BUREAU OF RECLAMATION

Lower Yellowstone Intake Diversion Dam Fish Passage Project

Adaptive Management and Monitoring Plan

Lower Yellowstone Project, Montana
Missouri Basin Region

U.S. Department of the Interior

May 2021

Mission Statements

The mission of the Department of the Interior is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Lower Yellowstone Intake Diversion Dam Fish Passage Project

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Lower Yellowstone Project, Montana
Missouri Basin Region

prepared by

Bureau of Reclamation - Montana Area Office

Cover Photo: Lower Yellowstone Project Historic Headworks Structure and Existing Intake Diversion Dam. (Reclamation/David Trimpe)

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List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
AM	Adaptive Management
AMMP	Adaptive Management and Monitoring Plan
BiOp	Biological Opinion
BRT	Biological Review Team
CFS	Cubic Feet Per Second
CY	Cubic Yards
CWA	Clean Water Act
DOI	Department of Interior
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FT/S	Feet Per Second
HOPS	Hatchery-origin Pallid Sturgeon
LYBOC	Lower Yellowstone Board of Control
LYP	Lower Yellowstone Project
MOA	Memorandum of Agreement
MM	Millimeters
MRRP	Missouri River Recovery Program
MTDNRC	Montana Department of Natural Resources and Conservation
MTFWP	Montana Fish Wildlife & Parks
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
Reclamation	U.S. Bureau of Reclamation
ROD	Record of Decision
SAMP	Science and Adaptive Management Plan
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1 Introduction

The U.S. Bureau of Reclamation (Reclamation) and the U.S. Army Corps of Engineers (USACE) are joint lead agencies on the Lower Yellowstone Intake Diversion Dam Fish Passage Project (Lower Yellowstone Fish Passage Project). The purpose of the project is to improve pallid sturgeon fish passage at Intake Diversion Dam, continue the viable and effective operation of the Lower Yellowstone Project (LYP), and contribute to ecosystem restoration. Intake Diversion Dam is a rock-filled timber crib structure that spans the Yellowstone River and is a feature of the LYP which provides irrigation water to approximately 58,000 acres of cropland in eastern Montana and western North Dakota.

In 2016, Reclamation and the USACE released the Lower Yellowstone Intake Diversion Dam Fish Passage Environmental Impact Statement (2016 EIS) which was developed based on the best available scientific information for pallid sturgeon and identified the Bypass Channel Alternative as the preferred alternative (USACE and Reclamation 2016a). In December 2016, Reclamation and the USACE issued a Record of Decision selecting the Bypass Channel Alternative for implementation (USACE and Reclamation 2016b). The Bypass Channel Alternative includes a replacement weir structure for irrigation diversions into the LYP Main Canal, an 11,150 ft long bypass channel for pallid sturgeon fish passage and an adaptive management and monitoring plan to monitor post construction success.

Reclamation and the USACE also completed Section 7 Endangered Species Act (ESA) consultation on the construction and long-term operation and maintenance of the Bypass Channel Alternative and implementation of an adaptive management program that resulted in the issuance of a Biological Opinion (USFWS 2016). Due to construction delays Reclamation and the USACE reinitiated ESA consultation with the U.S. Fish and Wildlife Service (USFWS) in April of 2020 with a new Biological Opinion being issued on October 2, 2020 (USFWS 2020).

This Adaptive Management and Monitoring Plan (AMMP) has been prepared by Reclamation in cooperation with the USACE consistent with the Memorandum of Agreement (MOA) between the two agencies (USACE and Reclamation 2015). It provides a structured framework for decision making that will be used to adjust project features and operations if monitoring results indicate the Lower Yellowstone Fish Passage Project is not meeting performance objectives as contemplated in the 2016 EIS and 2020 Biological Opinion.

The AMMP is consistent with the Department of Interior Technical Guide on Adaptive Management (Williams et al. 2012). This Department of Interior Guide frames adaptive management (AM) within the context of structured decision making, with an emphasis on uncertainty about resource responses to management actions and the value of reducing that uncertainty to improve management. The technical guide defines AM as:

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances

> scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

The technical guide recommends implementing projects in two phases. The first phase sets up the AM plan's key components such as project objectives and metrics. This phase was completed through project planning, the development/completion of the 2016 EIS and Record of Decision, and subsequent ESA consultations. The second phase is an iterative phase, in which the components are linked in a sequential iterative process of monitoring, assessment, and decision-making. This iterative process is described in this AMMP.

1.1 Scope and Timeline

The scope and Project Area of the AMMP is limited to the fish passage and entrainment features (described below) associated with the LYP. This area can generally be described as one mile upstream and one mile downstream of the bypass channel entrance and exit (Figure 1). Although the scope of this AMMP is limited to the facilities associated with the LYP, it will have an influence on the entire pallid sturgeon population located in the Missouri River between Fort Peck Dam and Lake Sakakawea and the Yellowstone River.

This AMMP is considered a living document that will evolve over time as research and knowledge of pallid sturgeon expands. If changes in monitoring strategies or criteria are required, Reclamation will update the AMMP and issue a new version. Different versions of this plan will be identified by dates and versions on the front cover (i.e. January 2022 – Version 2.0, January 2023 – Version 3.0 etc.). This AMMP is only intended to last eight years following construction of the Bypass Channel Alternative. After eight years, Reclamation will initiate discussions with the USFWS to determine if the existing AMMP should continue as is, or if significant modifications are necessary. Final monitoring requirements, timelines, or adaptive management fixes may be subject to additional National Environmental Policy Act (NEPA) and Endangered Species Action (ESA) compliance beyond what was complete in 2016 (USACE and Reclamation 2016a; 2016b) and 2020 (USFWS 2020).

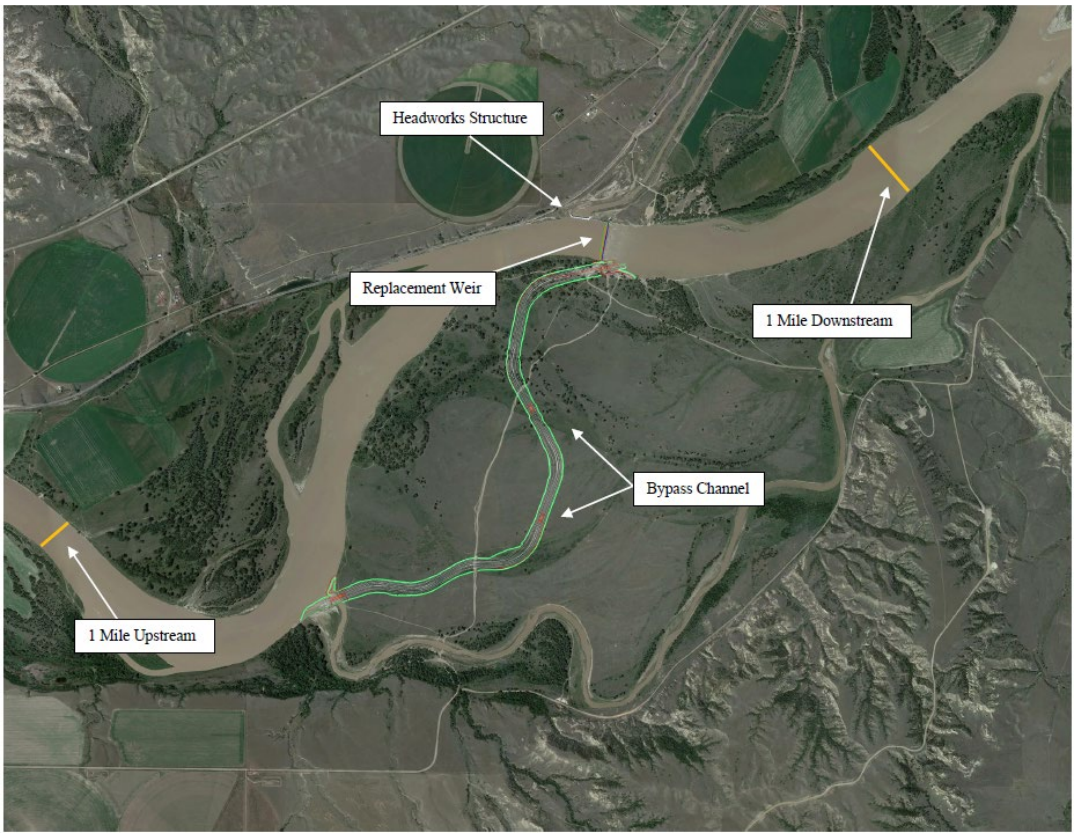

Figure 1: Project Area and Scope of the Lower Yellowstone AMMP

Described in this document is an Adaptive Management Cycle (AM Cycle) that is set up in the following manner: 1) Plan/Design, 2) Implement Management Action, 3) Monitor Species Reaction to Management Actions, 4) Assessment of Data, and 5) Decision Making.

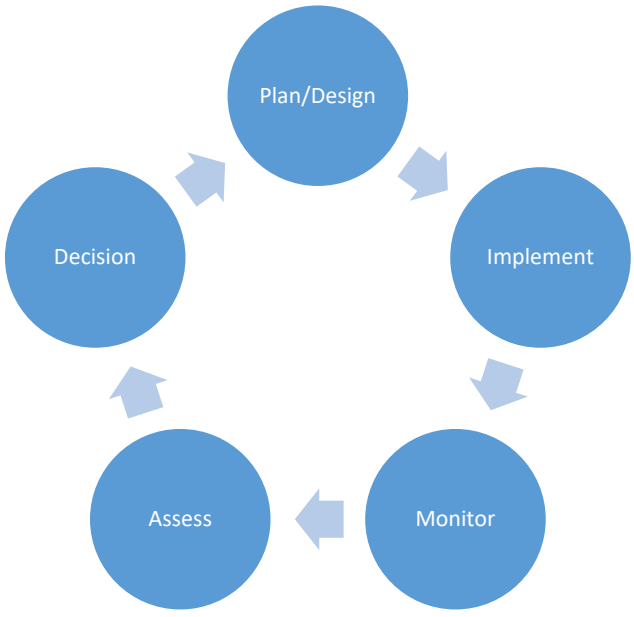

Figure 2: Adaptive Management Process

The AM cycle will begin each January with planning, design, identification of funding, and implementation of various project aspects. The AM cycle will be completed in November/December of the same year when the Executive Team is briefed on the results, a decision is made on how to move forward, and the results provided to the USFWS in a final adaptive management report. The yearly process will proceed as follows:

1. **Planning/Design/Implementation (January – March)**
    a. Design of monitoring plans
    b. Design of special studies (if necessary)
    c. Design of AM measure (if necessary)
    d. Commitment of resources

2. **Monitor (April – October)**
    a. Monitor pallid sturgeon biological criteria
    b. Monitor bypass channel physical and hydraulic criteria
    c. Monitor native species passage criteria
    d. Monitor irrigation diversions criteria

3. **Assess (October – November)**
    a. Analyze physical, hydraulic, and biological data
    b. Adaptive Management Workshop
    c. Develop Planning Team recommendation(s)

4. **Decision (November – December)**
    a. Executive Team briefing and decision
    b. Implementation guidance
    c. Development of AM report

1.2 Implementation Teams

To implement the AMMP, three teams will be formed that will have varying degrees of oversite and participation throughout the AM process. These three teams are:

- Technical Team: Federal and non-federal members tasked with developing yearly monitoring plans, implementing yearly monitoring plans, and assessing physical, hydraulic, and biological data to determine if the Lower Yellowstone Fish Passage Project is meeting objectives and metrics identified in this AMMP.

- Planning Team: Planning level staff from Reclamation, USACE, and USFWS. This Team will be responsible for planning and coordinating all aspects of the AMMP, assessing the data with the Technical Team, and making recommendations to the Executive Team. This team will also be responsible for ensuring the AM process and results are in compliance with the 2016 EIS/ROD and 2020 Biological Opinion.

- Executive Team: Decision-making officials from Reclamation, USACE, and USFWS. The Executive Team will oversee the entire AM process and will decide whether to implement the planning team recommendations. This team will also be responsible for determining how/when the recommendations get implemented within existing agency authorities and budgetary constraints.

How each of these teams fit within the AM process is further described later in this document.

1.3 Relationship with Missouri River Recovery Program Science and Adaptive Management Plan

The Lower Yellowstone AMMP is not the only adaptive management effort on-going in the upper Missouri River Basin. In November of 2018, the USACE signed a Record of Decision to implement a Science and Adaptive Management Plan (SAMP) under the Missouri River Recovery Program (MRRP). The SAMP covers three endangered species currently located in the Missouri River basin: the pallid sturgeon (*Scaphirhynchus albus*), piping plover (*Charadrius melodus*), and Interior Least Tern (*Sternula antillarum athalassos*). The USACE's SAMP is much larger in scope than this AMMP, and therefore has larger and more broad goals and objectives. Specific to the pallid sturgeon, the SAMP scope includes:

- The upper Missouri River below Fort Peck Lake to Lake Sakakawea
- Yellowstone River from Intake Dam at Intake, Montana to its confluence with the Missouri River
- Missouri River from Fort Randall Dam, SD, to the headwaters of Lewis and Clark Lake
- Lower Missouri River from Gavins Point Dam to the confluence of the Missouri and Mississippi Rivers

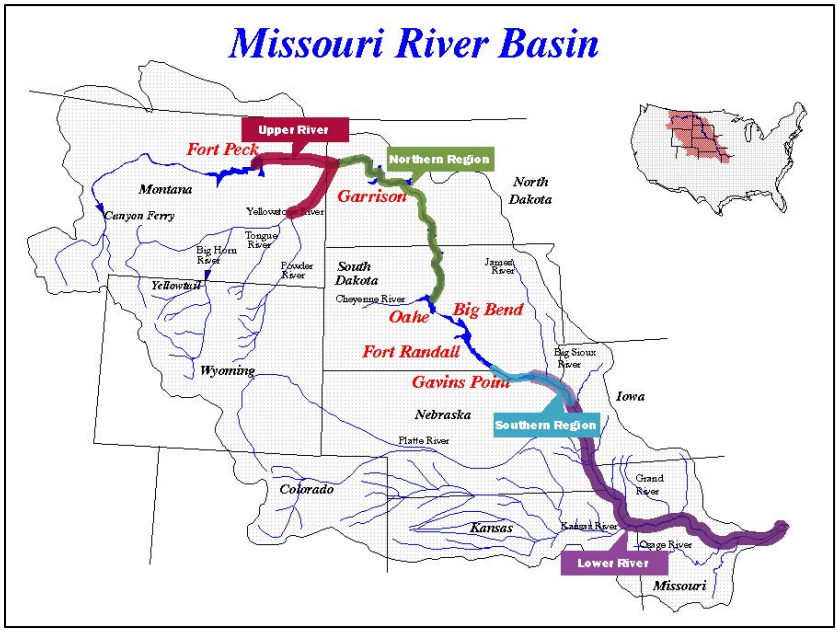

Figure 3: Scope of the Missouri River Recovery Program Science and Adaptive Management Plan (USACE 2018)

The main objective for pallid sturgeon within the SAMP is to avoid jeopardizing the continued existence of pallid sturgeon in the Missouri River. The Sub-objectives are 1) to increase recruitment to age-1, and 2) to maintain or increase numbers of pallid sturgeon as an interim measure until sufficient and sustained natural recruitment occurs (USACE 2018).

The Lower Yellowstone Fish Passage Project is included in the USACE's SAMP as a project that is currently on-going and is expected to have a large impact on the current population of pallid sturgeon located in the Missouri River below Fort Peck Dam and on the lower Yellowstone River.

The SAMP identifies several "Big Questions" and hypotheses associated with the upper Missouri River basin and Lower Yellowstone Fish Passage Project:

- **Big Question 5 – Drift Dynamics:** Can combinations of flow manipulation from Fort Peck, drawdown of Lake Sakakawea, and fish passage at Intake Dam on the Yellowstone River increase probability of successful dispersal of free embryos and retention of exogenously feeding larvae?

    - **Hypothesis 3** – Reduction in mainstem Missouri Flows from Fort Peck Dam during free-embryo dispersal will decrease mainstem velocities and drift distances thereby decreasing mortality by decreasing numbers of free embryos transported into headwaters of Lake Sakakawea.

    - **Hypothesis 7** – Fish passage at Intake Diversion Dam on the Yellowstone River will allow access to additional functional spawning sites, increasing spawning success and effective drift distance, and decreasing downstream mortality of free embryos and exogenously feeding larvae.

    - **Hypothesis 10** – Drawdown of Lake Sakakawea will increase effective drift distance, decreasing downstream mortality of free embryos and exogenously feeding larvae.

As stated in the SAMP, Reclamation will be responsible for monitoring key metrics specific to the bypass channel (described in this document), while the USACE will look at population level effects on a much broader scale in the upper Missouri and Lower Yellowstone rivers. Specifically, the USACE will focus on using telemetry tags in adult pallid sturgeon to test the response of adult spawning in the Yellowstone River to improved passage at Intake, assessing drift of free embryos downstream of Intake Dam, and assessing the longer-term population response to passage improvement at Intake Dam (USACE 2018).

Although Reclamation and the USACE are operating under different documents and different objectives (primarily in scope and scale), these two efforts will need to be coordinated on a yearly basis. It is anticipated that Reclamation staff will continue to participate under the SAMP effort while USACE staff will participate under this AM process to ensure the flow of information and continued coordination.

2 Project Overview

2.1 Lower Yellowstone Project

Reclamation's LYP is a single purpose irrigation project located in eastern Montana and western North Dakota. The project is operated and maintained (O&M) by the Lower Yellowstone Irrigation District Board of Control (LYBOC) under contract with Reclamation. The LYP includes the Intake Diversion Dam, a screened headworks structure, 71 miles of main canal, 225 miles of laterals and 118 miles of drains, three pumping plants on the Main Canal, four supplemental pumps on the Yellowstone River and one supplemental pump on the Missouri River.

The Intake Diversion Dam is a rock-filled timber crib structure spanning the entire Yellowstone River about seventy miles upstream from the Yellowstone and Missouri River confluence or eighteen miles downstream from Glendive, Montana. Intake Diversion dam raises the water elevation within the Yellowstone River so water can be diverted through the screened headworks structure on the north side of the Yellowstone River. Once water has entered the headworks it flows into the Main Canal and runs along the north side of the Yellowstone River. The diverted water is used to irrigate approximately 58,000 acres of crop land.

2.2 Pallid Sturgeon

Pallid sturgeon (*Scaphirhynchus albus*) are a large bodied fish native to the Missouri and Mississippi river basins and were listed in 1990 as endangered throughout its range under the Endangered Species Act (55 FR 36641-36647). Pallid sturgeon are well adapted to large, free-flowing, warm-water, turbid rivers with diverse and dynamic physical habitats (USFWS 2016). The pallid sturgeon has a flattened shovel-shaped snout and a long, slender, and completely armored caudal peduncle (Forbes and Richardson 1905). As with other sturgeons, the mouth is toothless, protrusible, and ventrally positioned under the head. Instead of bone, the skeletal structure is primarily composed of cartilage.

Though a single ecological constraint limiting recovery of pallid sturgeon populations has not been identified (DeLonay et al. 2016), habitat fragmentation due to the construction of dams is the most obvious ecological barrier to pallid sturgeon biological success upstream of Garrison Dam on the Missouri and Yellowstone rivers. Currently, it is thought that there is a lack of available continuous river to allow for free embryos of pallid sturgeon to naturally drift and mature before entering reservoirs (Guy et al. 2015).

An estimated 125 wild pallid sturgeon remain in the Missouri River downstream of Fort Peck Dam to the headwaters of Lake Sakakawea, including the lower Yellowstone River (Jaeger et al. 2009). Fewer fish likely remain since this estimate was published, as these adults are ageing, and natural mortality is slowly reducing their numbers each year (USFWS 2016). To help augment the population, the USFWS has been releasing hatchery-origin pallid sturgeon (HOPS) in the Missouri

and Yellowstone Rivers since 1998. The survival estimate for the HOPS has declined in recent years but is still estimated at 16,444 (12,138 – 20,759; Rotella 2017).

The Yellowstone River lies within the upper portion of the Missouri River basin and provides a nearly unaltered flow regime and retains the characteristic of a natural hydrograph (DeLonay et al. 2016). Wild adult pallid sturgeon typically move into the Yellowstone River from the Missouri River and Lake Sakakawea during early to mid-April. Between 60 and 90% of the telemetered population are present in the system during May and June (DeLonay et. al. 2014). After migrating into the Yellowstone River from the Missouri River, a portion of the population remains in the lower reaches, while others exhibit broad-scale migrations. Unimpeded upstream migration is possible throughout the lower Yellowstone River up to the location of Intake Dam (~ river mile 71), where further upstream movement is mostly halted by Intake Diversion Dam.

Based on recent research (Braaten et al. 2015; Braaten 2019), 9-26% of the telemetered (i.e., implanted with radio transmitters) population of wild adult pallid sturgeon migrates to the reach affected by Intake Dam annually.

2.3 Lower Yellowstone Fish Passage Project

Intake Diversion Dam is a known passage barrier to upstream migrating pallid sturgeon (Watson and Stewart 1991; Backes et al. 1994; Bramblett and White 2001; Delonay et al. 2014; Rugg et al. 2019) and other native species (Rugg et al. 2019) due to the turbulent environment that is caused by the structure and associated rock field. In fact, lab studies have shown that sturgeon have difficulty negotiating turbulent flows and high velocities (White and Mefford 2002) which are found across and just downstream of Intake Diversion Dam. Historically there was a natural side channel that routed around Joe's Island which provided periodic passage for pallid sturgeon and other native species. Past telemetry studies (Rugg et al. 2019) suggested that Yellowstone River flows needed to be greater than 35,000 cubic feet per second (cfs) for HOPS and greater than 40,000 cfs for wild adult pallid sturgeon before the channel provided enough flow and depth for effective passage. However, due to the construction of the bypass channel the natural side channel is no longer available for upstream passage.

To address the passage issues associated with the Intake Diversion Dam, Reclamation and the USACE partnered as joint lead agencies on the Lower Yellowstone Fish Passage Project. The Lower Yellowstone Fish Passage Project includes the construction of a bypass channel for fish passage, a replacement weir for water diversions in the Lower Yellowstone Main Canal, and implementation of an AMMP. Below are the major components and features of the Lower Yellowstone Fish Passage Project.

2.3.1 Bypass Channel

The bypass channel is 11,150 ft long (2.1 miles) extending from the upstream end of the existing side channel to approximately 500 feet downstream of the existing diversion structure and rock rubble field on the right bank (Figure 4). This required the excavation of approximately 881,000

cubic yards of material from Joe's Island. The bypass channel slope ranges from 0.02 to 0.07 percent. The slope of the Yellowstone River in this area is approximately 0.04 to 0.07 percent.

The bypass channel has been designed to divert 13 to 15 percent of the total Yellowstone River flow (Table 1). While the bypass channel would typically divert 13 - 15 percent of the total flow during spring and summer discharges, diversion percentages could vary from 10 percent at extreme low flows to greater than 18 percent at higher flows.

Table 1: Flows in the Yellowstone River and Expected Flows in the Bypass Channel

Total Yellowstone River Flow	Bypass Channel Flows Split (at upstream end)	Percentage of total Yellowstone River Flow
7,000 cfs	1,100 cfs	16 %
15,000 cfs	2,200 cfs	15 %
30,000 cfs	4,100 cfs	14 %
54,2000 cfs (2 year)	7,500 cfs	14 %
63,000 cfs	8,700 cfs	14 %
87,600 cfs (10 year)	10,700 cfs	14 %
116,200 cfs (50 year)	12,900 cfs	15 %
128,300 cfs (100 year)	20,000 cfs	16 %

The bypass channel was designed and constructed to meet physical and hydraulic criteria provided by the USFWS' Biological Review Team (BRT) which was based on the best available science regarding pallid sturgeon swimming abilities and preferred channel/substrate conditions (USFWS 2014; Table 2). The channel cross-section has a bottom width of 40 feet, a top width of 150-250 feet, and side slopes varying from 1V:8H to 1V:4H.

Vertical grade control structures (buried rock sills) are included at the downstream and upstream ends of the bypass channel as well as at two intermediate locations to prevent channel head-cutting or other scour that would impact passage success. The two intermediate sills are for maintaining channel slope and allowing for early identification of channel movement. The control structures were over-excavated and buried with natural river cobble to provide a natural substrate while providing stability during extreme events.

Approximately 50,000 CY of riprap was required for channel stability within the bypass channel. Bank riprap is included at four outside bends identified as having potential for erosion. It is possible that additional protection could be required in the future if assumptions about channel stability are proven incorrect, and channel migration or degradation begins to impact fish passage effectiveness.

Sediment modeling conducted for the design of the bypass channel (Reclamation 2014) showed some potential for bed erosion; therefore, placement of large gravel to cobbles along the length of the channel bed was included. This material is similar in size to the naturally occurring coarse channel material found on Yellowstone River point and mid-channel bars and similar to what would be expected to occur naturally over time.

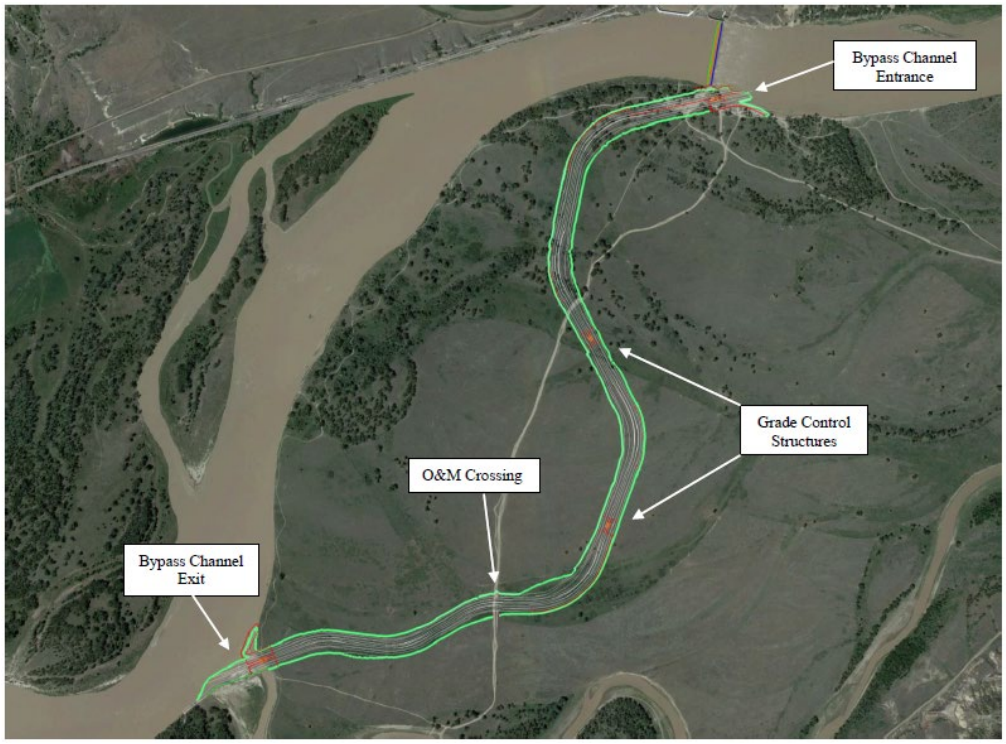

Figure 4: Bypass Channel Alignment and Features

Table 2: Biological Review Team Physical and Hydraulic Design Criteria of the Bypass Channel

Discharge at Sidney, Montana USGS Gauge	**7,000 – 14,999 ft^3/s**	**15,000 – 63,000 ft^3/s**
Bypass Channel Flow Split	≥ 12%	13% to ≥ 15%
Bypass Channel cross-section velocities (measured as mean column velocity)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Depth (minimum cross-sectional depth for 30 contiguous feet measured cross-section)	≥ 4.0 ft	≥ 6.0 ft
Bypass Channel Fish Entrance (measured as mean column velocity at HEC-RAS Station 136)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Fish Exit (measured as mean column velocity)	≤ 6.0 ft/s	≤ 6.0 ft/s

To improve attraction into the bypass channel two areas of fill were incorporated into the design. Approximately one acre of fill along the left bank of the bypass channel was required to reduce an eddy area that existed prior to construction of the bypass channel. This area of fill will help extend the flows from the bypass channel into the main channel of the river where pallid sturgeon are mostly likely to be present during upstream migration (Braaten et al. 2015). There is also a three-acre area of fill along the right bank of the Yellowstone River just downstream of the bypass channel entrance. Like the other fill area, this is expected to reduce chances of eddy formation and will increase attraction flows into the bypass channel.

2.3.2 Replacement Weir

The replacement weir spans the entire Yellowstone River and consists of a deep foundation of driven piles with a concrete cap (Figure 5). The top of the structure is at elevation 1991.0 ft which is the same elevation as the rock that was placed on the existing diversion structure. The new weir includes a reinforced concrete cap to protect it and allow for a smooth crest surface for ice to pass over.

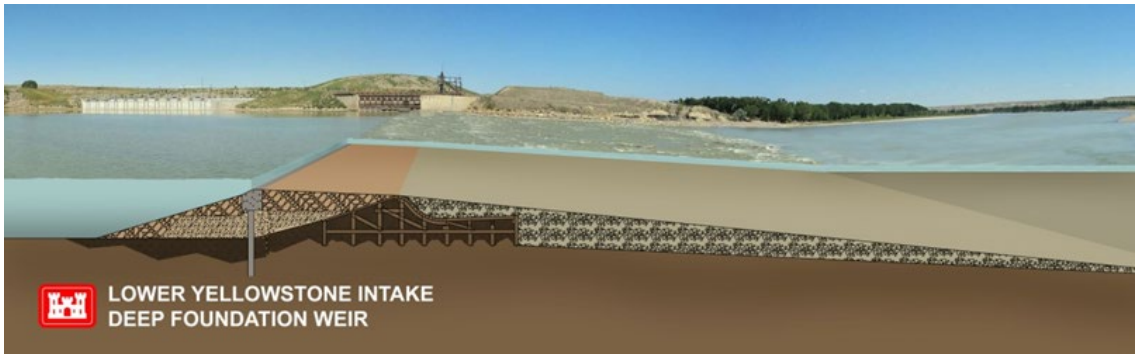

Figure 5: Cross-section of Replacement Weir, Existing Weir and Existing Rock Field

A low flow notch at elevation 1989.0 ft in the weir crest was included in the design. The notch is intended to facilitate downstream movement of adult, juvenile, free embryo, and larval pallid sturgeon and the upstream movement of stronger native fish species. The low-flow notch is 125 feet at its top width and 85 feet at its bottom width and located 100 feet out from the left bank near the thalweg of the river.

2.4 Screened Headworks Structure

In addition to pallid sturgeon passage issues, the LYP historic headworks structure was known to entrain adult and juvenile pallid sturgeon into the Main Canal because of unscreened water diversions. Hiebert et al. (2000) conducted entrainment studies on the original headworks structure and estimated that yearly entrainment of all species ranged from 400,000 – 1,000,000 fish during an average irrigation season. To address this issue, Reclamation and the USACE designed and constructed a new screened headworks structure that was put into operation during the 2012 irrigation season.

The new headworks structure spans 470 ft along the north bank of the Yellowstone River. The structure has 12 gates that control the flow of water and can be used to divert water from the Yellowstone River into the Main Canal. The headworks structure also includes twelve state-of-the-art integrated rotating drum fish screens to minimize fish entrainment (Figure 6).

The top of the headworks is approximately five feet above the 100-year ice-affected water surface elevation. Eleven of the gates and screens are used to divert the full 1,374 cfs water right, when necessary, with one additional back-up gate and screen that can be used if any of the screens require repair, replacement, or maintenance. Because screen design criteria specific to pallid sturgeon do not exist, the screens were designed to meet juvenile salmonid criteria established by the USFWS and the

National Marine Fisheries Service (NMFS 2011).

Figure 6: Lower Yellowstone Headworks and Fish Screen Structure (screens submerged)

Each drum screen is 6.5 feet in diameter and 25 feet in length. The screens have a maximum mesh size of 1.75 millimeters (mm) with a profile bar of 2.38 mm woven wire. Maximum approach velocity in front of the screen is designed at 0.4 feet per second providing even velocity distribution across the rotating screens. The cylindrical screens were constructed to be approximately one meter above the riverbed to minimize entrainment of drifting free embryos and larval pallid sturgeon. Water flows by gravity through the screens and slide gates where it then enters the Main Canal.

Removable rotating drums allow each screen to be adjusted on a track and be raised above the river when not in use (Figure 7). This feature minimizes damage from ice during winter and from other debris. Fixed brushes mounted on the inside and outside of the screens clean the screens when in use and remove aquatic organisms potentially impinged on the screens (Figure 8).

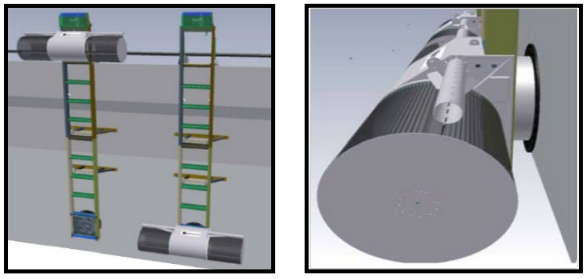

Figure 7: Removable Drum Screens on Adjustment Track

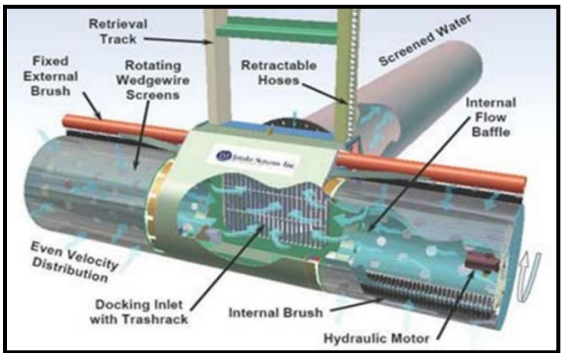

Figure 8: Schematic of Lower Yellowstone Fish Screens

3 Project Goals and Objectives

3.1 Project Goals

3.1.1 Improve Pallid Sturgeon Fish Passage

The primary goal of the Lower Yellowstone Fish Passage Project is to improve passage for the endangered pallid sturgeon at the Intake Diversion Dam. By providing passage at this location it opens an additional 165 miles of Yellowstone River, 300 miles of Powder River and 20 miles of Tongue River habitat for pallid sturgeon migration and spawning upstream of Intake Diversion Dam. Under current conditions, the majority of the spawning activity takes place within the lowest 10 miles of the Yellowstone River (Bramblett 1996; Delonay et al. 2014; 2016), which does not allow for adequate drift distance for free embryos and larval pallid sturgeon to mature and settle out before they reach the headwaters of Lake Sakakawea, where they are believed to succumb to hypoxia (Guy et al. 2015; Bramblett & Scholl 2016).

By improving passage at Intake Diversion Dam, adult pallid sturgeon would have the opportunity to continue their upstream migration and spawn further upstream either in the Yellowstone River or tributaries such as the Powder and Tongue rivers. By getting adults to spawn further upstream it would increase the available drift distance, potentially improving survival of offspring, which could ultimately contribute to recruitment of pallid sturgeon within the Great Plains Management Unit (Upper Missouri River and Yellowstone River area as defined by the USFWS in the Pallid Sturgeon Recovery Plan [USFWS 2014]).

Although not the primary goal of the project, the bypass channel and replacement weir are expected to improve fish passage for many other native species found in the Yellowstone River. The Yellowstone River is home to many native species that make long migrations to spawn which include blue sucker (*Cycleptus elongatus*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), sauger (*Sander canadensis*) and paddlefish (*Polyodon spathula*).

3.1.2 Irrigation Diversions to the LYP

As discussed in the 2016 EIS (USACE and Reclamation 2016a), a second purpose and need of the Lower Yellowstone Fish Passage Project is to allow for the continued viable and effective operation of the LYP. In order for the LYP to remain viable, they must have the ability to divert their full water right during critically dry, high demand times of the year. Historically, during low summer flows the LYP maintained diversions into the Main Canal by placing large sandstone boulders on top of the existing wooden crib structure. This method of water delivery is being replaced by the replacement concrete weir which will not require the annual placement of rock.

Project operation, maintenance, and rehabilitation is carried out by the LYBOC through funds generated by assessment on farms within the LYP. The ability of farms to pay assessments is dependent on income from crop production, which is a function of reliable and sufficient water deliveries to meet crop demands.

The LYP provides water to four irrigation districts that encompass approximately 58,000 acres of land located in both Montana and North Dakota. Reclamation and the four irrigation districts hold water rights in the state of Montana totaling 1,374 cfs. The four districts are:

- Lower Yellowstone Irrigation District #1
- Lower Yellowstone Irrigation District #2
- Intake Irrigation District
- Savage Irrigation District

3.2 Project Objectives

The Lower Yellowstone Fish Passage Project is the only known fish passage project specifically built for pallid sturgeon. Because the science of pallid sturgeon is not well understood, the USFWS convened a team of pallid sturgeon experts and a hydraulic engineer from the upper Missouri River Basin to help assist with fish passage designs. This team consisted of fish biologists from Montana Fish, Wildlife, & Parks (MTFWP), the U.S. Geological Survey (USGS), the USFWS, and a hydraulic engineer from Reclamation.

This team was responsible for making recommendations to Reclamation and the USACE on design parameters that would encourage the passage of pallid sturgeon. Specifically, during the design of the bypass channel, the BRT provided Reclamation and the USACE with physical and hydraulic criteria (flow splits, depth, and velocity ranges) that were incorporated into the final design (USFWS 2014). In 2016, the BRT provided biological passage criteria intended to evaluate the passage alternatives considered in the 2016 EIS (USFWS 2016). The objectives identified below are based on the physical, hydraulic, and biological criteria developed by the USFWS' BRT and assumptions made in the 2016 EIS, 2016 BiOp, and 2020 BiOp.

Objective 1: Construct and maintain the bypass channel to appropriate physical and hydraulic criteria parameters that allow improved pallid sturgeon passage.

- **Criteria 1a – Bypass Channel Cross-sectional Depth**
    - Minimum depths in fish passageway measured at the lower discharge range of 7,000 cfs to 14,999 cfs at any sampled cross-section must be greater than or equal to 4.0 ft across 30 contiguous feet of the measured channel cross section profile.
    - Minimum depths in the fish passageway measured at the discharge range of 15,000 cfs to 63,000 cfs at any sampled cross-section must be greater than or equal to 6.0 ft across 30 contiguous feet of the measured channel cross sectional profile.

- **Criteria 1b – Bypass Channel Cross-sectional Velocities**
    - Mean cross-sectional velocities must be greater than or equal to 2.0 ft/sec, but less than or equal to 6.0 ft/sec over the discharge range of 7,000 cfs to 14,999 cfs.
    - Mean cross-sectional velocities must be greater than or equal to 2.4 ft/sec, but less than or equal to 6.0 ft/sec over the discharge range of 15,000 cfs to 63,000 cfs.

- **Criteria 1c – Bypass Channel Flow Split**
    - Greater than or equal to 12% over the discharge range of 7,000 cfs to 14,999 cfs
    - 13% to greater than or equal to 15% over the discharge range of 15,000 cfs to 63,000 cfs.

- **Criteria 1d – Bypass Channel Fish Entrance and Exit**
    - Mean cross-sectional velocity of greater than or equal to 2.0 ft/s (measured as mean column velocity for the range of 7,000 cfs to 14,999 cfs.
    - Mean cross-sectional velocity of greater than or equal to 2.4 ft/s (measured as mean column velocity) for the range of 15,000 cfs to 63,000 cfs.
    - Mean cross-sectional velocities (measured as mean column velocity) at both the upstream and downstream opening should be less than or equal to 6.0 ft/s for the range of 7,000 cfs to 63,000 cfs.

Objective 2: Improve upstream and downstream passage of pallid sturgeon

- **Criteria 2a – Upstream Adult Passage**
    - Greater than or equal to 85% of motivated adult pallid sturgeon (fish that move up to the weir) annually pass upstream of the weir location during the spawning migration period (April 1 to June 15) within a reasonable amount of time without substantial delay (≥0.19 miles/hour).

- **Criteria 2b – Upstream Juvenile Passage**
    - No criteria set – develop decision criteria to trigger adaptive management options to improve passage for juveniles if the lack of juvenile passage is demonstrated to result in negative population level effects.

- **Criteria 2c – Downstream Adult and Juvenile Passage**
    - Mortality of adult and juvenile pallid sturgeon that migrate downstream of the weir location cannot exceed 1% annually during the first 10 years. Document any injury or evidence of adverse stress.

- **Criteria 2d – Downstream Free Embryo and Larval Passage**
    - No criteria set – Assess impingement and entrainment of free embryos, larvae, and young-of-the-year sturgeon at headworks screens, irrigation canal, and downstream of the weir location.

Objective 3: Maintain or improve upstream and downstream passage success of Native Fish (Secondary Objective)

- **Criteria 3a – Native Species Upstream Passage**
    - Passage rates of native fishes migrating upstream of the weir location at levels greater than or equal to pre- Fish Passage Project conditions.

- **Objective 3b – Native Species Downstream Passage**
    - Passage rates of native fishes migrating downstream of the weir location at levels greater than or equal to pre- Fish Passage Project conditions.

Objective 4: Maintain irrigation diversions into the Lower Yellowstone Project Main Canal

- **Criteria 4a – Irrigation Diversions**
    - Maintain water diversions from the Yellowstone River for irrigation demands up to the full water right of 1,374 cfs during the irrigation season (mid- April through mid-October).

4 Planning, Design, and Implementation

The initial planning for the Lower Yellowstone Fish Passage Project took place during the NEPA compliance and ESA Section 7 consultations in 2015 (USACE and Reclamation 2015), 2016 (USACE and Reclamation 2016a; 2016b), and 2020 (USFWS 2020). These efforts helped Reclamation and the USACE pick a passage alternative and allowed the public to provide valuable input into the process. The resulting documents from these efforts can be found on Reclamation's Montana Area Office's webpage: https://www.usbr.gov/gp/mtao/loweryellowstone/index.html.

Although the main planning and selection of a passage alternative for the Lower Yellowstone Fish Passage Project is complete, there is still a need for yearly planning, design, and implementation in the adaptive management process as described below.

4.1 Monitoring Plans

Each AM cycle begins with planning for the upcoming field season. This will require coordination and collaboration between the Planning Team, Technical Team, and the field staff who will be collecting the data. The Planning Team, Technical Team, and field staff will start meeting in January of each year with the goal of having final monitoring details/plans in place by late March. Once plans are agreed to, a formal monitoring plan will be developed and shared with the USFWS. Yearly changes to the monitoring plans are expected and will be made based on lessons learned from the previous year or new objectives for the upcoming field season. The written monitoring plans will include details such as:

1) Scope and timeline of activities
2) Identification of Agency conducting each monitoring activity
3) Goals and objectives of that years monitoring activities
4) Description of any special studies (if necessary)
5) Estimated costs of each activity.

By developing yearly monitoring plans, it ensures Reclamation has the appropriate resources (funding and staff) in place to effectively monitor project objectives.

4.2 Adaptive Management Measures

There may be a need to implement an AM measure if the objectives of the Lower Yellowstone Fish Passage Project are not being met or the bypass channel is not functioning as anticipated. The decision to implement an AM measure will not be based on just one year of monitoring data, instead will be based on at least two to three years of data collection and design work. As described in this AMMP, the Technical, Planning, and Executive teams will work through a very structured process before moving forward with changes such as implementation of an AM measure. Below is a brief explanation of the process (Figure 9).

Year 1: Monitoring plans are developed and executed. During the field season it is determined the bypass channel is not meeting physical, hydraulic, or biological criteria. After the field season the Technical Team meets to assess the monitoring data with an attempt to identify the cause of the issue. The Technical Team will discuss if changes are needed to the current monitoring plan or if a special study is required to focus on a very specific issue.

Year 2: Adjusted monitoring plans are developed and executed. After the field season the Technical Team is reconvened to assess the new data. If a clear cause can be identified and enough data has been collected, the Technical and Planning teams will work together to identify a potential adaptive management measure for implementation.

If enough information still isn't available, the Technical Team will consider more aggressive approaches such as, increased monitoring activities in the field, laboratory investigations, or 1-Dimensional/2-Dimensional (1-D/2-D) computer modeling. Additional monitoring in the field is typically easy to coordinate, however, laboratory investigations and computer modeling require more resources and could involve longer wait times. The goal will be to have the additional information collected within 8-12 months after initial identification of a problem.

Year 3-4: Once enough information has been collected, and an AM measure has been identified, it will need to go through a design process. Reclamation typically goes through a 30/60/90 percent design process that allows for agency review at each stage of the design.

Designing a new feature could involve the development of a physical model or use of a 1-D/2-D computer model to ensure the design is going to work as intended, which could impact how quickly it can be implemented. Once a design has been agreed on and finalized, Reclamation may need to conduct environmental reviews such as NEPA, ESA, or Clean Water Act compliance prior to construction.

Year 5-6: A construction contract is awarded, and the AM measure is implemented. After construction is complete, physical, hydraulic, and biological monitoring resumes to assess the effectiveness of the AM measure.

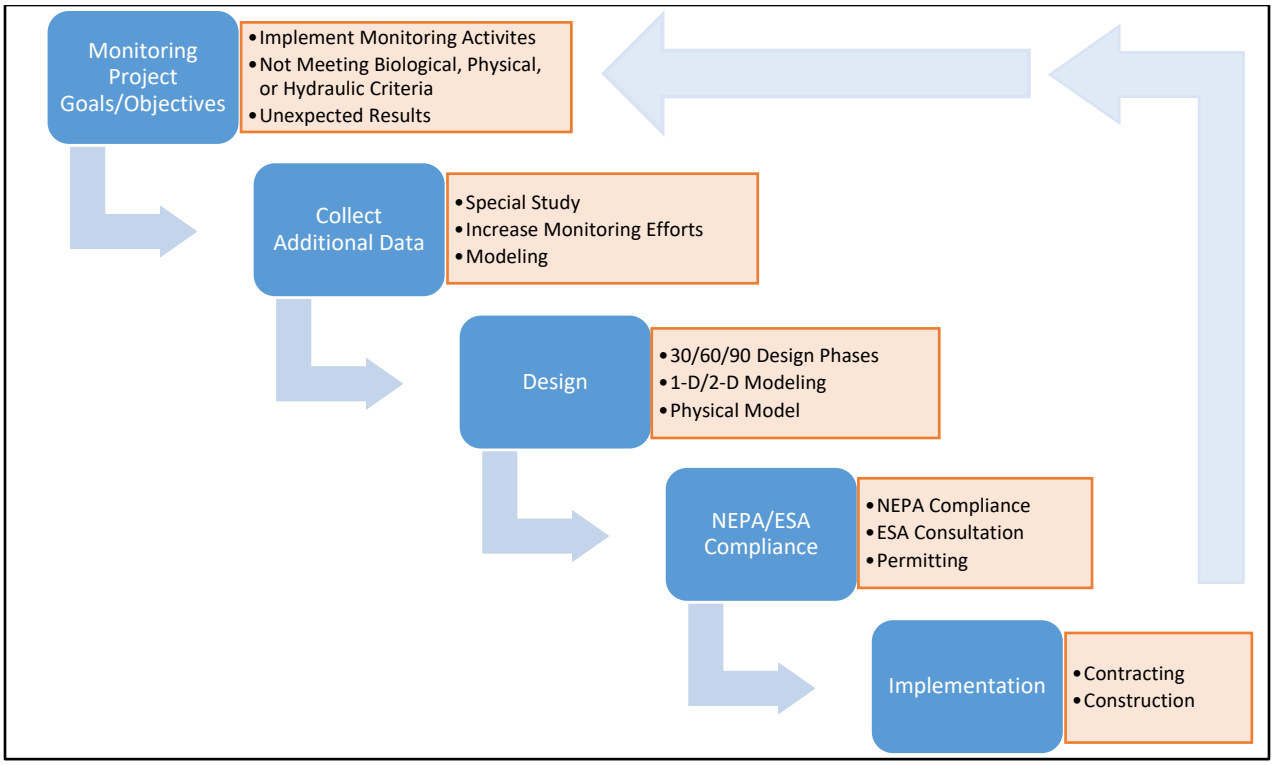

Figure 9: Process for Implementing an Adaptive Management Measure

Other considerations that will be taken into account when implementing an AM measure include; staffing levels, funding availability, construction timing/season, in-water work restrictions, permitting, NEPA and ESA requirements/commitments and all other Federal laws that might require coordination or approval prior to implementation.

As noted above, there are several steps that must be taken prior to the implementation of an AM action. However, Reclamation is committed to completing this process as expeditiously as possible. Example AM measures are identified later in this document (Section 13).

5 Monitoring and Assessment

5.1 Monitoring

Monitoring is used in adaptive management to track resource system behavior and, in particular, the responses to the management actions over time. Monitoring is an ongoing activity, producing new data after each monitoring cycle to evaluate management actions and ensure that goals and objectives are being met. Monitoring also includes a means to validate assumptions and prioritize management actions during follow-up monitoring periods.

The monitoring program included in this AMMP is designed to be coordinated with existing monitoring programs conducted by the USACE, MTFWP, and the USGS. The monitoring program commitments in this AMMP are designed to be inclusive of the commitments between the USACE and Reclamation as described in the MOA signed April 7, 2015 (Section 6.2) and any requirement as a result of ESA Section 7 consultation (USFWS 2020).

The following monitoring activities will be covered under this AMMP and will generally take place from April 1 – October 31:

1. Physical and hydraulic monitoring (Section 9)
2. Biological monitoring (Section 10)
3. Native species monitoring (Section 11)
4. Irrigation diversion monitoring (Section 12)

All monitoring activities will begin the first full migration season after construction of the bypass channel is complete.

5.2 Assessment

Data collected from physical, hydraulic, biological, and irrigation diversion monitoring will be evaluated and compared to AMMP objectives/metrics, assumptions, and the anticipated results contained in the 2016 EIS/ROD and 2020 BiOp. The assessment phase will be conducted through an annual Adaptive Management Workshop that will engage the Technical Team and Planning Team in the fall/winter of each year.

The Technical team will be responsible for determining whether a response by pallid sturgeon or other native species occurred and if that response was anticipated. The Technical Team will also analyze whether the LYBOC was able to divert water based on irrigation demands up to their water right of 1,374 cfs.

To assist with assessment of the Lower Yellowstone Fish Passage Project performance, the Project Area will be divided into four segments (Figure 10). By breaking the Project Area into the four segments, the Technical Team will have the ability to analyze each component of fish passage (approach, attraction, entrance, exit or passage). The following components will be considered when determining the effectiveness of the bypass channel:

- Attraction Efficiency - the proportion of approaching fish that locate the bypass channel entrance.
- Entrance Efficiency - the proportion of attracted fish that enter the bypass channel
- Passage Efficiency - the proportion of fish that entered the bypass channel and successfully pass through the entire channel
- Overall Efficiency – the proportion of fish that are attracted to, enter, and pass the bypass channel.

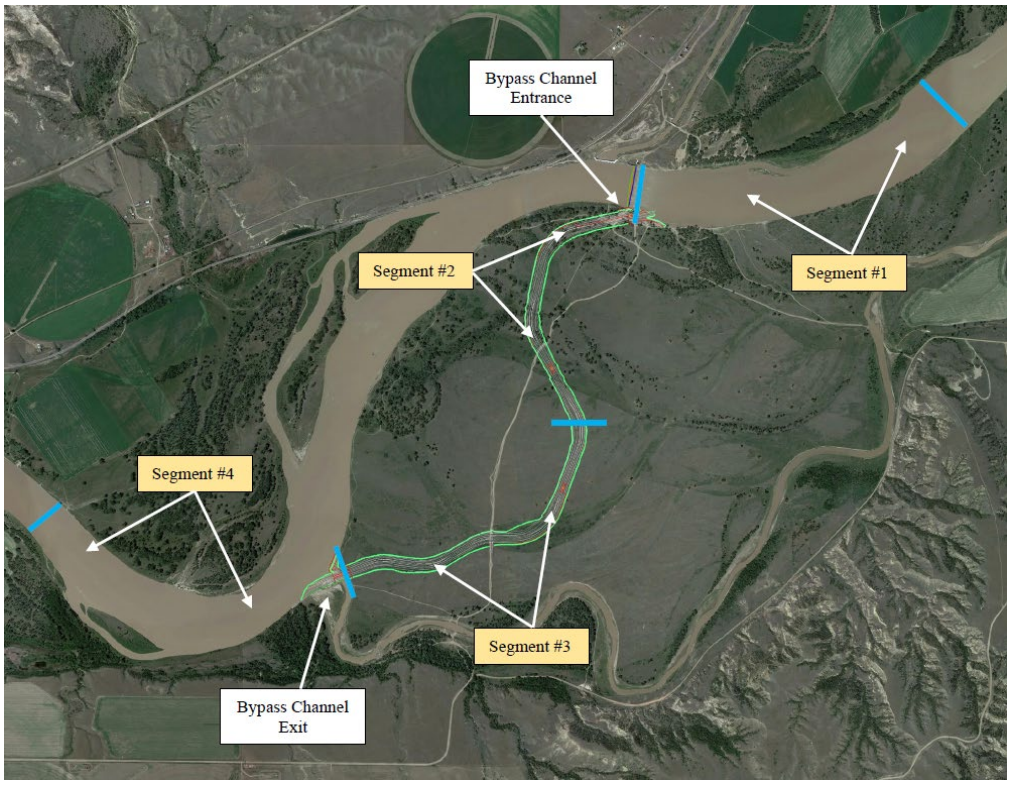

Figure 10: Project Area Segments to Help Determine Passage Effectiveness of the Bypass Channel

5.2.1 Technical Team

The Technical Team is made up of federal and non-federal members tasked with developing yearly monitoring plans, implementing yearly monitoring plans, and assessing physical, hydraulic, biological, and irrigation diversion data to determine if the Lower Yellowstone Fish Passage Project is meeting the criteria identified in this AMMP. The Technical Team may also assist with the identification or design of an AM measure.

This team will participate in the annual Adaptive Management Workshop but will not make formal decisions or recommendations. Below are the agencies and disciplines to be represented on the Technical Team. Additional support staff and disciplines would be added as necessary to address specific team needs.

- U.S. Bureau of Reclamation (Lead Agency)
  - Project Manager
  - Fisheries Biologist/Environmental Specialist
  - Hydraulic Engineer

- U.S. Fish and Wildlife Service
  - Fisheries Biologist
  - Consultation Biologist

- U.S. Army Corps of Engineers
    - Project Manager
    - Fisheries Biologist/Environmental Specialist
    - Hydraulic Engineer

- U.S. Geological Survey
    - Fisheries Biologist
    - Hydraulic Engineer

- Montana Fish, Wildlife & Parks
    - Fisheries Biologist
    - Fisheries Biologist

- Montana Department of Natural Resources
    - Engineer/Hydrologist/Irrigation Specialist

- Lower Yellowstone Irrigation Project
    - District Manager/Engineer

5.2.2 Assessment Questions

During the yearly Adaptive Management Workshop, the Technical Team will analyze the collected field data and determine if the Lower Yellowstone Fish Passage Project is meeting the objectives and criteria described in this AMMP. In order for the Technical Team to make a full assessment of the project, the following questions need to be considered and addressed during this assessment stage:

1) **Did the Project meet pallid sturgeon biological criteria (Criteria 2a – 2d)?**
    a. If yes, move on to #2
    b. If no:
        i. What was the likely cause?
            1. Did fish approach the bypass channel?
            2. Did fish find the entrance to the bypass channel?
            3. Did fish successfully enter the bypass channel?
            4. Did fish successfully pass through the entire bypass channel?
            5. Did hydraulic conditions play a role?
            6. Did substantial delays occur? Where?
        ii. Did not meeting biological criteria impact spawning and reproduction success upstream of Intake Diversion Dam?
        iii. Did basin wide hydrology play a role?
        iv. Is there enough information to clearly identify an adaptive management measure or does additional monitoring need to be conducted?
            1. Identify modifications to the monitoring plan.
            2. Identify any special studies that may be needed.

2) **Did the Project meet bypass channel physical/hydraulic criteria (Criteria 1a – 1d)?**
    a. If yes, move on to #3
    b. If no:
        i. What was the likely cause?
            1. Flow split?
            2. Debris or sedimentation?
            3. Channel changes due to high flows, flooding, or ice?
        ii. Was it the entire bypass channel or only certain areas?
        iii. Did this occur in critical areas (entrance or exit)?
        iv. Did not meeting physical/hydraulic criteria impact fish passage success considered above?
        v. Did not meeting physical/hydraulic criteria impact spawning and reproduction success upstream of Intake Diversion Dam?
        vi. Did basin wide hydrology play a role?
        vii. Is there enough information to identify a potential adaptive management measure or does additional monitoring need to be conducted?
            1. Identify specific monitoring plan changes
            2. Identify any special studies that may be needed.

3) **Did the Project meet native species criteria (Criteria 3a – 3b)?**
    a. If yes, move on to #4
    b. If no:
        i. What was the likely cause?
            1. Did fish approach the bypass channel?
            2. Did fish find the entrance to the bypass channel?
            3. Did fish successfully enter the bypass channel?
            4. Did fish successfully pass through the entire bypass channel?
            5. Did hydraulic conditions play a role?
            6. Did substantial delays occur? Where?
        ii. Did basin wide hydrology play a role?
        iii. Is there enough information to identify a potential adaptive management measure or does additional monitoring need to be conducted?
            1. Identify specific monitoring plan changes
            2. Identify any special studies that may be needed.

4) **Was the Lower Yellowstone Irrigation Project able to divert water to meet irrigation demands up to their full water right of 1,374 cfs (Criteria 4a)?**
    a. If yes, done with assessment
    b. If no:
        i. What was the likely cause?
            1. Sediment or debris?
            2. Screen issues?
            3. Weir elevations?
        ii. Did basin wide hydrology play a role?
        iii. Is there enough information to identify a potential adaptive management measure or does additional monitoring need to be conducted?
            1. Identify specific monitoring plan changes
            2. Identify any special studies that may be needed

5.2.3 Planning Team

The Planning Team is made up of planning level staff from Reclamation, USACE and USFWS that will be responsible for facilitating and coordinating the activities identified in this AMMP, including the yearly Adaptive Management Workshop. Many of the day to day decisions on monitoring plans, resources, agreements, and program funding can be made by this team. This team will also ensure the AM process and results are in compliance with the 2016 EIS/ROD and 2020 Biological Opinion.

Each fall after the Adaptive Management Workshop, the Planning Team will provide a briefing to the Executive Team. These briefings will include a synopsis of how the project performed (did it meeting criteria and objectives), status of monitoring efforts, status of funding, outcomes from the Adaptive Management Workshop, and any recommended changes to the AMMP.

Planning Team recommendations could include, changes to existing criteria or identification of new criteria, implementation of special studies, or implementation of an AM measure to correct unsatisfactory conditions. All recommendations will be based on information that was learned during the Adaptive Management Workshop and the Technical Team's assessment of whether the project met the criteria established in this AMMP.

Below are disciplines to be represented on the Planning Team. Additional support staff and disciplines would be added as necessary to address specific team needs.

- U.S. Bureau of Reclamation (Lead Agency)
    - Project Manager
    - Fisheries Biologist
    - O&M/Hydraulic Engineer

- U.S. Fish and Wildlife Service
    - Fisheries Biologist
    - Consultation Biologist

- U.S. Army Corps of Engineers
    - Project Manager
    - Fisheries Biologist/Environmental Specialist
    - Hydraulic Engineer

5.2.4 Other Technical Team and Planning Team Considerations

5.2.4.1 Physical and Hydraulic Criteria vs. Biological Criteria

There could be a scenario where the Lower Yellowstone Fish Passage Project is meeting biological criteria but is failing to meet physical and hydraulic criteria. In this instance additional studies would be recommended to determine a cause. If a cause is identified, the Planning Team may or may not recommend an adaptive management measure to address the shortcomings of the physical and hydraulic criteria. Providing fish passage is the main priority of the project, so if the project is

passing at least 85% of motivated adults there may not be a need to modify the bypass channel. In this case, the Planning Team and the Executive Team will need to weigh the risks of modifying the bypass channel in a way that could be detrimental to existing passage success.

Long-term, if physical and hydraulic parameters continue to fall below criteria and fish passage is still occurring, the following will need to be considered:

- What is the cause of not meeting physical and hydraulic criteria?
- Does not meeting physical or hydraulic criteria happen every year or is it runoff dependent?
- Are the measured bypass channel physical and hydraulic parameters changing each year or have they stabilized?
- Does not meeting physical and hydraulic criteria jeopardize the integrity or the design of the bypass channel?
- Are the physical and hydraulic criteria still appropriate? Should they be changed?

If fish passage continues to achieve biological criteria described in this AMMP and the bypass channel integrity is not compromised, then the Planning Team and the Executive Team may consider revising or changing the physical and hydraulic criteria that were established by the USFWS' BRT.

5.2.4.2 Adult Pallid Sturgeon Criteria vs. Juvenile Pallid Sturgeon Criteria

Similar to the scenario described above, there is a possibility that adult pallid sturgeon passage is meeting, or exceeding biological criteria described in the AMMP, but there is a lack of juvenile pallid passage. In this scenario, increased monitoring efforts or special studies to help determine a cause would be recommended. If a cause is identified the Planning Team may or may not identify an adaptive management measure for implementation. Providing fish passage for the motivated adults will be prioritized over juvenile passage, as access to upstream spawning grounds by adults could be the key to natural recruitment in the upper basin. In this case, the Planning Team and the Executive Team will need to weigh the risks of modifying the bypass channel in a way that could be detrimental to existing adult passage success.

Long-term, if juvenile passage continues to be an is issue, the following will need to be considered:

- What is the cause?
- Is lack of passage consistent from year to year or is it runoff dependent?
- Does not passing juvenile pallid sturgeon negatively affect the population?
- Are juvenile pallid sturgeon motivations understood?
- Are juvenile pallid sturgeon swimming abilities different than the adults?
- Should juvenile criteria be changed or reconsidered?
- Does a special study need to be designed and implemented?

If juvenile fish passage continues to under achieve but adult criteria continue to be met, then the Planning Team and the Executive Team may consider revising or changing juvenile objectives.

5.2.4.3 Small Passage Numbers

As described in the USFWS' BRT biological criteria (USFWS 2016) approximately 12 – 26 % of reproductive adult pallid sturgeon have been historically motivated to move upstream to Intake Diversion Dam. Depending on the size of the tagged population, which varies from year to year, this could result in very few radio-tagged fish moving upstream to the Lower Yellowstone Fish Passage Project. During 2015 to 2018, Rugg et al. (2019) documented an average of 7 radio-tagged wild origin pallid sturgeon (range: 6 – 8) and 10 radio-tagged HOPS (range: 3 – 16) encountering Intake Diversion Dam on a yearly basis. This trend of small numbers of radio tagged fish migrating up the Yellowstone River is expected to continue as it is not feasible to radio-tag and maintain tags on every individual in the population. However, the fish that are tagged are expected to provide a good representation of the entire population both tagged and untagged.

Because there is a relatively small number of fish radio-tagged in the population and an even smaller percentage that migrate upstream to Intake Diversion Dam, there is a possibility that passage rates and success percentages may be skewed in some years. For example, if four adult pallid sturgeon approach the bypass channel and three of those fish successfully passed, that would equate to a passage rate of 75%. This is obviously below the 85% criteria identified in this AMMP; however this may be more of a result from the small number of fish moving upstream than the bypass channel not adequately providing passage. Situations like the one described here need to be carefully considered by the Technical, Planning, and Executive Teams. It will be important to collect multiple years of passage data prior to identification and implementation of an AM measure.

5.2.5 Adaptive Management Workshop

The Adaptive Management Workshop (AM Workshop) will be held each year during the first week of November and will be the forum for presenting the physical, hydraulic, biological and irrigation diversion data that was collected during the field season. This will provide the Technical and Planning teams an opportunity to question, assess and understand the data, as well as, discuss the implications of the monitoring results. This Workshop will also be an opportunity to start planning activities or studies for the upcoming field season.

The Planning Team will be responsible for coordinating and facilitating the yearly AM Workshop. The Adaptive Management Workshop is expected to be one to two days in length and will be attended by field staff, Technical Team, and Planning Team members. After the AM Workshop, the Planning Team will get together to discuss what was learned during the workshop and begin to formulate recommendations for the Executive Team to consider.

6 Decision/Governance

This step in the process represents AM decision-making based on the current level of understanding, the best available science, and anticipation of consequences from the decisions being made. Throughout the AM process there will be decisions made every day, with the majority of them being focused on yearly monitoring logistics. These decisions can be made within the Planning Team and do not need to be elevated to a higher level. However, there will be times when significant decisions, such as changing the AMMP criteria or implementation of an AM measure for instance need to be made. These decisions can only be made by the Executive Team.

6.1 Executive Team

The Executive Team is made up of decision-making officials that have the authority to make program and budget related decisions. The Executive Team will consist of the following:

- U.S. Bureau of Reclamation – Delegated Official (Lead Agency)
- U.S. Fish and Wildlife Service – Delegated Official
- U.S. Army Corps of Engineers – Delegated Official

Each year after the Adaptive Management Workshop, the Planning Team will provide a written summary report and a briefing to the Executive Team. This report and briefing will include an overview of monitoring results, whether the project is meeting criteria defined in this AMMP, and any recommendations that the Executive Team needs to consider. The Executive Team's final decision on recommendations and any implementation guidance will be provided to the Technical Team via memo for planning and implementation.

The executive Team, will consider the following when deciding on the Technical Team's recommendation(s):

- Funding/staffing levels
- Agency authorities
- Contribution to science
- Timeframes
- Effects to pallid sturgeon
- Effects to the operation and maintenance of the Lower Yellowstone Project

6.2 Agency Roles, Responsibilities and Funding

Reclamation and the USACE signed a Memorandum of Agreement (MOA), April 7, 2015 outlining each agencies' roles and responsibilities as it pertains to this AMMP. The MOA states the following:

6.2.1 Bureau of Reclamation

Using its own funds, or funding identified through partnerships or contractual agreements, Reclamation shall perform the following activities:

- Develop an action specific Adaptive Management and Monitoring Plan in consultation with the USACE, the USFWS, and MTFWP.
- Provide funding and coordinate post-construction adaptive management and monitoring consistent with applicable success criteria specified by the BRT, conferred by the USFWS, and agreed upon by Reclamation for any Adaptive Management and Monitoring plan modifications.
- Provide Reclamation staff to lead and execute implementation of any Adaptive Management and Monitoring Plan. Implementation will consist of establishing a Technical Team, and Executive Managers who will coordinate and recommend appropriate strategies for any actions as a result of implementing the Adaptive Management and Monitoring Plan. Such recommended action may be carried out with the approval of the parties.
- Coordinate the execution of operation and maintenance activities consistent with Reclamation's obligations through ESA consultation with the USFWS for continued operation of the Lower Yellowstone Project. Operation and maintenance of the new headworks and screens; as well as the fish passage, will commence on each feature as the physical construction of each feature is completed or at the date that feature is deemed substantially complete and put into service and the one year construction warranty on the feature starts. Warranty covers issues related to construction defects. If the defect is caused by O&M activities, then it would not be covered under warranty. Operation and maintenance activities will be conducted concurrent with the Adaptive Management and Monitoring Plan.
- Additional responsibilities as designated and described further in any Adaptive Management and Monitoring Plan, to the extent not inconsistent with the MOA dated April 7, 2015.

In addition to the commitments in the MOA, Reclamation recognizes there may be adaptive management measures or additional monitoring that the Technical or Executive teams believe would be beneficial to implement in response to monitoring or other data, which are not planned in Reclamation's budget (i.e., action that should be implemented with some immediacy). To address this, Reclamation plans to provide additional funding for these measures through transfers or other means within existing authorities.

Historically, Reclamation's annual appropriations bill has included authority to perform fund transfers. Based on current authority, a fund transfer may be performed to provide "up to $300,000 for any program, project, or activity for which less than $2,000,000 is available at the beginning of

the fiscal year." The Lower Yellowstone Fish Passage Project falls into this category and could benefit from this authority in the year of execution, provided that funds are available for transfer.

Reclamation has used its authority to fund these types of unanticipated monitoring and investigations associated with pallid sturgeon entrainment monitoring and passage planning activities over the last several years. As an example, Reclamation used the fund transfer authority in FY2016 to provide an additional $229,000 to the Project's enacted level of $380,000 resulting in total funding of $609,000 for Project use. Because the benefits of this monitoring, data gathering, and analysis are not limited to the Project, expenditure of these funds is considered non-reimbursable.

6.2.2 U.S. Army Corps of Engineers

Consistent with its authority under Section 3109 of WRDA 2007, P.L. 110-114 and using its own funds, the USACE shall:

- Demonstrate and ensure that project design and hydraulic performance criteria have been met. In coordination with the USFWS and Reclamation, develop the monitoring and measurement plan that will be used to verify that the completed construction project meets the design and hydraulic performance criteria. The Plan shall include measurement of flow split to the bypass channel, bypass channel depth, and bypass channel velocity within the range specified in the design criteria. Additionally, the plan shall account for uncertainty and inherent variability of flow conditions in the bypass channel.
- The USACE, in coordination with Reclamation, will complete any construction modifications required to meet the design and hydraulic performance criteria (i.e. correction of any design and/or construction related deficiencies) identified within the one-year warranty period after substantial completion.
- Additional responsibilities as designated and described further in any Adaptive Management and Monitoring Plan, to the extent not consistent with the MOA dated April 7, 2015.

6.2.3 Lower Yellowstone Irrigation Project Joint Board of Control (LYBOC)

Reclamation constructed the LYP under the authority of the Reclamation Act/Newlands Act of 1902 (Public Law 161; Act). The Act authorized development of irrigation projects to establish farms in the western United States. As is the case for most authorized Reclamation projects, the long-term operation, maintenance, and rehabilitation of project facilities is the responsibility of the water users. Reclamation retains ownership of the LYP facilities, and O&M is carried out by the LYBOC under contract with Reclamation.

Under the authority of Section 5 of the Reclamation Extension Act of August 13, 1914 and subsection nine (9) of the December 5, 1924 Fact Finders' Act, O&M of the diversion and supply works were transferred to the two Lower Yellowstone districts in 1926, to Intake Irrigation District in 1945, and to Savage Irrigation District in 1951. The LYBOC is required to maintain the transferred works in full compliance with Reclamation law, other federal and state laws, and the regulations of the Secretary of the Interior. By policy, Reclamation is required to inspect the facilities every six years. Should the Districts fail to maintain the facilities, Reclamation could resume O&M and charge the LYIP for the cost of O&M.

It is assumed that once construction of the Lower Yellowstone Fish Passage Project is complete, the operation, maintenance, and rehabilitation of all features including the bypass channel, replacement weir, and the screen headworks will be the responsibility of the LYBOC.

6.3 Four- and Eight-Year Review of AMMP and Objectives

This is the first and only known fish passage project specific to the endangered pallid sturgeon. There was no previously established passage design or biological criteria, instead, the criteria and objectives in this AMMP were based on the best available science. The physical and hydraulic criteria for the bypass channel are based on measured conditions in natural side channels on the lower Yellowstone River that pallid sturgeon have used for upstream migration (Braaten et al. 2015; USFWS 2014). The biological criteria are based on telemetry data collected from 2011 – 2015 and a passage event through the historic natural side channel around Joe's Island in 2014 (USFWS 2016). Although these criteria are based on the best available science, there is some uncertainty about whether the criteria will remain appropriate or if they need to be changed based on new science and monitoring efforts described in this AMMP.

After four- and eight- years of monitoring, the Planning Team in coordination with the Executive Team will facilitate an independent review of the AMMP and the following elements:

- Physical and Hydraulic Monitoring Plans
- Physical/Hydraulic Criteria and Objectives
- Biological Monitoring Plans
- Biologic Criteria and Objectives
- Irrigation Diversion Monitoring Plan
- Irrigation Diversion Criteria and Objective
- AM Process/Cycle

Once the independent review is completed, the recommendations will be provided to both the Planning Team and Executive Team for consideration. As with many other elements of this plan, the Executive Team has the final say and approval of any major changes to this AMMP. Such changes may require additional compliance with NEPA, ESA, CWA, or other environmental laws.

7 Reporting

7.1 Monitoring Plans

There will be several annual reporting requirements associated with this AMMP. The first reporting requirement will be the yearly monitoring plans. The Technical Team will begin formulating these plans in January of each year with the final plan being in place by March of each year. The monitoring plans will include:

1) Scope and timeline of activities
2) Agency conducting each monitoring activity
3) Goals and objectives of that years monitoring activities
4) Description of any special studies (if necessary)
5) Estimated costs of each activity.

By developing yearly monitoring plans, it ensures Reclamation has the appropriate resources (funding and staff) in place to effectively monitor project criteria. Once completed, these plans will be shared with the USFWS prior to the start of the field season.

7.2 Adaptive Management Workshop – Executive Team Decision

The second reporting requirement will be a brief synopsis of the Adaptive Management Workshop, Planning Team recommendations and the Executive Team's decision on recommendations. These are very critical pieces in the adaptive management process as it shows 1) the recommendations and thoughts of the Technical Team and Planning Team based on the analysis of field data that was collected and 2) the decision(s) made by the Executive Team whether to implement the recommendations. The Planning Team will be responsible for compiling this report which will be completed in December of each year. This report will line out the following items:

1) Overview of Adaptive Management Workshop
2) Overview of monitoring results
3) Overview of whether criteria were met
4) Proposed criteria changes (if necessary)
5) Proposed AM measure (if necessary)
6) Executive Team decision

7.3 Yearly Adaptive Management and Monitoring Report

The final reporting requirement is the yearly adaptive management and monitoring report that will be provided to the USFWS. This report will be a joint effort by the field staff, Technical Team, and Planning Team. Once finalized, the report will be shared with the USFWS no later than March 1st each year. The final adaptive management and monitoring report will include:

1) Synopsis of the monitoring results from the four main components of the AMMP;
    a. Hydraulic/physical monitoring
    b. Biological monitoring
    c. Native species monitoring.
    d. Irrigation diversion monitoring
2) Discussion on whether AMMP criteria were met or not. If not, why.
3) Any recommendations by either the Planning or Executive Teams for changes to monitoring or management actions as necessary.
4) Description of any monitoring plan changes for the following field season or any special studies (i.e. larval release) that may be warranted outside the yearly monitoring described in this document.
5) Summary of Incidental Take monitoring results identified in the Biological Opinion.

All three reports will be posted on Reclamations Montana Area Office's website which can be found at: https://www.usbr.gov/gp/mtao/loweryellowstone/.

8 Data Management

Monitoring of the four components of the project (hydraulic/physical criteria, biological criteria, native species, irrigation diversion) will require a large amount of data to be collected in a very short amount of time. Monitoring will also include several different sets of crews collecting different types of information.

Reclamation will be the primary keeper of all data and any requests for current or past data should be directed to the Adaptive Management lead for Reclamation.

All monitoring data will be stored electronically on a secured server maintained by Reclamation and will comply with Reclamation's data stewardship guidelines. All data collected by contractors will be provided to Reclamation in an agreed upon electronic format. Additionally, contractors will provide hard copies of any field notes or data sheets. Upon completion of the Monitoring and Adaptive Management Program, all data, results of analysis, and reports will be archived.

9 Bypass Channel Physical and Hydraulic Monitoring

This section is intended to provide a high-level overview of anticipated efforts for monitoring the hydraulic and physical criteria. Yearly monitoring plans with more specific details will be developed and agreed upon by the Technical Team prior to the start of each field season. For consistency, the downstream end to the bypass channel will be known as the "bypass channel entrance" and the upstream end will be known as the "bypass channel exit." The physical and hydraulic objectives and criteria are:

Objective 1: Construct and maintain appropriate physical and hydraulic criteria parameters that allow improved pallid sturgeon passage.

- **Criteria 1a – Bypass Channel Cross-sectional Depth**
    1) Minimum depths in fish passageway measured at the lower discharge range of 7,000 cfs to 14,999 cfs at any sampled cross-section must be greater than or equal to 4.0 feet across 30 contiguous feet of the measure channel cross section profile.
    2) Minimum depths in fish passageway measured at the lower discharge range of 15,000 cfs to 63,000 cfs at any sampled cross-section must be greater than or equal to 6.0 feet across 30 contiguous feet of the measure channel cross section profile.

- **Criteria 1b – Bypass Channel Cross-sectional Velocities**
    1) Mean cross-sectional velocities must be greater than or equal to 2.0 feet/second, but less than or equal to 6.0 feet/second over the discharge range of 7,000 cfs to 14,999 cfs.
    2) Mean cross-sectional velocities must be greater than or equal to 2.4 feet/second, but less than or equal to 6.0 feet/second over the discharge range of 15,000 cfs to 63,000 cfs.

- **Criteria 1c – Bypass Channel Flow Split**
    1) Greater than or equal to 12% over the discharge range of 7,000 cfs to 14,999 cfs
    2) 13% to greater than or equal to 15% over the discharge range of 15,000 cfs to 63,000 cfs.

- **Criteria 1d – Bypass Channel Fish Entrance and Exit**
    1) Mean cross-sectional velocity of greater than or equal to 2.0 ft/s (measured as mean column velocity for the range of 7,000 cfs to 14,999 cfs.
    2) Mean cross-sectional velocity of greater than or equal to 2.4 ft/s (measured as mean column velocity) for the range of 15,000 cfs to 63,000 cfs.
    3) Mean cross-sectional velocities (measured as mean column velocity) at both the upstream and downstream opening should be less than or equal to 6.0 ft/s for the range of 7,000 cfs to 63,000 cfs.

The physical and hydraulic criteria are split into two different discharge ranges (Table 3). The range of 7,000 cfs – 14,999 cfs typically corresponds with pre- and post- pallid sturgeon migration, while 15,000 cfs – 63,000 cfs would correspond to runoff and the time pallid sturgeon would be migrating upstream in the Yellowstone River. Flow conditions and the discharge range will be determined by the USGS stream gauge at Sidney, Montana (USGS 06329500).

Table 3: BRT Physical and Hydraulic Design Criteria

Discharge at Sidney, Montana USGS Gauge	7,000 – 14,999 ft^3/s	15,000 – 63,000 ft^3/s
Bypass Channel Depth (minimum cross-sectional depth for 30 contiguous feet measured cross-section)	≥ 4.0 ft	≥ 6.0 ft
Bypass Channel cross-section velocities (measured as mean column velocity)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Flow Split	≥ 12%	13% to ≥ 15%
Bypass Channel Fish Entrance (measured as mean column velocity at HEC-RAS Station 136)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Fish Exit (measured as mean column velocity)	≤ 6.0 ft/s	≤ 6.0 ft/s

9.1 Sampling Cross-sections

Monitoring of the bypass channel physical and hydraulic criteria will begin the first full season after the completion of construction. To measure the above criteria, an Acoustic Doppler Current Profiler (ADCP) will be deployed in the bypass channel and the Yellowstone River at fourteen established cross-sections (Figure 11) that will be monitored for the life of the project. The exact locations of each cross-section will be established during the first year of monitoring but are generally located at (Table 4):

Table 4: Location of Physical and Hydraulic Monitoring Cross-sections

Cross-section #	Location - Construction Station
1	2+00
2	4+50
3	13+00
4	23+00
5	33+50
6	45+00
7	56+00
8	71+50
9	79+00
10	87+00
11	97+00
12	105+00
13	109+00
14	Yellowstone River Mile 74

In addition to the fourteen established cross-sections, six random cross-sections will also be taken each sampling trip. These random cross-sections will be based on data needs and potential studies that are on-going at the time of sampling. If biological monitoring identifies passage problems, additional cross-sections beyond the twenty cross-sections described here may be collected on an as needed basis.

Measurements at all twenty cross-sections will be taken the same day at approximately the same flow condition to ensure consistency among measurements. Once the field data is collected it will then be analyzed to determine if the bypass channel is meeting the AMMP criteria.

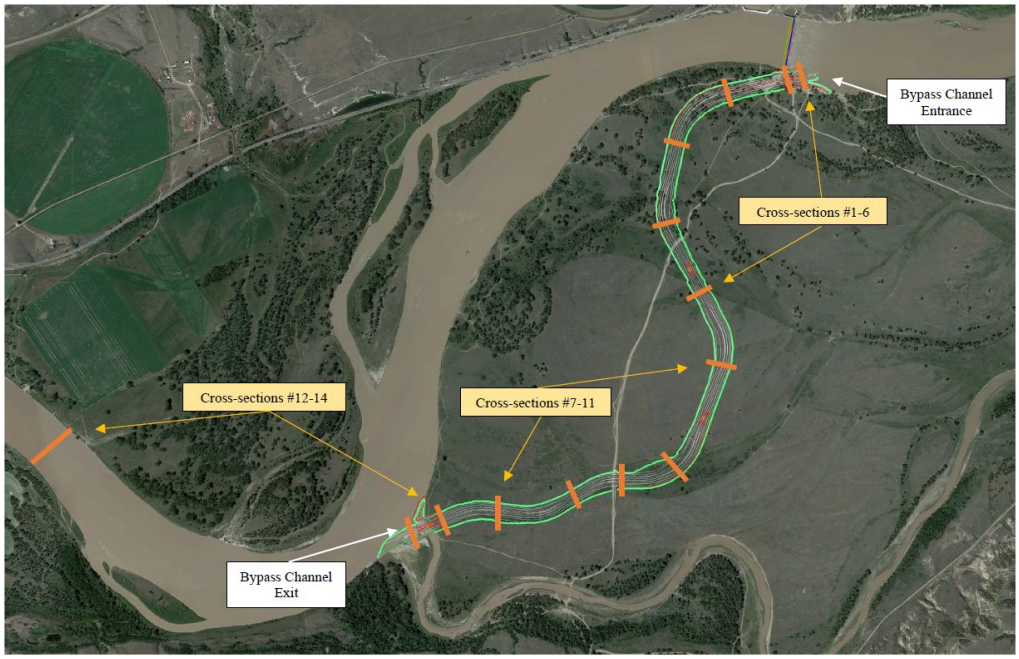

Figure 11: Cross-section Locations for Bypass Channel Physical and Hydraulic Objectives

The ADCP will be deployed by boat or line across the bypass channel and Yellowstone River at the established cross-sections several times throughout the field season from April 1 – October 31. The intent is to document flow split, depth, and velocity conditions throughout the year and during the three different flow conditions typically experienced on the Yellowstone River. The cross-sections will be measured at least twice during each of the following flow conditions:

- Pre-runoff (April – May) - 10,000 cfs – 20,000 cfs
- Runoff (June – July) – >20,000 cfs
- Post-runoff or Summer Baseline (August - October) – 5,000 cfs – 10,000 cfs

Pallid sturgeon are primarily migrating in and around the Intake Diversion Dam area between April – early July during the Pre-runoff and Runoff time frames. If crews notice a high concentration of pallid sturgeon entering and using the bypass channel the ADCP could be deployed more often to learn more about the desired hydraulic conditions for pallid sturgeon passage. In addition, the ADCP could be used to evaluate known congregations (determined through telemetry data) within

the bypass channel where upstream migration may be hindered due to undesirable hydraulic conditions.

If at any time during the field season crews note that the bypass channel criteria are not being met, additional ADCP data will be collected to look for irregularities with flows, depths, and velocities within the bypass channel. This data would then be available for the Technical Team during the Adaptive Management Workshop in the fall.

9.2 Timeline

Physical and hydraulic monitoring is anticipated to be more intensive during the first four years of operation. This will allow Reclamation and the USACE to understand how the bypass channel is functioning over a wide range of flows. As time goes on, the physical and hydraulic monitoring will be scaled back to the critical times of the year when pallid sturgeon are present in the area or after a high flow/ice event. This strategy is reflected in the timeline below (Table 5).

As mentioned in the Agencies Roles and Responsibilities section of this plan, the USACE will be responsible for the first year of physical and hydraulic monitoring then Reclamation and the LYBOC will be responsible for monitoring activities for the life of the project.

Table 5: Timeline for Physical and Hydraulic Monitoring Activities

Year (Post Const.)	Monitoring Frequency	Responsible Entity
1	Pre-runoff (April – May) Runoff (June – July) Summer Baseline (August – October)	USACE
2-4	Pre-runoff (April – May) Runoff (June – July) Summer Baseline (August – October)	Reclamation - LYBOC
4	Independent Review	Reclamation, Technical Team, and Executive Team
5-8	Pre-runoff and Runoff (April - June) After Major Flood/Ice Event (April or August)	Reclamation - LYBOC
8	Independent Review	Reclamation, Technical Team, and Executive Team
8+	Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of hydraulic and physical monitoring.	Reclamation - USFWS

10 Biological Monitoring

This section is intended to provide a high-level overview of anticipated efforts for monitoring the biological criteria. Yearly monitoring plans with more specific details will be developed and agreed upon by the Technical Team prior to the start of the field season.

The biological objectives and criteria are as follows:

Objective 2: Improve upstream and downstream passage of pallid sturgeon

- **Criteria 2a – Upstream Adult Passage**
  - Greater than or equal to 85% of motivated adult pallid sturgeon (fish that move up to the weir) annually pass upstream of the weir location during the spawning migration period (April 1 to June 15) within a reasonable amount of time without substantial delay (≥0.19 miles/hour).

- **Criteria 2b – Upstream Juvenile Passage**
  - No criteria set – develop decision criteria to trigger adaptive management options to improve passage for juveniles, if the lack of juvenile passage is demonstrated to result in negative population level effects.

- **Criteria 2c – Downstream Adult and Juvenile Passage**
  - Mortality of adult and juvenile pallid sturgeon that migrate downstream of the weir location cannot exceed 1% annually during the first 10 years. Document any injury or evidence of adverse stress.

- **Criteria 2d – Downstream Free Embryo and Larval Passage**
  - No criteria set - Assess impingement and entrainment of free embryos, larvae, and young-of-the-year sturgeon at headworks screens, irrigation canal, and downstream of the weir location.

10.1 Upstream Adult Passage Monitoring (Criteria 2a)

Pallid sturgeon considered to be adults under these criteria include:

- All wild adult pallid sturgeon
- HOPS that are captured and determined to reproductively active
- HOPS that have had at least one known reproductive cycle

An adult pallid sturgeon will be considered "motived" if it is migrating upstream in the Yellowstone River and comes within one mile of the bypass channel. This one-mile threshold will be monitored by a land-based telemetry station maintain by Reclamation (Figure 12).

10.1.1 Tracking and Movement Data

Monitoring of adult upstream passage will begin in the first full season after the completion of the bypass channel construction. Fish movements will be monitored by both manual tracking via boats and by land-based telemetry stations located along the Yellowstone River within the Project Area. The land-based telemetry stations will be deployed each March after ice-off and will be removed in November of each year. The locations of the land-based telemetry stations within the immediate Project Area include (Figure 12):

1) One mile downstream of bypass channel entrance
2) Bypass channel entrance
3) 5,500 ft upstream from bypass channel entrance
4) Bypass channel exit
5) One mile upstream of bypass channel exit
6) Old headworks structure

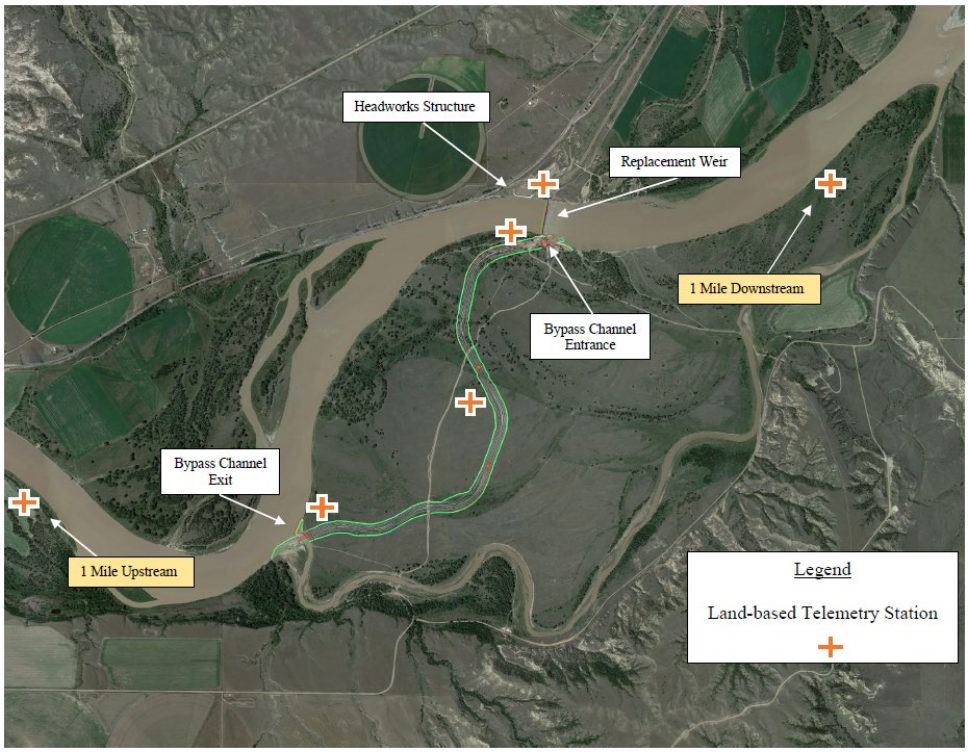

Figure 12: Approximate Locations of Land-based Telemetry Stations in Project Area

The long-range movements of fish outside of the immediate project area will be tracked by the 12 other land-based telemetry stations located on the Yellowstone, Powder, and Tongue rivers (Figure 13).

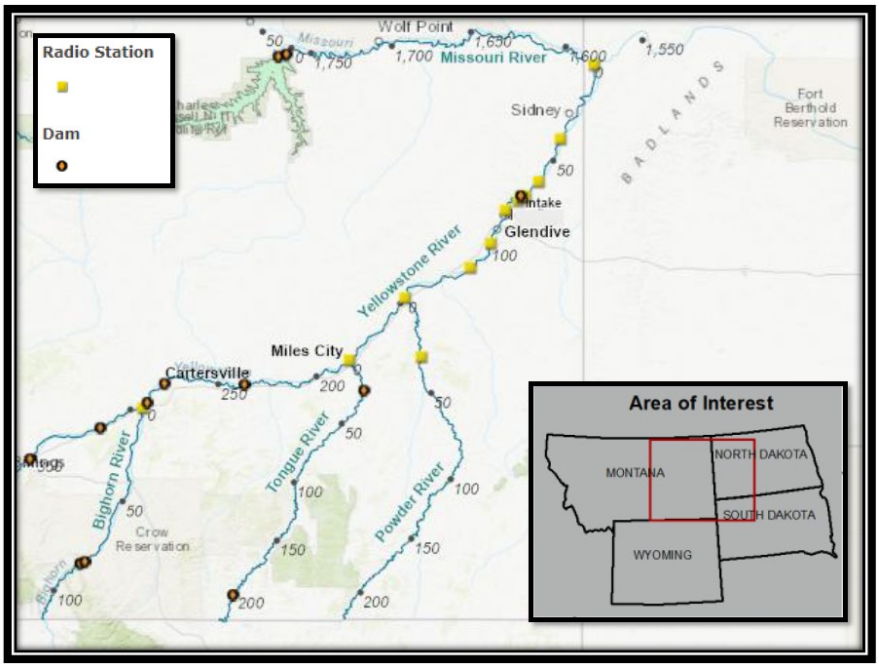

Figure 13: Land-based Telemetry Stations on the Yellowstone, Tongue, and Power Rivers (Source MTFWP 2019)

Because land-based telemetry station data only indicates when a fish is present near the station, manual tracking via boat will be used to supplement the data collected on fish moving through the Project Area. This supplemental information will include exact locations and routes through the bypass channel to better understand what depths, velocities, and other physical factors influence passage success. Manual tracking will also show problem areas where fish may be stalled out either in the Yellowstone River or within the bypass channel. Manual tracking of fish will take place from April – August of each year.

Generally, Reclamation will be responsible for maintaining the land-based radio telemetry stations and tracking pallid sturgeon from the Rock (River Mile [RM] 60) station to the station located one mile upstream of the bypass channel exit. Pallid sturgeon monitoring upstream and downstream of that area will be the responsibility of USGS and MTFWP crews. Although tracking will be handled by different agencies, data sharing and communication will be critical as these fish migrate upstream and downstream in the Yellowstone River.

To ensure this population of pallid sturgeon can be tracked on a yearly basis, MTFWP, USGS, USFWS, and Reclamation capture and implant radio-tags into adult and juvenile pallid sturgeon each year. This effort is expected to increase with a dedicated two-week effort each spring or fall to ensure a representative proportion of the population is tagged and can be tracked every year. Radio-tag battery life runs anywhere from 1 year in yearlings to 5-6 years in adults. To ensure fish are being retagged prior to the battery dying, Reclamation will work with USGS, USFWS, and MTFWP to develop a "priority list" each year that will line out the priority of each fish and when it should be retagged. Also, during this effort field crews will target fish that have not been tagged previously to ensure a broad sample of the population is being tracked on a yearly basis.

Not all adult pallid sturgeon in the upper Missouri and lower Yellowstone rivers are radio-tagged and can be tracked. To account for untagged fish encountering the bypass channel, field crews may consider deploying hoop nets or PIT tag arrays. Large hoop nets could be deployed at strategic locations such as outside bends to sample all fish species utilizing the bypass channel. These nets can be fished for several hours and can be pulled prior to a tagged individual entering the bypass channel. A PIT tag array could also be deployed near the entrance and exit of the bypass channel; however, this would also require a change in PIT tags that are currently being utilized in the upper basin. Long-term, PIT tags may become a less expensive option than trying to maintain a robust radio-tagged population, especially as thousands of HOPS are nearing sexual maturity.

As discussed under Assessment (Section 5.2) the Project Area will be broken into 4 segments to determine success in each phase of passage. The telemetry station one mile downstream of the bypass channel will determine how many fish are motived and approach the bypass channel. The telemetry station at the bypass channel entrance will determine how many fish successfully find and navigate the entrance to the bypass channel. The station located in the middle of the bypass channel and at the bypass channel exit will help determine how many fish successfully navigated the entire length of the bypass channel. The station located one mile upstream of the bypass channel will help determine how many fish successfully completed passage and how many continued their upstream migration. While extremely rare, there is also a chance fish decide to migrate upstream over the existing rock field, Intake Diversion Dam, and replacement weir. These fish will be monitored by the land-based telemetry station located on the old headworks structure.

10.1.2 Movement Rates

Movement rates of pallid sturgeon approaching, finding, entering, and continuing through the bypass channel will be tracked by a combination of land-based telemetry stations and manual boat tracking by Reclamation crews. Baseline movement rates of pallid sturgeon will be determined by the rate at which each fish moved from the Rock telemetry station (RM 60) to the telemetry station located one mile downstream of the bypass channel (RM 70). This baseline rate will be compared to the rate of travel through the entire Project Area as well as in each of the following segments (Figure 14):

- One mile downstream to the entrance of the bypass channel (Segment 1)
- Bypass channel entrance to construction station 52+00 (Segment 2)
- Construction station 52+00 to bypass channel exit (Segment 3)
- Bypass channel exit to one mile upstream (Segment 4)

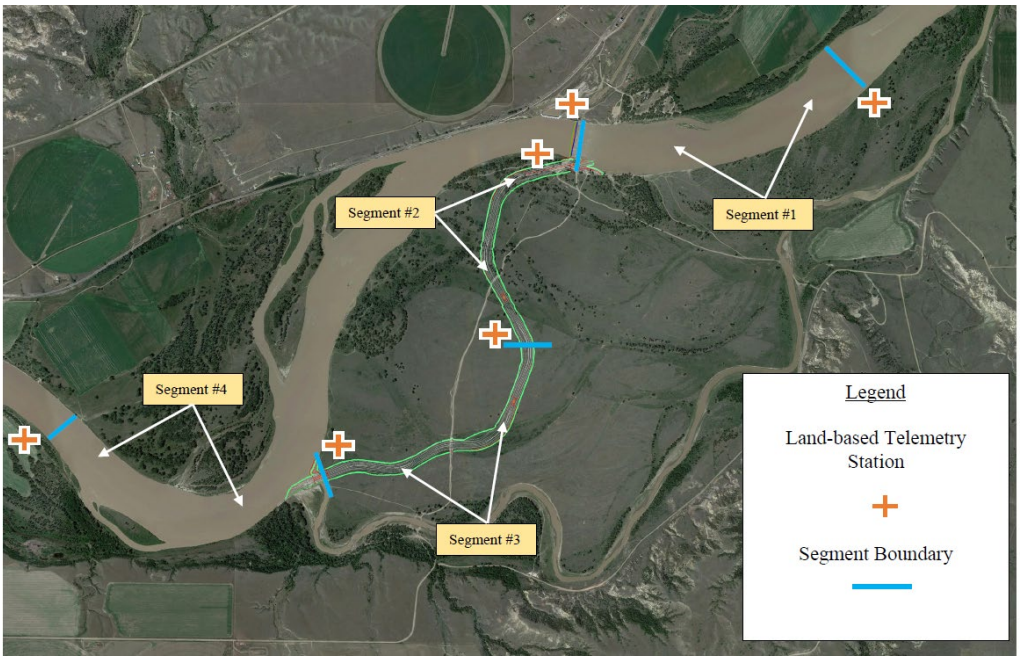

Figure 14: Bypass Channel Monitoring Segments

By breaking the bypass channel into different segments, it will offer insight to potential passage issues in the bypass channel. The overall travel time and rate will also be calculated and compared to the initial baseline rate.

10.1.3 Sexual Maturity and Reproductive Assessments

The majority of reproductively active adult HOPS captured between 2009 and 2019 were greater than 800 mm, with only 2 out of 36 females and 1 out of 73 males being less than 800 mm at the time of capture (USFWS 2020). With this information, it's reasonable to assume that any HOPS greater than 800 mm has a chance to be a reproductively active adult. To account for this, all HOPS greater than 800 mm in length and actively migrating upstream in the Yellowstone River will be captured and assessed for sexual maturity and reproductive condition.

To determine reproductive condition blood samples will be collected and sent off for sex steroid analysis which helps identify sex of the fish and determine if a fish is reproductively active that year. Blood samples are not always 100% accurate and the wait time on the results can be weeks or longer. To offset this delay, field crews will utilize a mobile ultrasound machine to do visual inspections of each fish. This device will be used to look for sex organs and the presence of eggs in females. This will give field crews real-time data on what sex the fish might be and if the fish is sexually mature.

Crews also maintain data sheets on all fish with a radio-tag that contain data such as, length, weight, sexual maturity status, sex, and spawning periodicity. Spawning periodicity information can help inform field crews whether a fish is reproductively active in a given year without ever having to draw blood or handle the fish. This information is extremely important to crews so they can understand

movements and prioritize which fish need to be tracked more closely than other (higher priority given to reproductively active fish, especially females).

10.1.4 Timeline

Reclamation and the LYBOC will be responsible for all biological monitoring after the construction of the bypass channel is complete. This monitoring is expected to last at least eight years. After eight years Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of adult pallid sturgeon upstream monitoring. This will include any changes that may be needed to this document or current monitoring plans (Table 6).

Table 6: Timeline for Adult Biological Monitoring

Year (Post Const.)	Monitoring Description	Responsible Entity
1 - 4	Monitor adult migrations within the Yellowstone River and the bypass channel via land-based radio telemetry stations and manual tracking by field crews.	Reclamation - LYBOC
4	Independent Review	Reclamation, Technical Team and Executive Team
5-8	Monitor adult migrations within the Yellowstone River and the bypass channel via land-based radio telemetry stations and manual tracking by field crews.	Reclamation - LYBOC
8	Independent Review	Reclamation, Technical Team and Executive Team
8+	Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of adult pallid sturgeon upstream passage monitoring.	Reclamation - LYBOC

10.2 Upstream Juvenile Passage Monitoring (Criteria 2b)

Unlike adults, juvenile pallid sturgeon motivations are not well understood. Juvenile fish are likely to be in search of food and foraging habitat that could exist anywhere in the system, rather than upstream spawning habitat. This distinct difference is noted in the BRT Criteria where no criteria was set for juvenile fish. Instead the BRT made the following recommendation:

> *"The Service acknowledges upstream passage for juvenile pallid sturgeon is likely biologically important, but that current data are insufficient to understand overall juvenile motivation and evaluate the need for passage to meet life history requirements and maintain viable populations. Thus, field and laboratory swimming capacity studies are recommended to evaluate the capability of juveniles to negotiate passage alternatives and to assess if juvenile passage is reasonably expected to occur.*
>
> *Field and laboratory studies are needed to assess the motivation of juveniles to use passage alternatives and population-level studies are required to assess whether passage would benefit condition, growth, and survival of juveniles. Additionally, the Service recommend that decision criteria be developed that would trigger adaptive management options to improve passage for juveniles if lack of juvenile pallid sturgeon passage is demonstrated*

to result in negative population level effects (for example, poor condition, impaired growth, delayed maturation, or reduced survival). If juveniles are negatively impacted by lack of or impeded passage, then the effects of the passage project should be reexamined.

Pallid sturgeon considered to be juveniles under these criteria include:

- HOPS that are captured and determined to not be reproductively active
- HOPS that have not had at least one known reproductive cycle.

10.2.1 Tracking and Movement Data

Monitoring of juvenile fish passage will begin in the first full season after the completion of the bypass channel construction. Juvenile fish passage will be monitored by both manual tracking efforts by field crews and by land-based telemetry stations located along the Yellowstone River and within the project area (Figure 12 and Figure 13).

MTFWP, USGS, USFWS, and Reclamation capture and implant radio-tags into adult and juvenile pallid sturgeon each spring. This effort is expected to increase with a dedicated two-week effort each spring or fall to ensure a portion of the population is tagged and can be tracked every year. To ensure fish are being retagged prior to the battery dying, Reclamation will work with USGS, USFWS, and MTFWP to develop a "priority list" each year that will line out the priority of each fish and when it should be retagged. Also, during this effort field crews will target fish that have not been tagged previously to ensure a broad sample of the population is being tracked on a yearly basis.

Like the adult monitoring, the telemetry station located one mile downstream of the bypass channel entrance will be used to establish the number of juvenile pallid sturgeon migrating upstream into the Project Area in any given year. The telemetry stations at the bypass channel entrance, within the bypass channel, and at the bypass channel exit will help determine if pallid sturgeon passage is successful through the bypass channel and how long it took. The station located one mile upstream of the bypass channel will confirm how many radio-tagged fish successfully migrated through the project area and continued their upstream migration. While extremely rare, there is also a chance fish decide to migrate upstream over the existing rock field, Intake Diversion Dam, and replacement weir. These fish will be monitored by the land-based telemetry station that is located on the old headworks structure.

Because land-based telemetry station data only indicates when a fish is present near the station, mobile tracking will be used to supplement the data collected on fish moving through the Project Area. This supplemental information will include exact locations and routes through the bypass channel to better understand what depths, velocities, and other physical factors influence passage success. Manual tracking will also show problem areas where fish may be stalled out either in the Yellowstone River or within the bypass channel.

Not all juvenile pallid sturgeon in the upper Missouri and lower Yellowstone rivers are radio-tagged and can be tracked. To account for untagged fish encountering the bypass channel, field crews may consider deploying hoop nets or PIT tag arrays. Large hoop nets could be deployed at strategic locations such as outside bends to sample all fish species utilizing the bypass channel. These nets

can be fished for several hours and can be pulled prior to a tagged individual entering the bypass channel. A PIT tag array could also be deployed near the entrance and exit of the bypass channel; however, this would also require a change in PIT tags that are currently being utilized in the upper basin. Long-term, this may become a less expensive option than trying to maintain a robust radio-tagged population, especially as thousands of HOPS are nearing sexual maturity.

As discussed under Assessment (Section 5.2) the Project Area will be broken into 4 segments to determine success in each phase of passage. The telemetry station one mile downstream of the bypass channel will determine how many fish are motived and approach the bypass channel. The telemetry station at the bypass channel entrance will determine how many fish successfully find and navigate the entrance to the bypass channel. The station located in the middle of the bypass channel and at the bypass channel exit will help determine how many fish successfully navigated the entire length of the bypass channel. The station located one mile upstream of the bypass channel will help determine how many fish successfully completed passage and how many continued their upstream migration. While extremely rare, there is also a chance fish decide to migrate upstream over the existing rock field, Intake Diversion Dam, and replacement weir. These fish will be monitored by the land-based telemetry station located on the old headworks structure.

10.2.2 Movement Rates

Movement rates of juvenile pallid sturgeon approaching the Intake Diversion Dam and through the bypass channel will be tracked by a combination of land-based telemetry stations and manual boat tracking by Reclamation crews. Baseline movement rates of juvenile pallid sturgeon will be determined by the rate at which each fish moved from the Rock telemetry station (RM 60) to the telemetry station located one mile downstream of the bypass channel (RM 70). This baseline rate will be compared to rate of travel through the entire Project Area as well as in each of the following segments (Figure 14):

- One mile downstream to the entrance of the bypass channel (Segment 1)
- Bypass channel entrance to construction station 52+00 (Segment 2)
- Construction station 52+00 to bypass channel exit (Segment 3)
- Bypass channel exit to one mile upstream (Segment 4)

10.2.3 Sexual Maturity and Reproductive Assessments

Blood samples will not be collected from the majority of the fish that are less than 800mm because it is likely they are not sexually mature. However, if a fish is greater than 700mm and supplies are available, blood samples may be collected from these smaller fish. Also, the mobile ultrasound machine will be used to differentiate sex of the juvenile fish.

10.2.4 Timeline

Reclamation and the LYBOC will be responsible for all biological monitoring starting in year 1. If juvenile pallid sturgeon passage is considered a problem or not meeting expectations expressed in

the 2020 Biological Opinion, Reclamation may initiate field/laboratory studies to determine swimming capabilities during years 3 and 4. During year 4 Reclamation and the USFWS will determine if a passage criteria can be identified similar to the adult criteria. If no criteria can be established, Reclamation and the USFWS will discuss what additional data needs are required to establish a criteria.

Juvenile upstream passage monitoring is expected to last at least eight years. After eight years Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of juvenile pallid sturgeon upstream passage monitoring (Table 7).

Table 7: Timeline for Juvenile Biological Monitoring

Year (Post Const.)	Monitoring Description	Responsible Entity
1 – 4	Monitor juvenile pallid sturgeon within the Yellowstone River and the bypass channel via land-based radio telemetry stations and manual tracking by field crews.	Reclamation - LYBOC
3 – 4	Conduct field and laboratory swimming capability studies (if necessary)	Reclamation
4	Establish upstream juvenile passage criteria (if possible)	Reclamation - USFWS
4	Independent Review	Reclamation, Technical Team, and Executive Team
5 – 8	Continue monitoring juvenile upstream passage success	Reclamation - LYBOC
8	Independent Review	Reclamation, Technical Team, and Executive Team
8+	Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of juvenile upstream passage monitoring.	Reclamation - USFWS

10.3 Downstream Adult and Juvenile Passage Monitoring (Criteria 2c)

10.3.1 Tracking and Movement Data

Monitoring of downstream migrating fish over the new weir structure, existing weir structure and rock field will begin in the first full season after the completion of the bypass channel construction. Downstream passage will be monitored by both manual tracking efforts by field crews and by land-based telemetry stations located along the Yellowstone River and within the Project Area.

Downstream passage monitoring will begin with the station located one mile upstream of the of the bypass channel entrance. This will provide a base number of radio-tagged pallid sturgeon attempting to move downstream through the project area.

If pallid sturgeon attempt to move back downstream over the new weir, existing weir, and rock field they will be monitored using the station located on the old headworks structure. The stations within

the bypass channel will detect pallid sturgeon choosing to use the bypass channel to migrate back downstream. The station located one mile downstream of the Project will detect the total number of pallid sturgeon successfully migrating downstream through either path.

Mobile tracking via boat will be used to supplement the land-based stations once fish are detected at the upstream station. This supplemental information will include exact locations/times, depths, velocities, and other physical factors influencing passage. Field crews may also need to capture an individual fish to determine whether mortality or injury occurred during downstream migration through the Project Area.

Although not specifically called out in the BRT criteria, juvenile pallid sturgeon choosing to migrate back downstream through the Project Area will also be monitored the same way as adults. It should be noted that historically when passage has occurred at Intake (through the natural side channel, over the dam, or by translocation), juvenile fish have remained upstream of Intake Diversion Dam for unknown reasons. These fish are thought to be seeking out additional food and foraging habitat and is considered a good thing for the species.

10.3.2 Movement Rates

Movement rates of adult and juvenile pallid sturgeon migrating back downstream through the Project Area will be tracked by a combination of land-based telemetry stations and manual boat tracking by Reclamation crews. Baseline movement rates of downstream migrating pallid sturgeon will be determined by the rate at which each fish moved from the Stipek FAS telemetry station (RM 80) to the telemetry station located one mile upstream of the bypass channel exit (RM 73). This baseline rate will be compared to rate of travel through the entire Project Area as they migrate downstream over the replacement weir structure, Intake Diversion Dam, and the existing boulder field.

10.3.3 Timeline

Reclamation and the LYBOC will be responsible for downstream passage monitoring starting in year one. This will continue for the life of the project. Downstream passage monitoring is expected to last at least eight years. After eight years Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of adult and juvenile pallid sturgeon downstream passage monitoring (Table 8).

Table 8: Timeline of Downstream Biological Monitoring

Year (Post Const.)	Monitoring Description	Responsible Entity
1 - 4	Monitor adult and juvenile downstream migrations within the Yellowstone River and the bypass channel via land-based radio telemetry stations and manual tracking by field crews.	Reclamation - LYBOC
4	Independent Review	Reclamation, Technical Team, and Executive Team
5-8	Monitor adult and juvenile downstream migrations within the Yellowstone River and the bypass channel via land-based radio telemetry stations and manual tracking by field crews.	Reclamation - LYBOC
8	Independent Review	Reclamation, Technical Team, and Executive Team
8+	Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of downstream passage monitoring.	Reclamation - USFWS

10.4 Downstream Free Embryo and Larval Passage Monitoring (Criteria 2d)

10.4.1 Sampling Efforts and Locations

Monitoring of free embryos and larval pallid sturgeon will take place in the LYP Main Canal, on the headworks screens, and in the Yellowstone River. This effort will take place each year during late-June and early July when free embryo and larval drift is expected to occur on the Yellowstone River. Once samples are collected all *Acipenseriformes* (sturgeon and paddlefish) will be separated and sent for genetic identification.

Entrainment monitoring in the LYP Main Canal will consist of collecting samples with larval entrainment nets. The entrainment nets will be fished directly behind 1-2 screens on the headworks structure and from the canal bridge approximately 1,300 ft down the Main Canal (Figure 15).

During entrainment monitoring efforts, crews will also sample around the fish screens to check for impingement on the screens. One possible way to monitor for this is to do a controlled release of beads or free embryos (either shovelnose or pallid sturgeon) directly on a screen and determine how many are entrained, impinged, or drift out into the Yellowstone River. If this is determined to not be feasible, this could also be looked at in a lab setting. A sample of the screens could be installed in a river model and appropriately sized free embryos or larvae could be released to determine entrainment, impingement, and escapement rates.

In addition to the Main Canal and headworks monitoring, monitoring will also take place in the Yellowstone River upstream of the headworks and downstream of the replacement weir, existing weir, and rock field (Figure 15). This sampling will determine fate of the free embryos and larvae as they travel downstream over the structures and existing rock field.

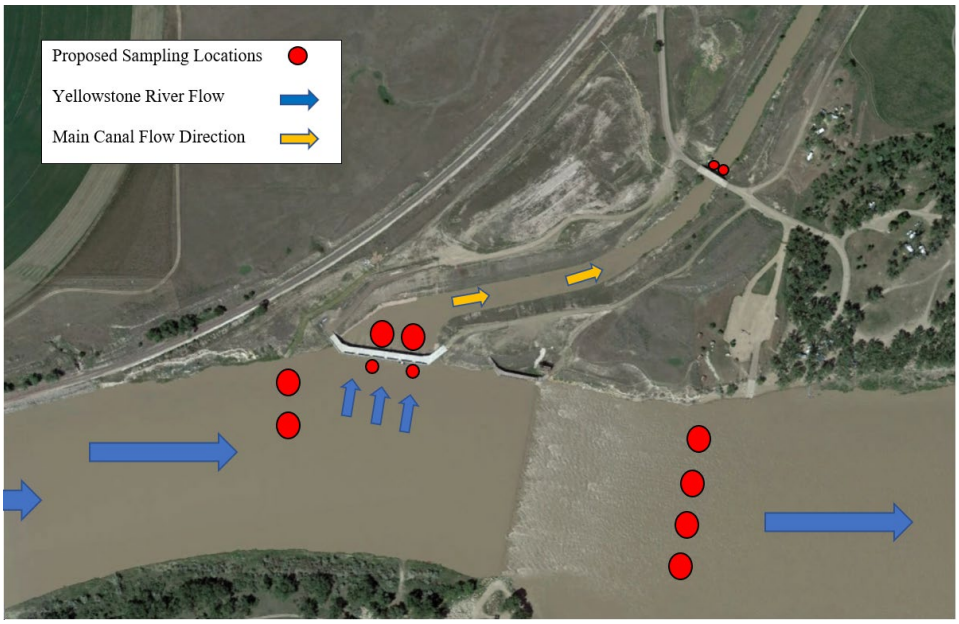

Figure 15: Free Embryo and Larval Sampling Locations

It is unknown if successful spawning will occur upstream of the Project Area within the first 8 years of the project. To address this concern, a shovelnose or pallid sturgeon free embryo/larval release could be conducted to assist with the assessment of entrainment or impingement at the screens and injury from drifting over the diversion weirs and through the existing boulder field. Reclamation will work with the USFWS to determine when and if a free embryo or larval release will be needed.

10.4.2 Timeline

Reclamation and the LYBOC will be responsible for downstream free embryo and larval passage monitoring. Initially downstream passage monitoring is expected to last at least eight years. After eight years, Reclamation in consultation with the USFWS, will meet to determine the long-term need and scope of free embryo and larval pallid sturgeon downstream passage monitoring (Table 9).

Table 9: Timeline for Downstream Larval and Free Embryo Sampling

Year (Post Const.)	Monitoring Description	Responsible Entity
1-4	Monitor free embryo and larval pallid sturgeon downstream passage in the Main Canal and the Yellowstone River.	Reclamation - LYBOC
4	Independent Review	Reclamation, Technical Team, and Executive Team
5-8	Monitor free embryo and larval pallid sturgeon downstream passage in the Main Canal and the Yellowstone River.	Reclamation - LYBOC
8	Independent Review	Reclamation, Technical Team, and Executive Team
8+	Reclamation, in consultation with the USFWS, will meet to determine the long-term need and scope of free embryo and larval pallid sturgeon downstream passage monitoring.	Reclamation - USFWS

11 Native Species Monitoring

Although not the primary goal or objective of the Lower Yellowstone Fish Passage Project, the bypass channel is expected to improve fish passage for other native species. This section is intended to provide a high-level overview of anticipated efforts for monitoring native species passage success within the Project Area. It is anticipated that yearly monitoring plans with more specific details will be developed and agreed upon by the Technical Team prior to the start of each field season.

The native species objective and criteria are:

Objective 3: Maintain or improve upstream and downstream passage success of Native Fish

- **Criteria 3a – Native Species Upstream Passage**
  - Passage rates of native fishes migrating upstream of the weir location at levels greater than or equal to pre- Fish Passage Project conditions

- **Criteria 3b – Native Species Downstream Passage**
  - Passage rates of native fishes migrating downstream of the weir location at levels greater than or equal to pre- Fish Passage Project conditions.

11.1 Tracking and Movement Data

Currently, Reclamation and MTFWP capture and tag native species and Montana Species of Special Concern in the spring of each year. These fish will be monitored using the same telemetry system that will be deployed for the pallid sturgeon adult and juvenile monitoring. Specifically, Reclamation and MTFWP will be monitoring paddlefish, shovelnose sturgeon, blue sucker, and sauger within the immediate project area. These species were selected because, like pallid sturgeon, they are known to make long migration movements during the spring of the year for spawning and have also shown difficulty in passing the existing weir structure.

A pre-construction study was completed by MTFWP (Rugg 2019) to show pre-construction passage levels of the migratory species noted above. The post-construction assessment will use the same means and methods. This will involve a test reach and a control reach on the lower Yellowstone River. The test reach extends from Intake downstream approximately 11 river miles. The control reach is upstream of Glendive is approximately 15 river miles in length and contains no known fish passage barriers. The upstream and downstream bounds of each reach will be equipped with ground-based logging telemetry stations to detect movement into and out of the reaches. Intake Dam Station (RM 71) and Rock Station (RM 60) mark the upper and lower bounds of the test reach, and Gibbs Station (RM 113) and Hoff Station (RM 100) marked the upper and lower bounds of the control reach. The telemetry stations within the bypass channel will be used to determine whether these native species are using the bypass channel. If native species are migrating over the weir, they will be monitored using the station located on the old headworks structure.

In addition to the land-based telemetry system, manual boat tracking will also be done on these fish throughout the year. The manual tracking runs occur approximately once a week and provide more precise data on where each radio tagged fish is located.

11.2 Timeline

Reclamation will be responsible for native species monitoring which will begin the first year after the bypass channel is operational. This monitoring is expected to last approximately four years which is consistent with the commitment that was made in the 2016 EIS (USACE and Reclamation 2016a). After four years Reclamation, in consultation with MTFWP, will meet to determine the long-term need and scope of the native species monitoring (Table 10).

Table 10: Timeline for Native Species Monitoring

Year (Post Const.)	Monitoring Description	Responsible Entity
1 – 4	Monitoring native species passage	Reclamation
4+	Reclamation, in consultation with MTFWP, will meet to determine the long-term need and scope of native species passage monitoring.	Reclamation - MTFWP

12 Irrigation Diversion Monitoring

As discussed in the 2016 EIS (USACE and Reclamation 2016a), a second purpose and need of the Lower Yellowstone Fish Passage Project is to allow for the continued viable and effective operation of the LYP. In order for the LYP to remain viable they must have the ability to divert their full water right during critically dry, high demand times of the year. This section is intended to provide a high-level overview of anticipated efforts for irrigation diversion monitoring into the LYP Main Canal. Yearly monitoring plans with more specific details will be developed and agreed upon by the Technical Team prior to the start of each field season.

The water delivery objective and criteria are:

Objective 4: Maintain irrigation diversions into the Lower Yellowstone Main Canal

- **Criteria 4a – Irrigation Diversions**
    - Maintain water diversions from the Yellowstone River for irrigation demands up to the full water right of 1,374 cfs during the irrigation season (mid- April through mid-October)

12.1 Monitoring Locations

Irrigation diversion rates will be monitored by the Main Canal gauging station that is located 1,400 ft down the main canal (Figure 16). The readings from this station will be recorded on an hourly basis and maintained by the LYBOC. As water demands within the district increases the LYBOC increase the amount of flow in the Main Canal up to 1,374 cfs which is their full water right.

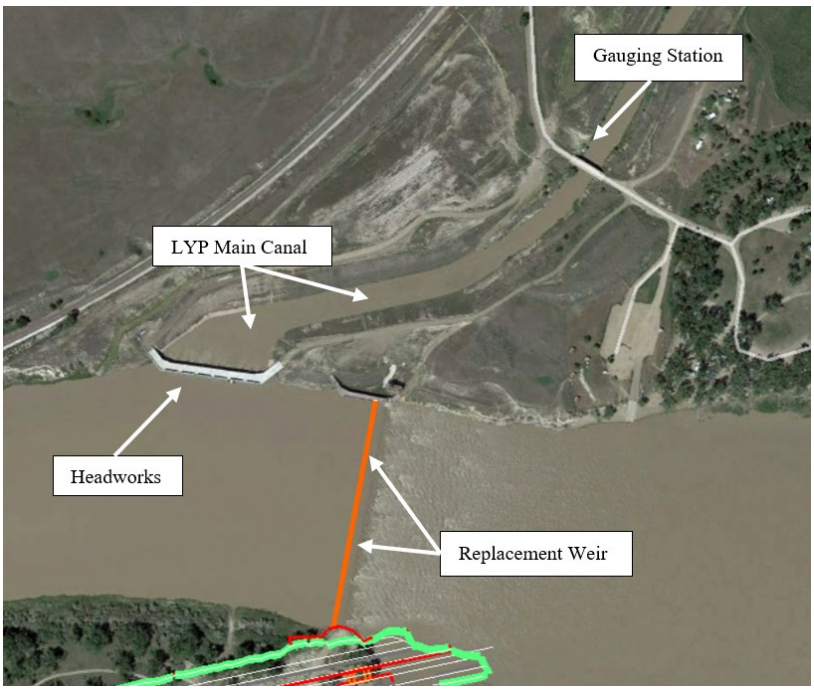

Figure 16: Location of Gauging Station on LYP Main Canal

Information from the LYP Main Canal diversions will be paired with the ADCP data collected on the bypass channel flow splits. If diversions into the main canal become an issue the ADCP could be deployed to help determine a cause.

12.2 Timeline

The LYBOC will be responsible for irrigation diversion monitoring which will begin the first year after the bypass channel is operational. This monitoring is expected to last at least eight years. After eight years Reclamation, in consultation with the LYBOC, will meet to determine the long-term need and scope of the monitoring (Table 11).

Table 11: Timeline for Irrigation Diversion Monitoring

Year (Post Const.)	Monitoring Description	Responsible Entity
1 – 4	Monitoring irrigation diversions into the LYP Main Canal	LYBOC
4	Independent Review	Reclamation, Technical Team, and Executive Team
5-8	Monitoring irrigation diversions into the LYP Main Canal	LYBOC
8	Independent Review	Reclamation, Technical Team, and Executive Team
8+	Reclamation, in consultation with the LYBOC, will meet to determine the long-term need and scope of irrigation diversion monitoring.	Reclamation - LYBOC

13 Potential Adaptive Management Measures

Data collected from physical, hydraulic, biological, and irrigation diversion monitoring will be evaluated and compared to the criteria established in this AMMP as well as, previous modeling, assumptions, and anticipated results contained in the 2016 EIS and 2020 Biological Opinion. Assessment of the data will be conducted through the annual Adaptive Management Workshop where the Technical Team will meet and discuss the results from the years monitoring efforts. The Technical Team will use their findings to recommend monitoring changes or adaptive management measures to the Executive Team.

The tables located below outline possible adaptive management measures and the associated timelines for implementation. Table 12 contains AM measures in response to various findings related to the physical and hydraulic performance of the bypass channel. Table 13 outlines AM measures for implementation based on pallid sturgeon passage response. Table 14 outlines AM measures for implementation based on results from irrigation diversion monitoring. It should be noted that these tables are not exhaustive of all the different scenarios or adaptive management measure that could be implemented.

In accordance with existing authorities, contracts, formal agreements, and ESA consultations, the USACE would be responsible for monitoring and implementing measures to ensure the bypass channel operates consistent with the physical and hydraulic criteria during the warranty period (one year) following completion of construction. The LYBOC would generally be responsible for operation and maintenance related adaptive management measures after the USACE's warranty period, and Reclamation would generally be responsible for measures that contribute to research or scientific investigation.

Table 12: Potential Adaptive Management Measures for Physical and Hydraulic Objectives

Year	Potential Adaptive Management Measures – Physical and Hydraulic Criteria
	Bypass Channel Depth Bypass channel not meeting depth criteria
1-2	1. Conduct additional ADCP measurements 2. Visual inspections of the bypass channel 3. Multi-beam depth sounder 4. 1-D/2-D hydraulic modeling
3-5	1. Depth not being met throughout the bypass channel a. Add boulders, large woody debris, or change channel roughness b. Excavate bypass channel deeper and narrower creating a more prominent thalweg c. Reduced slope of the bypass channel 2. Depth not being met at the bypass channel entrance a. Construction of a flow augmentation structure that introduces additional water near the bypass channel entrance. b. Excavate channel deeper, more prominent thalweg near entrance c. Removal of sediment
	Bypass Channel Velocity Bypass channel not meeting velocity criteria
1-2	1. Conduct additional ADCP measurements 2. Visual inspections of the bypass channel 3. Multi-beam depth sounder 4. 1-D/2-D hydraulic modeling

Year	Potential Adaptive Management Measures – Physical and Hydraulic Criteria
3-5	1. Velocities are not being met throughout bypass channel a. Add boulders, pools, or woody debris to change channel roughness creating additional pools or backwater areas b. Excavate bypass channel deeper and narrower c. Excavate bypass channel shallower and wider d. Increase slope of the bypass channel e. Decrease the slope of the bypass channel 2. Velocities are not being met near the bypass channel entrance. a. Construction of a flow augmentation structure that increases additional flow near the entrance to increase attraction and velocities b. Add boulders, pools, or woody debris to change channel roughness c. Excavate channel deeper, more prominent thalweg
Bypass Channel Flow Split Bypass Channel not meeting flow split criteria	
1-2	1. Conduct additional ADCP measurements 2. Visual inspections of the bypass channel 3. Multi-beam depth sounder 4. 1-D/2-D hydraulic modeling
3-5	1. Excavate bypass channel exit wider and shallower 2. Excavate bypass channel deeper with a more prominent thalweg 3. Construction of a flow augmentation structure

Year	Potential Adaptive Management Measures – Physical and Hydraulic Criteria
Bypass Channel Entrance and Exit Velocities Bypass channel not meeting entrance and exit velocity criteria	
1-2	1. Conduct additional ADCP measurements 2. Visual inspections of the bypass channel 3. Multi-beam depth sounder 4. 1-D/2-D hydraulic modeling
3-5	1. Velocities are not being met at the bypass channel exit a. Modify bypass channel exit to be deeper with a more prominent thalweg b. Modify bypass channel exit to be shallower and wider c. Increase or decrease flow splits into the bypass channel d. Add boulder, pools, or woody debris to change channel roughness and velocities e. Change bypass channel angle with Yellowstone River 2. Velocities are not being met at the bypass channel entrance a. Construction of a flow augmentation structure to increase flows and velocities near the entrance b. Modify bypass channel exit to be deeper with a more prominent thalweg c. Modify bypass channel exit to be shallower and wider d. Increase or decrease flow splits into the bypass channel e. Add boulder, pools, or woody debris to change channel roughness and velocities f. Change bypass channel angle with Yellowstone River

Table 13: Potential Adaptive Management Measures for Biological Objectives

Year	Potential Adaptive Management Measures – Biological Criteria
Upstream Passage of Adult Pallid Sturgeon No use of bypass channel; fish will not enter bypass channel	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Inadequate attraction flows likely cause; implement modification based on ADCP findings a. Guidance structure – construct jetty, wing wall or similar structure to enhance attraction b. Channel invert – excavation of bypass channel to increase flows splits or attraction c. Attraction Flows – design and construct auxiliary flow structure 2. Shear flows or eddy formation likely cause; implement modification based on ADCP findings a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material c. Fill – remove or add additional fill near bypass channel entrance 3. Sediment buildup or rock displacement from Intake Diversion Dam a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material 4. Entrance location and design likely cause; implement modification based on ADCP findings a. Entrance angle – redesign and construct bypass channel entrance angle b. Entrance width – redesign and construct wider or narrower bypass channel entrance c. Entrance location – redesign and construct bypass channel entrance further downstream 5. Pallid Sturgeon Translocation a. Translocate adult pallid sturgeon upstream of Intake Diversion Dam

Year	Potential Adaptive Management Measures – Biological Criteria
Upstream Passage of Adult Pallid Sturgeon Adults only use a portion of the bypass channel; adults enter bypass channel but do not successfully pass upstream	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Issues meeting physical and hydraulic criteria likely a. Depths – change channel invert, slope, channel roughness, removal of sediment or excavate bypass channel deeper b. Velocities – change channel invert, slope, channel roughness, change control structures, increase depths in bypass channel c. Flow split – change channel invert, slope, channel roughness, change control structures 2. Passage barrier within the bypass channel likely a. Debris – remove boulder, trees, riprap, or other material from bypass channel b. Control structure – add or remove fill to allow for smoother transitions over bypass channel features c. Low water crossing – add or remove fill to allow for smoother transitions over bypass channel features 3. Pallid Sturgeon Translocation a. Translocate adult pallid sturgeon upstream of Intake Diversion Dam
Upstream Passage of Adult Pallid Sturgeon Limited upstream passage; less than 85% of motivated adults successfully pass	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat

Year	Potential Adaptive Management Measures – Biological Criteria
3-5	1. Inadequate attraction flows likely cause; implement modification based on ADCP findings a. Guidance structure – construct jetty, wing wall or similar structure to enhance attraction b. Channel invert – excavation of bypass channel to increase flows splits or attraction c. Attraction Flows – design and construct auxiliary flow structure 2. Shear flows or eddy formation likely cause; implement modification based on ADCP findings a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material c. Fill – remove or add additional fill near bypass channel entrance 3. Sediment buildup or rock displacement from Intake Diversion Dam a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material 4. Entrance location and design likely cause; implement modification based on ADCP findings a. Entrance angle – redesign and construct bypass channel entrance angle b. Entrance width – redesign and construct wider or narrower bypass channel entrance c. Entrance location – redesign and construct bypass channel entrance further downstream 5. Issues meeting physical and hydraulic criteria likely a. Depths – change channel invert, slope, channel roughness, removal of sediment or excavate bypass channel deeper b. Velocities – change channel invert, slope, channel roughness, change control structures, increase depths in bypass channel c. Flow split – change channel invert, slope, channel roughness, change control structures 6. Passage barrier within the bypass channel a. Debris – remove boulder, trees, riprap, or other material from bypass channel b. Control structure – add or remove fill to allow for smoother transitions over bypass channel features c. Low water crossing – add or remove fill to allow for smoother transitions over bypass channel features 7. Pallid Sturgeon Translocation a. Translocate adult pallid sturgeon upstream of Intake Diversion Dam

Year	Potential Adaptive Management Measures – Biological Criteria
Upstream Passage of Adult Pallid Sturgeon 85% passage occurs in some years but not all	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Issues meeting hydraulic and physical criteria over all flow ranges in Yellowstone River a. Depths – change channel invert, slope, channel roughness, removal of sediment or excavate bypass channel deeper b. Velocities – change channel invert, slope, channel roughness, change control structures, increase depths in bypass channel c. Flow split – change channel invert, slope, channel roughness, change control structures 2. Pallid Sturgeon Translocation a. Translocate adult pallid sturgeon upstream of Intake Diversion Dam
Upstream Passage of Juvenile Pallid Sturgeon No use of bypass channel; no successful passage	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Initiate field and laboratory studies a. Assess the motivation of juvenile pallid sturgeon to use the bypass channel. b. Assess swimming abilities of juvenile pallid sturgeon 2. Assess juvenile pallid sturgeon for negative population level effects a. Look for signs of poor condition, impaired growth, delayed maturation, or reduced survival. 3. Pallid Sturgeon Translocation a. Translocate juvenile pallid sturgeon to a location in the bypass channel or upstream of Intake Diversion Dam.

Year	Potential Adaptive Management Measures – Biological Criteria
5-8	1. Shear flows or eddy formation likely cause; implement modification based on ADCP findings a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material c. Fill – remove or add additional fill near bypass channel entrance 2. Sediment buildup or rock displacement from Intake Diversion Dam a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material 3. Entrance location and design likely cause; implement modification based on ADCP findings a. Entrance angle – redesign and construct bypass channel entrance angle b. Entrance width – redesign and construct wider or narrower bypass channel entrance c. Entrance location – redesign and construct bypass channel entrance further downstream
Upstream Passage of Juvenile Pallid Sturgeon Juveniles only use a portion of the bypass channel; juveniles enter bypass channel but do not successfully pass upstream	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Initiate field and laboratory studies a. Assess the motivation of juvenile pallid sturgeon to use the bypass channel. b. Assess swimming abilities of juvenile pallid sturgeon 2. Assess juvenile pallid sturgeon for negative population level effects a. Look for signs of poor condition, impaired growth, delayed maturation, or reduced survival. 3. Pallid Sturgeon Translocation a. Translocate juvenile pallid sturgeon to a location upstream of Intake Diversion Dam.

Year	Potential Adaptive Management Measures – Biological Criteria
5-8	1. Passage barrier within the bypass channel a. Debris – remove boulder, trees, riprap, or other material from bypass channel b. Control structure – add or remove fill to allow for smoother transitions over bypass channel features c. Low water crossing – add or remove fill to allow for smoother transitions over bypass channel features
Upstream Passage of Adult Pallid Sturgeon Limited upstream passage	
1-2	1. Conduct additional ADCP monitoring at bypass channel entrance 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Initiate field and laboratory studies a. Assess the motivation of juvenile pallid sturgeon to use the bypass channel. b. Assess swimming abilities of juvenile pallid sturgeon 2. Assess juvenile pallid sturgeon for negative population level effects a. Look for signs of poor condition, impaired growth, delayed maturation, or reduced survival. 3. Pallid Sturgeon Translocation a. Translocate juvenile pallid sturgeon to a location upstream of Intake Diversion Dam.
5-8	1. Issues with physical and hydraulic criteria likely a. Depths – change channel invert, slope, channel roughness, removal of sediment or excavate bypass channel deeper b. Velocities – change channel invert, slope, channel roughness, change control structures, increase depths in bypass channel c. Flow split – change channel invert, slope, channel roughness, change control structures

Year	Potential Adaptive Management Measures – Biological Criteria
Downstream Passage of Adult and Juvenile Pallid Sturgeon Limited downstream passage occurs; greater than 1% mortality	
1-2	1. Conduct ADCP monitoring at the replacement weir 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Inadequate depth over weir or through the weir notch a. Fill – removal or placement of additional fill material to provide better transition over new weir structure b. Wing wall or jetty – construction of a wing wall or jetty to direct pallid sturgeon toward the weir notch. c. Weir notch – modification of weir notch, could be increased or decreased in size and depth. d. Boulder field – removal of portions or all of the existing boulder field 2. Pallid Sturgeon Translocation a. Translocate adult and juvenile pallid sturgeon downstream of Intake Diversion Dam
Downstream Drift of Free Embryo and Larval Pallid Sturgeon No successful downstream passage	
1-2	1. Conduct ADCP monitoring at the replacement weir 2. Conduct free embryo and larval drift study 3. Utilize 3-D mapping unit to determine route of free embryos and larvae through the project area.
3-5	1. Inadequate depth over weir or through the weir notch a. Fill – removal or placement of additional fill material to provide better transition over new weir structure b. Wing wall or jetty – construction of a wing wall or jetty to direct pallid sturgeon toward the weir notch. c. Weir notch – modification of weir notch, could be increased or decreased in size and depth. d. Boulder field – removal of portions or all of the existing boulder field

Year	Potential Adaptive Management Measures – Biological Criteria
	Upstream Passage of Native Species Less than baseline upstream passage
1-2	1. Conduct additional ADCP monitoring at fish entrance 2. Conduct additional ADCP monitoring at replacement weir 3. Adjust locations of land-based telemetry stations 4. Conduct more intensive active tracking via boat
3-5	1. Shear flows or eddy formation likely cause; implement modification based on ADCP findings a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material c. Fill – remove or add additional fill near bypass channel entrance 2. Sediment buildup or rock displacement from Intake Diversion Dam a. Boulders – remove or relocate b. Sand/gravel bar – dredge or add material
	Downstream Passage of Native Species Less than baseline downstream passage
1-2	1. Conduct additional ADCP monitoring at replacement weir 2. Adjust locations of land-based telemetry stations 3. Conduct more intensive active tracking via boat
3-5	1. Inadequate depth over weir or through notch a. Fill – removal or replacement of fill material to provide a better transition over the replacement weir 2. Rock Field a. Rock – removal of all or a portion of the rock field

Table 14: Potential Adaptive Management Measures for Irrigation Diversions

Year	Potential Adaptive Management Measures – Irrigation Diversion Criteria
LYBOC unable to divert water into the LYP Main Canal up to full water right of 1,374 cfs.	
1-2	1. Conduct additional ADCP measurements of the bypass channel 2. Visual inspections of the headworks and screens 3. Multi-beam depth sounder to look for sediment deposition
3-5	1. Issues with physical and hydraulic criteria of the bypass channel; bypass channel taking too much water a. Flow split – change channel invert, slope, channel roughness, change control structures 2. Sediment deposition at headworks a. Mechanically remove sediment near headworks

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15 Appendix A: BRT Criteria Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

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MAR 19 2014

David Ponganis
Director, Programs
U.S. Army Corps of Engineers, Northwestern Division
PO Box 2870
Portland, Oregon 97208-2870

Dear Mr. Ponganis:

The U.S. Fish and Wildlife Service (Service), in conjunction with the Lower Yellowstone Intake Project (Intake) Biological Review Team (BRT), has been working closely with the U.S. Army Corps of Engineers (Corps) to define performance objectives and subsequent design criteria for the Intake bypass channel. This letter serves to formally revise portions of the Reasonable and Prudent Alternative (RPA) in the 2003 amended Biological Opinion (BiOp) to the Corps. By this letter I am formally conferring the hydraulic and physical conditions the Service believes will maximize the probability of successful passage of pallid sturgeon at the Intake Dam and Irrigation Headworks Project on the Yellowstone River, Montana. As stated in my letter to you dated February 6, 2013, with the construction and successful performance of the project to these hydraulic and physical conditions, the Corps will achieve its responsibility under the Flow Enhancement below Fort Peck Dam – Intake Montana River Restoration BiOp RPA element.

Bypass Channel Hydraulic and Physical Performance Objectives

The following, unless subsequently modified based on new data, apply to conditions as measured at the United States Geological Survey (USGS) stream gauge at Sidney, Montana, regardless of date, over the discharge ranges specified. In order to maximize the probability of success, two sets of design criteria are recommended below; one set applies to discharges less than 15,000 ft^3/s and one set applies to discharges equal or greater than 15,000 ft^3/s (see also Table 1).

Bypass Channel Flow Split:
The flow split, or proportion of Yellowstone River discharge the Bypass Channel is designed to convey will influence many aspects of the Bypass Channel design and overall scale. Given the variability of the unregulated flows in the Yellowstone River, we recognize that the flow split will vary with river discharge.

As such, the general flow split percentage target for the Bypass Channel design should be 15% with final design attaining at least 12% over the discharge range of 7,000 to 14,999 ft^3/s (198– 424 m^3/s) and 13% to ≥ 15% over the discharge range of 15,000 to 63,000 ft3/s (424– 1784 m3/s).

Bypass Channel Cross-sectional velocities:
Mean bypass channel cross-sectional velocities at all sampled cross-sections must be equal or greater than 2.0 feet per second (ft/s) or 0.61 meters per second (m/s), but less than or equal to 6.0 ft/s (1.8 m/s) over the discharge range of 7,000 to 14,999 ft^3/s (198– 424 m^3/s).

Mean bypass channel cross-sectional velocities (measured as mean column velocities) at all sampled cross-sections must be equal or greater than 2.4 ft/s (0.73 m/s), but less than or equal to 6.0 ft/s (1.8 m/s) over the discharge range of 15,000 to 63,000 ft^3/s (424– 1784 m^3/s). The proportion of the channel exceeding maximum velocities should be minimized to the extent possible. Channel characteristics that maintain variability of flow within or on the margins of the Bypass Channel, without introducing significant turbulence are highly valued.

Bypass Channel Cross-sectional depths:
Minimum cross-sectional depths measured at the lower discharge range of 7,000 to 14,999 ft^3/s (198– 424 m^3/s) at any sampled cross-section must be greater than or equal to 4.0 feet (1.2 m) across 30 contiguous feet of the measured channel cross sectional profile. Minimum cross-sectional depth over the discharge range of 15,000 to 63,000 ft^3/s (424– 1784 m^3/s) at any sampled cross-section must be greater than or equal to 6.0 feet (1.8 m) across 30 contiguous feet of the measured channel cross sectional profile. Adult Pallid Sturgeon typically use depths greater than 1 meter throughout their range. Although adult sturgeon have occasionally been observed shallower, depths greater than 1 meter will reduce the likelihood that significant numbers of adult Pallid Sturgeon may fail to pass through the Bypass Channel.

Bypass Channel Fish Entrance and Exit:
The downstream entrance to the Bypass Channel (i.e., HEC-RAS station 136) is critical to the performance of the structure. Significant efforts remain to adequately characterize suitable conditions at the downstream and upstream openings. To provide sufficient attractant flows, the downstream fish entrance should have a mean cross sectional velocity of greater than or equal to 2.0 ft/s (0.61 m/s) (measured as mean column velocity) through the lower discharge range of 7,000 to 14,999 ft^3/s (198– 424 m^3/s) and mean cross sectional velocity greater than or equal to 2.4 ft/s (0.91 m/s) (measured as mean column velocity) through the range of discharge of 15,000 to 63,000 ft^3/s (424– 1784 m^3/s). Mean cross sectional velocities (measured as mean column velocity) at both the upstream and downstream Channel Bypass openings should be less than or equal to 6.0 ft/s (1.8 m/s) for river discharges ranging from 7,000 – 63,000 ft^3/s (198 – 1784 m^3/s) .

The proportion of the channel exceeding maximum velocities should be minimized to the extent possible.

Characteristics that maintain variability of flow within or on the margins of the Bypass Channel openings, without introducing significant turbulence are highly valued.

Table 1: Tabular Summary of design criteria

Discharge at Sidney, Montana USGS Gauge	7,000 -14,999 ft^3/s	15,000-63,000 ft^3/s
Bypass Channel Flow Split	≥ 12%	13% to ≥ 15%
Bypass Channel cross-sectional velocities (measured as mean column velocity)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Depth (minimum cross-sectional depth for 30 contiguous feet at measured cross-section)	≥ 4.0 ft	≥ 6.0 ft
Bypass Channel Fish Entrance (measured as mean column velocity at HEC-RAS station 136)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Fish Exit (measured as mean column velocity)	≤ 6.0 ft/s	≤ 6.0 ft/s

As you are aware, inevitable uncertainties remain that are inherent in both the hydraulic modeling upon which the project design is based and the monitoring and measurement needed to verify that the constructed bypass channel meets the hydraulic and physical conditions stated above. The Service requests that the Corps in coordination with the Service and the U.S. Bureau of Reclamation (BOR) develop the monitoring and measurement plan that will be used to verify that the completed project meets the hydraulic and physical conditions. As you are aware, the conditions on the river have inherent variability that is difficult to predict. This plan should account for this variability and be completed prior to completion of the construction phase of the project.

The Service further requests that the BRT remain involved throughout the remaining project design in order to provide recommendations on how the Corps can best meet the projects objectives and to keep the Corps apprised of the evolving science related to Pallid Sturgeon use of side channels as it relates to potential bypass channel design improvements.

It is my anticipation that the Service will continue to work closely with the Corps during the post-construction warranty period as you verify the bypass channel performance. We think that our continued involvement will be beneficial in helping to achieve pallid sturgeon passage, and would provide valuable lessons learned as we work with the BOR to develop a monitoring and adaptive management plan to ensure the long-term performance of the bypass channel.

As we have discussed previously, this project represents the most biologically superior project in the upper Missouri River Basin for the recovery of the Pallid Sturgeon. I appreciate your commitment to this effort to date and look forward to completing design and construction of the remaining features for a successful fish bypass project.

Sincerely,

Regional Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

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Douglas Epperley
US Bureau of Reclamation
2021 4th Avenue North
Billings, MT 59101

Dear Mr. Epperley:

The U.S. Fish and Wildlife Service (Service) has been working closely with the Lower Yellowstone Intake Dam Project (Intake Project) interagency Biological Review Team (BRT), to define biological success criteria for evaluation of pallid sturgeon movements both upstream and downstream through the Intake Project area. With this letter I am formally conferring the criteria and evaluation recommendations that the Service believes will indicate successful passage of pallid sturgeon past the Intake Dam and Irrigation Headwork's on the Yellowstone River, Montana.

Biological Success Criteria for Intake Project Fish Passage:

- The desired baseline condition for passage at the Intake Project on the Lower Yellowstone River is unimpeded movement by pallid sturgeon through the free-flowing river. The following criteria were developed to assess if the implemented passage alternative or suite of alternatives, as implemented, closely mimics unimpeded movement of pallid sturgeon through the Lower Yellowstone River under natural geomorphic and hydraulic conditions. It is recognized that upstream passage by pallid sturgeon may be reduced under altered conditions of constructed passage, and that passage criteria may be adjusted, within reasonable limits, provided that post project monitoring data indicate altered passage performance does not negatively affect movements or life history needs of the species.

- Evaluation of upstream adult passage should be based on the proportion of motivated adults that enter the reach affected by the passage alternative or that approach Intake Dam. It is a reasonable assumption that in the free-flowing Lower Yellowstone River all adults motivated to move further upstream would be able to do so; however, it is not entirely practical to assume that every adult sturgeon that encounters a barrier, such as Intake Dam, would detect, utilize and successfully navigate through a provided passage alternative. Nevertheless, because pallid sturgeon populations are small, and adults must aggregate in sufficient numbers at suitable spawning sites, and spawn during a relatively short period of time, it is necessary for the passage alternative to pass a high percentage of migrating adults with little impediment to upstream movement.

- Providing passage and access to upstream spawning areas for the greatest number of adults provides for annual variability in spawning migrations and reproductive success, while mitigating for losses in genetic diversity and effective population size in a small, fragmented population.

- Evaluation of upstream passage should include a temporal component such that passage is defined to occur at the optimal time and without undue delay for migrating fish. Preventing upstream passage for a portion of the spawning season or delaying migration of reproductive adult sturgeon may interrupt the timing and synchronicity of spawning events, and alter where spawning can occur and be successful on the landscape. Migrating adult sturgeon should detect and use the provided passage alternative without substantial delay. Once an adult sturgeon successfully detects the passage alternative and continues upstream it is expected that it will negotiate passage within a reasonable time based on minimum, unidirectional upstream rates of movement in the free flowing Lower Yellowstone River.

- Juvenile pallid sturgeon lack the upstream migratory motivation of spawning adults and are expected to have reduced swimming capacity as compared to larger adults. Although not reproductive, upstream movement of juveniles may be related to natural juvenile dispersal patterns or the exploitation of important, seasonally available food resources. Regardless of motivation, juvenile pallid sturgeon are likely to behave similarly to adults when approaching barriers, and detecting and using passage alternatives; some proportion of juveniles are expected to use provided passage alternatives and move upstream.

UPSTREAM PASSAGE CRITERIA:

1. Adults

Background: The BRT compiled 2011–2015 telemetry data sets for adult pallid sturgeon in the Lower Yellowstone River. For these years, movement by radio telemetry adults (based on manual locations and logging station detections) indicate that 12-26% of the existing telemetered population may migrate to Intake Dam or the reach affected by Intake Dam in a given year. Hereafter, this percentage of the telemetered population is referred to as "motivated" individuals, as they demonstrate the volition to migrate upstream to the reach affected by Intake Dam and would seemingly continue migrating upstream in the absence of any barrier to migration. The 2011–2015 data sets were also used to estimate migration rates for adult pallid sturgeon migrating upstream throughout the Lower Yellowstone River, including migration rates of fish passing through the natural high-flow side channel around Intake Dam in 2014. The data set (N = 60 migration pathways) indicates that adults, on average, migrate upstream at a rate of 0.76 km/hr. (1 standard deviation (SD) = 0.34 km/hr.) or 0.47 miles/hr. (1 SD = 0.21 miles/hr.). Note that ± 1 SD would include migration rates for about 68% of the population.

Recommended Criteria: Evaluated passage alternatives would be considered successful if ≥ 85% of motivated adult pallid sturgeons (i.e. fish that move upstream to the entrance of the passage alternative) annually pass upstream of Intake Dam during the spawning migration time period (April 01–June 15). Migrating adults should pass with a reasonable amount of time and without substantial delay based on an expected unidirectional upstream rate of movement ≥0.30 km/h (≥0.19 miles/h).

The minimum rate is less than the average and 1 SD observed for wild adults migrating through the Lower Yellowstone River to accommodate expected characteristic variation in migration rates among individuals. It is not uncommon for some individuals to consistently migrate upstream at slower rates than others in the Lower Yellowstone River. Applying this criterion to a 3.0 mile side-channel, for example, would indicate that an unimpeded upstream-migrating adult pallid sturgeon should negotiate passage in $\leq$ 16.7 hours. A better approximation of the degree to which adult sturgeon may be impeded by a passage alternative can be determined by monitoring the movement of sturgeon on their approach to the passage alternative (one river mile to several bends downstream) through the entire passage sequence; concluding when sturgeon successfully complete the upstream extent of the passage. This approach can provide improved long-term assessment of adult passage and is recommended as a useful replacement for movement rate-based criteria once telemetry data and infrastructure are available.

2. Juveniles

Background: There are a few observations of juvenile pallid sturgeon stocked below Intake Dam being collected above. Thus, the BRT recognized that upstream passage of juvenile pallid sturgeon is biologically important, and the BRT encouraged that juvenile passage be monitored as part of the project. However, sufficient information currently does not exist to justify concluding that lack of consistent juvenile passage at Intake Dam would constitute a threat to the species.

Recommended Criteria: The Service acknowledges upstream passage for juvenile pallid sturgeon is likely biologically important, but that current data are insufficient to understand overall juvenile motivation and evaluate the need for passage to meet life history requirements and maintain viable populations. Thus, field and laboratory swimming capacity studies are recommended to evaluate the capability of juveniles to negotiate passage alternatives and to assess if juvenile passage is reasonably expected to occur. Field and laboratory studies are needed to assess the motivation of juveniles to use passage alternatives and population-level studies are required to assess whether passage would benefit condition, growth, and survival of juveniles. Additionally, the Service recommends that decision criteria be developed that would trigger adaptive management options to improve passage for juveniles if lack of juvenile pallid sturgeon passage is demonstrated to result in negative population level effects (for example, poor condition, impaired growth, delayed maturation, or reduced survival). If juveniles are negatively impacted by lack of or impeded passage then the effects of the passage project should be reexamined.

DOWNSTREAM PASSAGE CRITERIA:

1. Juveniles and Adults

Background: There is little information available on the incidence of injury or mortality to pallid sturgeon that pass downstream over the existing Intake Dam. Hatchery-raised juvenile pallid sturgeons stocked upstream from Intake Dam have been captured in the Yellowstone River below the dam and in both the Missouri River upstream and downstream from the Yellowstone River confluence. These recaptures indicate that some juveniles survive downstream passage over the dam, but the existing recapture data cannot be used to determine whether injury or mortality is occurring associated with downstream passage. For adults, data from only two years (2014, 2015) are available to assess downstream passage survival over Intake Dam.

Specifically, all wild adult pallid sturgeon that migrated upstream of Intake Dam via use of the high-flow side channel (N = 6) survived downstream passage over the dam, thus establishing a downstream survival rate of 100% past this artificial structure. Wild adults and juveniles routinely negotiate natural obstructions and hydraulically challenging habitats (for example, rock ledges) while migrating downstream in the Lower Yellowstone River, and no mortality to date has been attributed to injury resulting from interactions in these settings. Thus, it is reasonable to believe that downstream passage associated with the implemented passage alternative at Intake Dam would approximate the 100% downstream survival rates currently associated with Intake Dam.

Recommended Criteria: For the Intake passage project to be successful, mortality of adult pallid sturgeon that encounter Intake Dam or other design alternative while migrating downstream cannot annually exceed 1% during the first 10 years of project implementation. Adult sturgeon passing downstream should be monitored for injury or evidence of adverse stress.

2. Early life stages

Background: Pallid sturgeon free-embryos hatch and begin downstream dispersal at about 7.0 to 8.0 mm in length and transition to exogenously feeding larvae at about 18 to 20 mm. Fish screens installed at the newly constructed intake structure above intake Dam on the Lower Yellowstone River were designed to protect pallid sturgeon ≥ 40mm. It is anticipated the screens will function as designed and intended as described in the biological opinion associated with those screens. Currently data is lacking to directly assign a threat to fish that drift over the existing Intake Dam and associated downstream boulder field.

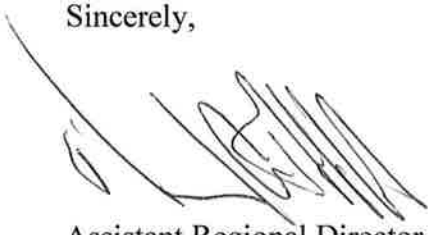
Recommended Criteria: The Service recommends that post-project monitoring be conducted both at the intake screens, in the irrigation canal, and immediately below the Intake Dam boulder field to assess potential injury and mortality to free-embryo, larvae and young-of-year sturgeon. Experimental options that might be considered include releasing free-embryo or larval pallid or shovelnose sturgeon near the existing intake fish screens to assess impingement effects and entrainment. Additionally, comparable releases could be used at the existing dam to assess potential effects associated with free-embryo and larval sturgeon drifting over the dam crest and through the boulder field.

CONCLUSIONS:

When considering passage alternatives and evaluating passage success for pallid sturgeon the desired baseline condition is unimpeded movement by pallid sturgeon through the free-flowing Lower Yellowstone River. The passage criteria in the previous sections are based on the Service's best understanding of the behavior and life history requirements of the pallid sturgeon in an unconstrained geomorphic setting and under natural hydraulic conditions. Criteria were then adjusted recognizing that the upstream and downstream passage success under altered conditions associated with a constructed passage alternative is likely to be reduced from the expected baseline condition. Given what we know about pallid sturgeon, the above criteria, if met, would successfully meet the expectation of a well-designed passage project. Failure to meet these specific criteria does not necessarily mean the project is a failure, but that the project deviates from what is expected (for example, if the structure accommodates 100% of the motivated fish but does so at a slightly slower rate than the defined upstream rates of movement ≥0.30 km/h (≥0.19 miles/h) it may not necessarily fail).

As always, as knowledge increases additional lines of evidence may need to be considered to assess the biological success of the project or if adaptive management of the project need be initiated.

Sincerely,



Assistant Regional Director
Ecological Services