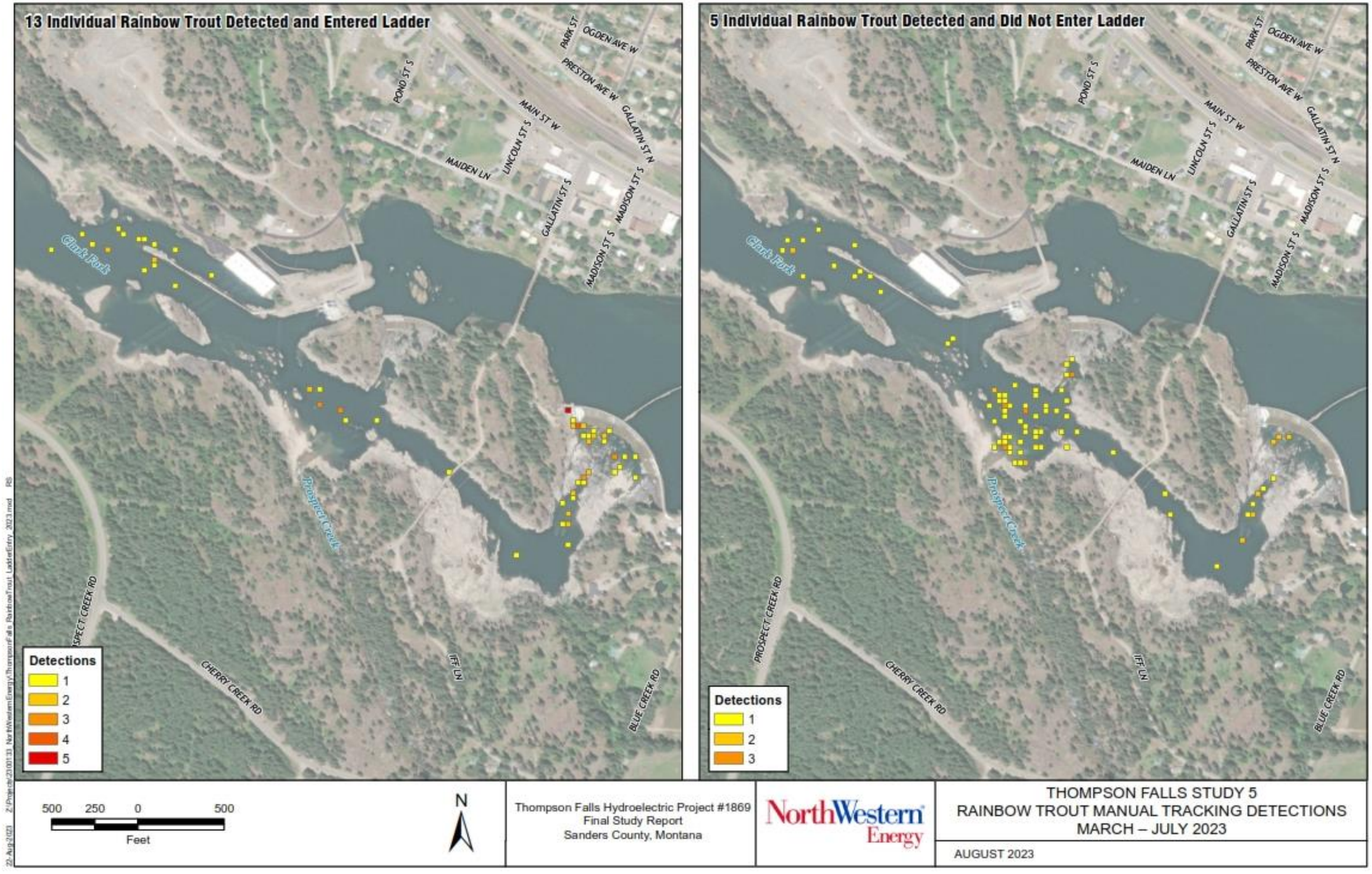
The 2022 and 2023 manual tracking illustrates Rainbow Trout explored and were recorded at similar locations within the ZOP regardless of whether the fish entered the fish passage facility (NorthWestern 2023c, **Figure 3-9**). In both years, the Rainbow Trout that entered the fish passage facility, were recorded more frequently at the falls and immediately outside of the fish passage facility entrance (MDR zone). Additionally, in 2023, there were more fish detections (manually and by fixed station receivers) from the MDL zone than in 2022. In 2023, the manual detections in the MDL zone represented three individual fish detected in the MDL zone prior to entering and ascending the fish passage facility in late April. In contrast, the Rainbow Trout that did not enter the passage facility in both years appeared to remain further downstream and more oriented immediately below the High Bridge and near Prospect Creek outlet (NorthWestern 2023c, Figure 3-9).

Of the 59 radio-tagged Rainbow Trout (2022 and 2023 combined), 8.5 percent (5 individuals) were detected upstream in Prospect Creek *via* the remote PIT tag array. In 2023, one Rainbow Trout was detected in Prospect Creek from April 4 through May 19 and appeared to leave the ZOP after May 20 based on fixed station receiver data. In 2022, four Rainbow Trout were detected in Prospect Creek from March 24 through May 4. None of the five Rainbow Trout that entered Prospect Creek were detected in the near field upstream of the falls. Manual detections accounted

for nearly 73 percent (40 individuals) of the 55 radio-tagged Rainbow Trout detected entering the ZOP by fixed station receivers.

In summary, Rainbow Trout were observed utilizing many locations in the ZOP. Detection data collected by fixed receivers and manual tracking indicate Rainbow Trout moved immediately upstream into the ZOP after release at Flatiron FAS and continued to the near field *via* the falls, concentrating below the Main Channel Dam and near the fish passage facility entrance during March and April. In 2022, there were few detections in the MDL zone. In 2023, there were more fixed station and manual detections in the MDL zone. Rainbow Trout presence in the ZOP during the 2022 and 2023 study appeared to be concentrated to the spring months. Neither the manual tracking nor the fixed receivers detected significant Rainbow Trout presence in the ZOP during peak spring flows or summer in 2022 or 2023 and fall of 2022.

Figure 3-9. Manual Tracking of 13 Individual Rainbow Trout that Entered the Fish Passage Facility (left) and 5 Individual Rainbow Trout that Did Not Enter the Fish Passage Facility (right) (March-July 2023)



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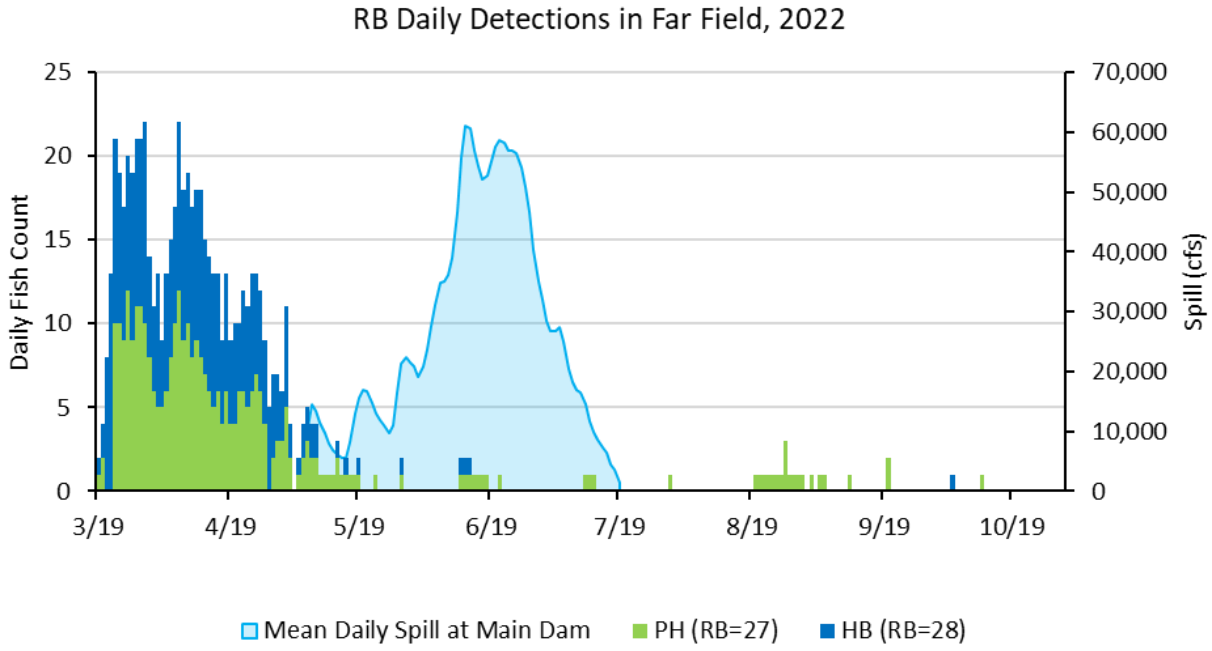
3.5.1 *Movement Patterns in the Far Field*

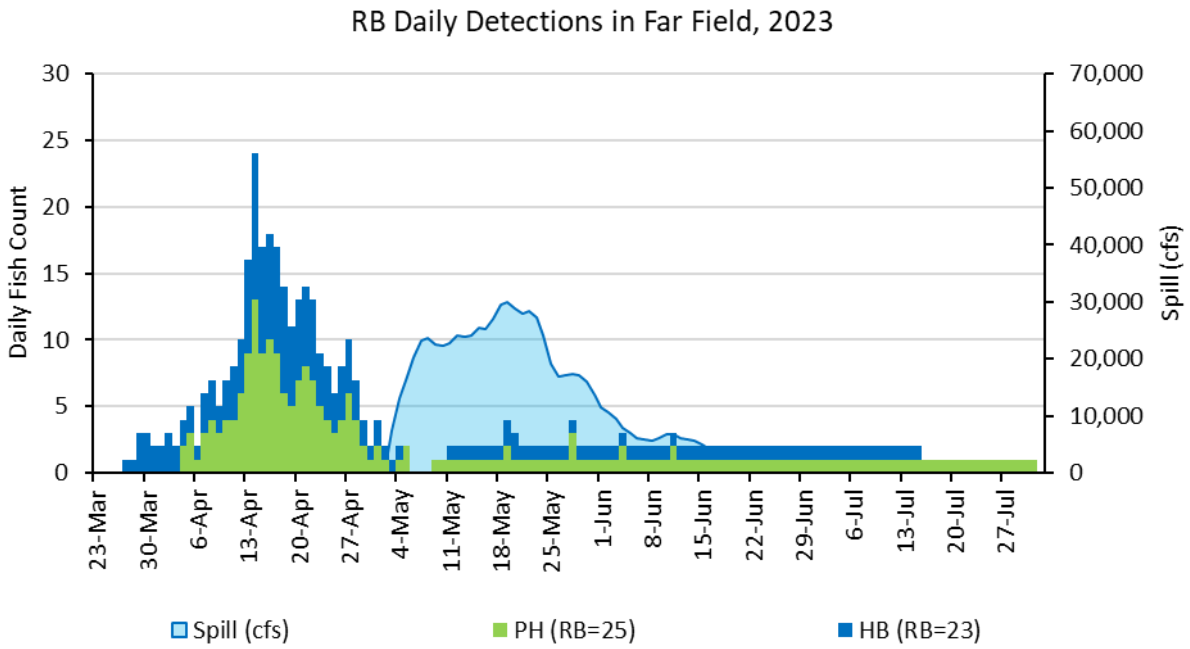
Daily detections of Rainbow Trout in the far field (*via* Powerhouse and High Bridge fixed station receivers) corresponding to the mean daily spill at the Main Channel Dam, May 6 through July 19, 2022, are illustrated in **Figure 3-10** and May 2 through June 23, 2023, are illustrated in **Figure 3-11**. Spill occurs at the Main Channel Dam when streamflow is 23,000 cfs or greater.

Figure 3-10. Summary of Daily Detections from the Powerhouse and High Bridge Fixed Receiver Stations of Rainbow in the Far Field and Mean Daily Spill at the Main Channel Dam (May 6 – July 19, 2022)



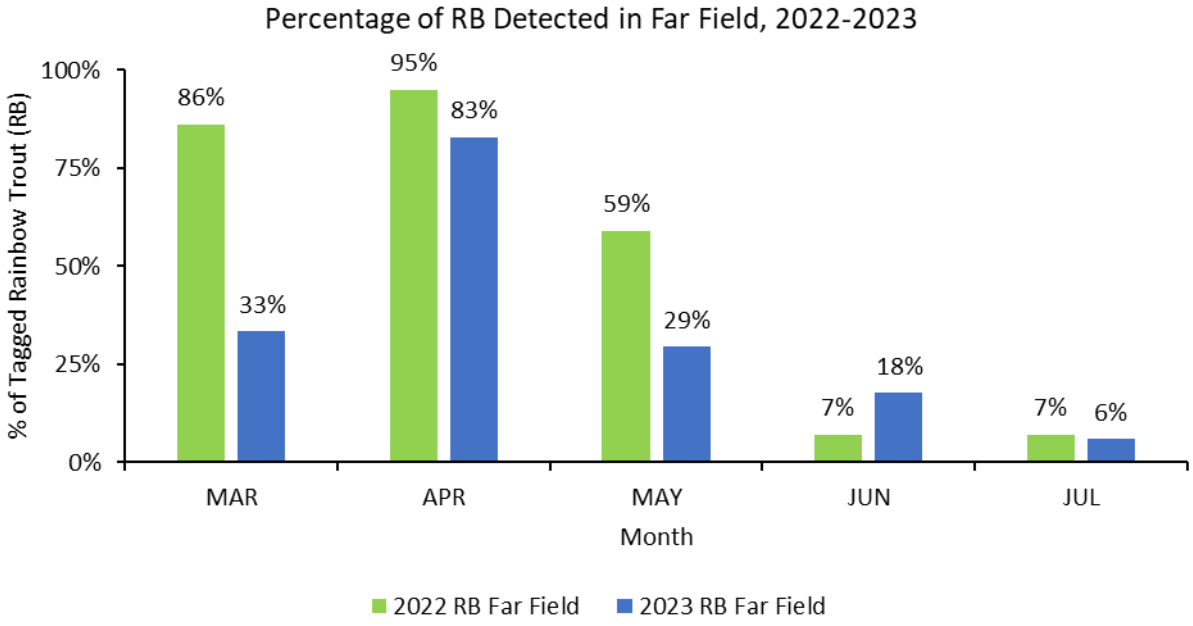
Notes: cfs = cubic feet per second; HB = High Bridge; PH = Powerhouse; RB = Rainbow Trout

Figure 3-11. Summary of Daily Detections from the Powerhouse and High Bridge Fixed Receiver Stations of Rainbow in the Far Field and Mean Daily Spill at the Main Channel Dam (May 2 – June 23, 2023)



Rainbow Trout detections in the far field were largely limited to the initial months following release at Flatiron FAS, March through early May (**Figure 3-12**). The number of Rainbow Trout in the far field declined substantially in May and the following months during both study seasons, 2022 and 2023. This was likely due to tagged fish entering the fish passage facility and thus leaving the study, and also tagged fish leaving the ZOP during high flow. In 2023, the fixed and manual tracking data indicate Rainbow Trout leaving the ZOP in April and May. Only one fish was detected in the ZOP in June and July 2023. In 2022, Rainbow Trout were present at low numbers (1-3 individuals) in the far field (primarily the Powerhouse area) between June and October. In 2022, between June and October, approximately 7 to 20 percent of the 16 Rainbow Trout present below the dam were detected in the far field with the lowest detections in June and July (**Figure 3-12).** In 2023, between June and July, approximately 6 to 18 percent of the 17 Rainbow Trout present below the dam were detected in the far field (Figure 3-12**).**

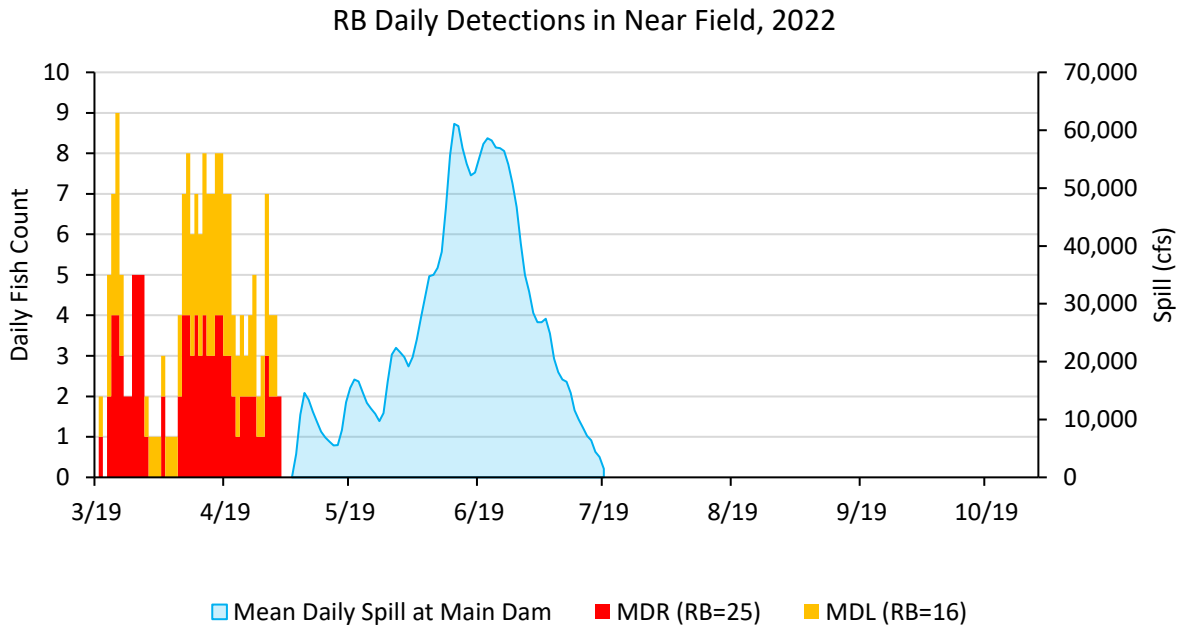
Figure 3-12. The Percentage of Rainbow Trout Detected in the Far Field by Month (March-July 2022-2023)



3.5.2 *Movement Patterns in the Near Field*

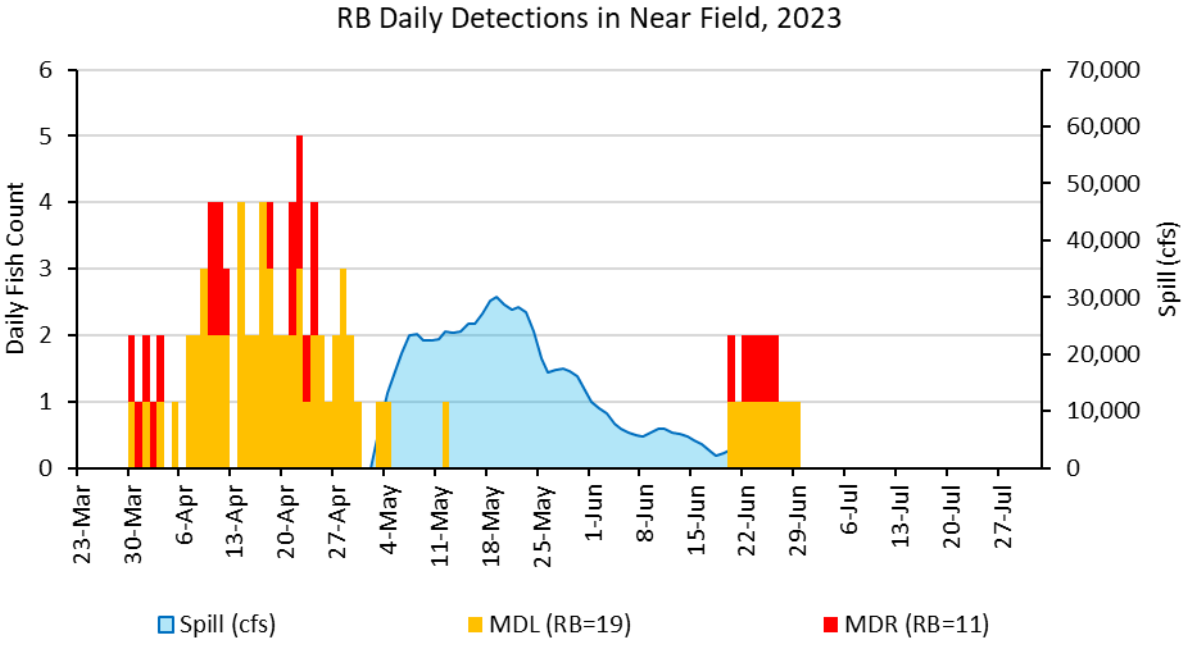
Daily detections of Rainbow Trout in the near field (*via* MDR and MDL fixed station receivers) corresponding to the mean daily spill at the Main Channel Dam, May 6 through July 19, 2022, and May 2 through June 23, 2023, are illustrated in **Figures 3-13 and 3-14,** respectively. The majority of near field activity and detections occurred pre-spill by Rainbow Trout in both years. Tagging in 2021 occurred during spill (June), thus there is no data from the first study season for comparison.

Figure 3-13. Summary of Daily Detections from the MDR and MDL Fixed Receiver Stations of Rainbow Trout in the Near Field and Mean Daily Spill at the Main Channel Dam (May 6 – July 19, 2022)



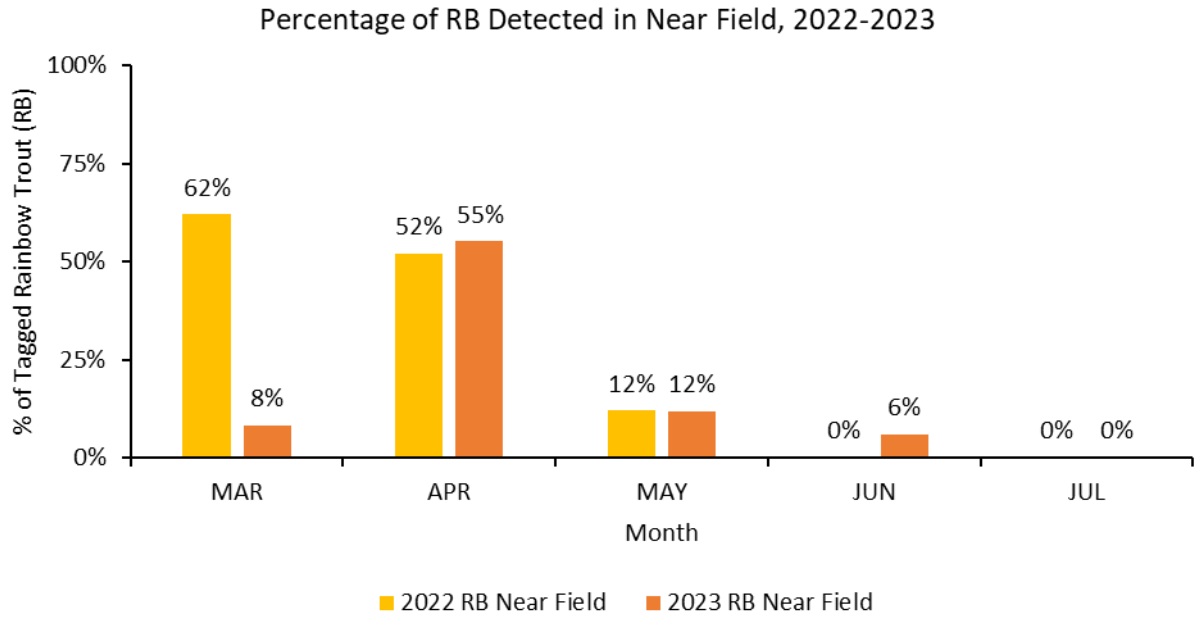
Notes: cfs = cubic feet per second; MDL = Main Channel Dam Left; MDR = Main Channel Dam Right; RB = Rainbow Trout

Figure 3-14. Summary of Daily Detections from the MDR and MDL Fixed Receiver Stations of Rainbow Trout in the Near Field and Mean Daily Spill at the Main Channel Dam (May 2 – June 23, 2023)



Results from both study seasons (2022 and 2023) show radio-tagged Rainbow Trout were primarily present in the near field in the spring months, March and April, and May, prior to spill (**Figure 3-15**). This early spring movement pattern observed by Rainbow Trout in 2022 and 2023 was not observed in 2021 because fish were not collected or tagged until early June, concurrent with spill at the Main Channel Dam. By summer (and through the fall 2022), no Rainbow Trout was detected in the near field.

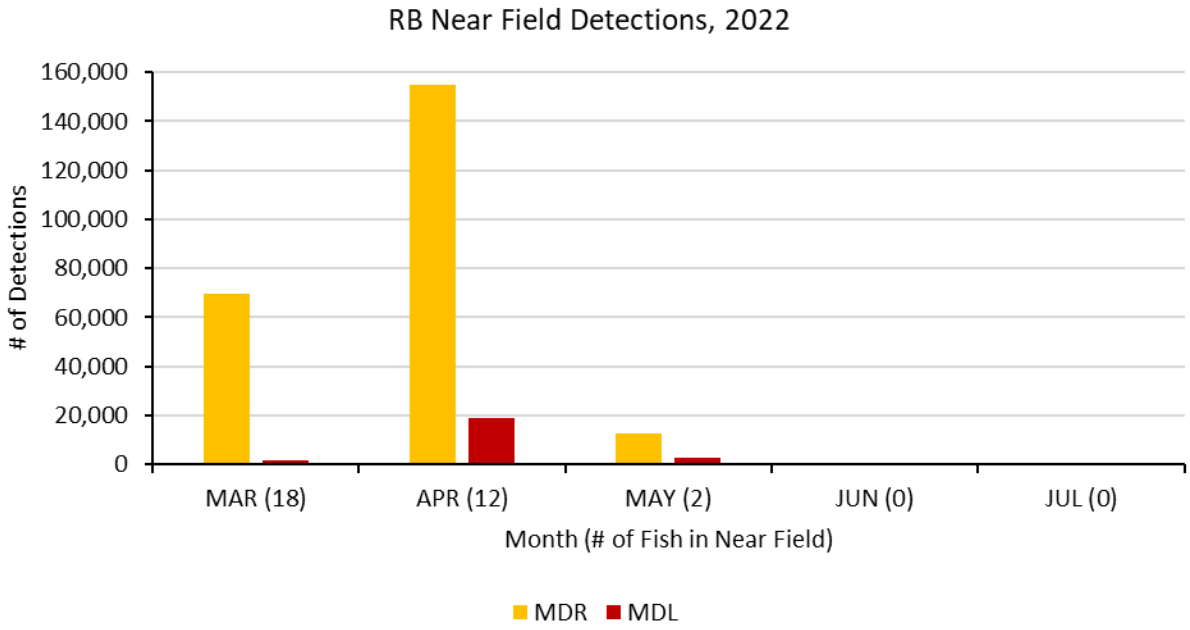
Figure 3-15. Percentage of Rainbow Trout Detected in the Near Field by Month (March-July 2022-2023)



Notes: MDL = Main Channel Dam Left; MDR = Main Channel Dam Right; RB = Rainbow Trout

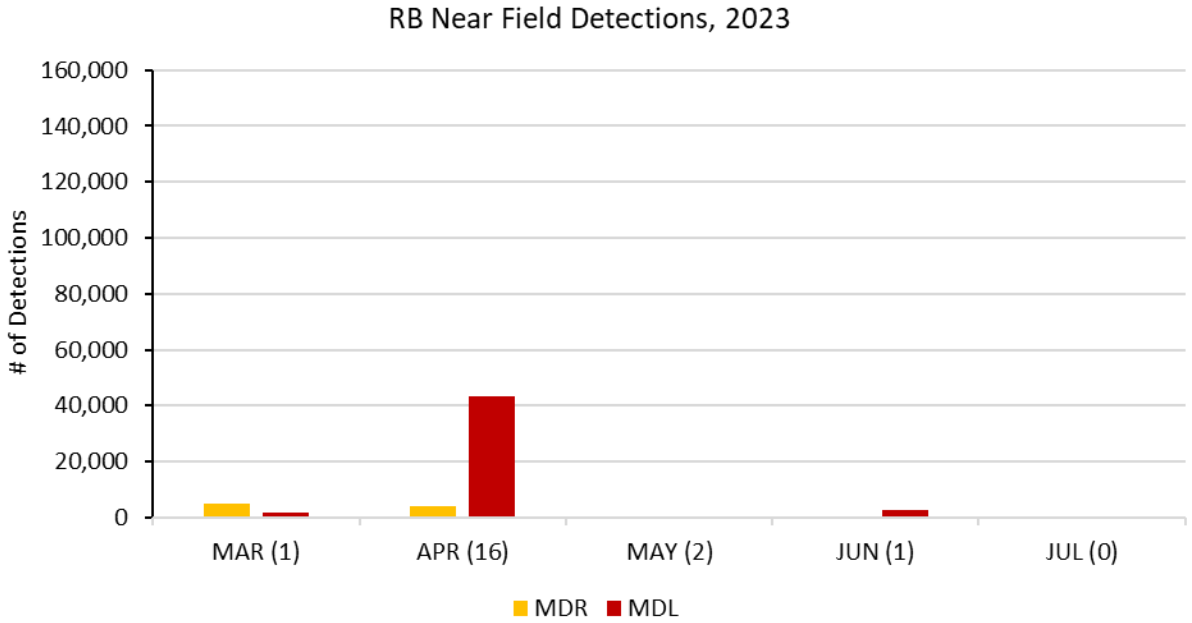
In 2022, the number of Rainbow Trout detected in the near field ranged from 0 to 18 fish per month, representing a total of 25 individuals. Rainbow Trout spent more time within the MDR zone than the MDL zone, as evidenced by a greater number of detections and numbers of fish (**Figure 3-16**). Rainbow Trout moved quickly after release upstream to the near field and -concentrated within the MDR zone near the fish passage facility with minimal detections in the MDL zone. Movement patterns/detections within the near zone (MDR and MDL) for Rainbow Trout appeared to vary between the 2 study years, 2022 and 2023. The overall number of detections in 2023 in the near field was substantially lower (54,491 detections) than in 2022 (606,687 detections) and with a greater proportion of detections by the MDL receiver as illustrated in **Figures 3-16** and **3-17**, respectively.

Figure 3-16. The Number of MDR and MDL Receiver Detections of Rainbow Trout by Month, 2022



During the 2023 study season, fixed station receivers in the near field detected 0 to 16 individual fish per month, representing 19 individual Rainbow Trout (**Figure 3-17**). Approximately 82 percent of all near field fixed station detections occurred in April, which coincided with 12 individual fish entering and ascending the fish passage facility. In 2023, the majority (84%) of Rainbow Trout near field detections were by the MDL receiver in contrast to the majority (91%) of Rainbow Trout near field fish detections in 2022 by the MDR receiver. Three of the fish that entered and ascended the fish passage facility were never detected by the MDR fixed station, and a fourth Rainbow Trout that entered the near field was only detected manually in the MDR area.

Figure 3-17. The Number of MDR and MDL Receiver Detections of Rainbow Trout by Month, 2023

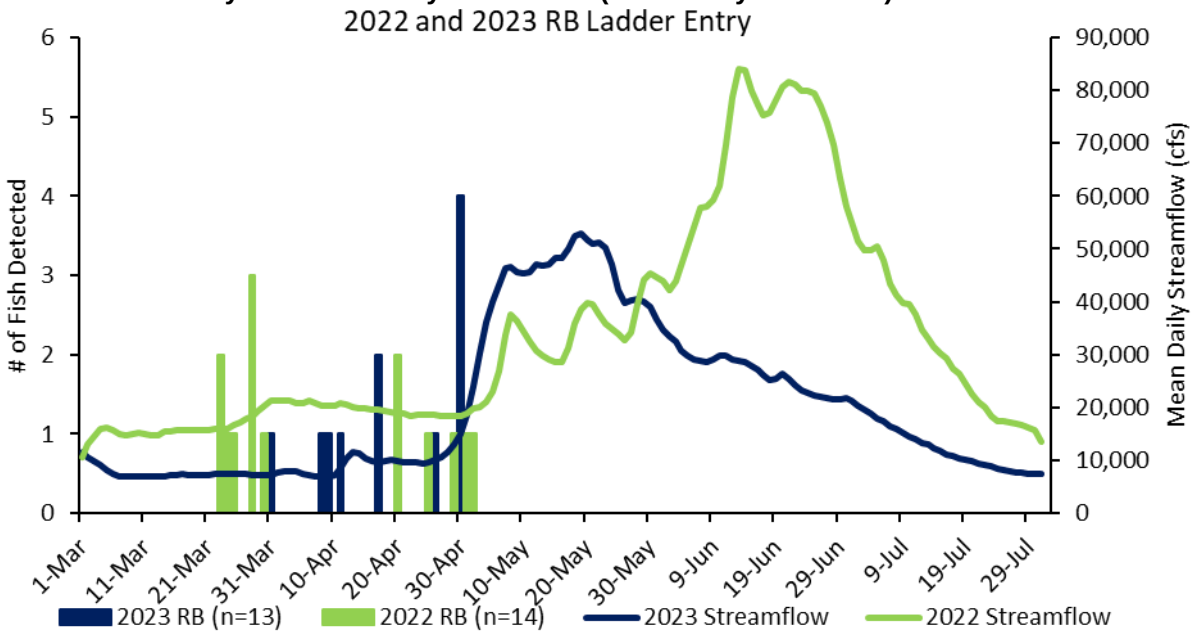


Notes: cfs = cubic feet per second; MDL = Main Channel Dam Left; MDR = Main Channel Dam Right; RB = Rainbow Trout

3.5.3 *Fish Passage Facility Entrances*

In 2022 and 2023, approximately half of radio-tagged Rainbow Trout detected in the ZOP each year (14 of 29 in 2022; 13 of 26 in 2023) entered the fish passage facility in the spring, prior to high flow (**Figure 3-18**). Rainbow Trout were not detected in the fish passage facility entrance during peak flows or post-peak flows. However, Rainbow Trout not associated with the telemetry study, continued to ascend the ladder in June (3 in 2022; 57 in 2023) and July (63 in 2022; 68 in 2023).

Figure 3-18. Summary of Individual Radio Tagged Rainbow Trout Entering the Fish Passage Facility and Mean Daily Streamflow (March-July 2022-2023)



Notes: CFR = Clark Fork River; cfs = cubic feet per second; RB = Rainbow Trout.
Spill occurs when flows exceed 23,000 cfs

3.5.4 *Summary of Locations Where Fish Hold within the ZOP*

Rainbow Trout displayed distinct movement patterns. In the spring, prior to spill, Rainbow Trout moved quickly following release after Flatiron FAS upstream to the ZOP and into the near field. During the spring months, Rainbow Trout are very active in the ZOP and are not "holding" in any one place for a significant duration. Many Rainbow Trout that moved into the near field continued to the fish passage facility entrance. In 2023, a few Rainbow Trout moved into the MDL zone prior to proceeding to the fish passage facility compared to 2022 observations.

Rainbow Trout that moved upstream into the ZOP and did not enter the near field appeared to prefer to remain between the outlet of Prospect Creek and the Dry Channel Dam (and downstream of the High Bridge). Most Rainbow Trout also appeared to leave the ZOP during high flow and re-enter the ZOP in the fall (observed in 2022 only).

During the spill period in 2022, May 6 through July 19, seven individuals were detected *via* the far field fixed station receivers. Three of these fish were also detected manually (#35, #43, and #80 in **Figure 3-19**). In 2022, two of the three fish detected manually were leaving Prospect Creek and moving downstream and out of the ZOP during spill.

The dates of detection, corresponding fixed station receiver(s), and approximate spill at the Main Channel Dam are provided in **Table 3-10**. Fish were detected in the far field during peak spill (~61,100 cfs). No fish were observed in the near field during the spill period. A summary of fixed station detections at each station for spill in 2022 is provided in **Table 3-11**.

Table 3-10. Summary of the Fixed Station Detections of Radio-Tagged Rainbow Trout in the ZOP during Spill (May 6 – July 19, 2022)

Radio Tag #	2022 Fixed Station Detections During Spill at Main Channel Dam		
	Date Detected	Location	Approximate Spill at Main Channel Dam (cfs)
33	May 7 and 23	PH	10,800 and 12,900
34	May 14	PH	6,200
35	May 6-9	PH, HB	4,000 – 14,600
40	May 29	PH, HB	21,200
43	May 6-9 May 10-18	PH, HB PH	4,000 – 14,600 5,500 – 13,000
78	May 19	PH, HB	15,500
80	June 12-14 June 15-18, 21 July 11-13	PH, HB PH PH	55,700-61,100 52,200-56,900 and 58,600 14,600-10,000

Notes: HB = High Bridge; PH = Powerhouse

Table 3-11. Summary of the fixed station detections of radio-tagged Rainbow Trout in the ZOP during spill (May 6 – July 19, 2022)

Radio Tag #	2022 Fixed Station Detections During Spill at Main Channel Dam			
	Powerhouse	High Bridge	Main Channel Dam Left	Main Channel Dam Right
33	7	-	-	-
34	3	-	-	-
35	19,362	21,076	-	-
40	1,189	3,196	-	-
43	34,003	42,821	-	-
78	200	285	-	-
80	23,935	3,529	-	-
Total	**78,699**	**70,907**	**-**	**-**

During spill at the Main Channel Dam in 2023, May 2 through June 23, five individual Rainbow Trout were detected *via* the fixed station receivers in the ZOP. Two of these fish were also detected manually (#123 and #119 in **Figure 3-19**). The dates of detection, corresponding fixed station receiver(s), and approximate spill at the Main Channel Dam are provided in **Table 3-12.** Fish were detected in the far field during peak spill (~30,000 cfs) and in the near field at an estimated maximum spill of 22,700 cfs. A summary of fixed station detections at each station for spill in 2023 is provided in **Table 3-13**.

Table 3-12. Summary of the Fixed Station Detections of Radio-Tagged Rainbow Trout in the ZOP during Spill (May 2 – June 23, 2023)

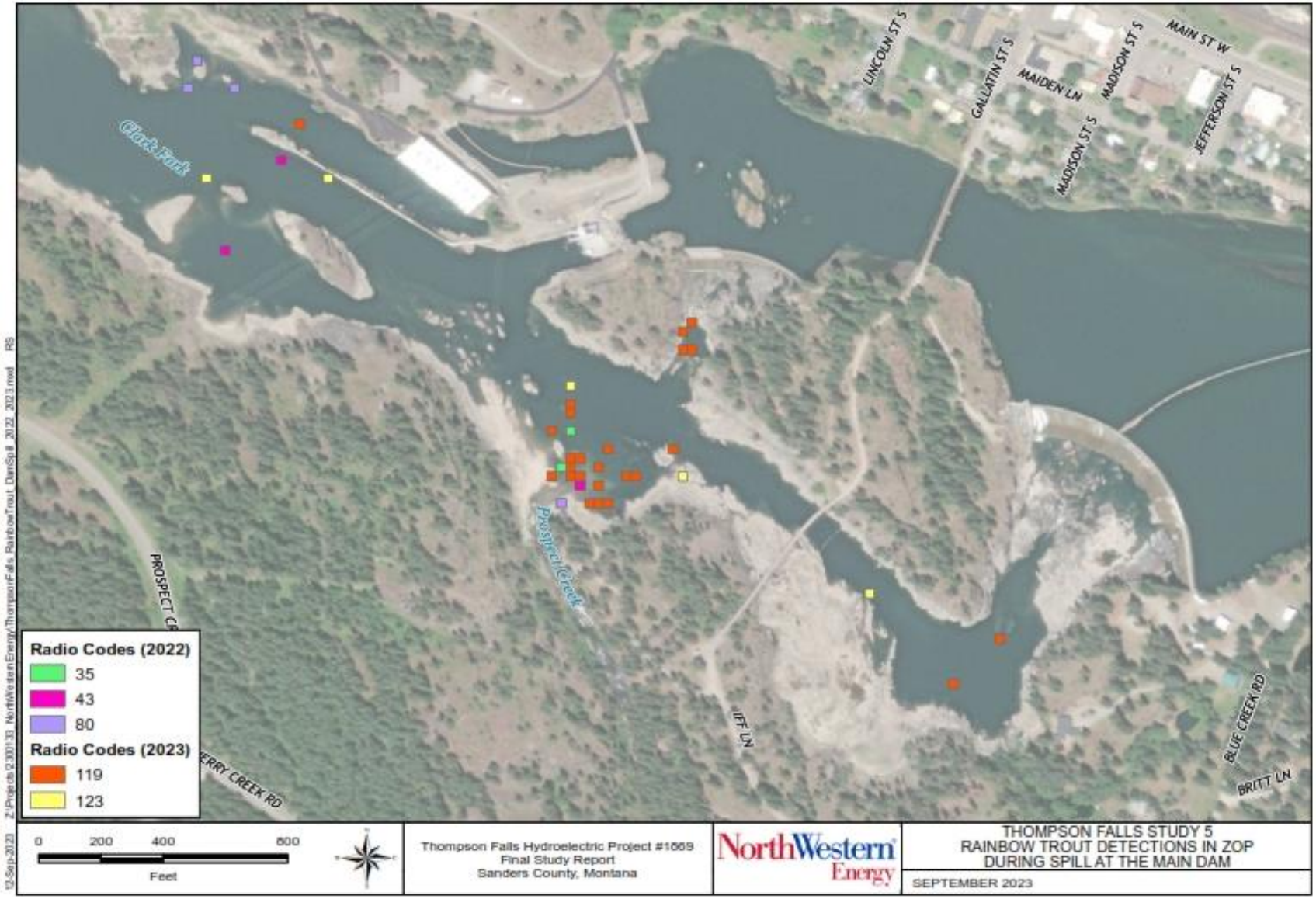
Radio Tag #	2023 Fixed Station Detections During Spill at Main Channel Dam		
	Dates Detected	Location Detected	Approximate Spill at Main Channel Dam (cfs)
117	May 28 June 11	PH PH	17,400 6,800
118	May 19 May 20	PH, HB PH, HB	30,000 28,800
119	May 9 – June 22 May 11 June 20-23	PH, HB MDL MDL & MDR	300-30,000 cfs 22,700 300-3,300
122	June 4	PH	7,800
123	May 2-4 May 3-4	PH, HB MDL	1,000-13,100 7,400-13,100

Notes: HB = High Bridge; PH = Powerhouse; MDL = Main Channel Dam Left; MDR = Main Channel Dam Right

Table 3-13. Summary of the Fixed Station Detections of Radio-Tagged Rainbow Trout in the ZOP during Spill (May 2 – June 23, 2023)

Radio Tag #	2023 Fixed Station Detections During Spill at Main Channel Dam			
	Powerhouse	High Bridge	Main Channel Dam Left	Main Channel Dam Right
117	28	-	-	-
118	2,162	155	-	-
119	117,943	112,390	2,061	403
122	3	-	-	-
123	15,598	4,682	202	-
Total	**135,734**	**117,227**	**2,263**	**403**

Figure 3-19. Manual Tracking of 3 Radio-Tagged Rainbow Trout in 2022 and 2 Radio-Tagged Rainbow Trout in 2023 during Respective Period of Spill (May 6 – July 19, 2022; May 2 – June 23, 2023) at the Main Channel Dam



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In 2023, there were no detections (fixed or manual) of Rainbow Trout in the immediate vicinity of the outlet for the New Powerhouse. There were some detections of Rainbow Trout observed in the outlet of the Original Powerhouse, and several of these fish continued further upstream to the fish passage facility. Fish manually tracked entering the ZOP near the Original Powerhouse were located between the wingwall and the islands (in the main channel) and sometimes along the inside of the wingwall. Rainbow Trout did not appear to "hold" around the High Bridge area or the large meander in the channel between the High Bridge and the falls. Most Rainbow Trout were detected entering the ZOP by the Original Powerhouse, holding position around the outlet of Prospect Creek, immediately downstream of the falls, or immediately upstream of the falls below the Main Channel Dam and concentrated on the right side near the fish passage facility.

The manual data compliment the fixed station data and show fish movement and presence in the near field is minimal during spill and fish tend to congregate near the outlet of Prospect Creek or the Dry Channel, or further downstream in the Original Powerhouse detection zone near the wingwall as they move out of the ZOP. Fixed Station detections in the near field in 2023 occurred on May 2 through 4 when spill at the Main Channel Dam climbed from about 1,000 to 13,100 cfs; May 12 when spill was approximately 24,000 cfs, and June 20 when spill had declined to around 3,300 cfs. In 2022, no Rainbow Trout were detected in the near field during spill.

The manual tracking data from 2022 and 2023 indicated most fish move up the main section of the channel and were not concentrated along the tailrace areas near the Original Powerhouse and New Powerhouse (*refer to* Figure 3-4, NorthWestern 2023c). Some fish were detected in these locations, but dispersed and infrequent in occurrence. The two areas where Rainbow Trout appear to congregate the most (2022-2023 seasons) were near the mouth of Prospect Creek and along the right side of the Main Channel Dam, near the upstream fish passage facility.

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4. Discussion

4.1 Effectiveness of Study Methodology

As described in **Section 1 – Introduction**, NorthWestern, in collaboration with the TAC, established a Scientific Panel in 2020 to evaluate the Project's fish passage facility. The Scientific Panel was convened *per* TC 1-h of the 2008 BO (FWS 2008) and the FERC License amendment approving construction of the fish passage facility (FERC 2009). The Scientific Panel identified a large volume of qualitative data gathered from the fish passage facility but noted a data gap when quantitatively evaluating the proportion of "motivated" fish entering the ZOP and finding the fish passage facility entrance. This Fish Behavior Study, and the Hydraulic Condition Study, were initiated by NorthWestern in response to recommendations from the Scientific Panel. Specifically, the Scientific Panel (2020) suggested NorthWestern,

> …initiate two parallel studies to assist in the determination of the fish passage facility's attraction and entrance efficiency:
>
> - 2D [two-dimensional] CFD study that incorporates measured or approximated bathymetry to resolve, at a minimum, a depth-averaged velocity field and water depths in the near field downstream of the dam/project.
> - telemetry (radio-tag) study using sufficient sample sizes of surrogates to posit movement paths/rates and behavior in response to hydraulic conditions in the near field; the telemetry should be augmented by a literature review of the relative swimming capacities and behaviors of Rainbow, Westslope Cutthroat (*Oncorhynchus clarki*), Brown and Bull trout.

The Scientific Panel (2020) recommended a minimum of 50 fish be used in the telemetry study, and potentially more if capture locations, species, fish lengths, time of year, etc. differ. NorthWestern has radio tagged and released 66 Rainbow and 34 Brown trout. Therefore, the sample size met the recommendations of the Scientific Panel (2020).

Over the 3 years of study, 95 percent of fish collected, tagged, and transported downstream for release at Flatiron FAS were later detected in the far field. This includes fish collected and tagged in March, June, September, and October; fish of both species; and fish collected by electrofishing and at the fish passage facility. These data indicate that handling or tagging mortality was low or none during the study. The data also support the assumption that tagged fish were motivated to move upstream. The study methodology was effective in generating information on fish movement in the study area.

Timing and location of fish collection for Rainbow Trout appeared to influence fish movement patterns. As noted in the ISR (NorthWestern 2022c), tagging happened late in June 2021, with quickly warming water temperatures (>16 °C), and after spring spawning migrations for Rainbow

Trout had occurred. Because of these conditions and the associated timing of radio tagging, Rainbow Trout movements in 2021 do not show the strong upstream motivation seen in subsequent study years. All the Rainbow Trout collected by electrofishing in 2021 were later detected in the far field and one was located in the near field. None were detected at the passage facility entrance in 2021, but one individual tagged in 2021 was recorded ascending the fish passage facility in late March 2023.

During 2022, 27 Rainbow Trout were collected at the fish passage facility vs. two collected electrofishing, making a comparison of fish movements between fish collected using the two different methods challenging. In 2023, there was a more equal distribution of fish collection for analysis, 19 Rainbow Trout collected at the fish passage facility and 11 fish *via* electrofishing the Clark Fork River upstream of Thompson Falls Dam. For Rainbow Trout collected upstream of the Project in the Clark Fork River in 2023, 73 percent were detected in the far field, 27 percent were detected in the near field, and 18 percent were detected entering the fish passage facility. Nearly 95 percent of the Rainbow Trout collected at the fish passage facility were detected in the far field, 79 percent were detected in the near field, and 73 percent were detected entering the fish passage facility. Based on 2023 collection data, the detection of fish entering the ZOP and entering the fish passage facility is almost three times greater for fish collected at the fish passage facility compared to upstream.

- There are a variety of potential explanations for this variance in movement upstream, including but not limited to: Rainbow Trout collected in the mainstem Clark Fork River upstream of Thompson Falls Dam have already spawned and are leaving the tributaries, fish with a history of ascending the fish passage facility have an advantage for repeating the journey and navigating more easily upstream, some fish may not be spawning annually and thus have reduced motivation to move upstream after release, or added stress of electrofishing capture is influencing behavior.
- As described in the USR (NorthWestern 2023c), Brown Trout did not demonstrate the same variation in behavior depending on capture location as Rainbow Trout. In general, capture location appeared to have little impact on detections in the far and near field areas for Brown Trout. Nearly identical proportions of Brown Trout were detected at the facility entrance and ascended the facility when comparing capture locations (NorthWestern 2023e).

4.2 Fish Passage Conditions at Varying Flows

The telemetry data, and the CFD modeling data, provide insight into fish passage conditions at flows at or exceeding the high design flow for the fish passage facility. The data from 2022 and 2023 indicate that, during spill at the Main Channel Dam, the detection of fish in the ZOP was limited to a few individuals. Rainbow Trout were very active in the ZOP from March through early May, prior to the start of high flow. Fixed station receivers, both in the far and near field areas included approximately 3 million detections (post-processing) as Rainbow Trout moved upstream into the ZOP and between sites. Of the 59-tagged Rainbow Trout in 2022 and 2023, 75 percent of

the Rainbow Trout (44 fish) moved upstream into the near field in the spring and 61 percent of the fish entering the near field entered the upstream fish passage facility. Detections of Rainbow Trout in the near field following spill was limited to one individual in June 2023 (out of the 2022 and 2023 study seasons). Upstream migration and movement to the Main Channel Dam by Rainbow Trout was essentially absent once spill started at the Main Channel Dam. These general trends were observed in a telemetry study conducted in the study area from 2004 to 2006 (Gillin and Haddix 2005, Haddix and Gillin 2006, GEI Consultants, Inc. 2007). The study included radio tagged Rainbow, Brown, Westslope Cutthroat, and Bull trout. The study found that the greatest amount of fish movement in the study area was recorded prior to the peak of spring runoff (Gillin and Haddix 2005, Haddix and Gillin 2006, GEI Consultants, Inc. 2007).

The 2004 to 2006 telemetry study (Gillin and Haddix 2005, Haddix and Gillin 2006, GEI Consultants, Inc. 2007) found that Rainbow Trout were the first to enter the study area, followed by Westslope Cutthroat and Brown trout, and then Bull Trout. In 2006, the peak detection of Rainbow Trout occurred between March 26 and April 23. Bull Trout were not detected in the study area in March. They made forays to the Main Channel Dam in April and May. By June, they were primarily detected by the antenna pointing upstream of the mouth of Prospect Creek. Similarly, Westslope Cutthroat Trout were rare in the study area in March and made forays to the Main Channel Dam in April and May. However, Westslope Cutthroat were rarely detected in the study area after May. Brown Trout were detected in the study area from late March through June. There appeared to be two peaks of Brown Trout activity, one in early April and again in mid-May (GEI Consultants, Inc. 2007).

The 2007 telemetry report noted that fish presence in the study area during peak flow season was detected by the fixed receiver with antennas pointed to areas in the far field, such as the mouth of Prospect Creek. The report noted that, “There are relatively quiescent areas in this portion of the river that would be suitable holding habitat for trout during runoff. It is likely that many fish left the main channel area during spill to avoid turbulent and high velocity conditions” (GEI Consultants, Inc. 2007). The results from the previous telemetry study are additional confirmation of the results from the current study.

As records and data collected from fish ascending the fish passage facility, manual fish tracking, and 3D model results support, velocities in much of the river often exceed swimming ability for most fish during spring flows and likely limit access upstream for fish in the ZOP and to the near field (NorthWestern 2023b, 2023c). The CFD model confirms that there is limited available area with suitable velocities at higher spill quantities for fish to navigate through the High Bridge and falls locations.

While the past and more recent telemetry data indicate that many fish leave the study area during high flow, a few fish remain and manage to find the fish passage facility. Fish are known to ascend the fish passage facility when spill is exceeding design capacity (>25,000 cfs spill). Records at the fish passage facility indicate 64 fish recorded at the fish passage facility at flows exceeding the design capacity from 2011 through 2023 (NorthWestern *in Progress*). The fish include

32 salmonids (21 Rainbow Trout, 5 Bull Trout, 3 Brown Trout, 3 Westslope Cutthroat Trout) and 31 non-salmonids (27 Largescale Sucker (*Catostomus macrocheilus*), four Northern Pikeminnow (*Ptychocheilus oregonensis)*, and one Smallmouth Bass (*Micropterus dolomieu*).

In general, non-salmonids recorded at the fish passage facility are primarily native Largescale Sucker, Northern Pikeminnow, and non-native Smallmouth Bass. Salmonids are primarily Rainbow and Brown trout. Over the last 10 years, about half of non-salmonids ascended the fish passage facility during low to moderate spill conditions (when spill is <15,000 cfs), and the majority of salmonids ascended after spill. Peak counts for Largescale Sucker and Northern Pikeminnow at the fish passage facility are in the spring when water temperatures are around 10 to 11°C, which also coincides with the ascending limb of the hydrograph and the start of spill at the Main Channel Dam. Smallmouth Bass counts peak in the latter part of July and August usually after spill has occurred and when water temperatures exceed 18°C.

Peak Rainbow Trout counts at the fish passage facility occurs prior to, and after spill. Peak Rainbow Trout counts at the ladder occur in, descending order July, April, September, August, and then March. Peak Brown Trout counts occur at the fish passage facility post spill in July and fall months. In contrast to Rainbow Trout, 78 percent of Bull Trout ascending the fish passage facility were documented between the onset of spill to approximately 33,000 cfs spill.

4.3 Velocity Barriers in the ZOP

During spill at the Main Channel Dam, the telemetry and CFD modeling results indicate velocity obstacles may exist in the ZOP, specifically at the falls where the channel is constricted by boulders and rock. The CFD model indicates the falls would be a particularly challenging area for slower swimming non-salmonids to navigate. Another area with high velocities, at and above 25,000 cfs, is immediately downstream of the High Bridge where the channel constricts again. Both constricted areas (at the falls and High Bridge) are natural features of the Clark Fork River. During spill, the area accessible for various fish species to move upstream declines and is limited to the margins of the wetted channel and near the bottom of the channel depending on the roughness and available topography.

The CFD modeling indicates velocities near the fish passage entrance are within fish swimming abilities at all flow scenarios. There are no apparent velocity barriers near the fish passage facility entrance that would discourage fish from finding or entering the fish passage facility (NorthWestern 2023b, 2023c).

When looking at flow path streamlines it appears that at modeled flows of 200 cfs there remains a distinguishable level of attraction flow near the fish passage facility entrance that flows downstream and through the falls. As flows increase to 2,000 cfs the flow path streamlines remain distinguishable near the fish passage facility entrance although as it reaches the falls area it begins mixing with the flow paths from spill at the radial gates. As total spill increases and reaches 25,000 and 37,000 cfs, flow path streamlines from the fish passage facility entrance area are not as distinct

and appear to be overwhelmed from flows at the radial gates and flow over the Main Channel Dam. These data may indicate that attraction flow may be insufficient at some flows to provide the velocity clues that upstream migrating fish require to readily find the fish passage facility entrance.

4.4 Fish Passage Efficiency

The results of the study indicate fish are motivated to move upstream and readily, unimpeded, and quickly access the ZOP following release. Rainbow Trout data represents three seasons (2021-2023), and Brown Trout data represents two seasons (2021-2022). Of the 66 radio tagged Rainbow Trout, 62 (92%) were later detected in the far field. Of the 34-radio tagged Brown Trout, 33 (97%) were later detected in the far field.

However, not all fish detected in the far field proceeded to the near field. Of the 95 fish that were detected in the far field, 73 percent of the radio-tagged Rainbow Trout (45 fish) and 52 percent of radio-tagged Brown Trout (17 fish) made a foray to the near field. The proportion of radio-tagged Rainbow Trout continuing to make the foray to the near field was greater in 2022 (86%) than in 2023 (73%) and in 2021 (14%). The time of fish collection may have been a factor in the proportion of fish that moved upstream into the near field. In contrast to 2021, when Rainbow Trout were tagged and transported in June and only one (of 7 fish) was detected in the near field, 75 percent of the 59 Rainbow Trout radio-tagged in March/April in 2022 and 2023 were detected in the near field.

Of the 45 Rainbow Trout that were detected in the near field in 2021, 2022 and 2023, 27 (60%) were detected in the fish passage facility entrance. Brown Trout results from 2021 and 2022 recorded 59 percent of the fish detected in the near field entering the fish passage facility. Annually, the percentage of Rainbow Trout detected in the near field continuing into the fish passage entrance was 0 percent in 2021, 56 percent in 2022, 68 percent in 2023. Annually, the percentage of Brown Trout detected in the near field continuing into the fish passage entrance was 75 percent in 2021 and 54 percent in 2022.

In total, over the 3-year study, 27 (41%) of the 66 radio tagged Rainbow Trout and 10 (29%) of 34 radio-tagged Brown Trout were detected at the fish passage facility entrance. Detections of Rainbow Trout at the fish passage facility entrance were similar in 2022 and 2023 (when fish collection occurred in March/April), 48 and 43 percent, respectively compared to 2021 when no Rainbow Trout entered the fish passage facility entrance. Detections of Brown Trout at the fish passage facility entrance were similar in 2021 and 2022, 33 and 28 percent, respectively.

4.5 Location of Fish Passage Facility

The efficacy of fish passage was noted during the development of study plans as a potential concern due to the location of the passage facility. The data collected during this study supports that the fish passage facility was correctly sited for the following reasons:

- Telemetry shows that fish enter the near field and preferentially select the right bank.
- The left side of the near field (MDL) is generally more turbulent and violent at various spill regimes at the Main Channel Dam. CFD modeling also shows the higher velocities along the left bank during spill are less accessible/suitable for several species based on their swimming abilities.
- The telemetry results indicate that a fish passage facility located at the powerhouses or Dry Channel Dam would be less effective than the current passage facility location.

4.6 Water Temperature Effects on Fish Migration

River temperature may be a contributing factor limiting salmonid movement during July and August when Clark Fork River temperatures peak. Summer water temperatures in the Lower Clark Fork River, both coming from upstream, and downstream of the Project, typically exceed optimal thermal conditions for trout (NorthWestern 2022d). During the hot summer season, few salmonids are generally recorded at the fish passage facility (NorthWestern 2016, 2017, 2018, 2019a, 2019b, 2020, 2021, 2022a, 2023a). Radio-tagged fish were not present in the near field, and relatively few were detected in the far field, during the period of high-water temperatures.

Temperature profiles taken in 2021 and 2022 indicate Prospect Creek provides a cooler water source and creates an area more tolerable for salmonids in the summer. Thermal stratification observed at the three sites near the High Bridge indicates thermal conditions are likely more preferrable for salmonids at the Prospect Hole compared to the High Bridge and Dollar Holes. This may explain observations of fish staying near the confluence of Prospect Creek during the summer and greater number of detections (*via* manual tracking) clustered in this region compared to other areas in the ZOP.

4.7 Summary of Study Results

The three study seasons (2021-2023) provided a representation of the variable physical habitat conditions fish experience in the Lower Clark Fork River. The study monitored fish movement during a year of above average streamflow and average streamflow, during the summer period when water temperatures were above average and remained elevated for long duration, as well as periods representing a more average water temperature. This variability is representative of conditions observed since the fish passage facility commenced operations in 2011.

CFD modeling and review of fish swimming abilities indicate velocity challenges near the High Bridge and through the falls during spill at the Main Channel Dam. Fish movement supported these findings and found few fish in the ZOP during periods of spill. Total fish captures at the upstream fish passage facility also decline during spill.

Fish behavior for both species was relatively similar from year to year. Fish collected for this study appeared most motivated by spawning. The telemetry study did not capture Rainbow or Brown trout movement observed at the ladder in July (descending limb of the hydrograph).

Fish showed the ability to move quickly after release upstream of the Flatiron FAS and enter the ZOP. Peak movement of Rainbow Trout occurred in the spring prior to spill. Peak movement of Brown Trout occurred in the fall (post-spill) and prior to the fish passage facility closing for the season. Both species observed in the ZOP prior to spill, appeared to leave the ZOP during spill. The CFD model also revealed the area around the fish passage facility entrance maintains suitable velocities for fish to swim during spill although there is no distinct attraction flow when spill reaches or exceeds 25,000 cfs.

Fish were not found at the outlets of the Original or New powerhouses and were most often detected moving up the middle of the main channel through the ZOP often utilizing the Prospect Creek outlet area for extended periods. Prospect Creek outlet area provides an important area for fish to hold, whether fish are moving upstream to the fish passage facility or holding during warmer periods of the summer. A small fraction of radio-tagged fish moved upstream into Prospect Creek. The fish utilizing Prospect Creek during the spawning season generally left the ZOP after leaving Prospect Creek and did not continue to move upstream.

The majority of radio tagged fish entering the far field continued to the near field (60% of Brown Trout and 73% of Rainbow Trout). Once in the near field, about half of the Brown Trout and 60 percent of the Rainbow Trout continued to the fish passage facility entrance. Telemetry data (fixed station and manual tracking) indicate fish were most often recorded in the MDR zone. Rainbow Trout presence and use of the MDL zone appeared to vary from 2022 to 2023. There were more fixed station detections in the MDL zone in 2023 compared to MDR. However, manual tracking continued to indicate fish were more frequently located near the fish passage entrance in the MDR zone in both years. In 2023, the MDR fixed station receiver did not detect some fish prior to entering the fish passage facility. The reason for inconsistent detections from the MDR fixed station receiver in 2023 is unclear. The manual tracking and fish passage facility entrance PIT detections indicate fish that enter the near field are able to navigate to the fish passage facility. It remains unclear as to why some fish move in proximity to the passage entrance but do not enter or why some fish that enter the facility do not continue to ascend to the top.

This FSR completes the study requirements for the fish telemetry studies, pursuant to the FERC approved Study Plan, from 2021, 2022, and 2023. NorthWestern successfully tagged collectively 100 Rainbow and Brown trout and monitored their movements through each season.

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5. Literature Cited

Federal Energy Regulatory Commission (FERC). 2009. Order Approving Construction and Operation of Fish Passage Facility. February 12, 2009. 126 FERC 62,105.

_____. 2021. *Study Plan Determination for the Thompson Falls (P-1869-060) Hydroelectric Project*. May 10, 2021. Accessed May 10, 2021. https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/ferc-study-plan-determination.pdf

_____. 2022. *Determination on Requests for Study Modifications for the Thompson Falls Hydroelectric Project*. September 1, 2022. Accessed September 1, 2022. https://elibrary.ferc.gov/eLibrary/filedownload?fileid=EFA12378-3CD8-C720-95C2-82FA17400000

_____. 2023. *Determination on Study Modification Requests*. August 24, 2023. Accessed August 24, 2023. https://elibrary.ferc.gov/eLibrary/filedownload?fileid=1E809CB2-36BF-C19E-94A2-8A27FB300000

GEI Consultants, Inc. 2007. *Results of 2006 Fish Telemetry Study Thompson Falls Dam*. Submitted to PPL Montana, Butte, Montana.

Gillin, G. and T. Haddix. 2005. *Thompson Falls Fish Passage Studies Annual Report for 2004, Thompson Falls, MT*. Prepared for PPL Montana by GEI Consultants, Inc.

Haddix, T. and G. Gillin. 2006. *Final Report: Fish Behavior in the Tailrace of Thompson Falls Dam, Results of 2005 Radio Telemetry*. Submitted to PPL Montana, Butte, Montana.

Mizell, M. and E. Anderson. 2015. *An investigation into the Migratory Behavior, Habitat Use and Genetic Composition of Fluvial and Resident Bull Trout (Salvelinus confluentus) in the Yakima River Basin.* Washington Department of Fish and Wildlife, Yakima, Washington. Submitted U.S. Fish and Wildlife Service, Lacey, WA. Cooperative Agreement 134102J017.

NorthWestern Energy (NorthWestern). 2016. *2015 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2017. *2016 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2018. 2017 *Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2019a. 2018 *Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2019b. *Thompson Falls Hydroelectric Project FERC Project No. 1869, Comprehensive Phase 2 Final Fish Passage Report*. Electronically filed with FERC on December 23, 2019.

_____. 2020. 2019 *Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2021. *2020 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C.

_____. 2022a. *2021 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*. https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson_falls_2020_annual_report_final_03232021.pdf

_____. 2022b. *Initial Study Report, Fish Behavior. Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C. https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/p1869-isr-fish-behavior-study-.pdf

_____. 2022c. *Initial Study Report, Hydraulic Conditions Study. Thompson Falls Hydroelectric Project, FERC Project Number 1869*. Submitted to FERC, Washington D.C. https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/p1869-isr-hydraulic-conditions-study.pdf

_____. 2022d. *Thompson Falls Project No. 1869, Water Quality Monitoring Report, 2019-2021*. Final Version – July 2022.

_____. 2023a. *2022 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869*.

_____. 2023b. *Final Study Report, Hydraulic Conditions Study*. Thompson Falls Hydroelectric Project, FERC Project Number 1869.

_____. 2023c. *Updated Study Report, Fish Behavior*. Thompson Falls Hydroelectric Project, FERC Project Number 1869. Submitted to FERC, Washington D.C.

_____. 2023d. Draft License Application. Thompson Falls Hydroelectric Project, FERC Project Number 1869. Submitted to FERC, Washington, D.C.

_____. 2023e. *NorthWestern Energy Thompson Falls Hydroelectric Project P-1869-060 Filing of Response to Comments on the Updated Study Report*. Submitted to FERC, Washington D.C., August 8, 2023.

_____. *In progress. 2023 Annual Report Fish Passage Project Thompson Falls Hydroelectric Project, FERC Project Number 1869.*

Thompson Falls Scientific Review Panel (Scientific Panel). 2020. Memorandum to NorthWestern Energy and Thompson Falls Technical Advisory Committee. Subject: Thompson Falls Fish Ladder Review. March 27, 2020. https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/expert-panel-review-of-fish-passage-2020.pdf

U.S. Fish and Wildlife Service (FWS). 2008. *Biological Opinion for Thompson Falls Hydroelectric Project Bull Trout Consultation*. Federal Energy Regulatory Commission Docket No. 1869-048 – Montana. PPL Montana, LLC, Licenses. Prepared by FWS Montana ES Field Office, Helena.

_____. 2017. *Fish Passage Engineering Design Criteria*. FWS, Northeast Region R5, Hadley, Massachusetts.

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Appendix A 2021, 2022, and 2023 Fish Collection Details

Table A-1. Trout Collection Sampling Dates, Method, Location, Water Temperature, Effort, and Catch Per Unit Effort in 2021

2021 Season	Date	Method	Location	Water Temp °C	Effort (Hours)	RB	RB CPUE	LL	LL CPUE
Spring	2-Jun	Electrofishing	MCFR	13.7	1.9	1	0.5		
	3-Jun	Electrofishing	MCFR	14.4	2.0	2	1.0		
	7-Jun	Electrofishing	MCFR	13.1	2.5				
	8-Jun	Electrofishing	MCFR	12.7	1.1	2	1.8		
	8-Jun	Angling	TR	12.7	8.0				
	9-Jun	Electrofishing	MCFR	12.7	3.5	1	0.3		
	11-Jun	Electrofishing	MCFR	12.1	1.5				
	14-Jun	Electrofishing	MCFR	14.5	1.0	1	1.0	4	3.9
	16-Jun	Electrofishing	MCFR	15.9	1.6			2	1.3
Spring Summary	**8 days**	**Electrofishing**	**MCFR**		**15.2**	**7**	**0.5**	**6**	**0.4**
	1 day	**Angling**	**TR**		**8.0**	**0**	**0**	**0**	**0**
Fall	29-Sep	Ladder		14.8				1	
	1-Oct			13.7				2	

Notes: °C = degrees Celsius; CPUE = Catch Per Unit Effort; Ladder = Upstream Fish Passage Facility Workstation; LL = Brown Trout; MCFR = Main Clark Fork River; NA = not applicable; RB = Rainbow Trout; TR = Thompson River

Table A-2. Trout Collection Sampling Dates, Method, Location, Water Temperature, Effort, and Catch Per Unit Effort in 2022

2022 Season	Date	Method	Location	Water Temp °C	Effort (Hours)	RB	RB CPUE	LL	LL CPUE
Spring	16-Mar	Electrofishing	MCFR	4.5	0.4	1	2.5	1	2.5
	24-Mar			7.1	0.4	1	2.5	6	14.7
	17-Mar	Ladder		4.8		3		1	
	18-Mar			5.7		2			
	21-Mar			5.6		13			
	23-Mar			6.1		1			
	28-Mar			8.2		6			
	29-Mar			7.9		2			
Spring Summary	**2 days**	**Electrofishing**	**MCFR**		**0.8**	**2**	**2.5**	**7**	**8.8**
	6 days	**Ladder**				**27**		**1**	
Fall	20-Sep	Ladder		16.8				1	
	21-Sep			16.6				3	
	22-Sep			15.6				1	
	23-Sep			15.5				2	
	26-Sep			15.5				4	
	21-Sep	Electrofishing	MCFR	16.6	1.5			2	1.3
	26-Sep			15.5	2.1			-	-
	29-Sep			16.5	1.5			4	2.7
Fall Summary	**3 days**	**Electrofishing**	**MCFR**		**5.1**			**6**	**1.2**
	5 days	**Ladder**				**-**		**11**	

Notes: °C = degrees Celsius; CPUE = Catch Per Unit Effort; Ladder = Upstream Fish Passage Facility Workstation; LL = Brown Trout; MCFR = Main Clark Fork River; NA = not applicable; RB = Rainbow Trout

Table A-3. Trout Collection Sampling Dates, Method, Location, Water Temperature, Effort, and Catch Per Unit Effort in 2023

2023 Season	Date	Method	Location	Water Temp °C	Effort (Hours)	RB	RB CPUE
Spring	27-Mar	Electrofishing	MCFR	5.4	1.66	5	3.0
	5-Apr			5.8	0.78	5	6.4
	6-Apr			6.1	0.93	1	1.1
	24-Mar	Ladder		5.1		1	
	27-Mar			4.8		1	
	28-Mar			5.4		2	
	29-Mar			5.1		1	
	31-Mar			6.5		2	
	10-Apr			8.2		3	
	11-Apr			9.8		3	
	12-Apr			9.4		3	
	13-Apr			9.1		2	
	14-Apr			8.7		1	
Spring Summary	**3 days**	**Electrofishing**	**MCFR**		**3.37**	**11**	**3.3**
	10 days	**Ladder**				**19**	

Notes: °C = degrees Celsius; CPUE = Catch Per Unit Effort; Ladder = Upstream Fish Passage Facility Workstation; LL = Brown Trout; MCFR = Main Clark Fork River; NA = not applicable; RB = Rainbow Trout

Table A-4. Trout Tagged and Transported in 2021

Date Tagged & Transported	Species	Length (mm)	Weight (g)	Radio Tag #	PIT TAG ID[13]
6/2/2021	RB	383	682	58	3212832
6/3/2021	RB	398	862	49	3212788
6/3/2021	RB	457	1052	51	3212871
6/8/2021	RB	534	1304	52	3211820
6/8/2021	RB	502	1328	56	3211805
6/9/2021	RB	409	616	54	3212869
6/14/2021	RB	433	705	55	3212787
Total RB	**7**				
6/14/2021	LL	436	896	39	3212850
6/14/2021	LL	444	959	48	3212806
6/14/2021	LL	506	1501	59	3212840
6/14/2021	LL	392	623	60	3212798
6/16/2021	LL	379	574	46	3212853
6/16/2021	LL	472	917	47	3212794
9/29/2021	LL	483	996	28	3212709
10/1/2021	LL	334	326	26	3212719
10/1/2021	LL	406	616	27	0300297
Total LL	**9**				

Notes: g = gram; ID = identification; LL = Brown Trout; mm = millimeters; RB = Rainbow Trout

[13] 98900103 are the first digits of each PIT tag.

Table A-5. Trout Tagged and Transported in 2022

Date Tagged & Transported	Species	Length (mm)	Weight (g)	Radio Tag #	PIT TAG ID[14]
3/16/2022	RB	518	1758	35	3212802
3/17/2022	RB	522	1344	43	3212696
3/17/2022	RB	549	1440	44	3212732
3/17/2022	RB	511	1086	61	3212755
3/18/2022	RB	516	1528	38	3212764
3/18/2022	RB	447	818	64	3212765
3/21/2022	RB	536	1816	31	0300845
3/21/2022	RB	500	1242	32	3212747
3/21/2022	RB	452	994	33	3212707
3/21/2022	RB	388	672	36	3212761
3/21/2022	RB	603	1486	41	3211792
3/21/2022	RB	410	676	45	3211966
3/21/2022	RB	495	1076	50	3211807
3/21/2022	RB	550	1728	53	3211933
3/21/2022	RB	510	1400	57	3211861
3/21/2022	RB	597	788	62	3211790
3/21/2022	RB	513	1290	63	3211858
3/21/2022	RB	533	1582	79	3212917
3/21/2022	RB	414	650	80	3212713
3/23/2022	RB	450	1066	77	3211851
3/24/2022	RB	412	688	67	3212781
3/28/2022	RB	529	1318	34	0300523
3/28/2022	RB	521	1362	42	3211827
3/28/2022	RB	463	1114	65	3211788
3/28/2022	RB	551	1542	74	3211907
3/28/2022	RB	494	1118	75	3211816
3/28/2022	RB	470	1094	78	3211847
3/29/2022	RB	493	1212	40	3212744
3/29/2022	RB	506	1312	73	3211781
RB TOTAL	**29**				
3/16/2022	LL	476	1048	37	3212776
3/21/2022	LL	409	586	72	3211808
3/24/2022	LL	392	530	66	3212792
3/24/2022	LL	400	588	68	3212849
3/24/2022	LL	414	644	69	3212795

[14] 98900103 are the first digits of each PIT tag.

Date Tagged & Transported	Species	Length (mm)	Weight (g)	Radio Tag #	PIT TAG ID[14]
3/24/2022	LL	430	736	70	3212809
3/24/2022	LL	407	664	71	3212857
3/24/2022	LL	479	876	76	3212844
Spring LL Total	**8**				
9/20/2022	LL	602	1714	20	3212726
9/21/2022	LL	340	344	18	3212630
9/21/2022	LL	370	400	24	3212672
9/21/2022	LL	446	824	19	3212576
9/21/2022	LL	377	526	21	3212648
9/21/2022	LL	402	572	23	3212624
9/22/2022	LL	467	738	22	3212955
9/23/2022	LL	482	1058	11	3212635
9/23/2022	LL	442	830	12	3212628
9/26/2022	LL	518	1178	13	3212695
9/26/2022	LL	382	502	14	3212662
9/26/2022	LL	496	1076	15	3212610
9/26/2022	LL	444	824	30	3212608
9/29/2022	LL	502	1254	16	3212580
9/29/2022	LL	397	536	17	3212583
9/29/2022	LL	323	336	25	3212582
9/29/2022	LL	347	374	29	3212627
Fall LL Total	**17**				
LL Total	**25**				

Notes: g = gram; ID = identification; LL = Brown Trout; mm = millimeters; RB = Rainbow Trout

Table A-6. Trout Tagged and Transported in 2023

Date Tagged	Date Transported	Species	Length (mm)	Weight (g)	Radio Tag #	PIT TAG ID[15]
3/24/2023	3/24/2023	RB	417	700	120	33212388
3/27/2023	3/27/2023	RB	528	1292	101	33212449
3/27/2023	3/28/2023	RB	555	1906	116	07069819
3/27/2023	3/28/2023	RB	564	1816	113	33212409
3/27/2023	3/28/2023	RB	455	970	114	33212440
3/27/2023	3/28/2023	RB	503	1150	115	33212463
3/27/2023	3/28/2023	RB	474	1162	119	33212414
3/28/2023	3/28/2023	RB	514	1352	118	33212429
3/28/2023	3/28/2023	RB	440	896	117	33212419
3/29/2023	3/29/2023	RB	590	1976	109	33212376
3/31/2023	3/31/2023	RB	475	1090	110	33212395
3/31/2023	3/31/2023	RB	524	1620	111	33212871
4/5/2023	4/6/2023	RB	404	730	102	33212426
4/5/2023	4/6/2023	RB	504	1432	103	33211867
4/5/2023	4/6/2023	RB	521	1622	104	33212456
4/5/2023	4/6/2023	RB	501	1428	105	33212425
4/5/2023	4/6/2023	RB	514	1598	112	33212422
4/6/2023	4/7/2023	RB	494	1224	106	33212473
4/10/2023	4/10/2023	RB	455	946	107	33212412
4/10/2023	4/10/2023	RB	497	1322	108	33212383
4/10/2023	4/10/2023	RB	534	1298	130	33212460
4/11/2023	4/11/2023	RB	430	848	125	33212433
4/11/2023	4/11/2023	RB	484	1238	129	33212432
4/11/2023	4/11/2023	RB	496	1228	126	33212474
4/12/2023	4/12/2023	RB	420	806	127	33212428
4/12/2023	4/12/2023	RB	426	788	128	33212467
4/12/2023	4/12/2023	RB	406	734	121	33212415
4/13/2023	4/13/2023	RB	607	1878	122	33212386
4/13/2023	4/13/2023	RB	471	1022	123	33212417
4/17/2023	4/17/2023	RB	497	1048	124	33212443
RB TOTAL		**30**				

Notes: g = gram; ID = identification; mm = millimeters; RB = Rainbow Trout

[15] 9890010 are the first digits of each PIT tag.

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Appendix B Travel Time for 2021, 2022 and 2023 Radio Tagged Trout

Table B-1. Travel Time for 9 Brown Trout and 7 Rainbow Trout Radio Tagged Trout in 2021

Tag #	Spp.	Date Transport to Flatiron (2021)	Date First Detected (2021)			Travel Time (Days)				Comments
			Far Field	*Near Field*	*Fish Passage Facility Entrance*	*From Flatiron to Far Field*	*From Far to Near Field*	*From Near to Fish Passage Facility Entrance*	*Far Field to Fish passage facility Entrance*	
26	LL	10/1	10/17	-	-	18	-	-	-	
27[16]	LL	10/1 10/25	10/2 10/26	10/19 10/27	10/22	1 1	17 1	3	20	10/22 ascended ladder 10/25 transported to Flatiron 10/27 Main Channel Dam
28	LL	9/29	10/1	-	-	2	-	-	-	10/25-11/4 detected by Prospect Ck array
39	LL	6/14	6/21	9/30	-	7	101	-	-	9/30 manual tracked fish just below falls
46	LL	6/16	6/29	-	-	13	-	-	-	
47[7]	LL	6/16 10/25	6/19 10/26	10/14 10/31	10/15	3 1	114 5	1	115	10/24 ascended fish passage facility; 10/25 transported to Flatiron 10/29 Fish passage facility closed 11/1 Main Channel Dam
48	LL	6/14	6/19	-	-	5	-	-	-	
59	LL	6/14	6/20	-	-	6	-	-	-	

[16] Brown Trout #27 and #47 were transported back downstream on October 25. Brown Trout #60 entered the near field during two separate forays.

Tag #	Spp.	Date Transport to Flatiron (2021)	Date First Detected (2021)			Travel Time (Days)				Comments
			Far Field	*Near Field*	*Fish Passage Facility Entrance*	*From Flatiron to Far Field*	*From Far to Near Field*	*From Near to Fish Passage Facility Entrance*	*Far Field to Fish passage facility Entrance*	
60[7]	LL	6/14	6/23 6/30	6/25 9/26	6/29	9	2 88	4	6	6/29 water temp 21.3°C
49	RB	6/3	7/5	-	-	32	-	-	-	
51	RB	6/3	6/29	-	-	26	-	-	-	
52	RB	6/8	7/6	8/12	-	28	37	-	-	8/12 water temp 21.4°C
54	RB	6/9	6/29	-	-	20	-	-	-	
55	RB	6/14	6/30	-	-	16	-	-	-	
56	RB	6/8	6/24	-	-	16	-	-	-	
58	RB	6/2	6/2	-	-	0.2	-	-	-	9/13 angler mortality at mouth of Prospect Ck

Notes: °C = degrees Celsius; LL = Brown Trout; RB = Rainbow Trout

Table B-2. Travel time for 29 Rainbow Trout Radio Tagged in 2022. In chronological order of transported and released at Flatiron FAS.

Tag #	Spp.	Date Transport to Flatiron (2022)	Date First Detected (2022)			Travel Time (Days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
35	RB	16-Mar	23-Mar	28-Mar	-	6.7	5.3	-	-	Detected near Blueside
61	RB	17-Mar	19-Mar	20-Mar	-	1.9	1.2	-	-	Detected in Graves Creek and Prospect Creek
43	RB	17-Mar	23-Mar	29-Mar	-	5.4	6.5	-	-	Detected in Prospect Creek
44	RB	17-Mar	20-Mar	-	-	3.0	-	-	-	
38	RB	18-Mar	20-Mar	22-Mar	23-Mar	2.1	2.0	1.0	3.0	Detected in Thompson River
64	RB	18-Mar	21-Mar	29-Mar	-	3.1	8.3	-	-	
31	RB	21-Mar	21-Mar	23-Mar	23-Mar	0.3	1.8	0.2	1.9	Detected in Thompson River
36	RB	21-Mar	21-Mar	23-Mar	24-Mar	0.4	1.9	0.9	2.9	Detected in Thompson River
41	RB	21-Mar	21-Mar	28-Mar	28-Mar	0.2	7.0	0.03	7.1	
45	RB	21-Mar	21-Mar	28-Mar	28-Mar	0.4	6.7	0.2	6.9	Detected in Thompson River
53	RB	21-Mar	23-Mar	24-Mar	30-Mar	1.8	1.3	5.9	7.2	
32	RB	21-Mar	28-Mar	8-Apr	20-Apr	7.4	10.9	12.2	23.1	Detected in Thompson River
33	RB	21-Mar	22-Mar	29-Mar	-	1.0	7.1	-	-	
62	RB	21-Mar	22-Mar	24-Mar	25-Mar	1.0	2.0	1.0	3.1	Detected in Thompson River
57	RB	21-Mar	24-Mar	26-Apr	2-May	3.1	32.7	6.3	39.0	

Tag #	Spp.	Date Transport to Flatiron (2022)	Date First Detected (2022)			Travel Time (Days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
80	RB	21-Mar	22-Mar	-	-	0.6	-	-	-	Detected in Prospect Creek
79	RB	21-Mar	22-Mar	27-Mar	28-Mar	1.3	4.9	1.0	5.9	
63	RB	21-Mar	21-Mar	22-Mar	20-Apr	0.05	0.4	29.9	30.3	Detected in Thompson River
50	RB	21-Mar	22-Mar	22-Mar	29-Apr	0.4	0.6	37.7	38.3	Detected in Thompson River
77	RB	23-Mar	26-Mar	23-Apr	-	2.9	28.6	-	-	
67	RB	24-Mar	27-Mar	30-Mar	-	3.1	2.4	-	-	
75	RB	28-Mar	8-Apr	8-Apr	25-Apr	11.4	0.1	16.4	16.5	
34	RB	28-Mar	5-Apr	14-Apr	-	8.1	9.4	-	-	
74	RB	28-Mar	28-Mar	29-Mar	-	0.2	0.9	-	-	Detected near Vermilion River
65	RB	28-Mar	29-Mar	-	-	0.7		-	-	Detected in Graves Creek
42	RB	28-Mar	29-Mar	-	-	0.9		-	-	Detected near Marten Creek
78	RB	28-Mar	2-Apr	14-Apr	-	5.2	12.3	-	-	Detected in Prospect Creek
73	RB	29-Mar	31-Mar	29-Apr	1-May	2.2	28.7	2.5	31.2	Detected in Thompson River
40	RB	29-Mar	29-Mar	30-Mar	-	0.2	0.4	-	-	Detected in Prospect Creek

Note: RB = Rainbow Trout.

Table B-3. Travel time for 25 Brown Trout Radio Tagged in 2022. In chronological order of transported and released at Flatiron FAS.

Tag #	Spp.	Date Transported to Flatiron (2022)	Date First Detected (2022)			Travel Time (Days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
37	LL	16-Mar	19-Mar	29-Mar	20-Jul	3.0	10.1	112.6	122.7	Detected in Thompson River
72	LL	21-Mar	6-Apr	-	-	16.1	-	-	-	
70	LL	24-Mar	28-Mar	24-Apr	12-Oct	4.2	26.4	171.6	198.0	Detected in Graves Creek
68	LL	24-Mar	26-Mar	28-Mar	-	1.6	2.2			
66	LL	24-Mar	3-Apr	26-May	27-Sep	9.9	53.0	123.9	176.9	Detected in Graves Creek
76	LL	24-Mar	25-Mar	28-Mar	-	0.8	3.0	-	-	
69	LL	24-Mar	29-Mar	9-Jul	-	4.5	102.9	-	-	Detected near Blueside
71	LL	24-Mar	25-Mar	26-Mar	-	0.7	1.1	-	-	
20	LL	20-Sep	20-Sep	-	-	0.3	-	-	-	
18	LL	21-Sep	30-Sep	-	-	9.3	-	-	-	
19	LL	21-Sep	22-Sep	14-Oct	15-Oct	0.9	21.9	1.2	23.1	
21	LL	21-Sep	22-Sep	-	-	0.8				
23	LL	21-Sep	22-Sep	10-Oct	10-Oct	0.7	18.1	0.3	18.5	
24	LL	21-Sep	23-Sep	29-Sep	30-Sep	2.0	5.9	0.9	6.9	
22	LL	22-Sep	22-Sep	-	-	0.5	-	-	-	
11	LL	23-Sep	24-Sep	6-Oct	7-Oct	0.9	12.1	0.9	13.0	Detected in Thompson River
12	LL	23-Sep	27-Sep	-	-	4.5	-	-	-	

Tag #	Spp.	Date Transported to Flatiron (2022)	Date First Detected (2022)			Travel Time (Days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
13	LL	26-Sep	26-Sep	29-Sep	-	0.5	2.4	-	-	
14	LL	26-Sep	26-Sep	-	-	0.2	-	-	-	
15	LL	26-Sep	29-Sep	-	-	3.1	-	-	-	
30	LL	26-Sep	26-Sep	22-Oct	-	0.2	25.8	-	-	
16	LL	29-Sep	2-Oct	-	-	3.0	-	-	-	
17	LL	29-Sep	29-Sep	-	-	0.03	-	-	-	
25	LL	29-Sep	-	-	-	-	-	-	-	
29	LL	29-Sep	1-Oct	-	-	1.6	-	-	-	

Note: LL = Brown Trout.

Table B-2. Travel time for 30 Rainbow Trout (RB) Radio Tagged in 2023. In chronological order of transported and released at Flatiron FAS.

Tag #	Spp.	Date Transported to Flatiron (2023)	Date First Detected (2023)			Travel Times (days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
120	RB	24-Mar	8-Apr	17-Apr	22-Apr	15.1	9.1	4.9	14.0	Ascended Ladder, Detected in Thompson River 5/1/2023
101	RB	27-Mar	27-Mar	30-Mar	31-Mar	0.3	2.8	0.9	3.7	Ascended Ladder, Detected in Thompson River 4/3/2023
113	RB	28-Mar	-	-	-	-	-	-	-	No detections in Project Area
114	RB	28-Mar	23-Apr	-	-	25.6	-	-	-	
115	RB	28-Mar	31-Mar	14-Apr	-	2.4	14.5	-	-	Left Project Area 4/14/2023
116	RB	28-Mar	5-Apr	-	-	7.6	-	-	-	Left Project Area 4/21/2023
117	RB	28-Mar	14-Apr	-	-	17.0	-	-	-	
118	RB	28-Mar	29-Mar	-	-	0.6	-	-	-	Entered Prospect Creek 4/4/2023 - Left Prospect Creek 5/19/2023, Left Project Area 5/20/2023
119	RB	28-Mar	9-May	12-May	-	42.1	3.0	-	-	Only RB in Project Area in July
109	RB	29-Mar	31-Mar	1-Apr	7-Apr	1.6	1.9	5.7	7.6	Ascended Ladder
110	RB	31-Mar	7-Apr	8-Apr	12-Apr	7.1	0.5	4.7	5.2	Did Not Ascend Ladder, Left Project Area 4/15/2023
111	RB	31-Mar	2-Apr	2-Apr	9-Apr	1.8	0.2	7.1	7.3	Ascended Ladder, Detected in Thompson River 4/11/2023
102	RB	6-Apr	15-Apr	-	-	8.8	-	-	-	

Tag #	Spp.	Date Transported to Flatiron (2023)	Date First Detected (2023)			Travel Times (days)				Comments
			Far Field	Near Field	Fish Passage Facility Entrance	From Flatiron to Far Field	From Far to Near Field	From Near to Fish Passage Facility Entrance	Far Field to Fish passage facility Entrance	
103	RB	6-Apr	8-Apr	9-Apr	10-Apr	1.6	1.4	1.0	2.4	Ascended Ladder, Detected in Thompson River 4/13/2023
105	RB	6-Apr	8-Apr	-	-	2.4	-	-	-	Left Project Area 4/28/2023
112	RB	6-Apr	-	-	-	-	-	-	-	No detections in Project Area
104	RB	6-Apr	-	-	-	-	-	-	-	No detections in Project Area
106	RB	7-Apr	11-Apr	17-Apr	30-Apr	4.4	6.1	12.7	18.8	Ascended Ladder
107	RB	10-Apr	11-Apr	14-Apr	17-Apr	1.2	2.5	3.3	5.8	Ascended Ladder, Detected in Thompson River 8/13/2023
108	RB	10-Apr	12-Apr	15-Apr	26-Apr	1.9	3.5	10.4	13.9	Ascended Ladder
130	RB	10-Apr	10-Apr	10-Apr	12-Apr	0.3	0.04	1.9	2.0	Ascended Ladder
125	RB	11-Apr	13-Apr	14-Apr	28-Apr	1.8	0.9	13.9	14.8	Mortality (found below PH) after ladder ascent and release upstream
126	RB	11-Apr	13-Apr	-	-	2.3	-	-	-	
129	RB	11-Apr	18-Apr	24-Apr	25-Apr	6.9	6.1	0.9	7.1	Did not ascend ladder and left Project Area 5/11/2023
121	RB	12-Apr	16-Apr	27-Apr	30-Apr	3.9	11.2	3.0	14.2	Ascended Ladder, Detected in Thompson River 5/1/2023
127	RB	12-Apr	12-Apr	16-Apr	-	0.3	4.2	-	-	Left Project area 4/21/2023
128	RB	12-Apr	-	-	-	-	-	-	-	No detections in Project Area
122	RB	13-Apr	13-Apr	14-Apr	-	0.3	0.8	-	-	
123	RB	13-Apr	14-Apr	3-May	-	0.8	18.9	-	-	Left Project Area 5/4/2023
124	RB	17-Apr	17-Apr	21-Apr	-	0.2	3.6	-	-	Left Project Area 5/1/2023

Note: RB = Rainbow Trout.