Lower Yellowstone River Pallid Sturgeon Translocation Project 2019

Technical Memorandum ENV-2020-048

U.S. Department of the Interior **April 2020**

Mission Statements

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prepared by

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Pallid Sturgeon (*Scaphirhynchus albus*)

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.

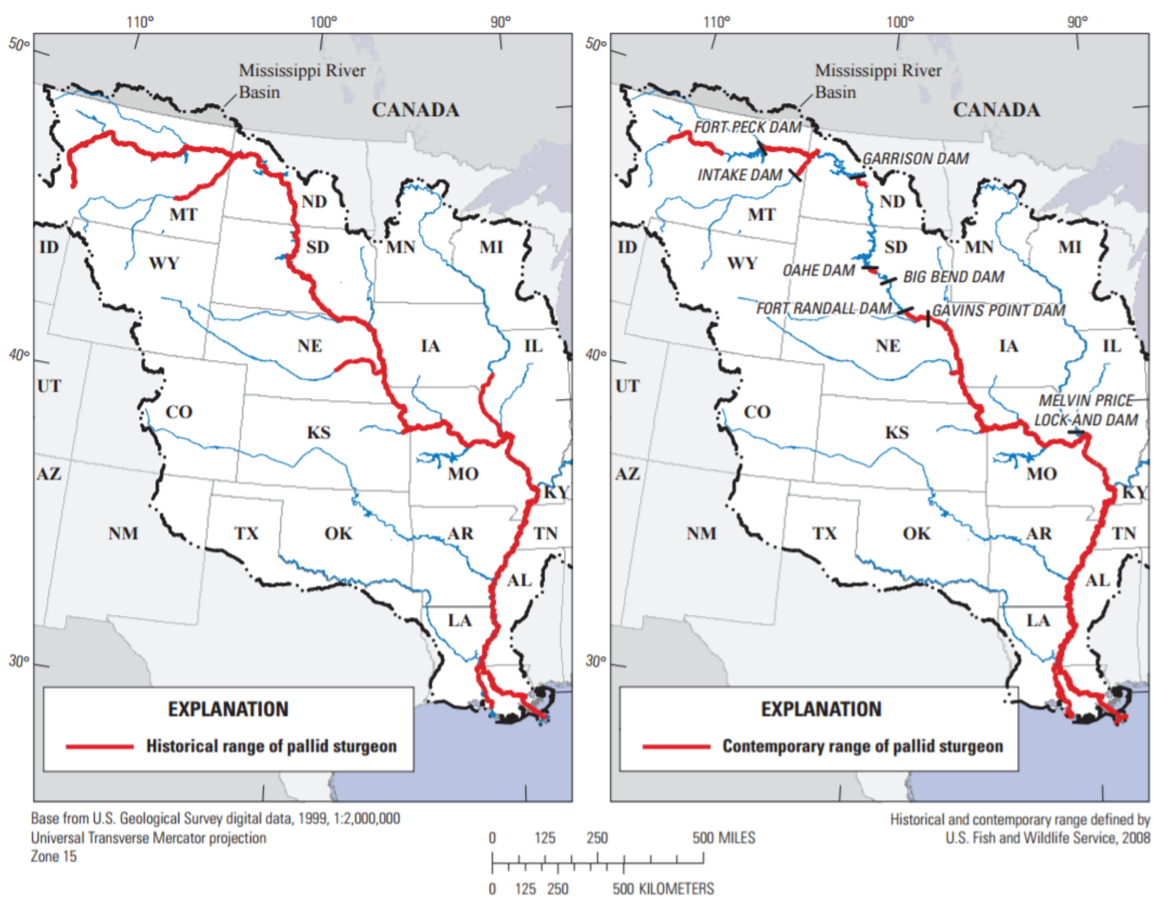

Figure 1. Maps of the historical (left) and current (right) range of pallid sturgeon in the United States. Major locks and dams which impede migration of pallid sturgeon are noted. Map is from DeLonay et al. 2016.

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 ongoing and not expected to be completed until FY2023. 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 juvenile pallid sturgeon above Intake Dam until construction of a fish passage project is complete" (USFWS 2016; Incidental Take Statement pg. 65).

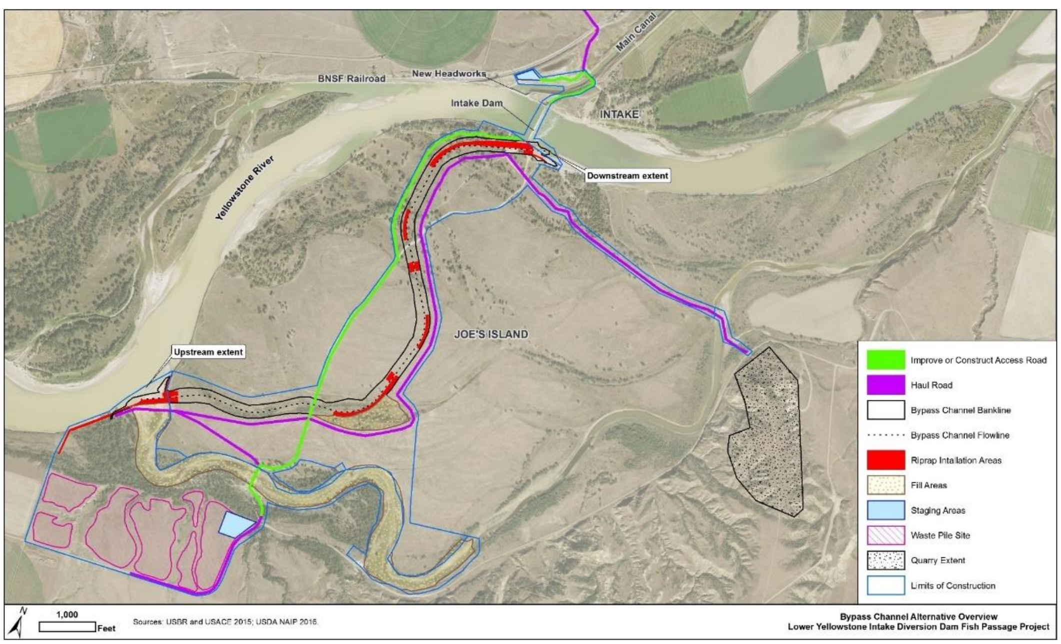

Figure 2. Proposed location of bypass channel alternative.

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 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 Yellowstone River before entering the Powder River and ascending an additional 80+ miles. In 2018, seven sturgeon were translocated of which one wild male entered the Powder River and ascended 87 miles.

METHODS

The initial range of dates for translocation efforts to take place were between 5/1/2019 and 6/15/2019. 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 15th 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. In mid-May a temporary road with culverts was constructed across the HFSC. As flows increased in the Yellowstone the road was partially washed out. It was unknown if the water velocities through the culverts or through the partially washed out road would allow for sturgeon passage. Due to the uncertainty of the side channel allowing passage for pallid sturgeon, the catch zone was extended to include the HFSC downstream of the road and an additional half mile downstream of the HFSC entrance to include an island where sturgeon often congregated.

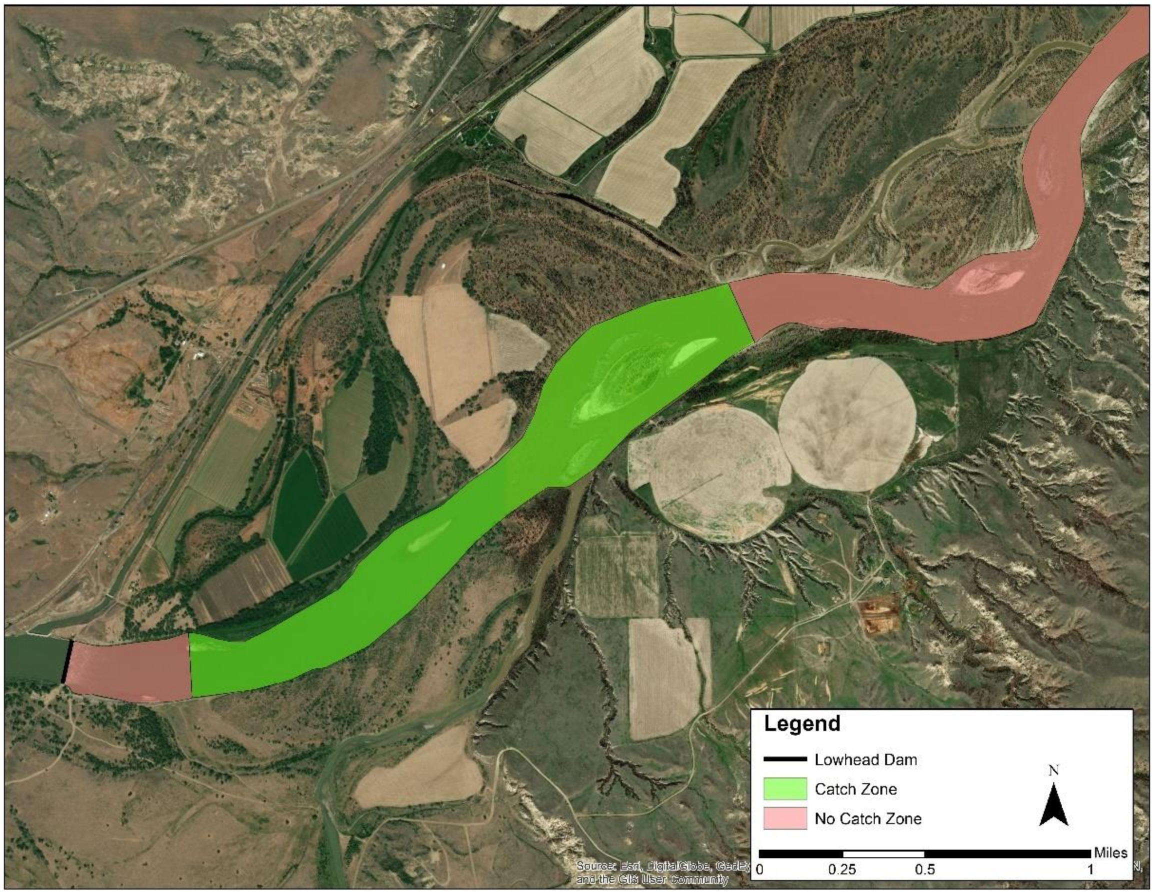

Figure 3. Project area for pallid sturgeon translocation project. Black line indicates Intake Dam, red shade is the no-catch zone, green shade is the catch zone.

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, 2019. 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. If pallid sturgeon were caught and qualified for translocation during the paddlefish angling season (May 15 – 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.

RESULTS

Capture efforts occurred on 35 days beginning on 5/1/2019 and ending on 6/14/2019. High flows (> 45,000 cfs at USGS Station 06327500) and high debris loads rendered trammel netting ineffective and unsafe between 6/3/19-6/12/19. Discharge in the Yellowstone River during the 2019 translocation season varied between 13,200 cfs and 60,900 cfs (Figure 4). Telemetered fish were located and captured within the catch zone between 5/4/2019 and 5/31/2019.

Twelve pallid sturgeon (range 810 mm – 1330 mm FL) were captured and translocated above Intake Dam. These fish were captured in the catch zone between 5/4 and 5/31. Ten fish were hatchery origin and unknown sex and immature (based on results from plasma analyzed by USFWS Bozeman Fish Technology Center), and two were adult wild males, (Table 1). Two fish had been translocated in previous years; Code 11 in 2017 and 2018 and Code 66 in 2018 (Fullard and Best 2018; Best 2019). All pallid sturgeon were translocated via haul tank truck and released at the Stipek FAS Boat Launch (47.26065, -104.56656; RM 83). Handling and transport times for translocated fish took about 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 5 and 6).

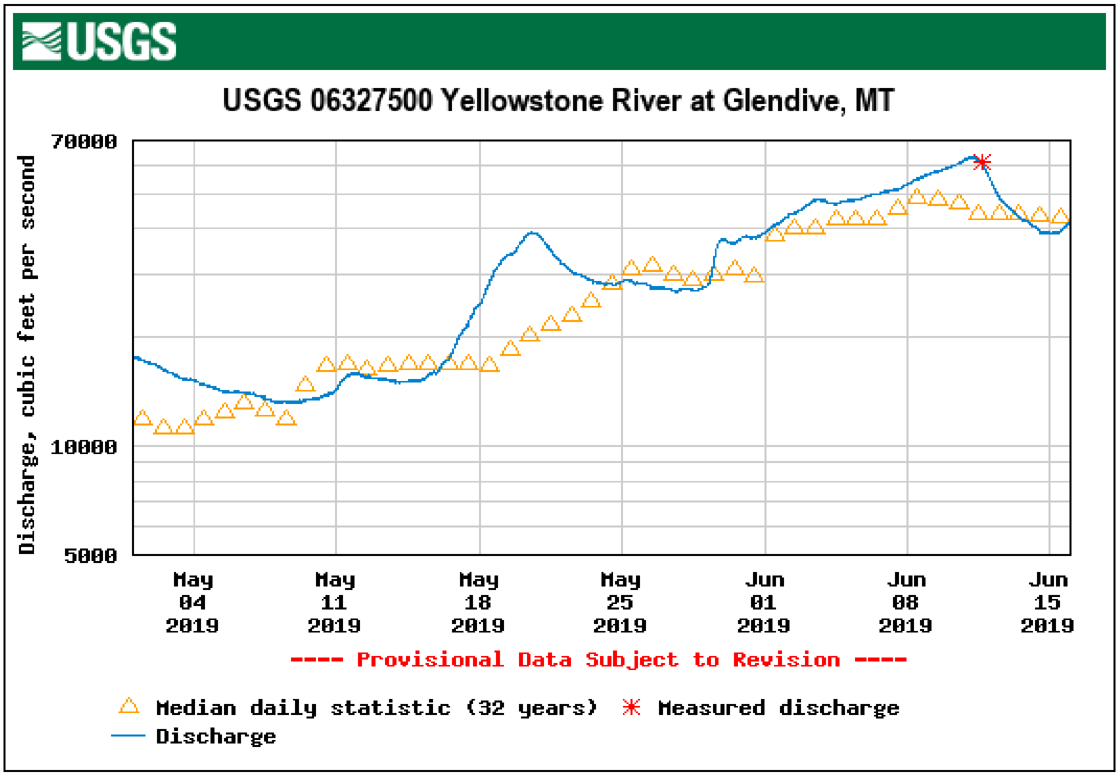

Figure 4. USGS hydrograph of Yellowstone River discharge at Glendive Station 06327500 from 5/1/2019 to 6/16/2019. Monitoring efforts were abandoned from June 3rd – June 12th when discharge increased over 45,000 cfs. Graph is from the National Water Information System, available at nwis.waterdata.usgs.gov.

Table 1. Summary of translocated pallid sturgeon from the 2019 Reclamation sampling season (5/1/2019 through 6/15/2019)

Date of Translocation	Radio Frequency	Code	Fork Length (mm)	Weight (kg)	Year Class	Sex	Reproductive	PIT Tag #
5/4/2019	149.620	112	1080	5.55	2001	Unk	No	47047A2318
5/7/2019	149.620	147	875	3.15	2001	Unk	No	4874403D09
5/16/2019	149.620	155	810	1.98	2007	Unk	No	471A732E23
5/18/2019	149.620	167	965	3.70	2006	Unk	No	4C38004E2F
5/19/2019	149.620	177	902	3.07	2006	Unk	No	471A7C7147
5/22/2019	149.620	66	860	2.40	2008	Unk	No	4868642C3F
5/25/2019	149.620	156	985	4.62	2004	Unk	No	0A180E0F2A
5/26/2019	149.620	160	1050	5.06	2001	Unk	No	435E094F0E
5/27/2019	149.620	69	875	2.62	2007	Unk	No	471E156C2F
5/27/2019	149.760	131	1330	12.5	Wild	Male	Yes	7F7F05635A
5/30/2019	149.620	133	910	2.60	2001	Unk	No	0A180E0F03
5/31/2019	149.760	11	1260	8.10	Wild	Male	No	7F7D7C2447

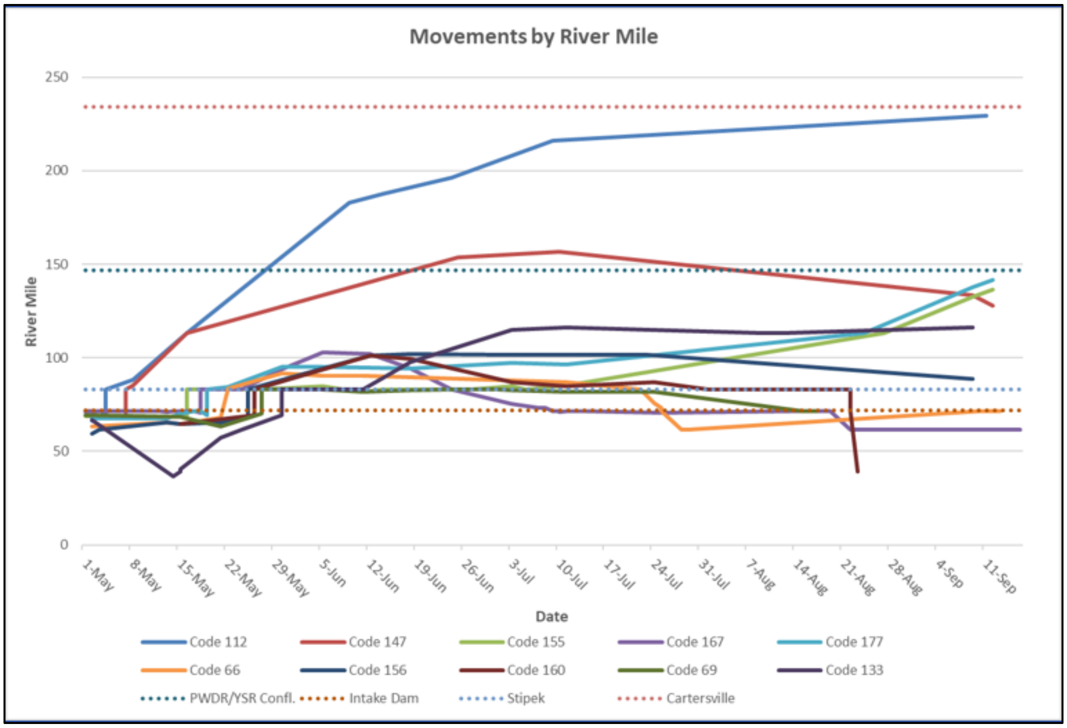

Figure 5. Movements by river mile for 2019 translocated pallid sturgeon in the Yellowstone River, MT (Rugg et al. 2019).

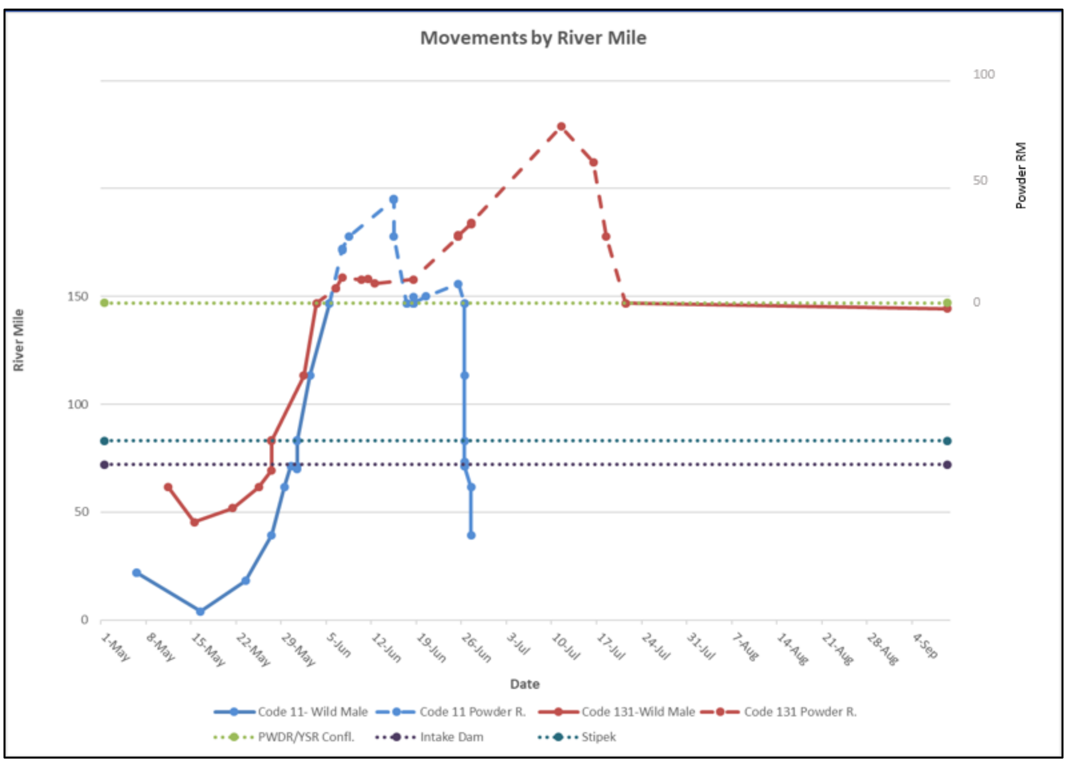

Figure 6. Movements by river mile for 2019 translocated pallid sturgeon in the Yellowstone River and Powder River, MT (Rugg et al. 2019).

Eight of the twelve pallid sturgeon translocated upstream of Intake Dam remained downstream of the confluence with the Powder River (RM 147). Two HOPS gradually migrated upstream of the Powder River confluence during the summer. Six of the twelve translocated fish remained upstream of Intake Dam as of September. Two wild males made swift, pointed movements up the Yellowstone and entered the Powder River in early June where they later exited on June 26th and July 21st. Pallid sturgeon code 11 (frequency 149.760; wild male) 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 48 river miles before descending back into the Yellowstone River and over Intake Dam. Code 11 was also translocated the previous two years and made similar ascents to river mile 88 of the Powder River. Pallid sturgeon code 131 (frequency 149.760; wild male) ascended 63 RM up the Yellowstone River from its release point at Stipek FAS and then entered the Powder River where it traveled an additional 82 river miles. Code 131 remains upstream of Intake near the mouth of the Powder as of late October.

Tracking runs by BOR above and below Intake Dam detected 32 individual radio tagged pallid sturgeon over 4 tracking days (Table 2) and resulted in 57 detections to be added to the SIMS database. Average depth of radio-located pallid sturgeon was 2.27 m. Channel types noted for fish include four fish located along inside bends, 38 located in mid-channel and eight along outside bends.

Table 2. Frequency and code of radio tag detections from 5/1/2019 to 6/04/2019, including river mile migration apex. Red denotes fish that were translocated.

Freqeuncy 149.620 MHz			Freqeuncy 149.620 MHz			Frequency 149.760 MHz		
Code	# Detections (BOR)	Apex RM	Code	# Detections (BOR)	Apex RM	Code	# Detections (BOR)	Apex RM
66	3	91	154	1	70	11	1	PRM 48
69	3	83	155	2	143	131	2	PRM 82
90	2	61	156	3	102	185	1	63
92	2	54	159	1	67			
93	2	62	160	1	101			
94	3	63	162	1	61			
95	2	71	167	2	102			
96	1	55	168	2	56			
112	2	229	171	1	61			
128	1	8	172	1	50			
133	3	117	173	1	71			
139	2	58	177	2	141			
144	1	67	178	2	54			
147	2	156	181	2	71			
153	2	67						

DISCUSSION

The 2019 field season was the third year of translocation efforts associated with the Lower Yellowstone Fish Passage Project. Like 2017 and 2018, several pallid sturgeon were successfully captured downstream of Intake Diversion Dam and transported upstream where they were released. Pallid sturgeon showed varying degrees of motivation moving upstream. Two wild males displayed swift upstream migration up to Intake Dam where they were captured and translocated to Stipek FAS. Their movements continued up the Yellowstone River and into the Powder River where they reached Powder River Miles 48 and 82 before out-migrating back to the Yellowstone River. This is consistent with 2017, when three out of the five translocated fish (Fullard and Best 2018) and 2018, when two of the seven translocated fish continued their upstream migrations into the Powder River. Code 11 (wild male) was translocated and ascended the Powder River approximately 48 river miles. This fish was also translocated in 2017 and 2018 when it made similar migrations up the Powder River where it peaked at approximately Powder River Mile 88.1. This is not the first documented use of the Powder 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).

A hatchery origin pallid sturgeon (code 112, year class 2001) also made a significant yet slower migration upstream after being translocated. However, code 112 bypassed the Powder River and continued upstream to approximately Yellowstone RM 229 - five river miles downstream of Cartersville Diversion Dam located in Forsyth, Montana. This is one of the furthest documented upstream migrations by a pallid sturgeon in recent years (a translocated HOPS code 98 migrated to Cartersville Dam in 2018). Although much smaller in size than Intake Diversion Dam, Cartersville Dam is also expected to be a passage barrier to some migrating fish such as pallid sturgeon.

In contrast to 2017 and 2018, no pallid sturgeon attempted to utilize the HFSC when Yellowstone River flows reached 46,000 cfs. The HFSC had a temporary road with culverts constructed across it in the spring of 2019. The road was partially washed out as flows increased. It is suspected that the lack of attempted use was not necessarily due to the constructed road as flows in the HFSC remained the same but were most likely due to the catch zone being extended an additional half mile below the entrance of the side channel when the road was first constructed allowing crews to target pallid sturgeon that often held near an island downstream of the HFSC entrance. Seven of the twelve sturgeon translocated in 2019 were collected in the half-mile downstream of the HFSC entrance.

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 have allowed 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, eleven in 2018 and twelve in 2019 (all translocated). 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), 2018 (nine out of the eleven) and 2019 (six of the twelve remained upstream as of September 12th) 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 2019, translocated fish codes 112, 147, 155, 177, 133 and 131 (wild male) have remained upstream of Intake Dam. Field crews have occasionally documented pallid sturgeon remaining upstream of Intake Dam as residents but 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.

In 2019, 32 radio-tagged wild adult pallid sturgeon used the Yellowstone River during the spawning season (May 1 – July 1). Of those 32 fish, two (~6%) wild adults migrated upstream to Intake Dam (Pesik et al. 2020) (since 2011, 9 – 26% have migrated upstream to Intake Dam). The reduced number is most likely attributed to a number of radio tag batteries going dead prior to advertised battery life. In addition to the two wild fish, twenty hatchery-origin pallid sturgeon migrated up to Intake Dam during the spawning season (May 1-July 1) (Pesik et al. 2020) which is consistent with past years (Rugg et al. 2019, Rugg 2014; 2015). 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 hypothesized to be one of the reasons 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 the 2017, 2018 and 2019 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 at distances upstream that they have not been documented before. In addition, several fish from the last two years' translocation efforts have remained upstream of Intake indicating that suitable habitat is present upstream of the dam. 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 2019

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-112	4/30/2019	61.5	Rock GS	
149.620-112	5/2/2019	66.3	BOR	
149.620-112	5/4/2019	70.5	BOR	Translocated to Stipek
149.620-112	5/4/2019	83.3	BOR	Released at Stipek FAS
149.620-112	5/4/2019	71.3	Intake GS	
149.620-112	5/4/2019	71.3	Intake GS	
149.620-112	5/4/2019	83	Stipek GS	
149.620-112	5/8/2019	88.1	Reg. 7 FWP	
149.620-112	5/16/2019	113.2	Gibbs GS	
149.620-112	6/9/2019	182.8	Miles City GS	
149.620-112	6/14/2019	187.7	Reg. 7 FWP	
149.620-112	6/24/2019	196.2	Reg. 7 FWP	
149.620-112	7/9/2019	216.2	Reg. 7 FWP	
149.620-112	9/11/2019	229.5	Reg. 7 FWP	
149.620-112	10/15/2019	182.8	Miles City GS	
149.620-112	10/23/2019	181.4	Reg. 7 FWP	
149.620-133	4/22/2019	16	Reg. 7 FWP	Random recap
149.620-133	5/2/2019	66.7	BOR	
149.620-133	5/21/2019	57.1	BOR	
149.620-133	5/24/2019	61.5	Rock GS	
149.620-133	5/30/2019	69.3	BOR	Translocated to Stipek
149.620-133	5/30/2019	83.3	BOR	Released at Stipek FAS
149.620-133	5/30/2019	83	Stipek GS	
149.620-133	6/1/2019	83	Stipek GS	
149.620-133	6/5/2019	83.1	Reg. 7 FWP	
149.620-133	6/11/2019	82.9	Reg. 7 FWP	
149.620-133	6/11/2019	83	Stipek GS	
149.620-133	6/18/2019	97.7	Reg. 7 FWP	
149.620-133	7/3/2019	114.8	Reg. 7 FWP	
149.620-133	7/11/2019	116.4	Reg. 7 FWP	
149.620-133	8/9/2019	113.2	Gibbs GS	
149.620-133	8/12/2019	113.2	Gibbs GS	
149.620-133	9/9/2019	116.2	Reg. 7 FWP	
149.620-133	9/17/2019	117.4	Reg. 7 FWP	
149.620-133	9/24/2019	113.2	Gibbs GS	
149.620-133	9/25/2019	113.2	Gibbs GS	
149.620-133	9/26/2019	113.2	Gibbs GS	
149.620-133	9/27/2019	113.2	Gibbs GS	
149.620-133	10/24/2019	112.4	Reg. 7 FWP	
149.620-147	4/21/2019	71.3	Intake GS	
149.620-147	4/23/2019	71.3	Intake GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-147	4/24/2019	71.3	Intake GS	
149.620-147	4/25/2019	71.3	Intake GS	
149.620-147	4/26/2019	71.3	Intake GS	
149.620-147	4/27/2019	71.3	Intake GS	
149.620-147	4/28/2019	71.3	Intake GS	
149.620-147	4/29/2019	71.3	Intake GS	
149.620-147	4/30/2019	71.3	Intake GS	
149.620-147	5/1/2019	71.3	Intake GS	
149.620-147	5/2/2019	71.2	BOR	
149.620-147	5/2/2019	71.3	Intake GS	
149.620-147	5/3/2019	71.3	Intake GS	
149.620-147	5/4/2019	71.3	Intake GS	
149.620-147	5/5/2019	71.3	Intake GS	
149.620-147	5/6/2019	71.3	Intake GS	
149.620-147	5/7/2019	69.9	BOR	Translocated to Stipek
149.620-147	5/7/2019	83.3	BOR	Released at Stipek FAS
149.620-147	5/7/2019	71.3	Intake GS	
149.620-147	5/8/2019	85.3	Reg. 7 FWP	
149.620-147	5/16/2019	113.2	Gibbs GS	
149.620-147	6/25/2019	153.6	Reg. 7 FWP	
149.620-147	7/10/2019	156.7	Reg. 7 FWP	
149.620-147	9/9/2019	133.6	Reg. 7 FWP	
149.620-147	9/12/2019	127.8	Reg. 7 FWP	
149.620-147	9/17/2019	126.5	Reg. 7 FWP	
149.620-147	9/26/2019	113.2	Gibbs GS	
149.620-147	10/24/2019	98.3	Reg. 7 FWP	
149.620-155	5/1/2019	69	BOR	
149.620-155	5/13/2019	68.5	Reg. 7 FWP	
149.620-155	5/15/2019	68.7	Reg. 7 FWP	
149.620-155	5/16/2019	69	BOR	Translocated to Stipek
149.620-155	5/16/2019	83.3	BOR	Released at Stipek FAS
149.620-155	5/17/2019	83	Stipek GS	
149.620-155	5/19/2019	83	Stipek GS	
149.620-155	5/20/2019	83	Stipek GS	
149.620-155	5/21/2019	83	Stipek GS	
149.620-155	5/22/2019	83.4	Reg. 7 FWP	
149.620-155	5/22/2019	83	Stipek GS	
149.620-155	5/23/2019	83	Stipek GS	
149.620-155	5/24/2019	83	Stipek GS	
149.620-155	5/25/2019	83	Stipek GS	
149.620-155	5/26/2019	83	Stipek GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-155	5/27/2019	83	Stipek GS	
149.620-155	6/5/2019	84.8	Reg. 7 FWP	
149.620-155	6/8/2019	83	Stipek GS	
149.620-155	6/9/2019	83	Stipek GS	
149.620-155	6/10/2019	83	Stipek GS	
149.620-155	6/11/2019	82	Reg. 7 FWP	
149.620-155	6/11/2019	83	Stipek GS	
149.620-155	6/14/2019	83	Stipek GS	
149.620-155	6/26/2019	83	Stipek GS	
149.620-155	6/27/2019	83	Stipek GS	
149.620-155	7/3/2019	84.7	Reg. 7 FWP	
149.620-155	7/5/2019	83	Stipek GS	
149.620-155	7/11/2019	85.1	Reg. 7 FWP	
149.620-155	8/27/2019	113.2	Gibbs GS	
149.620-155	9/9/2019	132.8	Reg. 7 FWP	
149.620-155	9/12/2019	136.6	Reg. 7 FWP	
149.620-155	9/17/2019	137.9	Reg. 7 FWP	
149.620-155	9/26/2019	139.4	Reg. 7 FWP	
149.620-155	10/24/2019	143.2	Reg. 7 FWP	
149.620-156	5/2/2019	59.6	BOR	
149.620-156	5/3/2019	61.5	Rock GS	
149.620-156	5/13/2019	65.4	Reg. 7 FWP	
149.620-156	5/15/2019	64.8	Reg. 7 FWP	
149.620-156	5/21/2019	65.4	BOR	
149.620-156	5/25/2019	69.1	BOR	Translocated to Stipek
149.620-156	5/25/2019	83.3	BOR	Released at Stipek FAS
149.620-156	5/25/2019	83	Stipek GS	
149.620-156	6/5/2019	94.1	Reg. 7 FWP	
149.620-156	6/12/2019	101.1	Reg. 7 FWP	
149.620-156	6/18/2019	102.1	Reg. 7 FWP	
149.620-156	7/3/2019	101.4	Reg. 7 FWP	
149.620-156	7/11/2019	101.5	Reg. 7 FWP	
149.620-156	7/23/2019	101.4	Reg. 7 FWP	
149.620-156	9/9/2019	88.7	Reg. 7 FWP	
149.620-156	9/18/2019	88.6	Reg. 7 FWP	
149.620-156	10/8/2019	83	Stipek GS	
149.620-156	10/12/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.620-156	10/12/2019	71.3	Intake GS	
149.620-156	10/12/2019	71.3	Intake GS	
149.620-156	10/12/2019	73.4	SC Upstream GS	
149.620-156	10/13/2019	71.3	Intake GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-156	10/13/2019	71.3	Intake GS	
149.620-156	10/14/2019	71.3	Intake GS	
149.620-156	10/14/2019	71.3	Intake GS	
149.620-156	10/21/2019	61.3	Reg. 7 FWP	
149.620-160	4/29/2019	61.5	Rock GS	
149.620-160	5/15/2019	64.6	Reg. 7 FWP	
149.620-160	5/26/2019	69.3	BOR	Translocated to Stipek
149.620-160	5/26/2019	83.3	BOR	Released at Stipek FAS
149.620-160	6/12/2019	101.3	Reg. 7 FWP	
149.620-160	6/18/2019	99.5	Reg. 7 FWP	
149.620-160	7/3/2019	86.9	Reg. 7 FWP	
149.620-160	7/11/2019	84.7	Reg. 7 FWP	
149.620-160	7/24/2019	86.9	Reg. 7 FWP	
149.620-160	8/1/2019	83	Stipek GS	
149.620-160	8/22/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.620-160	8/22/2019	71.3	Intake GS	
149.620-160	8/22/2019	83	Stipek GS	
149.620-167	4/23/2019	61.5	Rock GS	
149.620-167	4/25/2019	71.3	Intake GS	
149.620-167	4/26/2019	71.3	Intake GS	
149.620-167	4/27/2019	71.3	Intake GS	
149.620-167	5/1/2019	71.2	BOR	
149.620-167	5/1/2019	71.3	Intake GS	
149.620-167	5/2/2019	71.3	Intake GS	
149.620-167	5/3/2019	71.3	Intake GS	
149.620-167	5/4/2019	71.3	Intake GS	
149.620-167	5/4/2019	71.3	Intake GS	
149.620-167	5/5/2019	71.3	Intake GS	
149.620-167	5/6/2019	71.3	Intake GS	
149.620-167	5/7/2019	71.3	Intake GS	
149.620-167	5/8/2019	71.3	Intake GS	
149.620-167	5/8/2019	71.3	Intake GS	
149.620-167	5/9/2019	71.3	Intake GS	
149.620-167	5/9/2019	71.3	Intake GS	
149.620-167	5/10/2019	71.3	Intake GS	
149.620-167	5/10/2019	71.3	Intake GS	
149.620-167	5/12/2019	71.3	Intake GS	
149.620-167	5/12/2019	71.3	Intake GS	
149.620-167	5/13/2019	71.2	Reg. 7 FWP	
149.620-167	5/14/2019	71.3	Intake GS	
149.620-167	5/15/2019	71.1	Reg. 7 FWP	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-167	5/15/2019	71.3	Intake GS	
149.620-167	5/15/2019	71.3	Intake GS	
149.620-167	5/16/2019	71.3	Intake GS	
149.620-167	5/16/2019	71.3	Intake GS	
149.620-167	5/17/2019	71.3	Intake GS	
149.620-167	5/17/2019	71.3	Intake GS	
149.620-167	5/18/2019	70.5	BOR	Translocated to Stipek
149.620-167	5/18/2019	83.3	BOR	Released at Stipek FAS
149.620-167	5/18/2019	83	Stipek GS	
149.620-167	5/19/2019	83	Stipek GS	
149.620-167	5/20/2019	83	Stipek GS	
149.620-167	5/21/2019	83	Stipek GS	
149.620-167	5/22/2019	83	Reg. 7 FWP	
149.620-167	5/22/2019	83	Stipek GS	
149.620-167	5/23/2019	83	Stipek GS	
149.620-167	5/24/2019	83	Stipek GS	
149.620-167	5/30/2019	94	Reg. 7 FWP	
149.620-167	6/5/2019	102.8	Reg. 7 FWP	
149.620-167	6/12/2019	101.9	Reg. 7 FWP	
149.620-167	6/18/2019	94.1	Reg. 7 FWP	
149.620-167	6/24/2019	83	Stipek GS	
149.620-167	7/3/2019	75.5	Reg. 7 FWP	
149.620-167	7/7/2019	73.4	SC Upstream GS	
149.620-167	7/8/2019	73.4	SC Upstream GS	
149.620-167	7/9/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.620-167	7/9/2019	71.3	Intake GS	
149.620-167	7/9/2019	71.3	Intake GS	
149.620-167	7/10/2019	71	Reg. 7 FWP	
149.620-167	7/10/2019	71.3	Intake GS	
149.620-167	7/10/2019	71.3	Intake GS	
149.620-167	7/11/2019	71.3	Intake GS	
149.620-167	7/11/2019	71.3	Intake GS	
149.620-167	7/14/2019	71.3	Intake GS	
149.620-167	7/25/2019	70.5	Reg. 7 FWP	
149.620-167	8/13/2019	71.3	Intake GS	
149.620-167	8/14/2019	71.3	Intake GS	
149.620-167	8/14/2019	71.3	Intake GS	
149.620-167	8/15/2019	71.3	Intake GS	
149.620-167	8/16/2019	71.3	Intake GS	
149.620-167	8/16/2019	71.3	Intake GS	
149.620-167	8/17/2019	71.3	Intake GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-167	8/17/2019	71.3	Intake GS	
149.620-167	8/18/2019	71.3	Intake GS	
149.620-167	8/18/2019	71.3	Intake GS	
149.620-167	8/19/2019	71.3	Intake GS	
149.620-167	8/22/2019	61.5	Rock GS	
149.620-167	9/16/2019	62.8	Reg. 7 FWP	
149.620-167	9/16/2019	61.5	Rock GS	
149.620-167	9/17/2019	71.3	Intake GS	
149.620-167	9/17/2019	71.3	Intake GS	
149.620-167	9/18/2019	71.3	Intake GS	
149.620-167	9/20/2019	71.3	Intake GS	
149.620-167	9/21/2019	71.3	Intake GS	
149.620-177	4/17/2019	65.5	Reg. 7 FWP	
149.620-177	5/2/2019	67.6	BOR	
149.620-177	5/13/2019	67.7	Reg. 7 FWP	
149.620-177	5/15/2019	70.3	Reg. 7 FWP	
149.620-177	5/17/2019	71.3	Intake GS	
149.620-177	5/18/2019	71.3	Intake GS	
149.620-177	5/18/2019	71.3	Intake GS	
149.620-177	5/19/2019	69.5	BOR	Translocated to Stipek
149.620-177	5/19/2019	83.3	BOR	Released at Stipek FAS
149.620-177	5/19/2019	83	Stipek GS	
149.620-177	5/22/2019	84.5	Reg. 7 FWP	
149.620-177	5/30/2019	95.2	Reg. 7 FWP	
149.620-177	6/5/2019	95.1	Reg. 7 FWP	
149.620-177	6/12/2019	94.9	Reg. 7 FWP	
149.620-177	6/18/2019	94.4	Reg. 7 FWP	
149.620-177	7/3/2019	97.4	Reg. 7 FWP	
149.620-177	7/11/2019	96.3	Reg. 7 FWP	
149.620-177	8/24/2019	113.2	Gibbs GS	
149.620-177	9/9/2019	137.9	Reg. 7 FWP	
149.620-177	9/12/2019	141.8	Reg. 7 FWP	
149.620-66	4/29/2019	61.5	Rock GS	
149.620-66	5/2/2019	63.3	BOR	
149.620-66	5/13/2019	65.6	Reg. 7 FWP	
149.620-66	5/15/2019	64.6	Reg. 7 FWP	
149.620-66	5/21/2019	68	BOR	
149.620-66	5/22/2019	69.1	BOR	Translocated to Stipek
149.620-66	5/22/2019	83.3	BOR	Released at Stipek FAS
149.620-66	5/22/2019	83.4	Reg. 7 FWP	
149.620-66	5/22/2019	83	Stipek GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-66	5/30/2019	91.6	Reg. 7 FWP	
149.620-66	6/5/2019	90.4	Reg. 7 FWP	
149.620-66	6/11/2019	90.5	Reg. 7 FWP	
149.620-66	7/11/2019	87	Reg. 7 FWP	
149.620-66	7/22/2019	83	Stipek GS	
149.620-66	7/24/2019	75.9	Reg. 7 FWP	
149.620-66	7/25/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.620-66	7/25/2019	71.3	Intake GS	
149.620-66	7/25/2019	71.3	Intake GS	
149.620-66	7/25/2019	73.4	SC Upstream GS	
149.620-66	7/28/2019	61.5	Rock GS	
149.620-66	7/29/2019	61.5	Rock GS	
149.620-66	9/10/2019	71.3	Intake GS	
149.620-66	9/11/2019	71.3	Intake GS	
149.620-66	9/13/2019	71.3	Intake GS	
149.620-66	9/13/2019	71.3	Intake GS	
149.620-66	9/25/2019	71.3	Intake GS	
149.620-66	9/26/2019	71.3	Intake GS	
149.620-69	4/17/2019	51.7	Reg. 7 FWP	
149.620-69	4/28/2019	71.3	Intake GS	
149.620-69	5/1/2019	69.3	BOR	
149.620-69	5/15/2019	68.5	Reg. 7 FWP	
149.620-69	5/21/2019	63.2	BOR	
149.620-69	5/27/2019	70.2	BOR	Translocated to Stipek
149.620-69	5/27/2019	83.3	BOR	Released at Stipek FAS
149.620-69	6/5/2019	83	Reg. 7 FWP	
149.620-69	6/11/2019	82	Reg. 7 FWP	
149.620-69	6/18/2019	82.8	Reg. 7 FWP	
149.620-69	6/24/2019	83	Stipek GS	
149.620-69	6/26/2019	83	Stipek GS	
149.620-69	6/30/2019	83	Stipek GS	
149.620-69	7/1/2019	83	Stipek GS	
149.620-69	7/3/2019	82.5	Reg. 7 FWP	
149.620-69	7/11/2019	81.9	Reg. 7 FWP	
149.620-69	7/24/2019	82	Reg. 7 FWP	
149.620-69	8/15/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.620-69	8/15/2019	71.3	Intake GS	
149.620-69	8/15/2019	71.3	Intake GS	
149.620-69	8/16/2019	71.3	Intake GS	
149.620-69	8/16/2019	71.3	Intake GS	
149.620-69	8/17/2019	71.3	Intake GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.620-69	8/17/2019	71.3	Intake GS	
149.620-69	9/16/2019	51.4	Reg. 7 FWP	
149.620-69	9/26/2019	71.3	Intake GS	
149.620-69	9/27/2019	71.3	Intake GS	
149.760-11	4/1/2019	0	Conf. Powder GS	
149.760-11	5/29/2019	61.5	Rock GS	
149.760-11	5/30/2019	71.3	Intake GS	
149.760-11	5/30/2019	71.3	Intake GS	
149.760-11	5/31/2019	69.8	BOR	Translocated to Stipek
149.760-11	5/31/2019	83.3	BOR	Released at Stipek FAS
149.760-11	5/31/2019	71.3	Intake GS	
149.760-11	5/31/2019	71.3	Intake GS	
149.760-11	5/31/2019	83	Stipek GS	
149.760-11	6/2/2019	113.2	Gibbs GS	
149.760-11	6/5/2019	146.8	Conf. Powder GS	
149.760-11	6/5/2019	0	Conf. Powder GS	Powder River
149.760-11	6/7/2019	24.7	Reg. 7 FWP	Powder River
149.760-11	6/7/2019	25.3	Reg. 7 FWP	Powder River
149.760-11	6/8/2019	30.9	Powder GS	Powder River
149.760-11	6/15/2019	48.1	Reg. 7 FWP	Powder River
149.760-11	6/15/2019	48.2	Reg. 7 FWP	Powder River
149.760-11	6/15/2019	48.4	Reg. 7 FWP	Powder River
149.760-11	6/15/2019	30.9	Powder GS	Powder River
149.760-11	6/17/2019	0	Conf. Powder GS	Powder River
149.760-11	6/17/2019	146.8	Conf. Powder GS	
149.760-11	6/18/2019	0	Conf. Powder GS	Powder River
149.760-11	6/18/2019	0	Conf. Powder GS	Powder River
149.760-11	6/18/2019	0	Conf. Powder GS	Powder River
149.760-11	6/18/2019	2.8	Reg. 7 FWP	Powder River
149.760-11	6/18/2019	146.8	Conf. Powder GS	
149.760-11	6/18/2019	146.8	Conf. Powder GS	
149.760-11	6/20/2019	3.2	Reg. 7 FWP	Powder River
149.760-11	6/25/2019	9	Reg. 7 FWP	Powder River
149.760-11	6/26/2019	71.3	Intake GS	Downstream Intake Passage Over Dam
149.760-11	6/26/2019	0	Conf. Powder GS	Powder River
149.760-11	6/26/2019	146.8	Conf. Powder GS	
149.760-11	6/26/2019	113.2	Gibbs GS	
149.760-11	6/26/2019	71.3	Intake GS	
149.760-11	6/26/2019	71.3	Intake GS	
149.760-11	6/26/2019	73.4	SC Upstream GS	
149.760-11	6/26/2019	83	Stipek GS	

Radio_Code	Track_Date	River_Mile	Relocation Method	Notes
149.760-11	6/27/2019	61.5	Rock GS	
149.760-131	4/18/2019	61.5	Rock GS	
149.760-131	5/11/2019	61.5	Rock GS	
149.760-131	5/21/2019	51.9	BOR	
149.760-131	5/25/2019	61.5	Rock GS	
149.760-131	5/27/2019	69.3	BOR	Translocated to Stipek
149.760-131	5/27/2019	83.3	BOR	Released at Stipek FAS
149.760-131	5/27/2019	83	Stipek GS	
149.760-131	6/1/2019	113.2	Gibbs GS	
149.760-131	6/3/2019	146.8	Conf. Powder GS	
149.760-131	6/3/2019	0	Conf. Powder GS	Powder River
149.760-131	6/6/2019	6.9	Reg. 7 FWP	Powder River
149.760-131	6/6/2019	7	Reg. 7 FWP	Powder River
149.760-131	6/7/2019	11.3	Reg. 7 FWP	Powder River
149.760-131	6/10/2019	10.8	Reg. 7 FWP	Powder River
149.760-131	6/11/2019	11.4	Reg. 7 FWP	Powder River
149.760-131	6/12/2019	9.2	Reg. 7 FWP	Powder River
149.760-131	6/18/2019	11.1	Reg. 7 FWP	Powder River
149.760-131	6/25/2019	30.9	Powder GS	Powder River
149.760-131	6/25/2019	31.3	Reg. 7 FWP	Powder River
149.760-131	6/25/2019	31.6	Reg. 7 FWP	Powder River
149.760-131	6/25/2019	30.9	Powder GS	Powder River
149.760-131	6/27/2019	36.7	Reg. 7 FWP	Powder River
149.760-131	6/27/2019	36.9	Reg. 7 FWP	Powder River
149.760-131	6/27/2019	37.2	Reg. 7 FWP	Powder River
149.760-131	7/11/2019	82	Reg. 7 FWP	Powder River
149.760-131	7/16/2019	65.5	Reg. 7 FWP	Powder River
149.760-131	7/18/2019	30.9	Powder GS	Powder River
149.760-131	7/21/2019	0	Conf. Powder GS	Powder River
149.760-131	7/21/2019	146.8	Conf. Powder GS	
149.760-131	9/9/2019	144.1	Reg. 7 FWP	
149.760-131	9/17/2019	144.5	Reg. 7 FWP	
149.760-131	9/26/2019	144.7	Reg. 7 FWP	
149.760-131	10/24/2019	144.7	Reg. 7 FWP	