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Technical Memorandum ENV-2019-092

Lower Yellowstone River Pallid Sturgeon Translocation Project 2018

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Pallid Sturgeon (*Scaphirhynchus albus*)

Lower Yellowstone River Pallid Sturgeon Translocation Project 2018

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Acronyms and Abbreviations

PSCAP:	Pallid Sturgeon Conservation Augmentation Program
USACE:	United States Army Corps of Engineers
USFWS:	United States Fish and Wildlife Service
USGS:	United States Geological Survey
FWP:	Montana Fish, Wildlife & Parks
Reclamation:	United States Bureau of Reclamation
HFSC:	High flow side channel
MT:	Montana
BiOp:	Biological Opinion
FAS:	Fishing Access Site
PIT:	Passive Integrated Transponder
SIMS:	Sturgeon Information Management System
PRM:	Powder River Mile
HOPS:	Hatchery-Origin Pallid Sturgeon

Units:

cfs	cubic feet per second
km	kilometer(s)
mm	millimeter(s)
m	meter(s)
RM	River mile(s)
MHz	Megahertz
FL	Fork Length

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INTRODUCTION

Pallid sturgeon (*Scaphirhynchus albus*) are a federally endangered (United States Fish and Wildlife Service (USFWS) 1990; 55 FR 36641-36647) large bodied fish native to the Missouri and Mississippi river basins (Figure 1). Pallid sturgeon are well adapted to large, free-flowing, warm-water, turbid rivers with diverse and dynamic physical habitats characteristic of the historical conditions of the Mississippi River basin (i.e., free-flowing with natural hydrologic conditions and temperature regimes; 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.

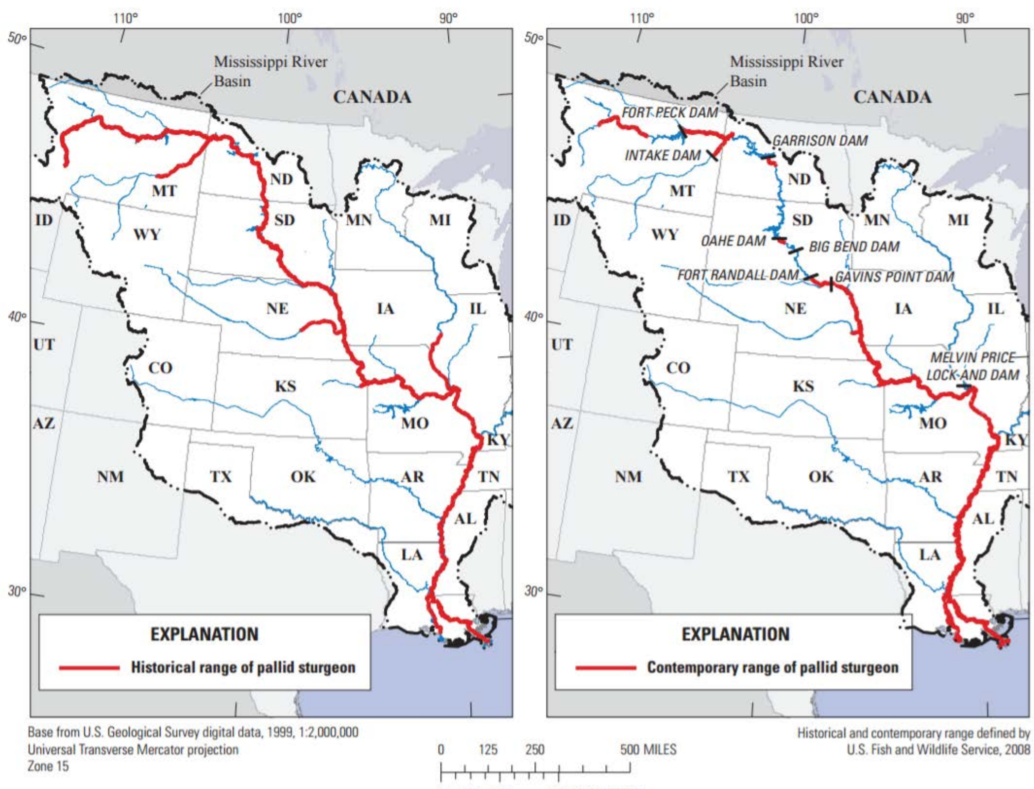

Figure 1. Maps of the historical (left) and current (right) range of pallid sturgeon in the United States. Major locks and dams which impede migration of pallid sturgeon are noted. Map is from DeLonay et al. 2016.

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 (Braaten et al. 2012). To assist with the recovery of the pallid sturgeon, habitat rehabilitation (fish passage) and stock restoration efforts in the upper Missouri River basin are major areas of focus for fisheries biologists. Natural recruitment of pallid sturgeon has been low to non-existent throughout its range for decades (DeLonay et al. 2016). An estimated 125 wild 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).

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), however Intake Dam near Glendive, Montana presents an impediment to upstream passage of pallid sturgeon, as well as other fishes.

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 72.0), where further upstream movement is mostly halted.

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. The exceptionally high flows of 2011 are attributed to encouraging the higher estimate of 26% of the telemetered population to migrate up to Intake Dam. Research in 2014 and 2015 revealed that pallid sturgeon can migrate beyond Intake Dam using the natural high-flow side channel (HFSC) to bypass the dam. Passage through the HFSC has been documented at mainstem flows from 39,500 – 75,000 cubic feet per second (cfs) (United States Geological Survey (USGS) stream Station 06327500, Yellowstone River at Glendive, MT) which provide suitable conditions in some years. However, the presence of elevated flows does not assure that a significant proportion of migrants close to Intake Dam will utilize the HFSC as other factors (e.g., location of HFSC entrance, individual motivation, detection of attraction flows from the HFSC, other unknown factors) may cue HFSC passage.

Restoration of the Yellowstone-Missouri population of pallid sturgeon by providing fish passage at Intake Dam is hypothesized to enable: 1) continued upstream migration for reproductively motivated adult and non-reproductive juvenile pallid sturgeon, 2) spawning in upstream reaches, 3) successful incubation of embryos, 4) increased drift distance for developing free embryos, and 5) survival of young life stages. The current proposed fish passage project at Intake Dam includes installation of a concrete weir, construction of a bypass channel to facilitate passage around the weir, filling in the natural HFSC (Figure 2), and implementation of a monitoring and adaptive management plan (Bypass Channel Alternative). The existing HFSC has been documented to attract native fish and provide passage at greater mainstem flows, but unlike the existing HFSC, the downstream entrance of the constructed bypass channel would be located just downstream from the constructed weir to attract sturgeon and other fishes at lower mainstem flows in close proximity to the dam.

The United States Bureau of Reclamation (Reclamation) and the United States Army Corps of Engineers (USACE) consulted with the USFWS in 2016 on the construction and implementation of the Bypass Channel Alternative (Reclamation and Corps 2016). The USFWS concluded in a Biological Opinion (2016 BiOp; USFWS 2016):

> "*there are limited minor adverse effects to the [pallid] sturgeon, the action is not likely to jeopardize the continued existence of the pallid sturgeon. And in fact, we believe the proposed action implements a high priority goal of the recovery plan and constitutes a substantial improvement to the outlook for the survival and recovery of this ancient fish in the Upper Missouri River*"

Currently, construction of the Bypass Channel Alternative is on hold due to an on-going litigation challenge. However, Reclamation and USACE continue to implement actions and requirements from the 2016 BiOp (USFWS 2016). One of the requirements being the translocation of "motivated spawning adults and

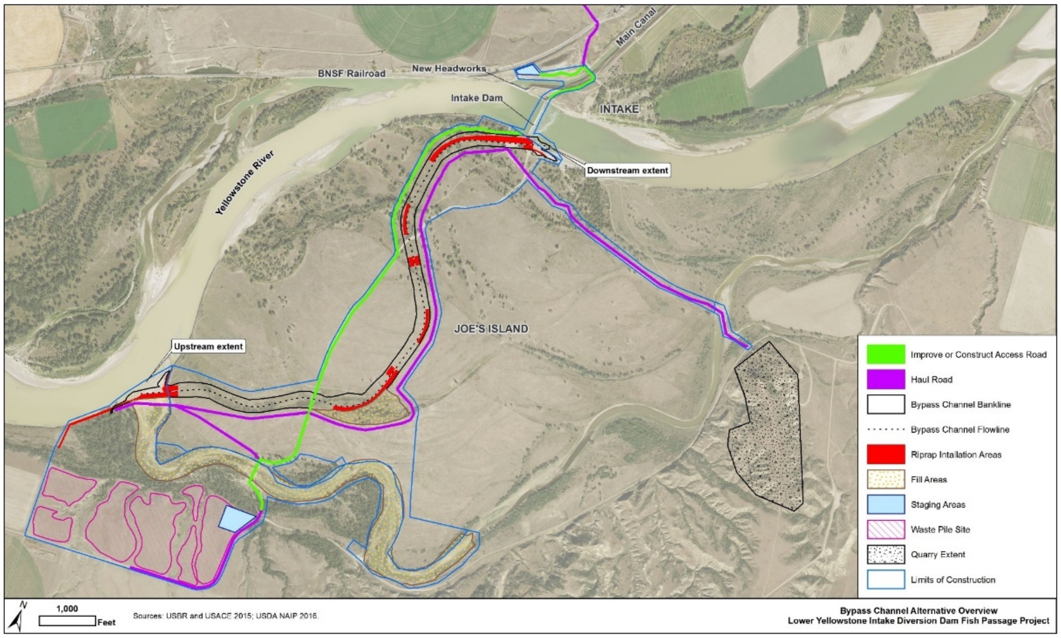

Figure 2. Proposed location of bypass channel alternative.

juvenile pallid sturgeon above Intake Dam until construction of a fish passage project is complete" (USFWS 2016; Incidental Take Statement pg. 65).

Fish translocation past barriers is not a novel concept (Lusardi and Moyle 2017), though attempts to translocate sturgeons have been limited. Translocation of pallid sturgeon across passage barriers has not previously been attempted but has been implemented in other sturgeon species. McDougall et al. (2013) captured 12 pre-spawn Lake Sturgeon (1,165-1,500 mm; 6 males, 6 females) downstream from a hydroelectric facility and released them 500 m upstream of the dam. The authors noted that all of the translocated individuals moved rapidly upstream to a known potential spawning reach, and no fallback was observed during initial upstream ascents. Their report cautioned the potential for mortality or injury of translocated fish from downstream passage through hydroelectric facilities. Concerns regarding outmigration and probable navigation over Intake Dam are less of a threat due to known survival of past pallid sturgeon descending over the dam, albeit in low numbers, and concern still exists. In addition, the authors cautioned on suitability of upstream habitat to support year-long residency in the event that out-migration does not occur. Limited observations from telemetry studies suggest that adults will out-migrate to reaches downstream from Intake Dam, so this is not a significant concern. In addition, Rust (2011) translocated 25 mature pre-spawn white sturgeon from one river reach to another, about 50 kilometers (km) upstream in an attempt to link fish with more suitable spawning, incubation, and rearing habitat. Results varied, as some fish out-migrated downstream after only a few days, while other individuals exhibited longer residency in the translocated reach. Rust (2011) suggested that the timing of translocation or unknown behavioral and physiological factors may control the upstream migration extent and residency of sturgeons released in new habitats.

In cooperation with the USFWS, the USGS, USACE, and Montana Fish, Wildlife, & Parks (FWP), Reclamation initiated translocation of migratory pallid sturgeon around Intake Dam in spring 2017. The protocol for translocation was developed in cooperation with partner agencies on how to safely capture, transport, and release motivated adult pallid sturgeon (Braaten et al. 2017). The goals for the 2017 efforts were to relocate telemetered pallid sturgeon upstream of the Intake Dam and document the effect of translocation on behavior and movements into upstream habitats. Five pallid sturgeon were translocated in 2017 of which three traveled over 60 miles up the Yellowtone River before entering the Powder River and ascending an additional 80+ miles.

METHODS

The initial range of dates for translocation efforts to take place were between 5/1/2018 and 6/15/2018. This timeframe encompassed the period when most pallid sturgeon were likely to arrive at Intake Dam, based on past observations. Efforts would continue until June 15^{th} or until the Yellowstone River flows reached a level of 45,000 cfs where it is believed that reduced capture efficiency and safety concerns could become problematic.

Pallid sturgeon utilizing the Yellowstone River may have varying degrees of motivation to migrate past Intake Dam, thus sturgeon were not targeted for translocation at great distances from Intake Dam. Rather, a “catch zone” was developed (Figure 3) which a) excluded the area immediately downstream of Intake Dam to minimize risk of net entanglement on boulders that have migrated downstream off the dam structure; b) reduce the possibility of disturbing paddlefish anglers; and c) excluded areas downstream of the HFSC so that pallid sturgeon ascending the river would first have the opportunity to use the natural HFSC for passage around the dam. The catch zone was ~ 2 km long, beginning 0.5 km downstream of Intake Dam and ending at the downstream terminus of the HFSC. Thus, the catch zone was delineated to focus on fish that were most likely motivated to travel upstream but were unable to do so as a result of impeded upstream passage from Intake Dam.

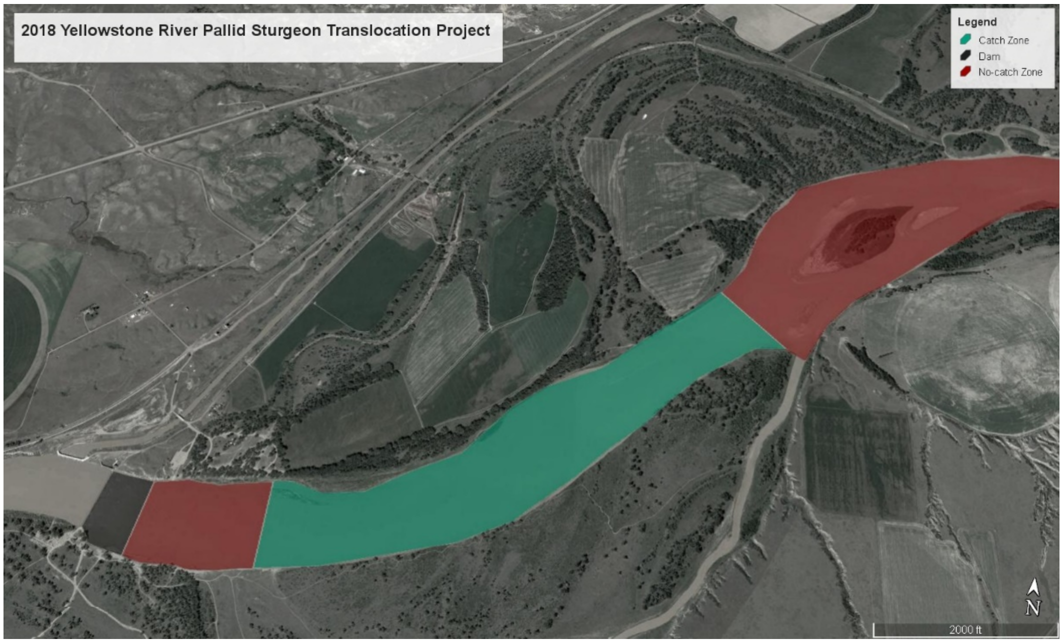

Figure 3. Project area for pallid sturgeon translocation project. Gray shade is the rock dam, red shade is the no-catch zone, green shade is the catch zone.

A two-compartment (150 gallons each) truck bed-mounted haul tank was filled with river water by employing a submersible water pump to fill the tanks. Water temperature and dissolved oxygen were closely monitored before transport and adjusted as needed with bagged ice (Williams et al. 2009, Harmon 2009) and supplemented oxygen to match ambient river conditions when needed. Water quality was monitored with a YSI™ handheld multiparameter meter.

Efforts to translocate pallid sturgeon began on May 1st, 2018. Fish tracking was done using open watercraft (length = 6 m) with a bow mounted 4-element Yagi antenna and Lotek SRX600 or SRX400 VHF radio receiver. Radio transmitters for pallid sturgeon operate at the frequencies of 149.760 and 149.620 MHz. Crews monitored both frequencies to locate any pallid sturgeon in the sampling area. Tracking began daily at ~ 0730 starting at the Intake Fishing Access Site (FAS) boat launch and continuing downstream. If no pallid sturgeon were found in the catch zone, the boat crew would look for telemetered fish upstream (near the dam) and downstream of the catch zone to monitor movement of pallid sturgeon in the vicinity. Downstream tracking from the Intake FAS boat launch was ended just upstream of the Elk Island FAS boat launch.Once pallid sturgeon were located, GPS locations were recorded for both translocation eligible and ineligible fish, along with depth, water temperature, turbidity, dissolved oxygen, and conductivity as close to the fish as possible. Water quality was monitored using a YSI™ handheld multi-parameter meter, and turbidity was measured using a Hatch® portable turbidimeter. Habitat (substrate and channel type) and location data were recorded to add to the Sturgeon Information Management System (SIMS) database.

Once a radio signal was identified, the sampling crew would examine the history of that fish before attempting capture to determine whether it was translocation-eligible or needed for reproduction at a hatchery. Crews coordinated via cell phone with partners at FWP and USGS during encounters with fish destined for the hatchery, or if there were questions on eligibility for translocation. Pallid sturgeon that had no history of genetic contribution to the Pallid Sturgeon Conservation Augmentation Program (PSCAP) were prioritized for hatchery propagation over translocation.

Fish were targeted for capture using 6' tall trammel nets of either 1" or 4" inner panel square mesh and 8" outer panel, depending on last known size of target fish. Nets were deployed upstream of pallid sturgeon once they were located and allowed to drift downstream to the fish's location. The trammel nets were buoyed on each end and contained continuous lead lines. Trammel nets were drifted perpendicular to the current. After one end of the net was deployed in the water, the boat would run in reverse to pay out the remaining net. A line was tethered to the net and held on board to maintain control of the net while it fished. If any non-target fishes were captured they were released immediately. Paddlefish encountered during trammel netting were examined for length, weight, and jaw tag ID and data transferred to FWP to add to their stock assessment database. When a pallid sturgeon was captured, all other fish were released and the livewell was constantly maintained with fresh river water while performing post-capture assessment and transport.

Captured pallid sturgeon were examined for fork length, weight, sex, and reproductive condition. Syringes were used to draw blood from the anal fin crease of pallid sturgeon greater than or equal to 800 mm fork length (FL) and stored in vacutainers. Red blood cells and plasma were separated, and the plasma was extracted using a pipette and frozen in a separate container. A syringe-style egg extractor was used for gonad inspection. Eggs were stored in 10% neutral buffered formalin (Protocol brand, Cat# 032-059). All pallid sturgeon were examined for passive integrated transponder (PIT) tags. Pectoral fin clips were collected for genetic investigation on all pallid sturgeon without PIT tags or other marking, and all pallid sturgeon greater than or equal to 700 mm FL.

Following post-capture assessment, pallid sturgeon were to be transported with the truck-mounted haul tank, or via boat through the HFSC if flows allowed (>35,000 cfs). If pallid sturgeon were caught and qualified for translocation during the paddlefish angling season (May 1 – June 30), they were to be loaded for truck transport at the furthest downstream location at Intake FAS campground to avoid interruption of anglers who heavily use the boat ramp during the limited paddlefish harvest season.

Following translocation, USGS and FWP partners were contacted to inform them of the details of the move which included, radio frequency and code number, time, and location of release. Detections from automated telemetry logging stations, as well as, from manual tracking runs via boat or plane-mounted telemetry gear were used to assess the extent of continued upstream migrations and potential out-migration from the translocated reach. As observed in 2014, the spawning location may occur at or near the apex of the female migration trajectory (Rugg 2015). If a reproductive female (i.e., full of eggs) were to have been translocated, her reproductive condition could be assessed at various intervals along the river to validate successful spawning (e.g., loss of weight due to egg deposition, change in reproductive hormones from pre-spawn assessments). Similarly, if one or more males along with a reproductive female are translocated, unity of both sexes at a single location and time may signal a spawning event. If spawning was suspected to have occurred, sampling for free embryos was to be initiated by USGS and FWP in an attempt to verify hatch and drift entry of free embryos. In addition, if spawning sites are determined or highly suspected, two USGS Columbia Environmental Research boats were to be deployed to characterize the site. One boat equipped with DIDSON/ARIS acoustic imagery system was set to document pallid sturgeon locations, behaviors, and spawning substrate conditions. The second boat, equipped with multibeam bathymetry system, singlebeam bathymetry system, and acoustic Doppler current profiler, was to map the spawning site to quantify hydraulics and bed conditions using established USGS protocols.

RESULTS

Capture efforts occurred on 17 days beginning on 5/1/2018 and ending on 5/19/2018. Sampling was scheduled through mid-June, but high flows (> 45,000 cfs at USGS Station 06327500) and high debris loads rendered trammel netting ineffective and unsafe. Discharge in the Yellowstone River during the 2018 translocation season varied between 24,100 cfs and 78,800 cfs (Figure 4). Telemetered fish were located and captured within the catch zone between 26,000 cfs and 44,000 cfs (Figure 5).

Seven pallid sturgeon (range 815 mm – 1512 mm FL) were captured and translocated above Intake Dam. These fish were captured in the catch zone between 5/6 and 5/19. Four fish were hatchery origin and unknown sex and immature, two were adult wild males (unknown reproductive status in 2018) and one was a wild female that was non-reproductive in 2018 (based on results from plasma analyzed by USFWS Bozeman Fish Technology Center), (Table 1). Four fish were boated to shore and transferred to the haul tank truck, and three were boat transported upstream via the HFSC. Pallid sturgeon translocated via haul tank truck were released at the Stipek FAS Boat Launch (47.26065, -104.56656; RM 83), and the other three were released upstream ~1.5 km from the upstream end of the HFSC (47.26065, -104.56656; RM 73.9). Handling and transport times for translocated fish was near an hour. Fish were then monitored for a short period to assess post-release movement, and further tracking was conducted by FWP and USGS as well as fixed radio receiver stations (Figures 6 and 7).

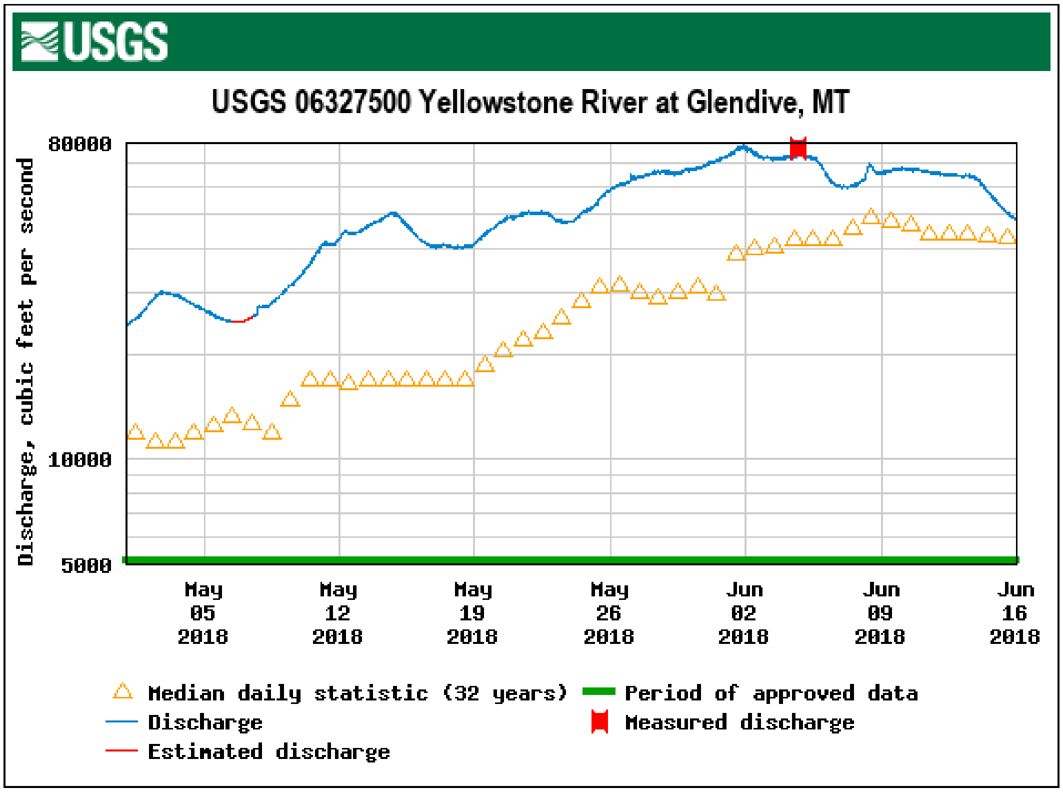

Figure 4. USGS hydrograph of Yellowstone River discharge at Glendive Station 06327500 from 5/1/2018 to 6/16/2018. Monitoring efforts were abandoned after 5/19/2018 when discharge increased over 45,000 cfs. Graph is from the National Water Information System, available at nwis.waterdata.usgs.gov.

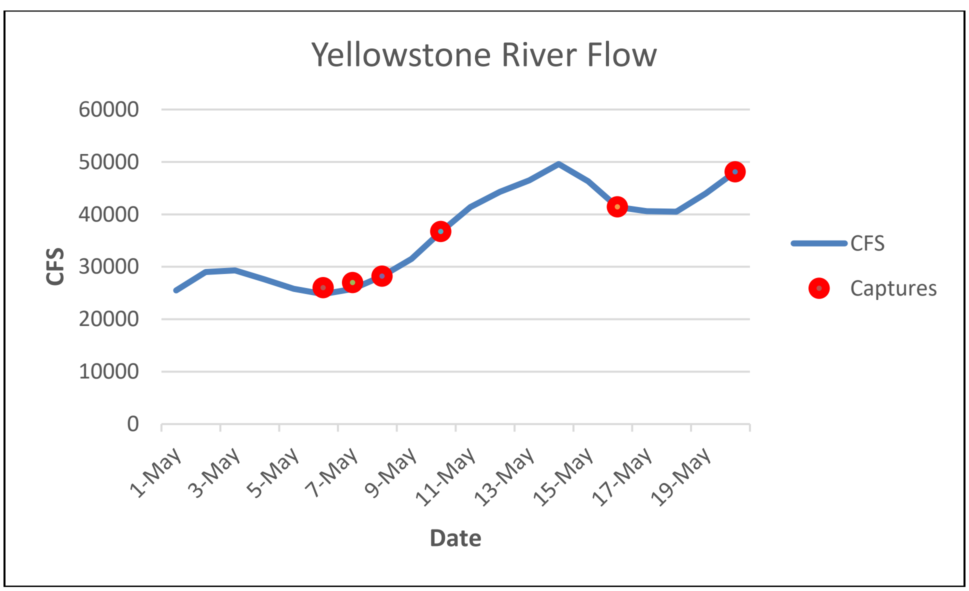

Figure 5. Yellowstone River discharge (cfs) during the 2018 pallid sturgeon translocation effort (USGS Station 06327500 near Glendive, MT). Red dots indicate dates pallid sturgeon were successfully captured and translocated above Intake Dam.

Table 1. Summary of translocated pallid sturgeon from the 2018 Reclamation sampling season (5/1/2018 through 5/19/2018).

Date of Translocation	Radio Frequency	Code	Fork Length (mm)	Weight (kg)	Year Class	Sex	Ripe	PIT Tag #
5/6/2018	149.620	154	1310	9.60	1998	Unk.	No	411D4A7764
5/7/2018	149.760	87	1512	21.60	Wild	Fem.	No	1F48421542
5/8/2018	149.620	66	815	2.02	Unk.	Unk.	No	4868642C3F
5/8/2018	149.760	11	1272	8.45	Wild	Male	NA	7F7D7C2447
5/10/2018	149.620	98	980	3.21	Unk.	Unk.	No	435E727840
5/16/2018	149.620	40	860	2.50	2007	Unk.	NA	4900076B0E
5/19/2018	149.760	77	1480	17.80	Wild	Male	NA	7F7B031F17

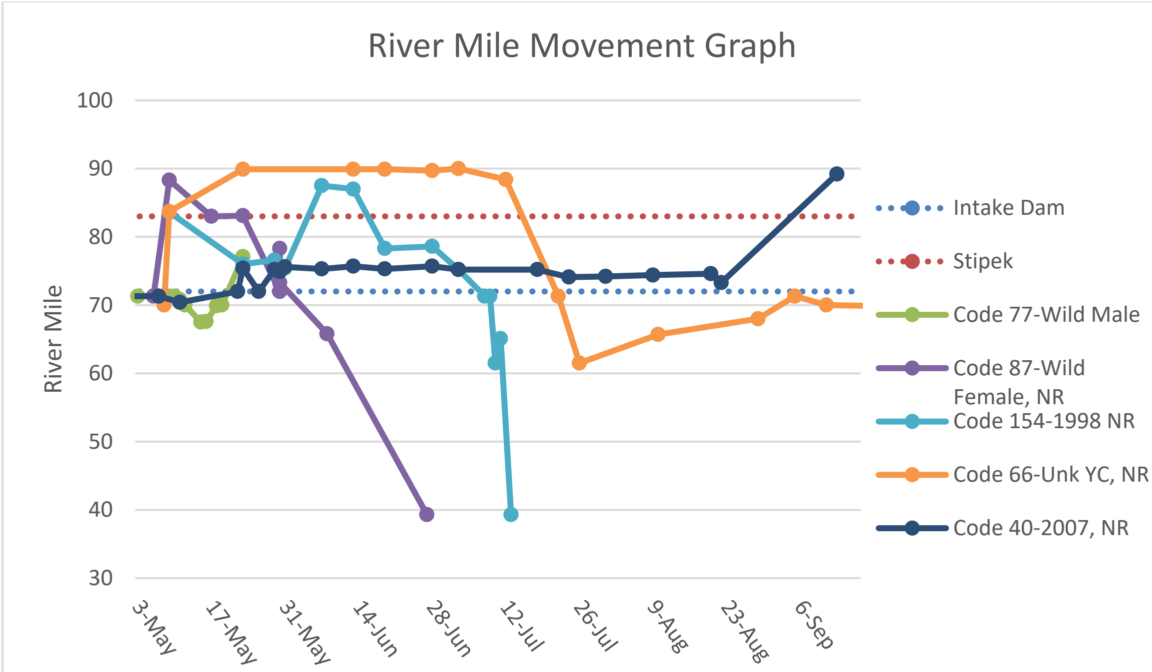

Figure 6. Movements by river mile for 2018 translocated pallid sturgeon in the Yellowstone River, MT (Rugg et al. 2019).

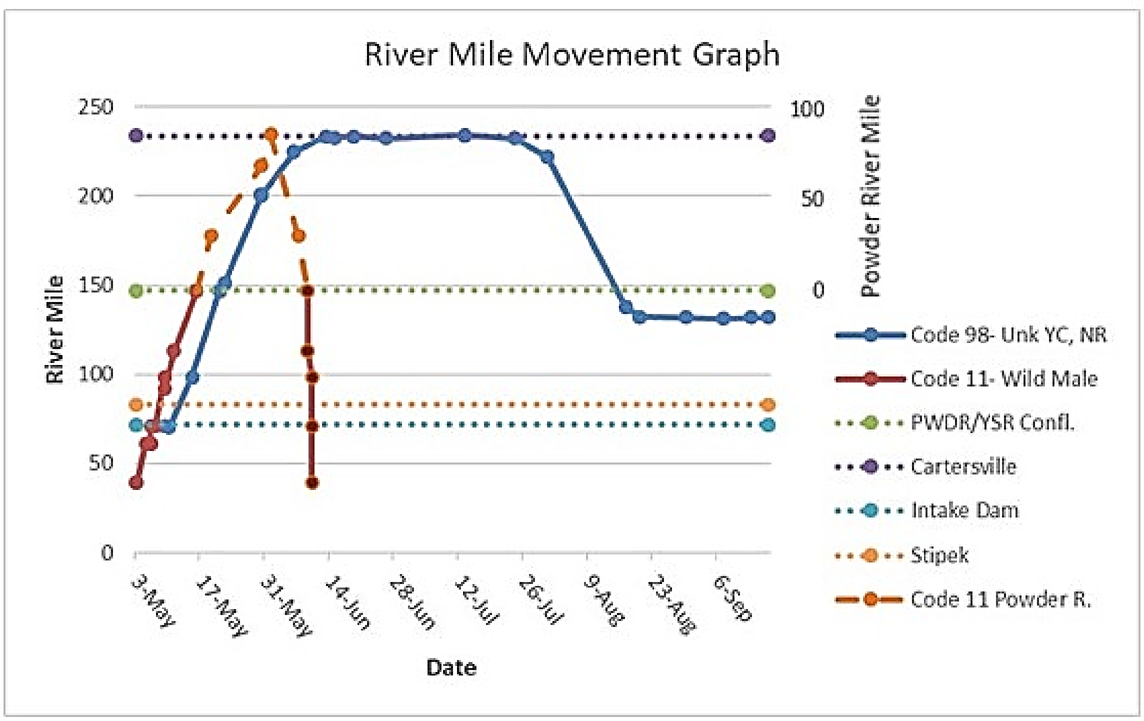

Figure 7. Movements by river mile for 2018 translocated pallid sturgeon in the Yellowstone River and Powder River, MT (Rugg et al. 2019).

Five of the seven pallid sturgeon translocated upstream of Intake Dam did not ascend more than 20 RM from their release location. Pallid sturgeon code 11 (frequency 149.760) ascended 63 miles up the Yellowstone River from its release point at Stipek FAS (RM 83) and then entered the Powder River where it traveled an additional 87 river miles. Code 11 was also translocated the previous year and made a similar ascent to river mile 88 of the Powder River. Pallid sturgeon code 98 (frequency 149.620) ascended 160 RM up the Yellowstone River from its release point at RM 74 to Cartersville Dam at Forsyth, MT (RM 234), where it remained in the vicinity (roughly 2 river miles) below the dam from June 13th to July 24th. Flows during this period exceeded 70,000 CFS at times and there was no confirmation that this fish ascended past the dam during the 8 tracking (by boat) events in the area during this period. Detection data for all translocated fish can be referenced in Appendix A (Rugg et al. 2019).

Tracking runs by BOR above and below Intake Dam detected 22 individual radio tagged pallid sturgeon over 13 tracking days (Table 2) and resulted in 55 detections to be added to the SIMS database. Average depth of radio-located pallid sturgeon was 2.45 m. Channel types noted for fish include 2 fish located within side channels, 23 in split channels, and 31 in single channel.

Table 2. Frequency and code of radio tag detections from 5/2/2018 to 5/19/2018, including river mile migration apex. Red denotes fish that were translocated and green denotes fish that ascended via the HFSC or over Intake Dam. Resident fish are those that have spent the previous year upstream of Intake Dam.

Freqeuncy 149.620 MHz			Frequency 149.760 MHz		
Code	# Detections	Apex RM	Code	# Detections (BOR)	Apex RM
40	4	89	11	1	PRM 88
66	2	90	77	4	77
98	2	234	87	3	88
123	3	65	131	2	70
133	7	73	169	1	65
140	2	134	179	3	71
143	1	100 (Resident)			
144	3	66			
146	2	63			
147	4	145			
154	3	88			
155	2	71			
158	1	101 (Resident)			
159	2	66			
160	2	105			
180	1	63			

DISCUSSION

The 2018 field season was the second year of translocation efforts associated with the Lower Yellowstone Fish Passage Project. Like 2017, several pallid sturgeon were successfully captured downstream of Intake Diversion Dam and transported upstream where they were released. Two out of the seven translocated fish (an unknown sex 1998 hatchery origin pallid sturgeon (HOPS) and a wild male) continued their upstream migration after tranlocation. This is consistent with 2017, when three out of the five translocated fish continued their upstream migrations (Fullard and Best 2018). Code 11 (wild male) was translocated and ascended the Powder River approximately 87 river miles. This fish was also translocated in 2017 and made a very similar migration up the Powder River where it peaked at approximately Powder River Mile 88.1. This is not the first documented use of the Power River in recent years. In 2014, three wild pallid sturgeon (2 males and 1 female) were documented successfully utilizing the HFSC and entering the Powder River where spawning was thought to have occurred (Rugg 2015).

The 1998 HOPS (code 98) also made a significant migration upstream after being translocated, however this fish bypassed the Powder River. Code 98 continued upstream to approximately Yellowstone RM 234, near Cartersville Diversion Dam located in Forsyth, Montana. This is one of the furthest documented upstream migrations by a pallid sturgeon in recent years. Although much smaller in size than Intake Diversion Dam, Cartersville is also expected to be a passage barrier to some migrating fish such as pallid sturgeon.

In addition to the translocated fish, four pallid sturgeon utilized the HFSC for upstream passage around the dam (YSR flows ranged from 57,000-76,200 cfs) and a single fish ascended over the rock field and dam (21,100 cfs; July 20th). These numbers are also consistent with 2017 when four fish used the HFSC for passage (YSR flows ranged from 46,000-58,000 cfs). The 2018 fish reached an apex river mile of 75, 105, 134, 145 and 187 in the Yellowstone River.

All of the translocated fish were moved upstream of Intake Diversion Dam in early to mid-May when flows in the Yellowstone river were below 45,000 cfs. Both 2017 and 2018 translocated fish that ascended the Powder River were nearing the apex of their ascent around the time that other pallid sturgeon were utilizing the HFSC to pass Intake Dam. This “head start” for motivated individuals may allow for sturgeon to make longer upstream migrations (distances of 2014 HFSC fish up the Powder River were 5, 8 and 20 river miles vs 87, 88, 89 and 97 river miles in 2017-2018 for translocated fish) or utilize the river over a varying array of river conditions that may allow for preferable conditions for spawning events. Sample size and high variation of conditions during events when pallid sturgeon have had access to the Yellowstone River above Intake Dam are limited but providing passage as early as fish are willing to utilize may be of significant importance.

Nine pallid sturgeon were translocated or utilized the HFSC in 2017 and eleven in 2018. The majority of fish that were translocated or passed utilizing the HFSC in 2017 (eight of the nine due to a mortality in the Powder River) and 2018 (nine out of the eleven) migrated safely back downstream over the diversion dam under its current configuration. No known mortality of these fish were documented after descending the dam. Once the replacement weir configuration is constructed it will be of importance to monitor downstream passage as there are no plans to remove Intake Dam and unforeseen complications may arise.

As of September 2018, translocated fish Code 98 (Unknown year class HOPS) and code 40 (2007 HOPS) have remained upstream of Intake Dam at roughly RM 131 and RM 89 respectively. While this is uncommon, field crews have occasionally documented pallid sturgeon remaining upstream of Intake Dam as residents and has been limited to HOPS. These individuals, particularly those nearing sexual maturity, should provide insight into habitat use and movements of pallid sturgeon not restricted by Intake Dam.

Overall in 2018, the majority of the wild pallid sturgeon population utilized the Yellowstone River over the Missouri River despite the higher than average flows out of Fort Peck Dam and the Milk River. In 2018, 52 radio-tagged wild adult pallid sturgeon used the Yellowstone River during the spawning season (May 1 – July 1). Of those 52 fish, eight (~15%) wild adults migrated upstream to Intake Dam (Rugg et al. 2019; Braaten 2019) (since 2011, 9 – 26% have migrated upstream to Intake Dam). In addition to the eight wild fish, thirteen hatchery-origin pallid sturgeon migrated up to Intake Dam during the spawning season (May 1-July 1) (Braaten 2019) which is consistent with past years (Rugg 2014; 2015; Fullard and Best 2018). These numbers continue to suggest that the Yellowstone River with its near natural hydrograph and sediment regime is likely an important river system for adult wild and hatchery origin pallid sturgeon during the spring runoff/spawning season.

Currently, the lack of pallid sturgeon free embryo drift distance is thought to be a major reason why natural recruitment is not occurring in the upper Missouri River Basin. By providing passage around the Intake Diversion Dam, it could open additional mainstem and major tributaries, such as the Powder River, for additional pallid sturgeon spawning/migration and allow for longer free embryo/larval drift distance. In 2018 code 98 migrated to RM 232 where it remained for 42 days below Cartersville Dam. Code 98's migration distance provides insight into future hurdles that pallid sturgeon may encounter if unrestricted migration to the upper reaches of the Yellowstone River are accessible. These additional miles (potentially 160 miles based on 2017 and 2018 translocation results) could give pallid sturgeon enough additional river miles for the free embryos/larvae to drift and mature before entering the headwaters of Lake Sakakawea where they are not known to survive (Bramblett and Scholl 2015, Guy et al. 2015).

Based on the results from both the 2017 and 2018 field seasons, translocation appears to be at least a temporary solution to getting endangered pallid sturgeon past migration barriers. Although spawning has not been documented with any translocated fish, the results are still encouraging as field crews are seeing fish in places and at distances upstream that they have not been documented before. It is important to assess pallid sturgeon behavior post translocation to both refine techniques for future translocation activities, as well as to determine what may be expected if pallid sturgeon are again allowed uninterrupted migration beyond Intake Dam via construction of the proposed Lower Yellowstone Fish Passage Project.

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Appendix A
Telemetry Detections for Translocated Pallid Sturgeon
2018

Fish Code	Date	River Mile	Relocation Method	Note
149.620-154	5/6/2018	72.0		Translocated
149.620-154	5/9/2018	83.6	Reg. 7 FWP	
149.620-154	5/23/2018	76.0	Reg. 7 FWP	
149.620-154	5/29/2018	76.6	Reg. 7 FWP	
149.620-154	5/30/2018	75.1	Reg. 7 FWP	
149.620-154	5/31/2018	75.4	Reg. 7 FWP	
149.620-154	6/7/2018	87.5	Reg. 7 FWP	
149.620-154	6/13/2018	87.0	Reg. 7 FWP	
149.620-154	6/19/2018	78.3	Reg. 7 FWP	
149.620-154	6/28/2018	78.6	Reg. 7 FWP	
149.620-154	7/3/2018	75.2	Reg. 7 FWP	
149.620-154	7/8/2018	71.3	Intake GS	
149.620-154	7/9/2018	71.3	Intake GS	
149.620-154	7/10/2018	61.5	Rock GS	
149.760-87	5/7/2018	72.0		Translocated
149.760-87	5/9/2018	88.3	Reg. 7 FWP	
149.760-87	5/17/2018	83.0	Reg. 7 FWP	
149.760-87	5/23/2018	83.1	Reg. 7 FWP	
149.760-87	5/30/2018	71.3	Intake GS	
149.760-87	5/30/2018	78.3	Reg. 7 FWP	
149.760-87	5/30/2018	71.3	Intake GS	
149.760-87	5/30/2018	73.3	SC Upstream GS	Downstream of Intake Via SC?
149.760-87	6/8/2018	65.8	Reg. 7 FWP	
149.620-66	5/8/2018	72.0		Translocated
149.620-66	5/9/2018	83.7	Reg. 7 FWP	
149.620-66	5/23/2018	89.9	Reg. 7 FWP	
149.620-66	6/13/2018	89.9	Reg. 7 FWP	
149.620-66	6/19/2018	89.9	Reg. 7 FWP	
149.620-66	6/28/2018	89.7	Reg. 7 FWP	
149.620-66	7/3/2018	90.0	Reg. 7 FWP	
149.620-66	7/12/2018	88.4	Reg. 7 FWP	
149.620-66	7/22/2018	71.3	Intake GS	
149.620-66	7/26/2018	61.5	Rock GS	
149.760-11	5/8/2018	72.0		Translocated
149.760-11	5/9/2018	98.5	Hoff GS	
149.760-11	5/9/2018	92.0	Reg. 7 FWP	
149.760-11	5/11/2018	113.0	Gibbs GS	

149.760-11	5/16/2018	146.8	Conf. Powder GS	
149.760-11	5/19/2018	30.9	Powder GS	Powder River
149.760-11	5/30/2018	70.1	Aircraft Reg. 7 FWP	Powder River
149.760-11	6/1/2018	87.7	Reg. 7 FWP	Powder River
149.760-11	6/7/2018	30.9	Powder GS	Powder River
149.760-11	6/9/2018	146.8	Conf. Powder GS	
149.760-11	6/9/2018	113.0	Gibbs GS	
149.760-11	6/10/2018	98.5	Hoff GS	
149.760-11	6/10/2018	71.3	Intake GS	Moved downstream over Intake Dam
149.620-98	5/10/2018	72.0		Translocated
149.620-98	5/15/2018	98.5	Hoff GS	
149.620-98	5/21/2018	146.8	Conf. Powder GS	
149.620-98	5/22/2018	151.0	Reg. 7 FWP	
149.620-98	5/30/2018	200.4	Reg. 7 FWP	
149.620-98	5/30/2018	200.7	Reg. 7 FWP	
149.620-98	6/6/2018	224.8	Reg. 7 FWP	
149.620-98	6/13/2018	233.4	Reg. 7 FWP	Cartersville Dam
149.620-98	6/15/2018	232.7	Reg. 7 FWP	Cartersville Dam
149.620-98	6/19/2018	233.5	Reg. 7 FWP	Cartersville Dam
149.620-98	6/26/2018	232.3	Reg. 7 FWP	Cartersville Dam
149.620-98	7/13/2018	234.2	Reg. 7 FWP	Cartersville Dam
149.620-98	7/13/2018	234.2	Reg. 7 FWP	Cartersville Dam
149.620-98	7/24/2018	232.4	Reg. 7 FWP	Cartersville Dam
149.620-98	7/31/2018	222.0	Reg. 7 FWP	
149.620-98	8/17/2018	138.1	Reg. 7 FWP	
149.620-98	8/20/2018	132.5	Reg. 7 FWP	
149.620-98	8/30/2018	131.9	Reg. 7 FWP	
149.620-98	9/7/2018	131.3	Reg. 7 FWP	
149.620-98	9/13/2018	131.9	Reg. 7 FWP	
149.620-98	9/17/2018	132.0	Reg. 7 FWP	Remained US of Intake Dam
149.620-40	5/16/2018	72.0		Translocated
149.620-40	5/22/2018	71.3	Intake GS	
149.620-40	5/23/2018	75.4	Reg. 7 FWP	
149.620-40	5/26/2018	71.3	Intake GS	
149.620-40	5/29/2018	75.2	Reg. 7 FWP	
149.620-40	5/30/2018	74.9	Reg. 7 FWP	
149.620-40	5/31/2018	75.6	Reg. 7 FWP	
149.620-40	6/7/2018	75.3	Reg. 7 FWP	
149.620-40	6/13/2018	75.7	Reg. 7 FWP	
149.620-40	6/19/2018	75.3	Reg. 7 FWP	
149.620-40	6/28/2018	75.7	Reg. 7 FWP	

149.620-40	7/3/2018	75.2	Reg. 7 FWP	
149.620-40	7/18/2018	75.2	Reg. 7 FWP	
149.620-40	7/24/2018	74.1	Reg. 7 FWP	
149.620-40	7/31/2018	74.2	Reg. 7 FWP	
149.620-40	8/9/2018	74.4	Reg. 7 FWP	
149.620-40	8/20/2018	74.6	Reg. 7 FWP	
149.620-40	8/22/2018	73.3	Side Channel Upstream GS	
149.620-40	9/13/2018	89.2	Reg. 7 FWP	Remained US of Intake Dam
149.760-77	5/19/2018	72.0		Translocated
149.760-77	5/23/2018	77.1	Reg. 7 FWP	

PEER REVIEW DOCUMENTATION

(Typical Form)

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Project and Document Information

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Team Leader Eric Best Biologist 86-68290 Leadership Team Member Eric Best
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Document Author(s)/Preparer(s) Eric Best

Peer Reviewer Jeremy Hammen Peer Reviewer David Trimpe

Peer Reviewer ____________________

Review Requirements

(Part A: Document does not require Peer Review)

Explain____

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Peer Review restricted to the following items/section(s): Complete Document Subject to Review

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Reviewer Jeremy Hammen

Review Certification

Peer Reviewer: I have reviewed the assigned items/sections(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer JEREMY HAMMEN Digitally signed by JEREMY HAMMEN Date: 2019.09.25 07:35:50 -06'00' Date reviewed____________________
(Signature)

Preparer: I have discussed the above document and review requirements and believe that this review is completed, and the document will meet the requirements of the project.

Team Member ERIC BEST Digitally signed by ERIC BEST Date: 2019.09.25 07:01:49 -06'00' Date signed____________________
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