

I. Project Title: **Stationary PIT detection system in the Green River Canal, Green River, UT**

II. Bureau of Reclamation Agreement Number(s):  
USU Cooperative Agreement Number: R15AC40021  
Lead Agency: U.S. Bureau of Reclamation

Project Start date: April 1, 2013  
End date: indeterminate  
Reporting period end date: December 9, 2019  
Is this the final report? No

III. Principle Investigators:

Dave Speas  
Fish Biologist, U.S. Bureau of Reclamation—Upper Colorado Regional Office  
445 West Gunnison Ave Suite 221, Grand Junction, CO 81501  
[dspeas@usbr.gov](mailto:dspeas@usbr.gov)

Julie Stahli  
Database Manager, Upper Colorado River Endangered Fish Recovery Program  
44 Union Blvd, Suite 100, Lakewood, Colorado 80228  
[julie\\_stahli@fws.gov](mailto:julie_stahli@fws.gov)

Peter MacKinnon  
Fish Detection Engineer, Department of Watershed Sciences Utah State University  
[pdmackinnon@gmail.com](mailto:pdmackinnon@gmail.com)

Kevin McAbee  
Nonnative Fish Coordinator, Upper Colorado River Endangered Fish Recovery Program  
44 Union Blvd, Suite 100, Lakewood, Colorado 80228  
[kevin\\_mcabee@fws.gov](mailto:kevin_mcabee@fws.gov)

Date: December 9, 2019

IV. Abstract: The goal of this project is to evaluate entrainment of PIT-tagged endangered fish in the Green River Canal (near Green River, Utah) using passive interrogation arrays (PIAs). Entrainment at this facility has been monitored in this fashion since 2013 and observed entrainment rates of endangered fish since that time have been considerable owing to a lack of fish excluding structures at the canal intake. In FY 2019, the top of the Green River Canal was reconfigured to include an innovative fish exclusion structure comprised of a weir wall with horizontal, fine-aperture screens at its crest which diverts entrained fish back to the Green River while also delivering the

canal's full capacity (ca. 85 cfs) to water users downstream. The screen was fitted with several PIT detection antennas, include two loops immediately above the screen intake, two loops in the return channel to the Green River, and two loops in the canal immediately below the screen. Whereas endangered fish entrainment rates in the canal have varied during 2013-2018 from 118 to 695 fish per irrigation season (in 2018 and 2013, respectively), no PIT-tagged endangered fish were detected in the canal below the newly-completed screen during the 2019 irrigation season.

V. Study Schedule: 2013 - indefinite

VI. Relationship to RIPRAP:

Green River Action Plan

II. Restore habitat

II.B.2 Screen Tusher Wash Diversion (aka Green River Canal) to prevent endangered fish entrainment, if warranted

II.B.2.b Design.

II.B.2.c Construct.

VII. Accomplishment of FY 2019 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: March-November, 2019 (irrigation season): Activate and operate system; download antennae data, perform diagnostics, repair system if necessary; system shut-down.

The Green River Canal irrigation season began on April 6, 2019 and continued through the end of October. The new fish screen and antenna arrays were operational in advance of the canal start date and antenna loops. Antenna loops can be identified in the Species Tagging, Research and Monitoring System (STReAMS; [streamsystem.org](http://streamsystem.org)) according to the following scheme Figure 1):

- a) Loops one (1; upstream) and two (2; downstream of 1): Weir and screen intake area just upstream of the trash rack (Figure 1).
- b) Loops three (3; upstream) and four (4; downstream of 3): Fish return channel flowing to the Green River.
- c) Loops five (5) and six (6; downstream of 5): Below horizontal screen in the Green River Canal.

Loops 1 and 2 initially experienced considerable interference with the steel trash rack but were tuned to maximize field strength immediately following start of canal operations on April 6. The remaining loops were tuned the following week. The first fish (a razorback sucker, *Xyrauchen texanus*) was detected on April 7 on antenna 1.

Task 2: December: Annual report (current document).

The goal of this project is to evaluate entrainment of PIT-tagged endangered fish in the Green River Canal (near Green River, Utah) using PIAs. Canal entrainment at this facility has been monitored in this fashion since 2013. Observed entrainment rates of endangered fish since 2013 have been considerable owing to a lack of fish excluding structures at the canal intake at the time and through 2018. In FY 2019, the top of the Green River Canal was reconfigured to include an innovative fish exclusion structure comprised of a weir wall with horizontal, fine-aperture screens at its crest (Figure 2) which diverts entrained fish back to the Green River while also delivering the canal's full capacity (ca. 85 cfs) to water users downstream. The screen was fitted with several PIT detection antennas, include two loops immediately above the screen intake, two loops in the return chute to the Green River, and two loops in the canal immediately below the screen.

Whereas endangered fish entrainment rates in the canal have varied during 2013-2018 from 118 to 695 fish per irrigation season (Table 1), no PIT-tagged endangered fish were detected in the canal below the newly-completed screen during the 2019 irrigation season. A total of 1,077 PIT-tagged fish was detected, however, on the intake and/or return channel antennas, indicating continued use of the canal by native fish at various times of the year (Table 2). Of these fish, 364 (34%) were detected both on the intake and return channel antennas, 181 (17%) were detected on return channel antennas only, and 532 (49%) fish were detected on the intake antennas only.

Since antenna systems are known to have detection efficiencies which are less than 100% under most conditions, we cannot rule out the possibility that entrainment didn't occur with the presence of the canal screen. Additionally, there is an unscreened area above screen at its lower end where a fish jumping at the right angle could conceivably enter the canal (Figure 2). However, despite these caveats it seems clear that all but certain that entrainment rates are now markedly reduced over levels observed in 2013 through 2018.

#### VIII. Additional noteworthy observations:

In the process compiling data for this report, we revisited STReaMS in an attempt to identify previously unidentified fish detected in the Green River Canal during 2013 through 2019. We assumed that since new information has continually been added to STReaMS since entrainment monitoring began in 2013, perhaps previously unidentified tags could now be identified. To perform this update, we first simply re-acquired species identification data from the STReaMS fish and encounter tabs using the tag numbers originally detected in the canal for the years 2013 through 2019. This action resulted in a limited number of positive identifications which had been added to the database since the Green River Canal monitoring began, but most previously unidentified tags still returned "unidentified" as a species designation.

To further reduce the numbers of unidentified fish, we then queried the PIT tag lot portion of the database using tags numbers which were still classified as "unidentified" after re-acquiring the data from fish and encounter portions of the database. The PIT tag lot database contains the purposes for which the original tag lots (100 each, generally) were intended for, i.e., tagging of bonytail *Gila elegans* or razorback sucker, field surveys, etc.

Most of the tag lots we found associated with previously “unidentified” fish were designated as “RZ stock” or “BT stock” which were assumed to refer to hatchery-reared razorback sucker or bonytail, respectively. This assumption has not been verified yet so these records are referred to as “presumed” identifications in Table 1.

The PIT lot query resulted in a total of 74 presumed identifications, but 116 of the 190 unidentified detections (61%) from the Green River Canal currently remain classified as such in STReaMS. This constitutes about 6% of all observations from this facility although the percentage will likely decline over time with additional data from hatcheries and other projects.

All of the remaining unidentified tag numbers are not associated with a lot number in STReaMS yet in most (but not all) cases their codes seem to indicate they should be from a common lot (i.e., most have the same characters except for the last 4 or 5 characters). There are currently 8,153 fish classified as “unidentified” in STReaMS, or 0.6% of all PIT tagged fish in the database.

IX. Recommendations:

- Continue to collect and analyze data from newly installed antennas to determine the effectiveness of the weir wall and fish screen at solving the entrainment issue at the Green River Canal.
- Consider evaluation of larval entrainment rates in the canal with the screen in place; also, since the return channel is a swift, turbulent environment, consider evaluating physical condition of fish that have negotiated it.
- Determine the best way to ensure continuous antenna operation and gather data from the antenna. Upcoming changes to BioMark’s reporting system may require/permit new solutions that allow for more effective remote monitoring of the antennas. A basin-wide SOW for antenna monitoring and maintenance is suggested to provide ongoing operation of these facilities.
- Consider querying principal investigators to determine whether additional data exists to aid in identifying currently unidentified fish species in STReaMS.

X. Project Status: Ongoing

XI. FY 2019 Budget Status

- A. Funds Provided: \$6,590.00
- B. Funds Expended: \$6590.00
- C. Difference: \$0
- D. Percent of the FY 2019 work completed, and projected costs to complete: 100%
- E. Recovery Program funds spent for publication charges: \$0

XII. Status of Data Submission (where applicable): Data are automatically uploaded into

STReaMS.

XIII. Signed: /s/Dave Speas  
Principal Investigator

Date: Dec 9, 2019

Table 1. Detections of PIT-tagged fish in the Green River Canal near Green River, UT during the 2013 through 2018 irrigation seasons. Numbers have been revised to reflect updated species identification data through 2019. “Presumed” species are designated as such according to PIT lot purposes listed in STReAMS.

Species	2013	2014	2015	2016	2017	2018	Total
Flannelmouth sucker <i>Catostomus latippinis</i>	7	6	4	0	4	2	23
Bluehead sucker <i>Catostomus discobolus</i>	0	0	0	0	0	1	1
FMS x RZB	1	1	0	1	0	0	3
Humpback chub <i>Gila cypha</i>	1	1	1	2	0	2	7
Bonytail	8	27	77	57	42	20	231
Colorado pikeminnow <i>Ptychocheilus lucius</i>	105	22	21	25	24	15	212
Razorback sucker	531	304	182	136	174	58	1385
Unidentified	42	55	20	19	34	20	190
<i>Presumed Bonytail</i>	2	0	8	1	2	0	13
<i>Presumed Razorback</i>	7	28	6	14	6	0	61
Total	695	416	305	240	278	118	2052

Table 2. Detections of PIT-tagged fish in the Green River Canal near Green River, UT during the 2019 irrigation season.

	Intake	Return	Canal	Total individual fish
Bonytail	403	194	0	443
Colorado pikeminnow	16	6	0	16
Flannelmouth sucker	1	1	0	1
Razorback sucker	128	55	0	134
Unidentified	348	289	0	483
<i>Presumed Razorback</i>	4	1	0	4
<i>Presumed Bonytail*</i>	na	na	0	457
Total	896	545	0	1077

\*Preliminary pending addition of hatchery data. Due to the large number of tags, also, antenna-specific detections for individual fish were not determined.

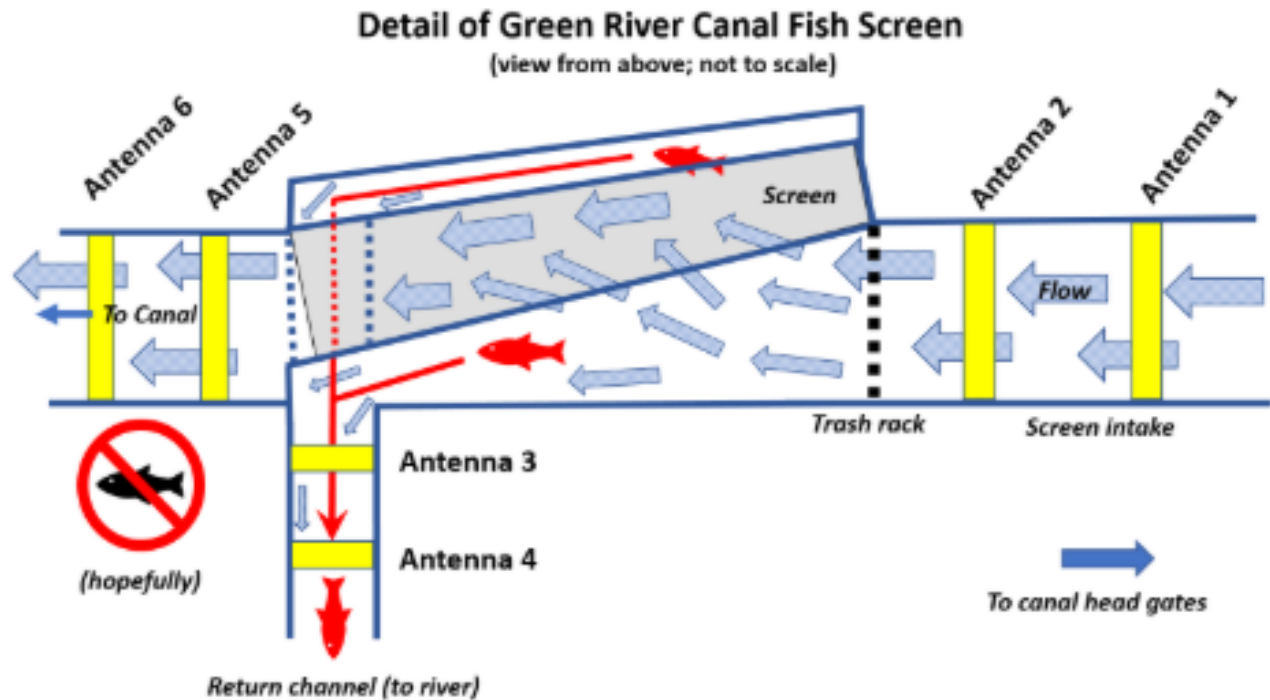


Figure 1. Schematic of the Green River Canal fish screen as viewed from above showing direction of flow (right to left) and location of PIT antennas.



Figure 2. Green River Canal fish screen in operation, looking downstream. Water flows left to right over the screen (foreground right). Screened water drops into the canal entrance while fish and unscreened water is collected and diverted back to the Green River. Photo: Ryan Christianson, USBR.