Project Title
Operation and Maintenance of Ouray National Fish Hatchery - Randlett Unit

Bureau of Reclamation Agreement Number:
N/A

Project/Grant Period:
Start date: 10/01/2021
End date: 09/30/2022
Reporting period end date: 09/30/2022
Is this the final report? Yes __ No __X__

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Abstract:
Ouray National Fish Hatchery (Randlett Unit; ONFH-R) is located on the Ouray National Wildlife Refuge 35 miles southwest of Vernal, Utah. ONFH-R is a warm/cool water hatchery established in 1996 as a fish production, refugia and technology development facility to assist the Upper Colorado River Endangered Fish Recovery Program (Recovery Program) in the recovery of razorback sucker (RZ), Colorado pikeminnow (CS), bonytail (BT), and humpback chub (HB). Hatchery infrastructure includes both a large indoor recirculating aquaculture system and an extensive outdoor pond system supplied with water from a nearby well system. Stocking goals established by the Recovery Program include the annual production and distribution of 6,000 RZ averaging 350 mm total length (TL) and 10,000 BT averaging 250 mm TL into the middle and lower Green River in Utah. In FY 2022, ONFH-R nearly met RZ stocking goals with 4,944 released in the Green River and 1,000 PIT-tagged RZ held for release at a later date as part of the Green River Canal Study (Colorado State University; Appendix 1).

BT stocking was moved to Spring 2023. ONFH-R assisted with the collection of, and currently maintains, CS for broodstock development and experimentation. The hatchery will continue to maintain HB as a source of future broodstock. Twenty-three HB were collected from Desolation Canyon and transferred to ONFH-R in 2022, adding to the 9 HB transferred in 2009. A complete inventory of fish species and lots, including broodstock, was completed in Spring 2022.

Study Schedule:
1996-Ongoing

Relationship to RIPRAP:

General Recovery Program Support Action Plan

IV.	Manage genetic integrity and augment or restore populations.
IV.A.	Genetics management.
IV.A.4	Secure and manage genetic stocks in refugia.
IV.A.4.a.	Razorback sucker
IV.A.4.b.	Bonytail
IV.A.4.c	Humpback chub
IV.A.4.d.	Colorado pikeminnow
IV.B	Conduct annual fish propagation activities.
IV.B.2.	Implement revised integrated stocking plan (Integrated Stocking Plan Revision Committee 2015); supersedes all earlier stocking plans, including species-specific and individual basin plans.
IV.C.	Operate and maintain facilities.
IV.C.1.	ONFH-R Unit

Green River Action Plan: Main Stem.

IV.A.	Augment or restore populations as needed.
IV.A.1.	Implement plan

Accomplishment of FY 2022 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Razorback Sucker

Ouray National Fish Hatchery (ONFH-R) nearly met stocking goals during 2022 for razorback (RZ; *Xyrauchen texanus*) stocking 4,944. This was despite a system failure just prior to stocking that led to an estimated loss of 1,424 RZ (see Appendix 2 for more details). RZ averaged 351 mm, weighed 455 g, and had a Fulton's Condition Factor (FCF) of 1.052. An FCF above 1 usually indicates a better conditioned fish (more mass per length), however, the relationship has not been validated for RZ. Fish distribution during 2022 resulted in 2,443 RZ stocked in the Green River near ONFH-R, and 2,501 RZ stocked at Green River State Park boat ramp in Green River UT (Table 1). As part of an internal pilot study, releases were paired (same location and day) at both locations during the day and night. No Health Condition Profiles were conducting for these stocking events.

RZ spawned in 2022 produced approximately 64,625 fry across 11 genetic lots. In addition, staff at ONFH-R modified fertilization protocols of the nursery ponds producing natural feed and supplementing with artificial feed for both the RZ and BT fry ponds.

Regarding the aforementioned system failure that led to the loss of 1,424 RZ, USFWS conducted internal investigations (both within complex and regional) into the incident in October of 2022. Within complex findings recommended review of onsite best management practices and risk-prevention practices including redundancy in facility walk-throughs (employees working independently to check on facility before leaving at end of day), daily system checklists, critical system repair practices, critical system back-ups, and heightened awareness of staff work, mental fatigue, and schedule planning to reduce the likelihood of these issues occurring. Regional findings are pending.

ONFH-R held back 1,000 PIT-tagged fish to conduct research by Colorado State University for the Green River Canal Study. This study will evaluate mortality and condition of larger-bodied native fishes that pass over the Green River Canal Fish Screen or through the bypass channel and return to the Green River (personal communication, Kevin Bestgen; kevin.bestgen@colostate.edu, see Appendix 1 for more details).

Bonytail

With approval from the Recovery Program, ONFH-R moved the bonytail (BT; *Gila elegans*) stocking to Spring 2023 with fish currently averaging 249.53 mm and 147.26 g. We requested and received 20,000 BT swim-up fry from the Southwestern Native Aquatic Resources and Recovery Center (SNARRC; Dexter, NM) in 2022.

Colorado Pikeminnow

This fall, hatchery staff at ONFH-R cooperated with the Green River Basin FWCO, Recovery Program Director's Office, and SNARRC to assist in acquisition of YOY Colorado pikeminnow (CS; *Ptychocheilus lucius*) for development of broodstock. In 2022 the Green River Basin FWCO collected and transferred 131 CS from the Green River to ONFH-R. From the 131 CS collected, 92 are extant and being held in the Isolation Room (ISO) at the hatchery. CS will be transferred to SNARRC in the future.

In addition to the wild CS, ONFH-R has been holding CS propagated and transferred from SNARRC in 2021. Approximately 5,000 were sent to ONFH-R for chemical exposure studies conducted under Matt Fry's supervision, though current staff cannot find background information or results for that work. On 20 July 2022 ONFH-R transferred 2,525 of those juvenile CS to David Ward on behalf of the USGS Colorado River Native Fish Research Facility located at 1801 South Lone Tree Road in Flagstaff AZ. Mean size of the transferred CS was 128 mm TL (range 81-190 mm TL). The fish are being used for predation trials to evaluate relative predation risks posed by native vs non-native predators in the Colorado River (personal communication David Ward USGS; dlward@usgs.gov). With some of the approximately 800 remaining CS (Table 2), ONFH-R assisted USGS employee David Ward in a study (conducted at ONFH-R in October 2022) to evaluate the potential predation impacts of CS on co-evolved species.

Humpback Chub

Nine adult humpback chub (HB; *Gila cypha*) collected from Desolation Canyon in 2009 remain in our indoor facility. In addition, the Utah Division of Wildlife Resources collected wild HB in the fall of 2022 from Desolation Canyon and transferred them to OHFH-R to increase genetic diversity for a potential future brood lot source. A total of 25 HB were transported and two mortalities occurred after arrival. These new HB averaged 238 mm TL and 300 g and are being held in the Isolation Room at the hatchery.

Education and Public Outreach Activities

ONFH-R continues to provide tours to the general public and local schools.

Facility Maintenance and Construction

- LED lighting continues to reduce electrical consumption as well as reducing stress on the fish.
- New hatchery tanks are working well.
- All wells were jetted and cleaned in FY2022 by the U.S. Bureau of Reclamation and increased flow by 200 gpm.
- All water lines running from the well field to the filtration building were jetted and cleaned of iron and manganese buildup.
- The current UV system is outdated and undersized, leaving holdings vulnerable to disease. Staff have been working on evaluation of designs and assessing cost for a replacement. Replace UV system as soon as is feasible.
- ONFH-R is currently outdated in many aspects and needs many repairs (all pumps, pond electrical, several pond liners, pond concrete structures, BIRM filler media, alarm system, lighting, flow meters, hatchery building heaters, heavy equipment, etc.). Hatchery staff have and will continue to spend many hours repairing and updating equipment.
- Improve current water supply system.
    - A Feasibility Study is currently being conducted to evaluate both water quality and quantity, both critical to any hatchery, and ONFH-R continues to suffer variabilities and inadequacies in both respects. An excerpt from the first paragraph of the 2010 Standard Operating Procedures states: “The quality of the water used here is so poor and of limited quantity, extreme measures must be taken to ensure the safety and health of the fish.”

      Currently, ONFH-R’s water source consists of 7 wells (5 in working condition) and is currently limited to under 450 gpm due to delivery limitations. Many of these wells struggle to consistently provide water, and in 2022 ONFH-R was down to one and a half wells being functional, which risked the ability to meet operational needs and potentially risked fish holdings.

The water from the current well field is of poor quality as it contains high levels of iron and manganese. The concentration of these metals has a deleterious effect on the wells themselves, all of the pipes, pumps, filters, and potentially the fish. The 2010 Ouray SOP listed the iron concentration of ONFH-R water as approximately 1.3 ppm, and the manganese concentration around 1.0 ppm. Suggested aquaculture concentrations were listed as not to exceed 0.5 ppm and 0.01 ppm respectively.

The metals in the source water slowly precipitate out and build up in pipes, pump impellers, small orifices, and begin to choke off flow through them. The manganese is slower to precipitate out and is harder to filter out than the iron. Special filters and media are used to help reduce/remove the heavy metals in the water before going to the fish. Recent upgrades in filtration are suspected to have led to improvements in the quality of water leading to the fish. The limit of the system due to water quality (including degassing) is about 600 gpm.

In addition, the current water system is costly. Former Hatchery Manger Matthew Fry stated: "Ouray NFH was listed as one of the three highest energy consumers in the 2015 energy audit. This comes to no surprise as the water supply is one half mile downhill of the hatchery. The water is pumped a minimum of five times before it ever touches a fish…" The wells also have a relatively short life expectancy and require yearly maintenance (per Reclamation).

Development of a new water source and delivery system is also critical for the wetland system on the Ouray National Wildlife Refuge (Refuge). Currently, water flowing through Ouray is restricted for use by the Refuge due to lack of proper water delivery and control structures. The plan is to improve the multi-use capability of the water to benefit both ONFH-R, Refuge, and the surrounding ecosystem.

- Provide a modicum of housing for ONFH-R employees.
    - Ouray is one of a minority of remote hatcheries that does not offer some manner of temporary or permanent housing. This lack of housing makes it more difficult to recruit and retain permanent and temporary employees. In addition, the lack of nearby employees reduces response times to alarms/emergencies at the hatchery and flexibility on facility oversight.

- Install a new raceway system.

    - A dual-raceway system would greatly benefit ONFH-R. It would be used as an intermittent holding location between the ponds and hatchery building. The raceway would be used for treatments, sorting, and sampling before fish enter the hatchery building. This would decrease the risk of infecting the building with parasites/diseases and adding organic load to the filters.

- Install heat-pumps for temperature Control.

    - Current temperatures are driven by well water at about 12 C year-round which is significantly below that needed for optimal growth of warm or even some cool-water

species. Currently, the only means to adjust water temperature for Ouray NFH's indoor aquaculture facility is to adjust ambient air temperature. This is inefficient, energy costly, and limited in ability to adjust water temperature, thus reducing culture options.

- Fencing for biosecurity.
    - Ouray was constructed in the middle of a Wildlife Refuge and unwanted animal species are a continued problem. Racoons, skunks, and otters often visit the ponds and eat valuable fish species and decrease the RZ brood. Some of the small mammal traffic is controlled by an old fence that surrounds the ponds. However, it is dilapidated and no longer keeps everything out. During the spring of 2022 alone, we lost over 40 RZ broodstock to a visiting otter.

      With Ouray being so close to the Green River and the wetlands on the refuge, aquatic invasive species (AIS) are a concern, and small animals can easily transport AIS Species. A new fence designed to help increase the biosecurity and decrease unwanted animals from entering the facility, spreading disease, and eating valuable fish is needed.
- Outflow settling basin.
    - The current outflow structures drain from the ponds/hatchery building in two separate pipes. Both pipes drain into a ditch system on the Refuge. The ditch system is inadequate to handle the flow from the hatchery and the water backflows up the pipes. This backflow in the drainpipes creates sediment buildup and decrease outflow, which sometimes plugs the system. The ditch also has a large amount of vegetation load that decreases the flow. These issues decrease drain flow and in turn increase the pond drain time, drastically increasing the likelihood of ponds going anoxic and creating fish kills. These drains also create a gateway for small animals entering the facility and increase the risk of AIS entering the facility. The current system currently does not allow the refuge to direct water for their needs.

      A settling basin would create an area where the outflow would flow swiftly and allow a place for pond buildup to settle out. This structure could also be constructed in a manner to stop unwanted animals from entering the ponds via the drain system. This structure could also be beneficial to the refuge and allow them to direct water as needed.
- Bird protection netting over the 0.2 ac ponds should be replaced in the next few years. Ouray is also going to work on obtaining a Federal Migratory Bird Permit to assist with predation.

Additional Information:

Both avian and salamander depredation were controlled at ONFH-R during FY 2022, allowing adequate survival to meet stocking schedules. Salamander control continues to be an ongoing process but pre-emptive efforts from the hatchery crew have significantly reduced salamander depredation. With the reduced depredation, more efficient production strategies can be employed. Additionally, otters invaded

ONFH-R this spring killing many fish from several different fish lots. Otters were live trapped and relocated by the Utah Division of Wildlife Resources.

A complete inventory of fish species and lots, including broodstock, was completed in Spring 2022. Fish holdings as of November 2022 can be found in Table 2.

Recommendations (order is not by priority):

Primary recommendations for ONFH-R include the following:

Administration

- Achieve a staffing level that facilitates safer conditions for employees and fish holdings.
    - Current permanent staffing is below historic levels despite increased workload. Borrowing of staff from other stations is not always possible and current staffing levels are below what is required to safely accomplish certain tasks. In addition, plans to increase production of native fishes (more species and/or fish) for the Recovery Program requires an adequate amount of staffing. Recent support from the Recovery Program for a temporary position has made a positive impact on staffing levels. The future direction of this support is unknown at this time.

Propagation

- Moving BT stocking from fall to spring stocking. RZ will continue to be stocked in the fall in 2023. We will be evaluating both species propagation and stocking schedules as we continue to improve rearing methodologies.
- Monitor and evaluate fecundity and egg viability of aging broodfish at ONFH-R.

Stocking

- Continue diel stocking experiment in fall of 2023.
    - Releasing fish at night has the potential to reduce stress and reduce predation. In contrast, logistic factors and safety concerns are easier to control in the day.
- Continuing the stocking of BT into receiving waters greater than 17°C, and stocking into backwaters connected to the river when possible.
- Continuing the practice of blending receiving water into hauling water for pre-stocking acclimation.
- Discuss stocking schedules that consider recent data synthesis on survival, release strategies and techniques, and when possible, reproductive contribution.

- Consider stocking various life stages of BT and RZ in nearby floodplain wetlands to continue evaluation of wetland areas for rearing of native species. Space and resources for rearing of entrained wild native fishes should be given priority.

Project Status: Ongoing

FY 2022 Budget Status
Funds Provided: $622,745
Funds Expended: $622,745
Difference: $0
Percent of the FY 2022 work completed, and projected costs to complete: 100%
Recovery Program funds spent for publication charges: $0

Status of Data Submission
Passive integrated transponder (PIT) tag data has been submitted to Program Directors Office.

Signed:
Zane C. Olsen, Principal Investigator
1/11/2022

Andrew A. Schultz, Ph.D., Principal Investigator
1/11/2022

Tables:

Table 1. Stocking event for razorback suckers from ONFH-Randlett Unit, fall 2022 fish stocking.

Stocking Date	Stocking Location	Stocking Time (Military Time)	# of Fish Stocked	AVG Length (mm)
9/21/2022	Green River, Green River State Park	1214	1,418	350.9
9/21/2022	Green River, ONFH Boat Ramp	1910	1,371	350.8
9/22/2022	Green River, Green River State Park	1915	1,083	350.8
9/22/2022	Green River, ONFH Boat Ramp	1021	1,072	351.1

Table 2. ONFH-Randlett Unit fish holdings as of November 2022.

Lot I.D.	Species	Number of Fish	Mean TL (mm)	Mean Weight (g)
210515CBBT-Dexter-01	BT	10,125	249.53	147.26
210515CBBT-Dexter-01	BT	5,619	114.70	12.71
220511CBBT-Dexter-01	BT	19,825	90.10	7.23
210621CPM-Dexter-01	CS	842	222.38	80.35
220621CPM-Wild-1	CS	92	71.00	1.90
210515RZBS-ONFHR-01	RZ	1,000	351.00	455.00
220513RZBS-ONFHR-01	RZ	19,192	154.17	46.19
Brood-RZBS (11, 13, 17)	RZ	848	499.25	1,419.00
RZBS Brood - 2010 & Older	RZ	199	558.00	1,962.00
Brood-RZBS (18, 19)	RZ	282	429.00	800.30
CBHB-Refuge Brood	HB	32	300.00	237.70

Appendix 1.

UPPER COLORADO RIVER ENDANGERED FISH RECOVERY PROGRAM

FY 2022-23 SCOPE OF WORK PROJECT: XXXX

Project Title
Survival and condition of fish after passage over the Green River Canal Fish Screen and return channel

Bureau of Reclamation Agreement Number:
[if applicable & known]

Reclamation Agreement Term
[if applicable & known, e.g., Oct. 1, 2013 – Sep. 30, 2020]

Note: Recovery Program FY22-23 scopes of work are drafted in May 2021. They often are revised before final Program approval and may subsequently be revised again in response to changing Program needs. Program participants also recognize the need and allow for some flexibility in scopes of work to accommodate new information (especially in nonnative fish management projects) and changing hydrological conditions.

Lead Agency:
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Category:
__ Ongoing project
__ Ongoing-revised project
__ Requested new project
_X_ Unsolicited proposal

Expected Funding Source:
__ Annual funds
__ Capital funds
__ Other *[explain]*

Relationship to RIPRAP:

2.2 II. Restore and Protect Habitat
Evaluation of potential entrainment into irrigation canals is an important part of the Recovery Program's decision-making process for screening canals

3.1. Green River
3.1.2 Recovery Actions
Monitoring of fish entrainment at the Green River Canal near Green River, Utah,

demonstrated that all four endangered species were entrained, some at substantial levels particularly during low flow years. Construction of a weir wall and fish screen was completed in 2019 to halt the entrainment of individuals. This project follows the reconstruction of the Tusher Diversion on the Green River, which included fish passage as a component of the rebuild.

Study Background/Rationale and Hypotheses:

The Upper Colorado River Recovery Program (Recovery Program) constructed a fish exclusion weir and fish screen at the head of the Green River Canal near Green River, UT, prior to the 2019 irrigation year. A set of three passive interrogation arrays (PIAs) were installed in the Green River Canal Fish Screen, one immediately above the screen intake, one in the return channel to the Green River, and one in the canal below the screen (Figure 1). The goal of the placement of these arrays was to detect fish that enter the canal and return to the Green River and any fish that pass the screen into the canal; fish that enter the canal are lost. Since beginning operation, the screen has been effective to exclude fish from the canal, based on only a few in-canal tagged fish detections (Speas et al. 2019; Speas and MacKinnon 2020; Speas and MacKinnon 2021), For example, in 2021, 1,724 fish were detected in the vicinity of the fish screen but only one Bonytail *Gila elegans* was detected in the canal (Speas and MacKinnon 2021). Thus, the screen and return design appear effective to exclude fish from the canal and pass fish back to the Green River.

One aspect of passage back to the river is whether fish are physically harmed in the process. The design of the return channel to funnel fish excluded from the canal back to the river is swift and turbulent. Also, it is possible some fish pass over the fish screen before entering the return channel, which may cause additional physical damage (Figure 1). Thus, recommendations have been made to assess the physical condition of fish that pass through the return channel (Speas et al. 2019; Speas and Mckinnon 2020; Speas and Mackinnon. 2021). This issue is important to investigate because increased physical damage may directly or indirectly increase mortality through added stress or decreased mobility making fish more susceptible to predation by non-native predators. Increased direct or indirect mortality would render the screen less effective at increasing survival of endangered fishes in its vicinity each year.

Study Goals, Objectives, End Product(s):

Goal: Evaluate mortality and condition of larger-bodied fish that pass over the Green River Canal Fish Screen or through the bypass channel and return to the Green River.

Objectives:

1. Release tagged fish immediately upstream of the fish screen so they either pass over the screen or return through the bypass channel, each of which leads to the return channel, and capture returned fish once in the Green River.

2. Assess survival and physical condition of treatment fish in relation to control fish not passed through the return channel.

Study Area:
The study area is at 0.7 RM of the Green River Canal near the town of Green River, UT and on the main stem Green River below the Tusher Diversion (RM 129.3).

Study Methods/Approach:

Investigations of fish condition after passage through the return channel of the fish screen will be conducted in autumn 2022 and in 2023. Both razorback sucker (355 mm mean total length; TL) and bonytail (200 mm mean TL) are stocked in autumn in the Green River at Green River State Park, UT (RM 120), 9.3 miles downstream from the Tusher Diversion (Fry and Schultz 2021). We plan to take advantage of this opportunity and use fish to be stocked as test and control individuals. To recapture fish and then assess fish condition after passage through the return canal we will use balloon tags (Heisey et al. 1992; Tuonomnen et al. 2022). These tags consist of a small balloon filled with sodium bicarbonate capsules and anhydrous oxalic acid capsules in a ratio of 2:1 (Tuonmnen et al. 2022). One or more balloons are attached to the fish depending on size and 10 ml of water is injected into each balloon. The water slowly dissolves the capsules allowing the remaining water and chemicals to mix after 6-10 minutes (Heisey et al. 1992; Tuonomnen et al. 2022). The mixed chemicals create gas which slowly inflates the balloon.

Test fish will be released immediately upstream of the fish screen after activation of the balloon tag (injection of water) after scanning and recording the PIT tag number. There will be two treatment groups, one with fish released just upstream of the bypass channel where fish do not go over the screen, and one with fish released just upstream of the return channel so that fish cross over the weir wall and fish screen before entering the return channel (Figure 1). Tag inflation will occur after passage through the return channel causing fish to float to the surface. They will be retrieved by netters downstream of the return channel inflow into the Green River. Recaptured fish will be assessed for survival and physical damage (Mueller et al. 2017). Control fish will be tagged and assessed similarly but released directly into the Green River where flow from the return channel enters.

Both treatment groups and the control group will have a sample size of 300 fish. Sample size was determined using the program G*Power (Faul et al. 2007). The program using input parameters including a statistical power level of interest (in our case 0.8, where power is the likelihood that a test will correctly detect an effect of a certain size if there is one) and statistical test used for analysis to compute sample sizes need to detect hypothesized differences between control and treatment groups. We hypothesize that if there is an impact of the return channel on the physical condition of fish it would be relatively small, which necessitates large sample sizes. Thus, using Fischer's exact test to investigate differences in proportion of fish with physical damage and a hypothesized proportion of 0.10 control fish with physical damage (10%) and a proportion of 0.2 treatment fish with physical damage (effect size of 0.10), approximately 250-350 fish would be needed to detect this effect with 95% confidence (alpha 0.05; Table 1; Figure 2). Comparisons will provide insight into differences in fish survival and condition based on passage through the channel, or over the fish screen and then through the channel, rather than due to the tagging and handling procedure. After fish condition is assessed for each individual, tags will be removed and fish released into the river as part of that year's stocking cohort. Because fish are PIT tagged prior to release, it is possible that future analyses of tag recapture rates could be used for longer-term survival assessments.

Fish recapture after release is a yet-undetermined aspect of this study. Ideally, we would like to net fish from the return flow area in a larger block-netted area of the Green River where water reenters. This would serve to constrain the distance that tagged fish are carried downstream. If flow velocity or water depths do not allow for this, tagged fish retrieval by boat or kayak may be needed.

After recapture, each fish will be evaluated for evidence of physical damage from passage. Individual data collected will include: (1) elapsed time to pass over or though the weir, screen and down the return channel (if possible); (2) survival: yes, no; (3) total length; (4) eyes: normal, abraded, exophthalmic, hemorrhagic, missing; (5) caudal, dorsal, right and left pectoral fins: normal, frayed, trace fin split (≤10%), fin split (>10%), broken (one or more rays disrupted into fragments attached by intervening fin tissue) or missing fin rays; (6) skin: normal, abraded, bruised, cut; and (7) scales: normal, scattered descaling (<20% per side of fish), severe descaling. We may also request to sacrifice a small number of fish to look for internal injuries, but that would occur only if we observe severe external injuries, which we do not expect. After assessment, the tag will be removed from the fish and it will be released into the Green River, having recorded the PIT tag number again.

Statistical analyses of survival and injury data appropriate for proportions will be used. A report will be completed and be available for review by Recovery Program staff and interested parties.

Task Description, Deliverables and Schedule: We anticipate conducting this adult life stage work over two seasons, perhaps under different flow rates over the screen or in the return channel. Additional testing will be conducted with early life stages of endangered razorback sucker, to determine if the weir wall and fish screen exclude larvae at rates higher than expected, based on the proportions of flows in the canal relative to that which enters the irrigation canal. The early life stage work will be proposed in a separate work description.

Budget Summary: Our budget was provided by Bureau of Reclamation with funds separate from Recovery Program sources.
[Note: PI's are REQUIRED to prepare their budget in the Cost Estimating Tool (to facilitate funding of projects from Bureau of Reclamation). Here, provide total AND subtotals by funding target (e.g., office/station) from those tables.]

FY Year	*[Office 1]*	*[Office 2]*
2022		
2023		
2024		
2025		
2026		
Total		

Reviewers:
Dave Speas, Mark McKinstry

References:

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Table 1. Results of an *a priori* power analysis (power = 0.8) using the program G*Power to determine the appropriate sample size to detect a 0.05, 0.10, or 0.15 difference in the proportion of control and treatment fish using Fisher's exact test. Reported sample sizes are in relation to the treatment group (Proportion p1) having a 0.15, 0.2, and 0.25 proportion of fish with physical damage while control fish (Proportion p2) are hypothesized to have only a 0.10 proportion of fish with physical damage.

	Total Sample Size		
α error probability	**Proportion p1=0.15**	**Proportion p1=0.20**	**Proportion p1=0.25**
0.01	1820	538	274
0.02	1534	456	232
0.03	1366	410	208
0.04	1244	372	190
0.05	1150	348	178
0.06	1074	326	168
0.07	1010	308	160
0.08	956	290	150
0.09	906	276	144
0.10	860	262	136

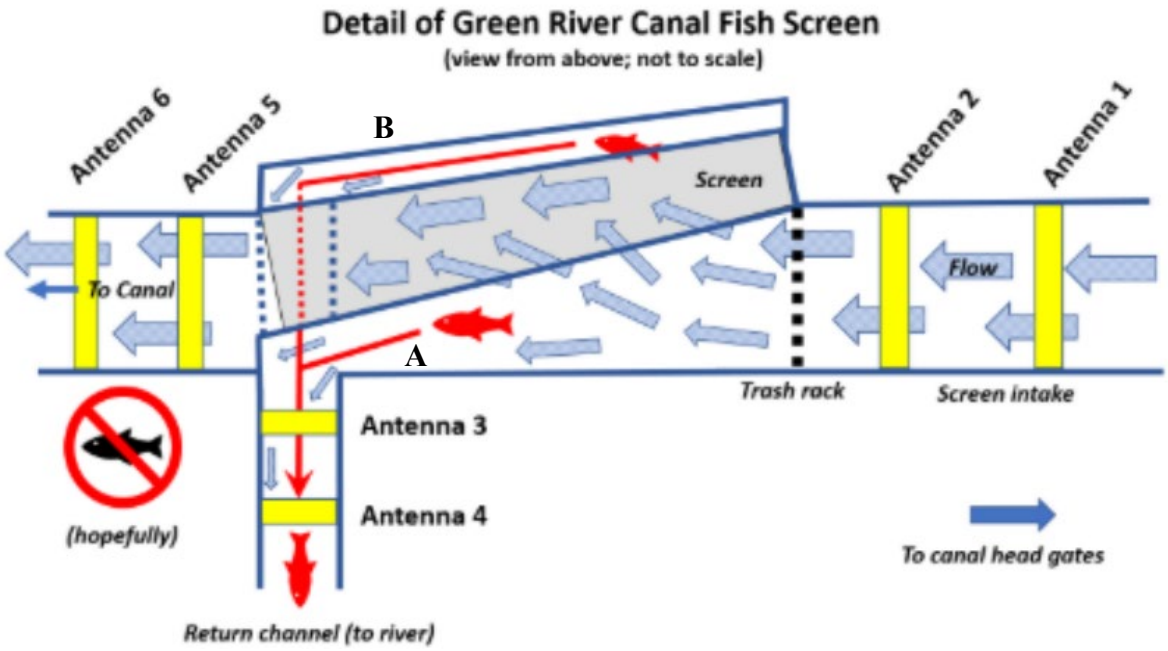

Figure 1. Conceptual drawing of the Green River Canal Fish Screen Weir including locations of passive integrated arrays (PIAs) for detecting tagged fish at the input and return channels and the canal. Water flows into the weir where some is funneled into the bypass channel and then into return channel (A). Water that does not enter the bypass channel flows over a weir wall and across the fish screen. At full capacity 85 cfs flows down through the screen and enters the canal. The remaining water flow over the screen enters another channel (B) that funnels remaining water back to the return channel to the Green River. Fish funneled through routes A or B into the return channel will be examined to determine survival and fish condition after returning to the Green River.

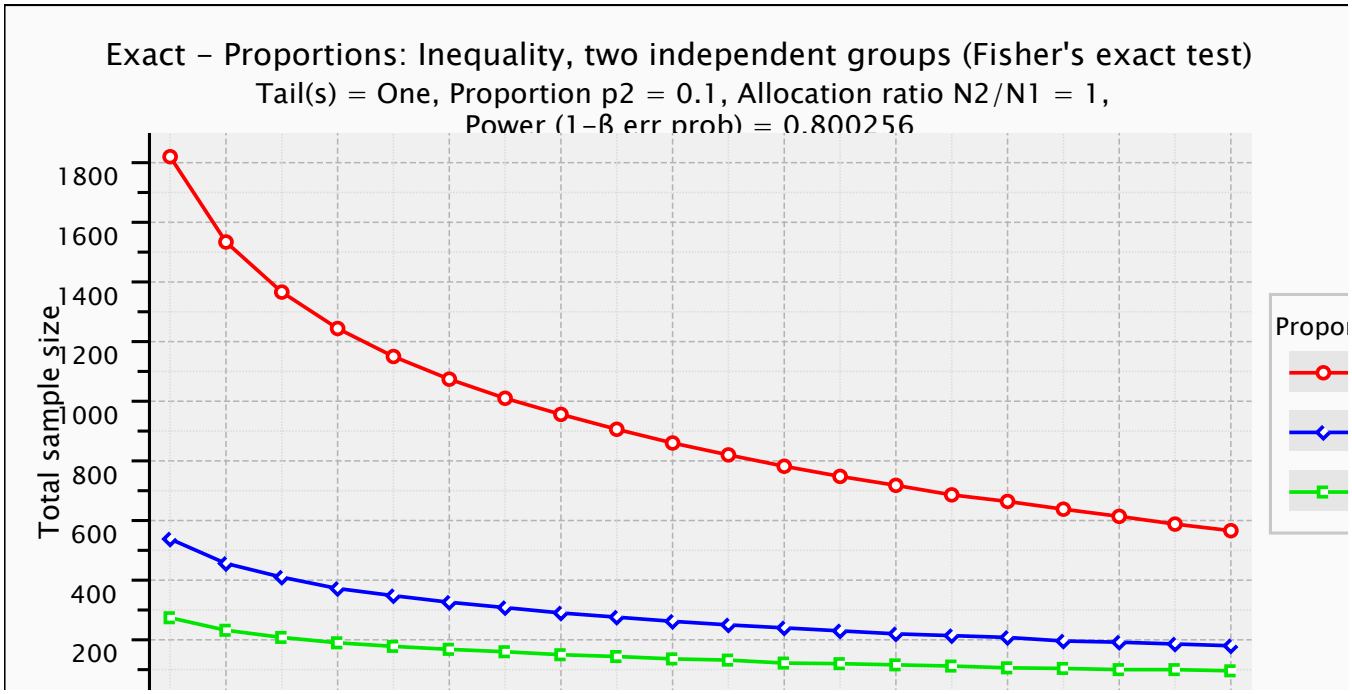

Figure 2. Results of an *a priori* power analysis using the program G*Power to determine the appropriate sample size to detect a 0.05, 0.10, or 0.15 difference in the proportion of control and treatment fish using Fisher's exact test. Plotted values of sample size are in relation to the treatment group (Proportion p1) having a 0.15, 0.2, and 0.25 proportion of fish with physical damage while control fish (Proportion p2) are hypothesized to have only a 0.10 proportion of fish with physical damage.

Appendix 2.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
USFWS Vernal Fisheries Office
1380 South 2350 West
Vernal, UT 84078

In Reply Refer To: FWS/R6/FAC-PL

Memorandum
To: Julie Stahli, Director, Upper Colorado River Endangered Fish Recovery Program
CC: Koreen Zelasko, Propagation Coordinator, Upper Colorado River Endangered Fish Recovery Program
From: Andrew Schultz Ph.D., Project Leader/Complex Manager, Utah FAC Complex
Subject: Loss of Razorback Sucker (*Xyrauchen texanus*) at Ouray National Fish Hatchery (Randlett Unit)

This correspondence is to inform you that on the evening of 9 September 2022 the Ouray National Fish Hatchery indoor facility experienced a system failure that led to significant stress and mortality of Razorback Sucker over the course of time following. During evening/early morning hours, efforts were applied by staff to reset the system, and recover and stabilize the remaining indoor Razorback Sucker holdings.

Following recent enumeration during tagging, the number of Razorback lost in relation to this stress event is estimated to be approximately 1,424 fish in total, or a little over 19 % of the Razorback Sucker being held indoors at the time of the system failure.

The cause of the system failure and subsequent fish loss is attributed to staff error on 3 levels.

- Following a water flush, valves were left unadjusted, which prevented flow from being returned to the recirculating system and led to significant water loss. The subsequent water/flow loss led to a system shut down.
- The emergency oxygen system was left in an inoperable condition following repair work earlier that same day.
- No final walk-through/system check was done.

During 15 and 16 September 2022, Ouray National Fish Hatchery tagged 6,037 Razorback Sucker in preparation to fulfill the stocking target of 6,000 Razorback Sucker established by the Upper Colorado River Endangered Fish Recovery Program. Therefore, depending on survival following recent tagging events, the impact of the fish loss to the 2022 stocking commitment is anticipated to be minor or negligible.

Please contact me with any questions or if you require more information/clarification. Sincerely,
Andrew Schultz (andrew_schultz@fws.gov)