Project Title
Stationary PIT detection system in the Green River Canal, Green River, UT

Bureau of Reclamation Agreement Number:
R19AC00153

Project/Grant Period:
Start date: 09/16/2019
End date: 09/30/2024
Reporting period end date: 12/01/2021
Is this the final report? No

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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, a fish screen was installed at the top of the Green River Canal along with several PIT antenna loops to detect its efficacy. Whereas endangered fish entrainment rates in the unscreened canal varied during 2013-2019 from 118 to 695 fish per irrigation season (in 2018 and 2013, respectively), entrainment of PIT tagged fish in the screened canal has ranged from zero in 2019 to two bonytail in 2020. Between December 2020 and December 2021, a total of 1,724 fish were detected in the vicinity of the fish screen but only one fish (a bonytail) bypassed the screen. Entrainment rates since completion of the screen in 2019 continue to be drastically lower than those observed prior to screen construction.

Study Schedule:
April 2013—indefinite

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.d.: Operate and maintain.

Accomplishment of FY 2021 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Operate and maintain PIA system; perform diagnostics, repair system if necessary.

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 before and after construction of a fish excluding structure at the top of the canal. Canal entrainment at this facility has been monitored in this fashion since 2013. Observed entrainment rates of endangered fish during 2013 - 2018 were considerable owing to a lack of fish excluding structures at the canal intake (Table 1). In 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 1) 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 and are configured as follows (Figure 2):

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

In 2021, the Green River Canal was flowing by April 2 (Figure 3) and continued through Nov 21. Antenna arrays are continually operational and thus were working in advance of the canal start date. Loops 1 and 2 continued to experience interference (thought to be caused by a nearby steel trash rack) but detected fish at rates comparable to data collected by the old (pre-2019) system. A PIT tag which had become lodged in loop 3 (return channel) and effectively disabled the array in 2020 was removed in March 2021. As a result, detections in the return channel increased dramatically in 2021 over 2020 (761 and 109 detections, respectively). Also during this time period, system firmware was updated, inspected and tuned prior to the 2021 irrigation season.

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

During the 2021 irrigation season[1], a total of 1,724 PIT-tagged fish was detected on the Green River Canal fish screen antenna loops, indicating continued fish visitation of the facility (Table 2). This was the greatest number of fish ever detected at the facility (pre- and post-screening) in a single year. The

[1] represented in this report by data collected during December 1, 2020 through December 1, 2021 (downloaded from STReaMS December 3, 2021; https://streamsystem.org).

majority of detected fish were bonytail (69%), followed in order of abundance by razorback sucker (22%), unidentified (5%), Colorado pikeminnow (2%), flannelmouth sucker (1%), flannelmouth/razorback sucker hybrids (<1%), and humpback chub (<1%).

Almost half (47%) of all fish were detected on both the intake and return loops, 42% were only detected on the intake loops only, and 11% were detected only on the return channel loops. These results were not markedly different from those observed in 2019 but return channel detection rates improved markedly over 2020 when only 1% of fish were detected on those loops. As mentioned above, this was due to the inoperability of loop 3 in 2020 which was rectified prior to the start of the 2021 irrigation season. Still, the large fraction of fish observed only on the intake loops in 2021 suggests that these fish may have avoided the return channel by exiting through the canal radial gates upstream from the screen. This could be investigated further by deploying submersible antennas in the vicinity of the canal gates.

Whereas endangered fish entrainment rates in the canal have varied during 2013-2018 from 118 to 695 fish per irrigation season (Table 1), no tags were detected in the canal below the screen during the first year of operation (2019), two PIT-tagged bonytail were detected there during the 2020 irrigation season, and a single bonytail was detected below the screen in 2021. This fish was detected on September 11, 2021 on both intake loops (1,2) and both canal loops (5,6).

Since antenna systems are known to have detection efficiencies which are less than 100% under most conditions, we cannot rule out the possibility that additional entrainment didn't occur with the presence of the canal screen. Despite these caveats, the difference in entrainment rates before and after screen construction indicates that entrainment rates are now markedly reduced over pre-screen levels observed in 2013 through 2018. While the current configuration of the fish screen functions to markedly reduce entrainment from historical levels, it obviously doesn't eliminate it. Exactly how a few fish have bypassed the screen is unknown, but it appears that a fish jumping at the correct angle could conceivably enter the canal through the gap at the downstream end of the screen (Figure 1), which is probably less than a meter above the flowing water. Therefore, Biology Committee members should consider discussing a potential remedy with engineers.

Recommendations:

- Continue to operate and maintain the Green River Canal fish screen
- Continue to collect data using the existing antenna array and evaluate data in relation to canal operations.
- Consider evaluation of larval entrainment rates in the canal with the screen in place; also, since flows in the return channel are swift and turbulent, consider evaluating physical condition of fish that have passed through it.
- Query principal investigators to determine whether additional data exists to aid in identifying currently unidentified fish species in STReaMS.
- Consider evaluating performance of antennas in the screen intake area in the presence of the steel trash rack which may be interfering with system signal strength. This can be done by deploying submersible portable antennas near the canal head

gates and comparing results those obtained at the screen intake arrays. Submersible data may also shed light on movement of fish out of the Green River Canal area.

- Consider potential for fish to bypass the screen and discuss remedies with engineers.

Project Status:
Ongoing.

FY 2021 Budget Status
Funds Provided: See "NEW PIT antenna O/M" project 179 annual report
Funds Expended: n/a
Difference: n / a
Percent of the FY 2021 work completed, and projected costs to complete: 100%
Recovery Program funds spent for publication charges: $0

Status of Data Submission
Data are automatically uploaded into STReaMS.

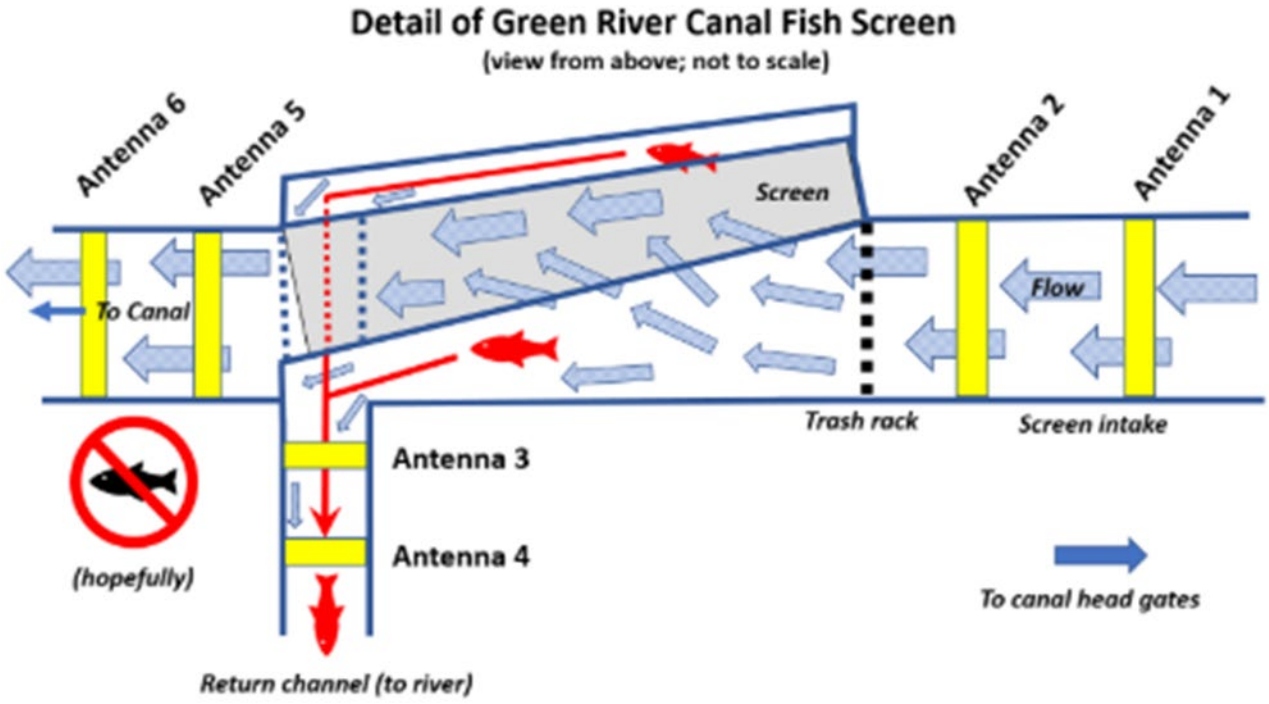
Signed:
/s/Dave Speas
Principal Investigator
Date: Dec 15, 2021

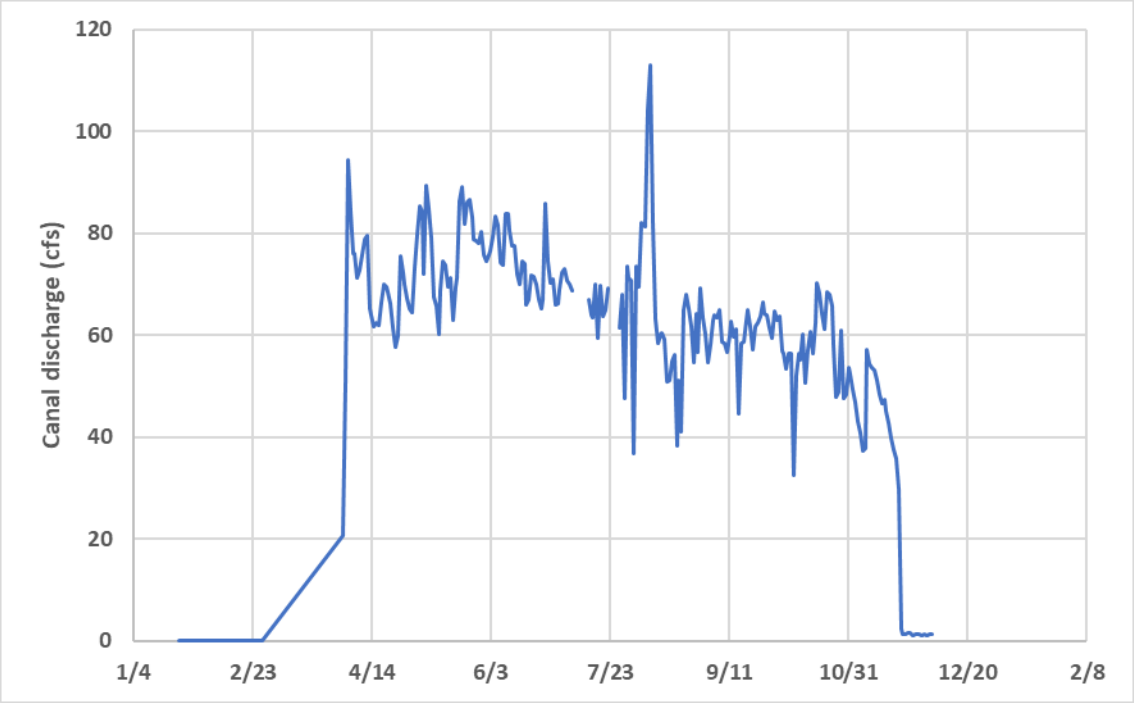
Table 1. Detections of PIT-tagged fish in the Green River Canal near Green River, UT during 2013 through 2019. Asterisk (*) reflects data collected after screen installation in 2019 and indicates fish detected near the fish screen but not entrained in the canal; (**) indicates two bonytail were entrained in the canal that year. "Presumed" indicates tags assigned for a specific purpose (e.g., stocked bonytail or razorback) but were recorded as "unidentified" when detected (included in the total for "unidentified).

Species	2013	2014	2015	2016	2017	2018	2019*	2020*	Total
Flannelmouth sucker *Catostomus latippinis*	7	6	4	0	4	2	2	5	30
Bluehead sucker *Catostomus discobolus*	0	0	0	0	0	1	0	0	1
FMS x RZB	1	1	0	1	0	0	0	0	3
Humpback chub *Gila cypha*	1	1	1	2	0	2	2	2	11
Bonytail	8	27	77	57	42	20	900	840**	1,131
Colorado pikeminnow *Ptychocheilus lucius*	105	22	21	25	24	15	17	36	265
Razorback sucker	531	304	182	136	174	58	134	99	1,618
Unidentified	42	55	20	19	34	20	22	21	233
Presumed Bonytail	*2*	*0*	*8*	*1*	*2*	*0*	*0*	*6*	*19*
Presumed Razorback	*7*	*28*	*6*	*14*	*6*	*0*	*4*	*2*	*67*
Total	695	416	305	240	278	118	1,077	1,003	4,132

Table 2. Detections of PIT-tagged fish in the Green River Canal near Green River, UT during Dec 1, 2020 through Dec 1, 2021 (accessed Dec 3, 2021; https://streamsystem.org). "Presumed" indicates tags assigned for a specific purpose (e.g., stocked bonytail or razorback) but were recorded as "unidentified" when detected. These counts are included in the total for "unidentified".

	Intake only	Return only	Intake and return	Canal	Total individual fish
Bonytail	425	142	619	1	1,187
Colorado pikeminnow	23	2	15	0	40
Flannelmouth sucker	9	5	11	0	25
Razorback sucker	220	42	123	0	385
FM x RZ hybrid	3	0	1	0	4
Humpback chub	0	0	1	0	1
Unidentified	41	7	34	0	82
Presumed Razorback	*n/a*	*n/a*	*n/a*	*0*	*18*
Presumed Bonytail	*n/a*	*n/a*	*n/a*	*0*	*6*
Total	721	198	804	1	1,724


Detail of Green River Canal Fish Screen
(view from above; not to scale)
Antenna 6
Antenna 5
Antenna 2
Antenna 1
Screen
To Canal
Flow
Trash rack
Screen intake
Antenna 3
Antenna 4
(hopefully)
To canal head gates
Return channel (to river)



https://www.waterrights.utah.gov/cgi-bin/dvrtview.exe. Data has been edited to exclude extreme outliers during July.