

**Project Title:** Invasive Carp Movement and Habitat Use in the Missouri River Basin to Inform Containment and Control Management Actions

**Geographic Location:** The study area includes Missouri River tributaries with direct connection to the Lower Missouri River and periphery streams within the states of South Dakota, Iowa, Kansas, and Missouri. The Lower Missouri River is the 1,305 river kilometers (rkm) of the mainstem Missouri River downstream of Gavins Point (the most downstream dam) to its confluence with the Mississippi River near St. Louis, MO. Tributaries of interest include:

- The James River joins the Missouri River approximately 18 rkm downstream of Gavins Point Dam and extends into South Dakota and North Dakota. The study area will focus on the lower 358 rkm of the James River upstream of the Missouri River confluence to Huron, South Dakota.
- The Vermillion River joins the Missouri River at approximately rkm 1,242 and extends into South Dakota. The study area will focus on the lower 192 rkm of the Vermillion River upstream to the East Vermillion Lake dam.
- The Big Sioux River joins the Missouri River at approximately rkm 1,181 and extends into Iowa and South Dakota. The study area will focus on the lower 255 rkm of the Big Sioux River upstream to the Sioux Falls in Sioux Falls, SD.
- The Little Sioux River joins the Missouri River at approximately rkm 1,077 and extends into Iowa and Minnesota by way of the Iowa Great Lakes, which are comprised of seven different waterbodies that are extremely important recreationally and economically. This study will focus on the 415 rkm from the confluence with the Missouri River to the electric barrier on the outlet of the Iowa Great Lakes and upstream to the Iowa-Minnesota border. Following flooding in 2012 that allowed invasive carps to invade the Iowa Great Lakes, the Iowa DNR, Minnesota DNR, and local partners installed the electric barrier. In December 2019, a Silver Carp was captured in the Ocheyedon River, about 100 yards from the Iowa border in southwestern Minnesota.
- The Kansas River joins the Missouri River at approximately rkm 591 and extends into Kansas. This study will focus on the area from the confluence with the Missouri River near Kansas City, MO, to Bowersock Dam near Lawrence, KS (rkm 60).
- The Grand River joins the Missouri River at approximately rkm 402 and extends north into Missouri with its headwaters in Iowa. This study will focus on the confluence with the Missouri River near Brunswick, MO.
- The Lamine River joins the Missouri River at approximately rkm 325 and extends south into Missouri. This study will focus on the confluence with the Missouri River near Booneville, MO.
- The Moreau River joins the Missouri River at approximately rkm 222 and extends south into Missouri. This study will focus on the confluence with the Missouri River near Jefferson City, MO.

- Creve Coeur Creek joins the Missouri River at approximately rkm 50 and provides access to Creve Coeur Park Lake, a high-use recreational area with a 320-acre oxbow lake in the Missouri River floodplain owned and maintained by St. Louis County Parks and Recreation Department. This study will focus on the 3.5 rkm from the confluence with the Missouri River to the concrete spillway on the outlet of Creve Coeur Lake.

**Lead Agency:** South Dakota Game, Fish and Parks, BJ Schall

**Participating Agencies:**

- Iowa Department of Natural Resources (IA DNR) & Iowa State University (ISU); Mike Weber
- Missouri Department of Conservation (MDC); Joe McMullen
- South Dakota Department of Game, Fish, and Parks (SDGFP) & University of South Dakota (USD); Tanner Davis
- USFWS – Gavins Point National Fish Hatchery (USFWS – Gavins Point NFH); Dan James

**Statement of Need:**

Containment (Goal 2 in the National Plan and Goal 3 in the Missouri River Framework) prevents invasive carp from expanding a known population confined to its current geospatial distribution. Knowing the movement range of Bighead and Silver Carp in the Missouri River basin as well as the environmental conditions associated with movements or congregations in association with deterrent barriers currently present in the Missouri River Basin will allow for the identification of locations where deterrence technologies, concentrated removal efforts, physical barriers, or other emerging technologies can be utilized for containment and control. Identification and evaluation of containment opportunities can facilitate the implementation of deterrent and/or removal systems that may limit dispersal, reproduction, or recruitment of invasive carp. A better understanding of the movement and behavior of invasive carp in tributaries and in association with barriers as outlined in this proposal is critical to devising strategies for successful containment.

As stated in National Plan Goal 6, scientifically valid research is necessary to provide accurate information for the effective management and control of Bighead and Silver Carp. This research will be used to develop criteria for deterrent barriers, harvest regulations, or other management activities. Invasive carp are well established throughout the Missouri River and tributaries downstream of Gavins Point Dam. Knowing when and under what environmental conditions adult Bighead and Silver carp are moving into the tributaries will help inform when to monitor the population as well as implement management actions. Understanding the movement range of Bighead and Silver Carp in the Missouri River basin, the environmental conditions associated with movements, and the conditions associated with congregations at deterrent barriers currently present in the Missouri River Basin will allow for the identification of locations where deterrence

technologies, concentrated removal efforts, physical barriers, or other emerging technologies can be utilized for containment and control. Identification and evaluation of containment opportunities can facilitate the implementation of deterrent and/or removal systems that may limit dispersal, reproduction, or recruitment of invasive carp. A better understanding of the movement and behavior of invasive carp in tributaries and in association with barriers as outlined in this proposal is critical to devising strategies for successful containment.

Invasive carp populations extend into the interior waters of Missouri River Basin states such as Minnesota via the Little Sioux River in northwestern Iowa and North Dakota via the James River. The Little Sioux and James rivers have barriers that act as deterrents under certain conditions. Flooding in 2012 allowed invasive carps to invade the Iowa Great Lakes that are comprised of seven different waterbodies that are extremely important recreationally and economically. The IADNR, Minnesota Department of Natural Resources, and local partners responded to the invasion by installing an electric barrier on the outlet of Little Gar Lake, the most downstream lake in the Iowa Great Lakes chain with a 352 km<sup>2</sup> watershed that includes both Iowa and Minnesota. Additionally, the Little Sioux River originates in southwestern Minnesota and in December 2019, a Silver Carp was captured in the Ocheyedon River, about 100 yards from the Iowa border in southwestern Minnesota.

The electric barrier on the outlet of the Iowa Great Lakes is 49 m wide and 8 m long and consists of eight electrodes and seven pulsers that span the width of the outlet with a gradient of electrical intensity. The barrier is only activated when water on the barrier surpasses 3", which typically occurs in the spring when invasive carps migrate upstream for spawning but can also occur periodically during the summer and fall, albeit less frequently. While the barrier has been in place since 2013, no evaluations have occurred to determine how effective it is at slowing or stopping upstream movements of invasive carp. Invasive carp are frequently observed below the barrier and anecdotal evidence suggests that they may have passed the barrier during high water in 2018, as individuals are occasionally captured in the Iowa Great Lakes; however, it is unknown if these fish are new individuals that have recently passed the barrier or fish that were part of the initial invasion. Downstream movement of fishes past the barrier from the Iowa Great Lakes is commonly observed; thus, upstream fish passage through the barrier may also be possible.

A number of different invasive carp barrier evaluations have been conducted to date using a variety of different deterrents. However, most of these evaluations have occurred in laboratory settings due to the cost and regulations associated with installing barriers in natural environments. Electrical barriers likely hold the most promise for limiting or stopping the upstream movement of invasive carp and the barrier currently in place on the Iowa Great Lakes is only one of a few systems available in the world that provides an opportunity to test its effectiveness under natural conditions. However, no evaluations of this barrier have been

conducted to date and it is currently unknown how effective the barrier is at preventing upstream movement of fish. Additionally, no information is available regarding the seasonal presence of invasive carp at the barrier or the source of these fish (e.g., Little Sioux River residents or migrants from the Missouri River). Further, the timing and frequency of invasive carp movements further upstream into Minnesota is unknown but could provide information about invasion phenology. Thus, more information regarding tributary movements of invasive carp and potential effectiveness of electric barriers at minimizing or stopping their upstream movements is needed.

**Project Objective:**

- 1) Determine Silver Carp and Bighead Carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers to inform containment and control management actions.
  - a. Determine if Silver Carp and Bighead Carp have extended presence in tributaries and directional movement into and out of Missouri River tributaries.
  - b. Evaluate environmental factors (e.g., season, temperature, discharge) for Silver Carp and Bighead Carp movements in select Missouri River tributaries.
  - c. Assess fish behaviors in association with an electric barrier at the outflow of the Iowa Great Lakes, a concrete spillway at Creve Coeur Lake, and dams on the Kansas River (WaterOne Dam and Bowersock Dam), particularly how fish approach, challenge, and pass the barriers.
  - d. Evaluate seasonal congregations of Silver Carp and Bighead Carp in Missouri River tributaries, particularly as they relate to fish barriers.

**Project Highlights:**

- A total of 30 new receivers were deployed in Missouri River tributaries in 2021, and 367 invasive carp have been tagged throughout the basin.
- Extensive drought conditions limited work activities in 2021 throughout the Missouri River Basin, resulting in delayed work and limited data collection.
- A variety of methods were used to deploy receivers in each of the study tributaries, including receivers fastened to bridge pilings and other submerged in the main river channel.
- Silver Carp exhibited limited movement in South Dakota tributaries, remaining near their tagging locations, and upstream movements on the Big Sioux River appeared to be linked to increases in the hydrograph.
- There was a limited number of detections of transient individuals moving from their tag location to another Missouri River tributary.

**Methods:**

*Agency: Iowa Department of Natural Resources (IADNR) and Iowa State University (ISU)*

Eighteen PVC housings for VEMCO acoustic receivers were installed on bridge piers along the Little Sioux River and two of its tributaries (Figure 1) from June to August 2021. Sixteen receiver housings were installed directly on the Little Sioux while one was installed on both the Ocheyedan River and West Fork of the Little Sioux River. The entire array of receiver housings span from the Little Sioux River's confluence with the Missouri River to the Highway 69 bridge on the Iowa-Minnesota border. Two more receiver installations were proposed on the Missouri River, one upstream of the confluence with the Little Sioux River and one downstream. We successfully installed a nineteenth receiver housing on the downstream bridge (US Highway 30 between Iowa and Nebraska). The upstream bridge (Highway 175 between Iowa and Nebraska) had an unexpected footing on the pier and alternative locations, or methods, are being investigated. Due to the current two-year drought throughout most of the Midwest, 2021 water levels were too low to deploy the receivers along the Little Sioux River. The only receiver that was deployed upon housing installation was at the US Highway 30 bridge over the Missouri River. Tagging will begin once river levels are more favorable and receivers are deployed.

For each housing, one 10-20-foot section of 4" PVC was attached below the bridge to the downstream side of a single pylon with no more than four 4" stainless steel pipe straps, 3/8" x 5" stainless steel wedge anchors, stainless steel lock washer, and stainless-steel nuts. To avoid damage to pier reinforcements/rebar, holes for wedge anchors were not drilled more than 3". If pier reinforcement/rebar was encountered, drilling was ceased instantly, and wedge anchors were installed as is. Installation of receiver housings occurred below the bridge from either a boat abutting the pylon or wading with a step ladder. Upon deployment, VEMCO receivers will be tethered within the PVC housing using stainless steel cable and stickers will be affixed to the PVC for identification.

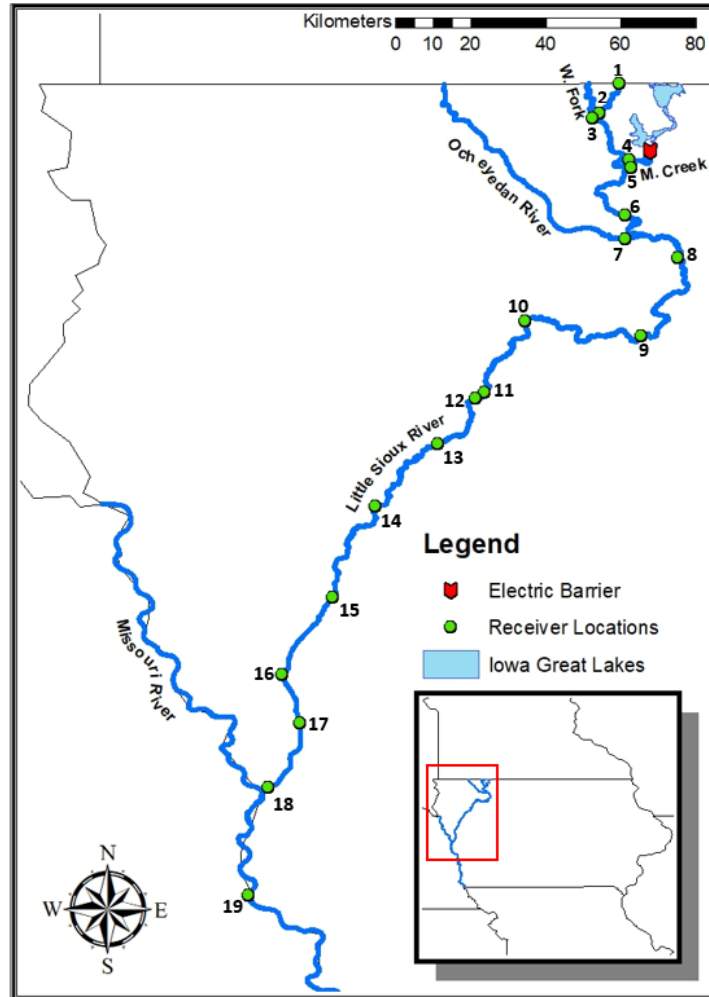


Figure 1. Little Sioux River in northwestern Iowa where 19 acoustic receiver housings were installed during 2021 (green points).

*Agency: Missouri Department of Conservation (MDC)*

During summer/fall 2021, standardized electrofishing utilizing Long Term Resource Monitoring power goal settings was conducted to capture invasive carps for surgical insertion of transmitters. Up to 10 individual fish were captured at a time during electrofishing runs and placed into stock tanks with aeration, until the total goal for implanted transmitters at that location was met. Innovasea, (formerly Vemco), standardized acoustic telemetry equipment continues to be used including long-term V16-6H coded transmitters and Vr2Tx style receivers. Transmitter specifications were: Innovasea V16-6H Power H; Random Delay: 30 to 60 seconds, Loop back to step 1. Estimated tag life 1460 days. Both transmitter and receiver operate at the acoustic signal of 69 khz. Transmitters were surgically implanted into the abdominal cavity of invasive carp by 1) removing scales near the incision then 2) with surgical scalpel, completing a lateral incision just above the pelvic fins large enough (i.e., 1.5-2 cm in length) to accept the transmitter. Three interrupted external surgical sutures were completed on the incision to improve healing

and reduce transmitter expulsion. All transmitters were checked for ping rate and coded ID prior to inserting into the fish. In addition to having an acoustic transmitter surgically implanted, each fish was measured, weighed, sexed, and externally tagged using a T-bar floy tag. Capture location data as well as water quality data was also recorded.

Vr2Tx receivers were deployed along sites utilizing platforms of opportunity. Suitable sites included locations of protected bankline (e.g., inside bend), large rock areas, and notable landmarks that improved chances of future retrieval. The receivers are further protected from damage by PVC encasement but allowing the end of the omni-directional hydrophone to be exposed. Cable (1/8-3/16-inch diameter) was used to anchor receivers to platforms of opportunity. The receiver was placed away from the bankline in water depths that accounted for record drought cycles and anchored using a rock bag. Each receiver was labeled with MDC logo/property control number and has a visible tag on the bankline and anchor ends engraved with “MDC Equip”.

*Agency: South Dakota Department of Game, Fish, and Parks (SDGFP) and University of South Dakota (USD)*

Prior to this study, an existing telemetry network spanned from river kilometer (rkm) 1 to rkm 156 of the James River. During the summer of 2021, 6 additional Vemco VR2W acoustic receivers and 5 VR2Tx transponding receivers were deployed in the James River upstream of the existing receivers, spanning from rkm 170 to rkm 358 (Figure 1). To collect habitat data, HOBO temperature loggers, 1 dissolved oxygen (DO) sensor, and 1 depth/temp logger were placed intermittently along the telemetry network (Figure 1).

Vemco V16 acoustic coded transmitters were implanted into 50 Silver Carp from June 7 to June 10, 2021. Fish had a mean weight of 3,019 g (range: 1042 g to 5454 g) and mean total length of 625 mm (range: 452 mm to 777 mm). A total of 25 transmitters were implanted near Mitchell, SD (43.760925°, -97.988167°), 11 transmitters were implanted northwest of Yankton, SD, near the Schramm public boat access (43.057850°, -97.398710°), and the final 14 transmitters were implanted approximately 2 rkm upstream of the confluence of the James and Missouri rivers (42.880131°, -97.279514°) (Figure 2).

All surgeries were performed according to the University of South Dakota’s Institutional Animal Care and Use Committee (IACUC) protocols. Tools were sterilized with 50 percent chlorhexidine, and gloves were worn during the procedures. A 1.5-2-inch incision was made on the dorsal side of the fish between the pelvic and pectoral fins, and a Vemco V16 tag was inserted into the body cavity. Sterile chromic catgut sutures were used to make three simple interrupted sutures post-surgery. Surgeries took an average of five minutes to complete. Fish were monitored to ensure they were swimming upright in the live well before being released back into the James River.

Detection data were offloaded from all receivers in the James River in late October or early November 2021.

*Agency: US Fish and Wildlife Service Great Plains Fish and Wildlife Conservation Office (GPFWCO)*

We developed a passive telemetry receiver array in the Big Sioux and Vermillion rivers to monitor movement and distribution of tagged Silver Carp (Figure 1). The array consisted of 10 Vemco VR2W acoustic receivers (n=5 per river). Each receiver was fastened to a steel frame, placed on the bottom of the river, and attached to a secure object on shore (e.g., large tree) with 1/8-inch steel cable. A HOBO temperature logger was attached to the furthest upriver and downriver receiver frames to collect water temperature data for each tributary.

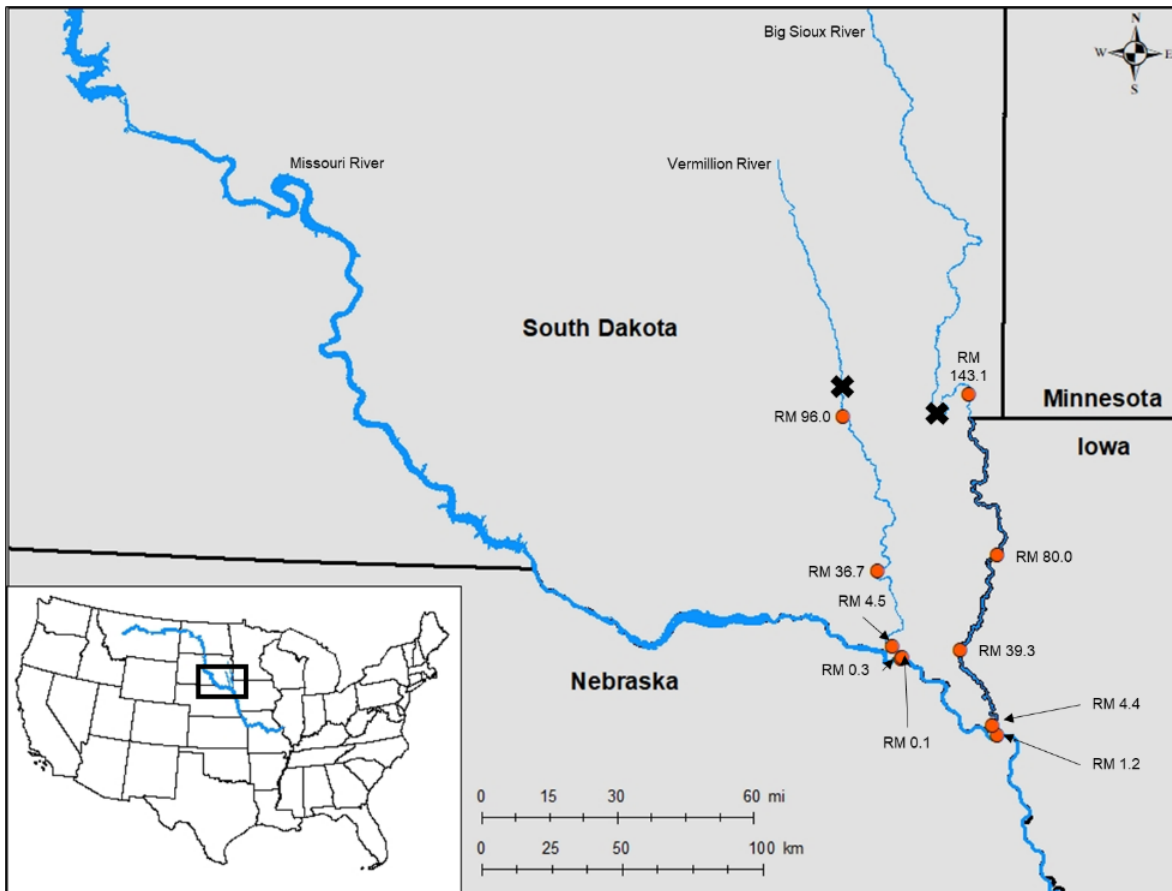


Figure 1. Location of passive receivers (orange circles) and barriers to fish movement (black “X”) in the Big Sioux and Vermillion rivers during 2021. Receiver locations labeled by approximate river mile (RM).



In the Big Sioux River, receivers were placed from 1.2 river miles upriver from its confluence with the Missouri River to 10 river miles downriver of Falls Park, Sioux Falls, SD (i.e., impassable fish barrier) where sufficient water depth was available. Total river distance spanned was 141.8 river miles.

In the Vermillion River, receivers were placed from 0.1 miles upriver of its confluence with the Missouri River to 6.5 miles downriver of Lake Vermillion dam (i.e., impassable fish barrier) where sufficient water depth was available. Total river distance spanned was 95.9 river miles.

Eighty Silver Carp were implanted with transmitters. Fish were caught using electrofishing methods beginning at the confluence of each river, continuing upstream until 40 fish were captured and implanted with a transmitter. Captured fish were held in a tank with a continuous flow of fresh river water. Each fish was anesthetized with Aqui-S 20E prior to surgery, weighed (g), measured for total length (mm), sexed, and implanted with acoustic transmitter tags (Vemco model V16-4H; 69kHz, 16 mm diameter, 68 mm length, 24 g). A Floy T-bar anchor tag (Model FD-94; Floy Tag & Mfg. Inc.) with a unique identification code and contact information ([CARP@FWS.GOV](mailto:CARP@FWS.GOV)) was attached to each fish near its dorsal fin base. Following surgery, fish were placed into a tank with a continuous flow of fresh river water until the fish was recovered enough to maintain equilibrium and swim independently. Once recovered, each fish was released near its point of capture.

Tags were implanted into 40 Silver Carp from the Vermillion River on May 26 – 27, 2021. Silver Carp in the Vermillion River had a mean total length of 590 mm (range: 519 – 713 mm) and mean weight of 2,418 g (range: 1,320 – 4,705 g). Tags were implanted into 40 Silver Carp from the Big Sioux River on June 1 – 2, 2021. Silver Carp had a mean length of 623 mm (range: 556 – 866 mm) and mean weight of 3,147 g (range: 2,280 – 6,500 g).

Receiver and temperature logger deployment began on May 26, 2021, and all receivers were retrieved from the river by October 15, 2021 to avoid loss or damage to equipment during winter. Stationary receiver data were downloaded from receivers monthly from May to October. Actual dates of receiver operation varied among rivers and locations (Table 1). Silver Carp detection data was summarized as the number of unique individuals detected at each receiver per day (i.e., individual daily detections).

Table 1. Passive receiver locations and dates of deployment and retrieval in the Big Sioux and Vermillion rivers during 2021.

River	Latitude (N)	Longitude (W)	River mile	Date deployed	Date retrieved
Big Sioux	42.49038	96.46936	1.2	6/1/2021	10/15/2021
Big Sioux	42.52106	96.49035	4.4	6/24/2021	10/15/2021
Big Sioux	42.76145	96.63244	39.3	6/23/2021	9/21/2021

Big Sioux	43.06215	96.47113	80.0	6/24/2021	9/21/2021
Big Sioux	43.57263	96.59994	143.1	7/22/2021	9/21/2021
Vermillion	42.73406	96.88859	0.1	5/26/2021	10/15/2021
Vermillion	42.73513	96.88616	0.3	6/29/2021	10/15/2021
Vermillion	42.77272	96.93047	4.5	5/28/2021	10/15/2021
Vermillion	43.01113	96.99540	36.7	6/15/2021	9/20/2021
Vermillion	43.49961	97.15772	96.0	6/15/2021	9/20/2021

### Results and Discussion:

*Agency: Iowa Department of Natural Resources (IADNR) and Iowa State University (ISU)*

No fish have been tagged to date due to drought and low water levels. We anticipate tagging and tracking fish beginning spring 2022. We did conduct acoustic telemetry range testing in the Iowa Great Lakes to determine our ability to detect tagged carp should they move upstream of the electric barrier.

*Agency: Missouri Department of Conservation (MDC)*

Eight stationary VR2Tx telemetry receivers were deployed in four lower Missouri River tributaries (Table 1). A total of 237 silver carp (150 male, 87 female) were captured and implanted with acoustic transmitters (Table 2). A total of 51, 67, 62, and 57 fish were implanted with acoustic transmitters in or near the mouth of Creve Coeur Creek, Grand River, Lamine River, and Moreau River respectively.

Table 1 Site name, date of installation, and location (latitude and longitude) of stationary telemetry receivers in lower Missouri River tributaries.

Site	Date	Latitude	Longitude
Creve Coeur Creek	9/24/21	38.74676	-90.49034
Creve Coeur Lake	9/24/21	38.72599	-90.48856
Grand River - Mouth	11/2/21	39.38456	-93.11004
Grand River – Upper	11/2/21	39.41060	-93.11469
Lamine River – Mouth	11/3/21	38.97925	-92.84944
Lamine River – Upper	11/3/21	38.94060	-92.87118
Moreau River – Mouth	11/9/21	38.55508	-92.09458
Moreau River – Upper	11/9/21	38.54064	-92.10685

Table 2. Date, site, species, length, weight, sex, transmitter ID, and FLOY tag ID for each invasive carp transplanted with an acoustic transmitter in lower Missouri River tributaries.

Date	Site	Species	Length (mm)	Weight (g)	Sex	Transmitter ID	FLOY Tag ID
11/1/2021	Creve Coeur Creek	Silver Carp	633	2600	M	48987	ORFS44492
11/1/2021	Creve Coeur Creek	Silver Carp	632	2420	F	48986	ORFS44491

11/1/2021	Creve Coeur Creek	Silver Carp	620	2400	F	48985	ORFS44490
11/1/2021	Creve Coeur Creek	Silver Carp	743	4140	F	48984	ORFS44489
11/1/2021	Creve Coeur Creek	Silver Carp	682	3100	F	48983	ORFS44488
11/1/2021	Creve Coeur Creek	Silver Carp	608	2520	F	48982	ORFS44487
11/1/2021	Creve Coeur Creek	Silver Carp	643	2520	M	48981	ORFS44486
11/1/2021	Creve Coeur Creek	Silver Carp	771	3960	M	48980	ORFS44485
11/1/2021	Creve Coeur Creek	Silver Carp	700	3480	M	48979	ORFS44484
11/1/2021	Creve Coeur Creek	Silver Carp	635	2780	M	48978	ORFS44483
11/1/2021	Creve Coeur Creek	Silver Carp	622	2340	M	48977	ORFS44482
11/1/2021	Creve Coeur Creek	Silver Carp	637	2640	M	48976	ORFS44481
11/1/2021	Creve Coeur Creek	Silver Carp	684	3020	F	48975	ORFS44480
11/1/2021	Creve Coeur Creek	Silver Carp	567	1840	M	48974	ORFS44479
11/1/2021	Creve Coeur Creek	Silver Carp	702	3740	M	48973	ORFS44478
11/1/2021	Creve Coeur Creek	Silver Carp	664	3080	M	48972	ORFS44477
11/1/2021	Creve Coeur Creek	Silver Carp	785	4240	M	48971	ORFS44476
11/1/2021	Creve Coeur Creek	Silver Carp	670	2820	F	48970	ORFS44475
11/1/2021	Creve Coeur Creek	Silver Carp	598	2120	M	48969	ORFS44474
11/1/2021	Creve Coeur Creek	Silver Carp	695	4160	F	48968	ORFS44473
11/1/2021	Creve Coeur Creek	Silver Carp	615	2360	F	48967	ORFS44472
11/1/2021	Creve Coeur Creek	Silver Carp	657	2940	F	48966	ORFS44471
11/1/2021	Creve Coeur Creek	Silver Carp	567	1860	M	48965	ORFS44470
11/1/2021	Creve Coeur Creek	Silver Carp	608	2340	M	48964	ORFS44469
11/1/2021	Creve Coeur Creek	Silver Carp	648	3260	M	48963	ORFS44468
11/1/2021	Creve Coeur Creek	Silver Carp	606	2380	M	48962	ORFS44467
11/1/2021	Creve Coeur Creek	Silver Carp	628	2860	F	48961	ORFS44466
11/1/2021	Creve Coeur Creek	Silver Carp	800	4940	F	48960	ORFS44465
11/1/2021	Creve Coeur Creek	Silver Carp	660	3450	F	48959	ORFS44464
11/1/2021	Creve Coeur Creek	Silver Carp	623	2830	M	48958	ORFS44463
11/1/2021	Creve Coeur Creek	Silver Carp	735	4280	F	48957	ORFS44462
11/1/2021	Creve Coeur Creek	Silver Carp	641	2720	F	48956	ORFS44461
11/1/2021	Creve Coeur Creek	Silver Carp	650	3050	F	48955	ORFS44460
11/1/2021	Creve Coeur Creek	Silver Carp	683	3060	M	48954	ORFS44459
11/1/2021	Creve Coeur Creek	Silver Carp	610	2620	M	48953	ORFS44458
11/1/2021	Creve Coeur Creek	Silver Carp	567	1900	M	48952	ORFS44457
11/1/2021	Creve Coeur Creek	Silver Carp	663	2740	F	48951	ORFS44456
11/1/2021	Creve Coeur Creek	Silver Carp	620	2680	M	48950	ORFS44455
11/1/2021	Creve Coeur Creek	Silver Carp	598	2320	F	48949	ORFS44454
11/1/2021	Creve Coeur Creek	Silver Carp	803	5650	M	48948	ORFS44453
11/1/2021	Creve Coeur Creek	Silver Carp	623	3520	M	48947	ORFS44452
11/1/2021	Creve Coeur Creek	Silver Carp	722	3900	M	48946	ORFS44451
11/1/2021	Creve Coeur Creek	Silver Carp	656	2900	M	48945	ORFS43250

11/1/2021	Creve Coeur Creek	Silver Carp	634	2900	M	48944	ORFS43249
11/1/2021	Creve Coeur Creek	Silver Carp	622	2860	F	48943	ORFS43248
11/1/2021	Creve Coeur Creek	Silver Carp	617	2750	M	48942	ORFS43247
11/1/2021	Creve Coeur Creek	Silver Carp	586	2120	M	48941	ORFS43246
11/1/2021	Creve Coeur Creek	Silver Carp	718	3460	F	48940	ORFS43245
11/1/2021	Creve Coeur Creek	Silver Carp	616	2460	F	48939	ORFS43244
11/1/2021	Creve Coeur Creek	Silver Carp	652	2980	F	48938	ORFS43243
11/1/2021	Creve Coeur Creek	Silver Carp	668	3480	F	48937	ORFS43242
11/2/2021	Grand River	Silver Carp	647	2940	F	49054	ORFS44559
11/2/2021	Grand River	Silver Carp	612	2200	F	49053	ORFS44558
11/2/2021	Grand River	Silver Carp	675	3280	M	49052	ORFS44557
11/2/2021	Grand River	Silver Carp	635	2620	F	49051	ORFS44556
11/2/2021	Grand River	Silver Carp	610	2360	F	49050	ORFS44555
11/2/2021	Grand River	Silver Carp	621	2480	F	49049	ORFS44554
11/2/2021	Grand River	Silver Carp	578	2160	M	49048	ORFS44553
11/2/2021	Grand River	Silver Carp	630	2760	F	49047	ORFS44552
11/2/2021	Grand River	Silver Carp	665	3100	F	49046	ORFS44551
11/2/2021	Grand River	Silver Carp	655	2940	F	49045	ORFS44550
11/2/2021	Grand River	Silver Carp	611	2480	F	49044	ORFS44549
11/2/2021	Grand River	Silver Carp	645	2840	F	49043	ORFS44548
11/2/2021	Grand River	Silver Carp	628	2560	F	49042	ORFS44547
11/2/2021	Grand River	Silver Carp	604	2260	M	49041	ORFS44546
11/2/2021	Grand River	Silver Carp	647	2820	F	49040	ORFS44545
11/2/2021	Grand River	Silver Carp	612	2600	F	49039	ORFS44544
11/2/2021	Grand River	Silver Carp	615	2600	F	49038	ORFS44543
11/2/2021	Grand River	Silver Carp	545	1560	M	49037	ORFS44542
11/2/2021	Grand River	Silver Carp	629	2680	M	49036	ORFS44541
11/2/2021	Grand River	Silver Carp	630	2640	F	49035	ORFS44540
11/2/2021	Grand River	Silver Carp	622	2540	M	49034	ORFS44539
11/2/2021	Grand River	Silver Carp	641	2620	F	49033	ORFS44538
11/2/2021	Grand River	Silver Carp	651	3000	F	49032	ORFS44537
11/2/2021	Grand River	Silver Carp	671	2780	F	49031	ORFS44536
11/2/2021	Grand River	Silver Carp	648	2680	F	49030	ORFS44535
11/2/2021	Grand River	Silver Carp	620	2180	M	49029	ORFS44534
11/2/2021	Grand River	Silver Carp	665	2940	F	49028	ORFS44533
11/2/2021	Grand River	Silver Carp	581	2140	M	49027	ORFS44532
11/2/2021	Grand River	Silver Carp	652	2800	F	49026	ORFS44531
11/2/2021	Grand River	Silver Carp	757	4540	M	49025	ORFS44530
11/2/2021	Grand River	Silver Carp	660	2960	F	49024	ORFS44529
11/2/2021	Grand River	Silver Carp	608	2440	F	49023	ORFS44528
11/2/2021	Grand River	Silver Carp	612	2780	M	49022	ORFS44527

11/2/2021	Grand River	Silver Carp	784	4840	F	49021	ORFS44526
11/2/2021	Grand River	Silver Carp	610	2420	F	49020	ORFS44525
11/2/2021	Grand River	Silver Carp	622	2600	F	49019	ORFS44524
11/2/2021	Grand River	Silver Carp	695	3230	M	49018	ORFS44523
11/2/2021	Grand River	Silver Carp	635	2880	F	49017	ORFS44522
11/2/2021	Grand River	Silver Carp	612	2460	M	49016	ORFS44521
11/2/2021	Grand River	Silver Carp	606	2620	F	49015	ORFS44520
11/2/2021	Grand River	Silver Carp	677	2000	F	49014	ORFS44519
11/2/2021	Grand River	Silver Carp	630	2640	F	49013	ORFS44518
11/2/2021	Grand River	Silver Carp	605	2420	M	49012	ORFS44517
11/2/2021	Grand River	Silver Carp	637	2600	F	49011	ORFS44516
11/2/2021	Grand River	Silver Carp	617	2620	F	49010	ORFS44515
11/2/2021	Grand River	Silver Carp	787	4980	M	49009	ORFS44514
11/2/2021	Grand River	Silver Carp	596	2380	F	49008	ORFS44513
11/2/2021	Grand River	Silver Carp	628	2680	F	49007	ORFS44512
11/2/2021	Grand River	Silver Carp	626	2540	M	49006	ORFS44511
11/2/2021	Grand River	Silver Carp	620	2540	F	49005	ORFS44510
11/2/2021	Grand River	Silver Carp	595	2440	M	49004	ORFS44509
11/2/2021	Grand River	Silver Carp	627	2620	M	49003	ORFS44508
11/2/2021	Grand River	Silver Carp	647	2680	F	49002	ORFS44507
11/2/2021	Grand River	Silver Carp	657	2890	F	49001	ORFS44506
11/2/2021	Grand River	Silver Carp	625	2320	F	49000	ORFS44505
11/2/2021	Grand River	Silver Carp	643	2480	F	48999	ORFS44504
11/2/2021	Grand River	Silver Carp	595	2440	F	48998	ORFS44503
11/2/2021	Grand River	Silver Carp	608	2480	M	48997	ORFS44502
11/2/2021	Grand River	Silver Carp	600	2300	F	48996	ORFS44501
11/2/2021	Grand River	Silver Carp	588	2320	M	48995	ORFS44500
11/2/2021	Grand River	Silver Carp	602	2380	F	48994	ORFS44499
11/2/2021	Grand River	Silver Carp	606	2720	F	48993	ORFS44498
11/2/2021	Grand River	Silver Carp	704	3640	M	48992	ORFS44497
11/2/2021	Grand River	Silver Carp	615	2720	F	48991	ORFS44496
11/2/2021	Grand River	Silver Carp	640	2560	F	48990	ORFS44495
11/2/2021	Grand River	Silver Carp	623	2540	F	48989	ORFS44494
11/2/2021	Grand River	Silver Carp	605	2380	M	48988	ORFS44493
11/3/2021	Lamine River	Silver Carp	513	1520	F	49116	ORFS42696
11/3/2021	Lamine River	Silver Carp	490	1380	M	49115	ORFS42695
11/3/2021	Lamine River	Silver Carp	578	2160	M	49114	ORFS42694
11/3/2021	Lamine River	Silver Carp	664	3100	F	49113	ORFS42693
11/3/2021	Lamine River	Silver Carp	575	2060	M	49112	ORFS42692
11/3/2021	Lamine River	Silver Carp	585	2280	M	49111	ORFS42691
11/3/2021	Lamine River	Silver Carp	601	2320	M	49110	ORFS42690

11/3/2021	Lamine River	Silver Carp	651	2840	M	49109	ORFS42689
11/3/2021	Lamine River	Silver Carp	575	2080	F	49108	ORFS42688
11/3/2021	Lamine River	Silver Carp	608	2360	M	49107	ORFS42687
11/3/2021	Lamine River	Silver Carp	626	2800	F	49106	ORFS42686
11/3/2021	Lamine River	Silver Carp	665	2840	F	49105	ORFS42685
11/3/2021	Lamine River	Silver Carp	611	2540	F	49104	ORFS42684
11/3/2021	Lamine River	Silver Carp	638	2880	M	49103	ORFS42683
11/3/2021	Lamine River	Silver Carp	640	2860	F	49102	ORFS42682
11/3/2021	Lamine River	Silver Carp	594	2240	M	49101	ORFS42681
11/3/2021	Lamine River	Silver Carp	659	3000	F	49100	ORFS42680
11/3/2021	Lamine River	Silver Carp	602	2360	F	49099	ORFS42679
11/3/2021	Lamine River	Silver Carp	588	2200	F	49098	ORFS42678
11/3/2021	Lamine River	Silver Carp	608	2620	F	49097	ORFS42677
11/3/2021	Lamine River	Silver Carp	570	2000	M	49096	ORFS42676
11/3/2021	Lamine River	Silver Carp	562	1940	M	49095	ORFS44600
11/3/2021	Lamine River	Silver Carp	601	2160	F	49094	ORFS44599
11/3/2021	Lamine River	Silver Carp	600	2290	M	49093	ORFS44598
11/3/2021	Lamine River	Silver Carp	650	2980	F	49092	ORFS44597
11/3/2021	Lamine River	Silver Carp	585	2200	F	49091	ORFS44596
11/3/2021	Lamine River	Silver Carp	640	3000	F	49090	ORFS44595
11/3/2021	Lamine River	Silver Carp	599	2390	F	49089	ORFS44594
11/3/2021	Lamine River	Silver Carp	631	2900	F	49088	ORFS44593
11/3/2021	Lamine River	Silver Carp	735	4040	F	49087	ORFS44592
11/3/2021	Lamine River	Silver Carp	545	1800	M	49086	ORFS44591
11/3/2021	Lamine River	Silver Carp	598	2360	M	49085	ORFS44590
11/3/2021	Lamine River	Silver Carp	603	2040	F	49084	ORFS44589
11/3/2021	Lamine River	Silver Carp	618	2600	F	49083	ORFS44588
11/3/2021	Lamine River	Silver Carp	613	2540	F	49082	ORFS44587
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11/3/2021	Lamine River	Silver Carp	597	2220	M	49080	ORFS44585
11/3/2021	Lamine River	Silver Carp	630	2540	F	49079	ORFS44584
11/3/2021	Lamine River	Silver Carp	620	2560	F	49078	ORFS44583
11/3/2021	Lamine River	Silver Carp	596	2580	F	49077	ORFS44582
11/3/2021	Lamine River	Silver Carp	629	2460	F	49076	ORFS44581
11/3/2021	Lamine River	Silver Carp	592	2300	F	49075	ORFS44580
11/3/2021	Lamine River	Silver Carp	621	2360	M	49074	ORFS44579
11/3/2021	Lamine River	Silver Carp	621	2400	F	49073	ORFS44578
11/3/2021	Lamine River	Silver Carp	657	3320	F	49072	ORFS44577
11/3/2021	Lamine River	Silver Carp	614	2520	M	49071	ORFS44576
11/3/2021	Lamine River	Silver Carp	597	2360	F	49070	ORFS44575
11/3/2021	Lamine River	Silver Carp	646	2620	F	49069	ORFS44574

11/3/2021	Lamine River	Silver Carp	577	2020	F	49068	ORFS44573
11/3/2021	Lamine River	Silver Carp	565	2100	M	49067	ORFS44572
11/3/2021	Lamine River	Silver Carp	599	2580	F	49066	ORFS44571
11/3/2021	Lamine River	Silver Carp	607	2380	M	49065	ORFS44570
11/3/2021	Lamine River	Silver Carp	622	2760	F	49064	ORFS44569
11/3/2021	Lamine River	Silver Carp	591	2100	M	49063	ORFS44568
11/3/2021	Lamine River	Silver Carp	605	2400	M	49062	ORFS44567
11/3/2021	Lamine River	Silver Carp	637	2720	F	49061	ORFS44566
11/3/2021	Lamine River	Silver Carp	610	2620	F	49060	ORFS44565
11/3/2021	Lamine River	Silver Carp	613	2700	F	49059	ORFS44564
11/3/2021	Lamine River	Silver Carp	617	2600	F	49058	ORFS44563
11/3/2021	Lamine River	Silver Carp	596	2120	M	49057	ORFS44562
11/3/2021	Lamine River	Silver Carp	565	2080	F	49056	ORFS44561
11/3/2021	Lamine River	Silver Carp	601	2480	F	49055	ORFS44560
11/9/2021	Moreau River	Silver Carp	581	2040	F	49173	ORFS43329
11/9/2021	Moreau River	Silver Carp	596	2100	M	49172	ORFS43328
11/9/2021	Moreau River	Silver Carp	601	2270	F	49171	ORFS43327
11/9/2021	Moreau River	Silver Carp	595	2300	F	49170	ORFS43326
11/9/2021	Moreau River	Silver Carp	581	2240	M	49169	ORFS43325
11/9/2021	Moreau River	Silver Carp	583	2280	F	49168	ORFS43324
11/9/2021	Moreau River	Silver Carp	580	2020	F	49167	ORFS43323
11/9/2021	Moreau River	Silver Carp	566	2000	M	49166	ORFS43322
11/9/2021	Moreau River	Silver Carp	586	2380	F	49165	ORFS43321
11/9/2021	Moreau River	Silver Carp	620	2380	F	49164	ORFS43319
11/9/2021	Moreau River	Silver Carp	589	2120	F	49163	ORFS43318
11/9/2021	Moreau River	Silver Carp	622	2900	M	49162	ORFS43317
11/9/2021	Moreau River	Silver Carp	638	2780	M	49161	ORFS43316
11/9/2021	Moreau River	Silver Carp	638	2680	M	49160	ORFS43315
11/9/2021	Moreau River	Silver Carp	563	1960	M	49159	ORFS43314
11/9/2021	Moreau River	Silver Carp	606	2260	F	49158	ORFS43313
11/9/2021	Moreau River	Silver Carp	600	2220	F	49157	ORFS43312
11/9/2021	Moreau River	Silver Carp	621	2540	F	49156	ORFS43311
11/9/2021	Moreau River	Silver Carp	611	2300	F	49155	ORFS43310
11/9/2021	Moreau River	Silver Carp	611	2600	F	49154	ORFS43309
11/9/2021	Moreau River	Silver Carp	616	2440	F	49153	ORFS43308
11/9/2021	Moreau River	Silver Carp	637	2640	F	49152	ORFS43307
11/9/2021	Moreau River	Silver Carp	597	2120	F	49151	ORFS43306
11/9/2021	Moreau River	Silver Carp	650	2720	F	49150	ORFS43305
11/9/2021	Moreau River	Silver Carp	922	8160	F	49149	ORFS43304
11/9/2021	Moreau River	Silver Carp	545	1760	F	49148	ORFS43303
11/9/2021	Moreau River	Silver Carp	568	1920	M	49147	ORFS43302

11/9/2021	Moreau River	Silver Carp	603	2220	F	49146	ORFS43301
11/9/2021	Moreau River	Silver Carp	562	1740	F	49145	ORFS42900
11/9/2021	Moreau River	Silver Carp	602	2480	F	49144	ORFS42899
11/9/2021	Moreau River	Silver Carp	606	2440	F	49143	ORFS42898
11/9/2021	Moreau River	Silver Carp	583	2180	M	49142	ORFS42897
11/9/2021	Moreau River	Silver Carp	597	2080	F	49141	ORFS42896
11/9/2021	Moreau River	Silver Carp	584	1940	F	49140	ORFS42895
11/9/2021	Moreau River	Silver Carp	582	2100	F	49139	ORFS42894
11/9/2021	Moreau River	Silver Carp	604	1920	F	49138	ORFS42893
11/9/2021	Moreau River	Silver Carp	575	2140	M	49137	ORFS42892
11/9/2021	Moreau River	Silver Carp	595	2100	M	49136	ORFS42891
11/9/2021	Moreau River	Silver Carp	592	2000	M	49135	ORFS42890
11/9/2021	Moreau River	Silver Carp	601	2240	F	49134	ORFS42889
11/9/2021	Moreau River	Silver Carp	613	2900	F	49133	ORFS42888
11/9/2021	Moreau River	Silver Carp	595	2260	F	49132	ORFS42887
11/9/2021	Moreau River	Silver Carp	646	2780	F	49131	ORFS42886
11/9/2021	Moreau River	Silver Carp	590	2080	M	49130	ORFS42885
11/9/2021	Moreau River	Silver Carp	607	2240	F	49129	ORFS42884
11/9/2021	Moreau River	Silver Carp	595	2280	F	49128	ORFS42883
11/9/2021	Moreau River	Silver Carp	613	2480	M	49127	ORFS42882
11/9/2021	Moreau River	Silver Carp	615	2520	F	49126	ORFS42881
11/9/2021	Moreau River	Silver Carp	607	2460	M	49125	ORFS42880
11/9/2021	Moreau River	Silver Carp	608	2260	M	49124	ORFS42879
11/9/2021	Moreau River	Silver Carp	582	2160	F	49123	ORFS42878
11/9/2021	Moreau River	Silver Carp	582	1880	F	49122	ORFS42877
11/9/2021	Moreau River	Silver Carp	585	2140	F	49121	ORFS42876
11/9/2021	Moreau River	Silver Carp	578	2100	F	49120	ORFS42700
11/9/2021	Moreau River	Silver Carp	588	2060	F	49119	ORFS42699
11/9/2021	Moreau River	Silver Carp	728	4180	F	49118	ORFS42698
11/9/2021	Moreau River	Silver Carp	620	2420	F	49117	ORFS42697

*Agency: South Dakota Department of Game, Fish, and Parks (SDGFP) and University of South Dakota (USD)*

#### 1) USD/GFP SILVER CARP IN THE MISSOURI

Two fish (48477 and 48486) are suspected to have left the James and entered the Missouri River. However, the USFWS revealed on 12/1/21 that no USD/GFP carp had been detected during their sweeps or on any of their receivers in the Missouri River. (Figures 1 and 2)

#### 2) SILVER CARP DETECTIONS FROM OTHER TRIBUTARIES



Only one GPFWCO Silver Carp was detected in the James River: 51768, which was initially tagged in the Vermillion River. It was first detected in the James River on 7/26 at the Hwy 50 receiver. It moved to the 309th St receiver on 9/10 and remained there until 9/29 when it was once again detected at Hwy 50. No subsequent detections were recorded. (Figure 3)

### 3) MOVEMENT SUMMARY

Of the 50 Silver Carp tagged in the James River, 9 fish were not detected after the initial tagging date and 41 were detected at least once on the telemetry network. Of those detected, 35 registered some type of movement. (Figure 4). The average total distance traveled from the date of tag deployment to the date of data offload was 4.9 rkm. Thirteen fish were detected moving only downstream (avg. 2.4 rkm), five fish were detected moving only upstream (avg 0.5 rkm), and seventeen fish were detected moving both upstream and downstream (avg 2.4 rkm upstream and avg 3.25 rkm downstream). The maximum amount of movement for any single fish tagged in the James was 33 rkm upstream over a period of 29 days (Figure 5).

Three fish were detected at a nearby receiver on the day they were implanted with tags but were otherwise not detected throughout the summer or fall of 2021. Two fish were detected on multiple dates at a single receiver, but no movement was detected. One fish has been detected at the same location every day since tagging; therefore, it is presumed to have died.

The next planned data offload is in early spring of 2022. Movement data analysis will be updated at that time. Additionally, batteries will be replaced, and firmware will be updated in receivers 11-20.

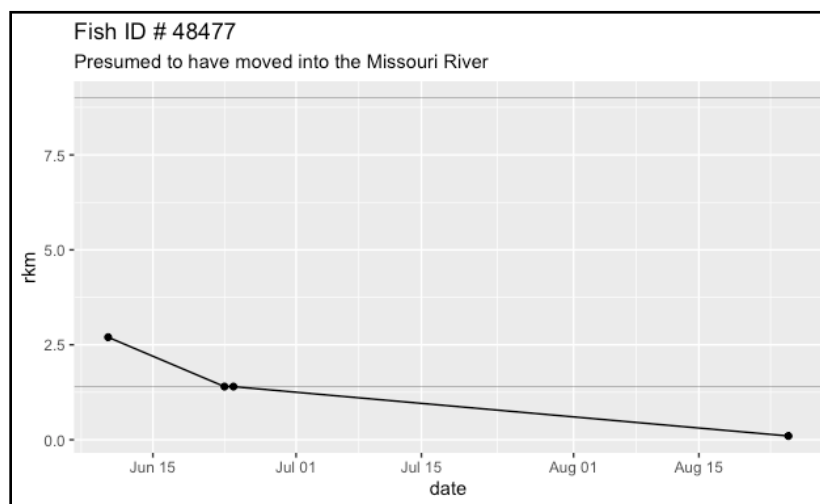


Figure 1: Fish 48477 was detected at the Hwy 50 receiver on 6/23 and 6/24 and once by active tracking at 0.1 rkm in the James on 8/25 and was not detected again on any James River receivers.

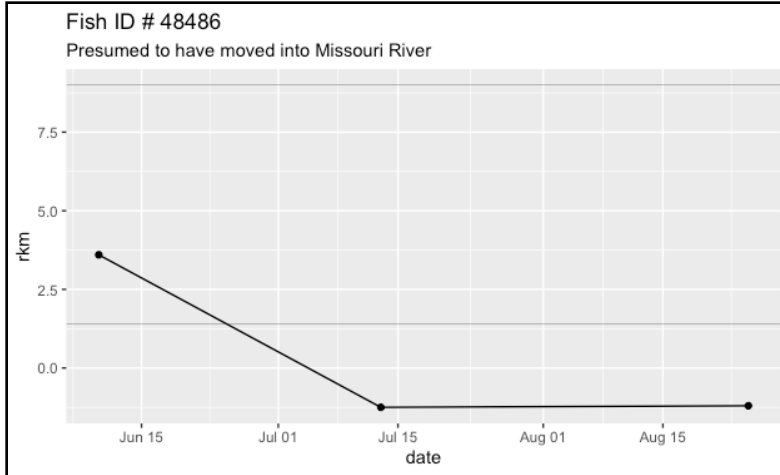


Figure 2: Fish 48486 was detected twice by active tracking in the Missouri River on 7/13 and 8/25 and was not detected again on any James River receivers.

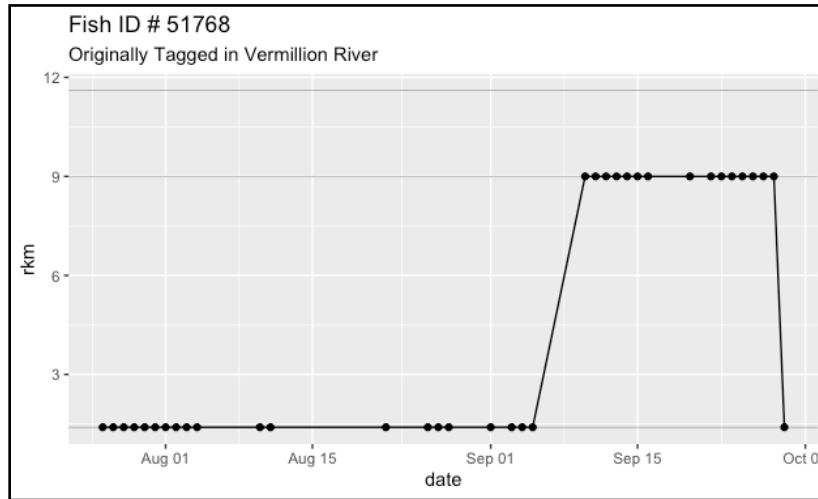


Figure 3: Fish 51768, GPFWCO Silver Carp detections in the James River.

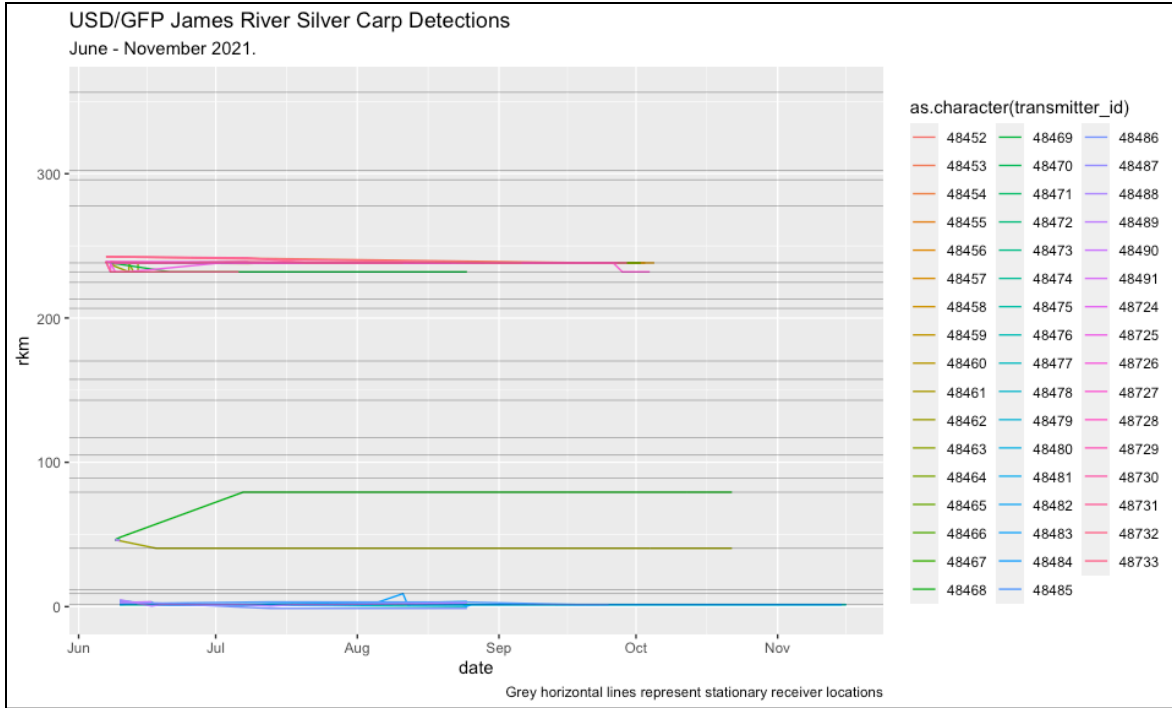


Figure 4: A graph of all USD/GFP Silver Carp detections in the James River from June – November 2021.

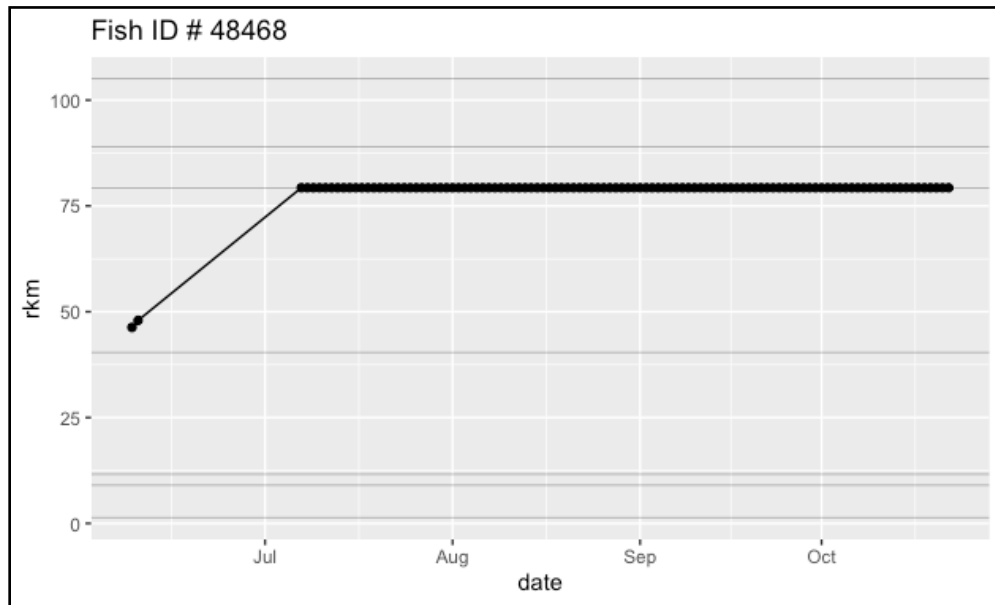


Figure 5: Movement patterns for fish 48468, which exhibited the most movement for any single fish tagged in the James (33 rkm upstream over a period of 29 days).

*Agency: US Fish and Wildlife Service Great Plains Fish and Wildlife Conservation Office (GPFWCO)*

- A total of approximately 1.5 million Silver Carp detections were recorded.
- A total of 3,723 individual daily detections were observed.
- River discharge in both tributaries was generally low and stable except for one storm event in the beginning of September.
- Silver Carp movement patterns generally coincided with discharge, including a storm event at the beginning of September (Figures 2 and 3).
- Silver Carp generally remained within the first 5 river miles of the confluence of the Missouri River for both the Big Sioux and Vermillion rivers during the entire study period (May to October).

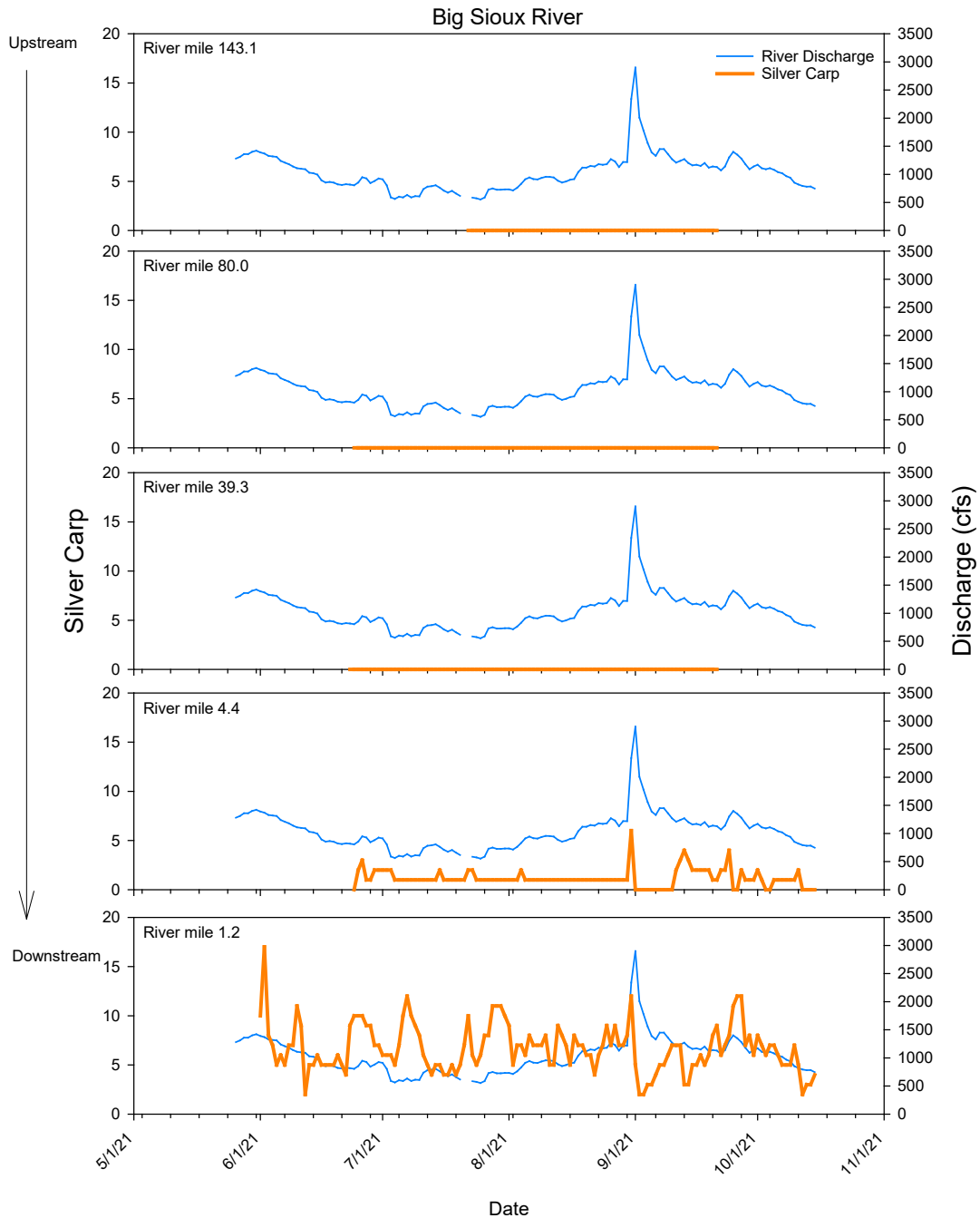


Figure 2. Number of daily detections of tagged Silver Carp by passive receivers and discharge (cubic feet per second; cfs) in the Big Sioux River at Sioux City, IA during 2021. Graphs arranged from upstream (top panel) to downstream (bottom panel). Receiver locations labeled by approximate river mile.

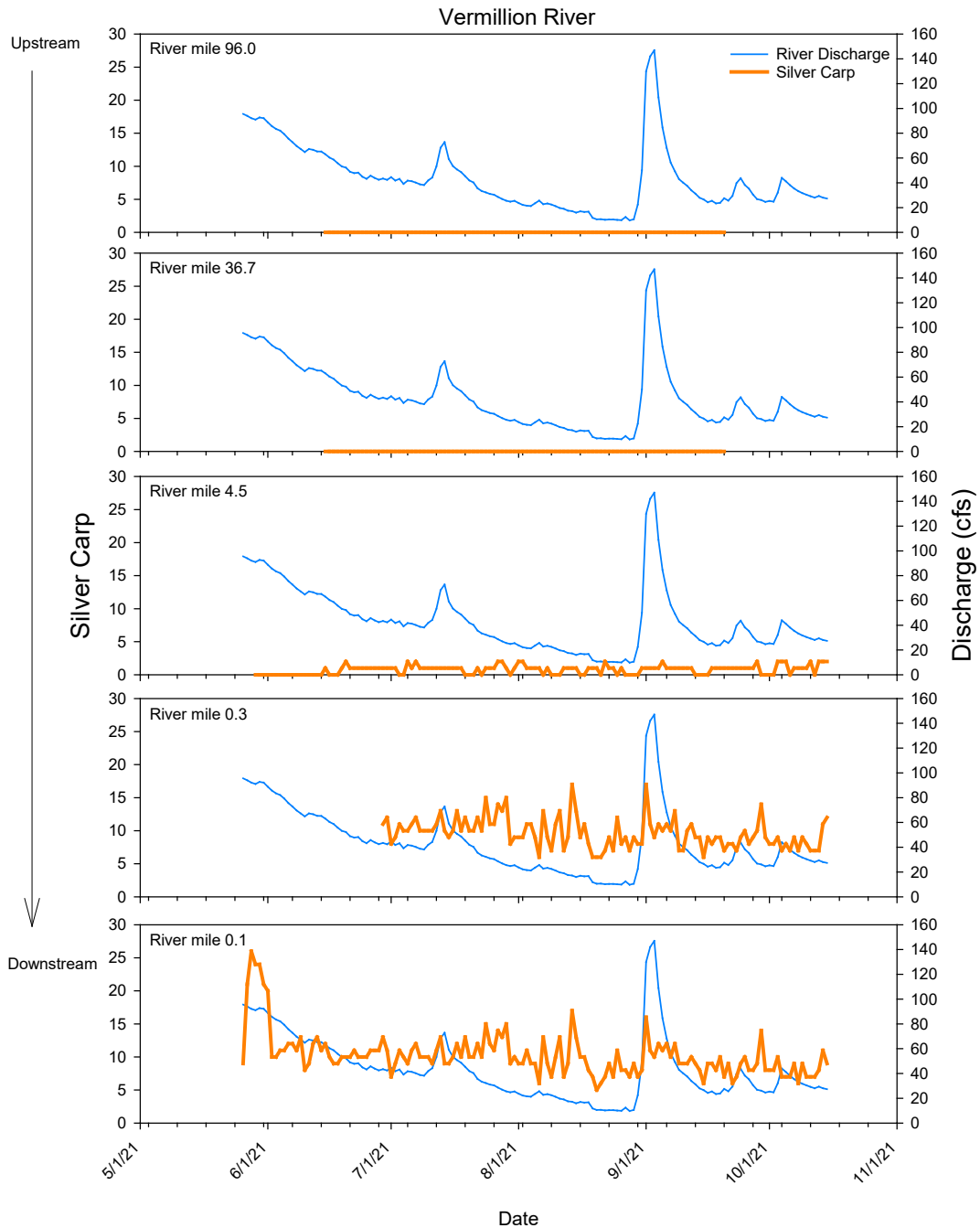


Figure 3. Number of daily detections of tagged Silver Carp by passive receivers and discharge (cubic feet per second; cfs) in the Vermillion River at Vermillion, SD during 2021. Graphs arranged from upstream (top panel) to downstream (bottom panel). Receiver locations labeled by approximate river mile.

**Recommendations:**

- Additional time will be required to assess movements of Silver Carp in these systems. Drought played a major role in limiting the movement of fish in South Dakota and prevented tag deployment in Iowa.

- Low snowfall totals in the upper Great Plains may allow drought conditions to persist in 2022, so continued monitoring may provide insight into Silver Carp movement under persistent low water conditions.
- Continued fish tagging may improve our understanding of fish movement, particularly under varying conditions. Data from additional tag deployments in 2022 and 2023, along with tag data from fish tagged in 2021, may begin to provide insights into movement patterns in these systems.
- Additional telemetry receivers still need to be deployed on the lower Missouri River and select tributaries. Telemetry receivers will be periodically downloaded to collect detection data. Maintenance may be required in the future to ensure that receivers are still in place and functioning properly. Damaged or lost receivers will be repaired and/or replaced as needed and if funding is available.