Facilitated fish passage for enhancing populations of endangered fishes in the San Juan River

Proposed Scope of Work for FY 2020 and 2021

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Background

Migration is integral to the life history of many riverine fishes because it can impact population vital rates. Many fishes require movements among spawning, rearing and feeding habitats (Schlosser and Angermeier 1995). As river systems have become fragmented by dams, water diversions, road crossings, and other human engineered structures, fish populations have declined (Gido et al. 2016). Accordingly, there has been active interest in promoting various forms of fish passage to conserve and manage populations (e.g., Bunt et al. 2012), and translocation, the intentional movement of individuals from one area to another, is a widely applied conservation tool used to increase the viability of threatened populations (IUCN/SSC 2013; Ranke et al. 2017). In the Colorado River system, it is likely that barriers affect reproductive success of razorback sucker, as this species is known to migrate up to 106 km to spawn (Tyus and Karp 1990). Spawning, and associated migrations, occur between March and June during the ascending or peak spring flows when water temperatures are between 9 and 17 °C (Tyus and Karp 1990; Farrington et al. 2014). Given that razorback sucker evolved in a historically open river network, barriers to movement have likely interrupt critical spawning opportunities and perhaps other aspects of their life cycle.

On the San Juan River, two major obstacles to fish movement are the Piute Farms Waterfall (PFW) and the PNM weir. The PFW formed most recently in 2001 after sediment deposition in the Lake Powell-San Juan River inflow area redirected the river during high water years (Cathcart et al. 2018a). Other than in 2011, when the elevation of Lake Powell last exceeded the elevation of the waterfall, this structure has excluded upstream migration of fishes from the Lake Powell-San Juan River inflow area. In most years, it is typical to have at least 10 river kilometers between the waterfall and the inflow to Lake Powell. One consequence of the PFW is that stocked razorback sucker and Colorado pikeminnow that move downstream of the waterfall cannot return to the mainstem San Juan River. We know a large number of razorback suckers (> 1000 individuals) occur in the San Juan Arm of Lake Powell and many of those fish are found immediately below the waterfall in early spring (Cathcart et al. 2018a). This large aggregation of razorback suckers suggests these individuals are trying to move upstream to spawn. Over the past three years, there have been efforts to translocate fish upstream of the waterfall. In 2016, 152 razorback sucker were moved upstream of the waterfall, 151 in 2017, and in 2018, 202 were moved. However, PIT tag data show that translocated fish do not necessarily reside in the river long, making seasonal returns to Lake Powell (Pennock, unpublished data). In 2016, 80% of translocated fish were subsequently detected below the waterfall, and in 2017 a similar number was observed with 79% of moved fish detected downstream of the waterfall. In contrast, when PIT tagged razorback suckers in the San Juan Arm of Lake Powell had the opportunity to move into the San Juan River in July 2011 (n = 6, Durst and Francis 2016; plus one additional fish , Schleicher 2016), many of these individuals remained in the mainstem for at least 3 years. Thus, the importance of potentially short durational movements above PFW or longer forays in the upper river is unknown. It is possible that allowing movement (open fish passage or facilitated by biologists) above the waterfall might allow access to critical spawning habitats or allow the return of individuals to the river population.

A similar fish barrier occurs at the PNM weir on the San Juan River near Fruitland, NM. This weir was constructed in 1971 and diverts water to the nearby San Juan Generating Station. The PNM weir forms a barrier to fish movement at base flows, but fish passage might be possible at higher discharges (>7,000 cfs, BOR 2001). As such, a fish passage facility was constructed to trap and manually move fish upstream of the barrier. However, recent analyses suggested that relatively few fish encountered on PIT antennas below the weir were passing through the diversion (Cheek 2014). In 2018, the selective fish passage barrier was opened to allow passive movement in hopes of increasing passage rates. Overall, and as with the PFW, it is important to understand how endangered fish movement above this barrier might influence the population dynamics of razorback sucker (e.g., reproductive success).

It is currently unclear if these major barriers to fish movement are impeding reproductive output and natural recruitment of razorback sucker in the San Juan River. To help answer this question, we propose to use PIT tagging and radio telemetry to track the movement of razorback sucker that are actively transported upstream of PFW and PNM weir. Specific research objectives are:

1) Quantify movement of fish transported above the PFW and PNM weir (**Task 1 – 4**)
2) Identify fish aggregations and potential spawning habitats above both barriers using radio telemetry and PIT antennas (**Task 2 and 3**)
3) Estimate the reproductive contribution of translocated razorback sucker to the San Juan River population (**Task 5**)

Conservation need

Razorback sucker have generally failed to recruit in the San Juan River, despite extensive efforts to stock adults in the river. At this point, it is not clear how important connectivity among habitats (i.e., the river and reservoir or river upstream of PNM weir) is to the ability to maintain sustainable populations of razorback sucker in the San Juan River. Rivers, reservoirs, and tributaries might play different roles relative to spawning, recruitment, foraging, and refugia for this species. Continuing to monitor the movement dynamics and reproductive success of translocated fish will help gauge the importance of linkage across habitats to the success of razorback sucker in the San Juan River. Specifically, this research will assess the efficacy of a potentially important management action (i.e., providing fish passage), while also identifying critical habitat needs of this species.

Task 1: Facilitated migration and telemetry study of razorback sucker through the Piute Farms Waterfall and PNM weir (Kansas State University)

Methods

Piute Farms Waterfall - Raft mounted electrofishing will be used to capture razorback sucker below the PFW and lengths and weights will be taken from each individual. Additionally, fin clips will be taken and preserved in ethanol to identify the contribution of translocated fish to that year's production of larvae (see Task 4). Fish will be scanned for PIT tags and if no tag is present, they will be tagged with BioMark 12 mm tags. Fish will be held in a holding tank with fresh river water (salt added to reduce stress) for a maximum of 3 hours while additional fish are captured. At this time, fish will be hauled upstream of the waterfall to a motor-mounted boat and fish will be transported and released at a location approximately 2 river miles (3.2 km) upstream of the waterfall. This effort will take place for 10 – 14 days during March of each year with the goal of capturing and transporting 200 adult razorback sucker.

Movements of fish transported upstream of the PFW will be assessed using a combination of physical recaptures, detection of PIT tagged individuals below the waterfall, and radio telemetry. Specifically, we know from previous work (Cathcart et al. 2018a) that the detection probability on a PIT antenna located in an eddy below the waterfall is relatively high (64 - 91% over a 15 day period). Thus, by using existing PIT tags or tagging untagged fish, we can estimate the proportion of translocated fish that are retained in the river in each year of the study, assuming that fish not detected are still above the waterfall. This estimate will consider a correction for detection probability of PIT antennas below the waterfall. To better quantify the detection probability of our PIT antennas below the waterfall, we will periodically deploy submersible antennas at several other locations below the waterfall to assess detection probability of the permanent PIT antenna below the waterfall. Submersible antennas will be placed in deep, low velocity habitats that are most likely holding areas for razorback sucker. Additionally, by scanning fish during each sampling effort, we might identify fish that have returned to the river below the waterfall but not detected on the permanent PIT antenna, allowing an additional estimate of detection probability. Additionally, we will monitor upstream movement and retention based on an array of submersible antennas in the lower canyon between Sand Island and Clay Hills (Task 2), standard fall monitoring, and stationary PIT antennas located at McElmo Creek, Restoration Channels, Hogback Diversion, and PNM.

Although PIT tagging will allow us to monitor coarse movement patterns of a large number of fish, we also propose to use radio telemetry on a subset of razorback sucker translocated above the PFW to monitor movement and habitat use. Stationary radio antennas will identify passage at critical periods and locations while monthly tracking by raft (Task 2) and airplane (Task 4) will help identify fine-scaled movements and habitat use by razorback sucker transplanted above the PFW. These efforts will serve to validate data obtained from PIT tagged fishes.

To provide fine-scaled movement of translocated razorback suckers, we propose to implant 40 fish with 300-day, body implant, coil radio transmitters (13g; Advanced Telemetry Systems). A stationary, uni-directional radio antenna and receiver will be place at Sand Island and a stationary, bi-directional antenna and receiver will be placed at the PFW. The receiver at Sand Island will be powered by an 12V battery that will be continually charged by a solar panel and will be used to assess if fish translocated above the PFW successfully migrated through the lower canyon. The receiver at the PFW will be attached to the solar unit powering the existing PIT antenna. A receiver with two antenna channels will have one antenna pointing upstream, one downstream. The combination of these signals along with recording signal strength by the receiver will allow us to determine when fish move downstream over the PFW. Unless there is a power failure, fish should not be able to pass either location without being detected. Antenna receivers will continuously run for the 300-day period to identify date and specific time fish are detected in these areas. We will only use 300-day tags so they expire before the following year.

That will allow us to replicate the design a second year and not risk the chance of having too many active tags in the river, making it difficult to scan frequencies.

PNM weir – Similar methods as described above for translocation of fish above PFW will be applied to river reaches below and above the PNM weir. We will take fin clips for genetic analysis and implant 40 suckers with radio tags and transport them approximately 2 river miles upstream (to match the design at the waterfall). We will also capture and take fin clips from up to 160 additional individuals captured below the weir and transported upstream to the same location as radio tagged fish. Thus, we might be able to identify the contribution of transported fish to larval razorback suckers collected that year.

A stationary radio telemetry receiver will be placed at the PNM weir with directional and unidirectional antennas to capture movements of fish above and below the weir. Additional efforts will focus on detecting PIT and radio tagged fish above the weir with an array of submersible PIT antennas (Task 3) and tracking radio tagged fish river-wide by airplane (Task 4).

Budget Justification

The majority of funds for this project are for personnel, telemetry equipment, field gear, and travel costs. The PI will oversee the entire project with primary responsibilities to mentor the graduate student and technician, assist with data analysis, and edit reports and manuscripts. The graduate student will be responsible for field work that includes translocating fish at the PFW and PNM weir and assisting with river trips to track radio tagged fish and replace batteries on PIT antennas. The student will also be in charge of data organization (including compiling PIT and radio telemetry data), analysis, and report/manuscript writing. A technician is necessary because field work will require a minimum of two people for safety. This person will assist with field work, data entry and general maintenance of equipment. Telemetry receivers (stationary and portable) and tags (148-151.999 MHz range) will be purchased through Advanced Telemetry Systems. Four-wheel drive trucks and rafts are available at Kansas State University and through the BOR and SJRIP Program Office. Due to extensive wear from using outboard motors to run upstream, additional funds are requested for an outboard motor to sample fish below barriers and transport fish upstream of PFW. Funds for field camping gear are included to accommodate extended periods of time in potentially cold conditions while translocating fish.

Task 2: Reproductive ecology of translocated razorback sucker in the lower canyon, Sand Island to Clay Hills (UDWR)

Spawning aggregations of razorback sucker have been observed by Utah Division of Natural Resources in the lower canyon above Slickhorn Wash since 2002 (Jackson 2003). It is possible that translocated razorback suckers will aggregate, and potentially spawn at this location, or in other locations in the lower canyon. To evaluate the potential spawning habitats of razorback sucker transported above the PFW, we propose fine-scaled radio tracking and submersible PIT tag antenna surveys to identify potential spawning habitats. Specifically, we propose to 1) sample around the Slickhorn Wash area using larval drift nets and submersible PIT antennas to verify Razorback Sucker spawning and 2) use radio telemetry to identify potential spawning habitats between Sand Island and Clay Hills. If additional spawning aggregations are identified with radio telemetry then additional sampling will occur at those locations the following season.

Methods

A maximum of four trips will take place in March, April, May and June (depending on flows) following translocation of fish above the PFW each year. Trips will begin at Sand Island and end at Clay Hills. Hand-held radio telemetry receivers will be used to track the location of radio tagged fish within that reach and GPS coordinates of fish will be noted at the location of each fish. Locations will also be marked on aerial photographs of the river. In the first trip, 6 – 12 submersible PIT antennas will be placed at strategic locations around suspected spawning locations. Additionally, a minimum of four submersible antennas will be placed at regular intervals above the waterfall (e.g., 10, 20, 30, 40 river miles) to evaluate upstream movement of fish. Exact locations and habitats where submersibles are placed will be adjusted according to locations of fish with radio transmitters. Not only can we test if detections decline with distance above the waterfall, but this will also provide data on the exact timing of fish moving into these habitats. Batteries in these antennas typically last about 3-4 weeks and efforts will be made to keep antennas operational from March through June.

Larval fish sampling will occur below spawning habitats (most likely Slickhorn Wash) to identify if razorback sucker larvae are being produced at putative spawning aggregations. Because it is possible that larval razorback suckers might be produced upstream and drift down, we also will sample habitat above the suspected spawning habitat. If higher abundances of larval fish are found downstream of the suspected spawning aggregation, that would indicate those larvae are coming from that aggregation. Larval fish will be sampled up-and downstream of spawning sites using standard methods from annual larval fish monitoring (Farrington et al., 2014). However, we will also use drift nets set out at dusk and dawn to increase the probability of capturing larvae around spawning beds. Larval fish will be preserved in 95% ethanol for potential genetic analysis. These data will supplement systematic larval fish surveys conducted by ASIR. All larval fish collections will include geographic coordinates to identify the distribution of samples along the river.

Budget justification

Funds are requested for personnel needed for field crews, travel to survey locations, sampling gear and basic maintenance.

Task 3: Reproductive ecology of translocated razorback sucker above PNM weir (USFWS Grand Junction)

The occurrence of larval razorback sucker as high up as the confluence with the Animas River in 2018 (Farrington et al., 2019 BC annual meeting presentation) indicates there is spawning habitat above PNM weir. We propose a parallel effort to the lower canyon described in Task 2 to 1) use radio telemetry to identify spawning aggregations and habitats in the San Juan River above the PNM weir and 2) strategically place PIT antennas to identify patterns of movement of PIT tagged razorback suckers in or around suspected spawning habitats.

Methods

Because the PNM weir has an existing fish passage facility we will focus our activities around tracking radio and PIT tagged fish that are transported above the barrier. A minimum of four trips (depending on flow) will take place in March, April, May, and June following translocation of fish above the PNM weir. Hand-held radio telemetry receivers will be used to track the location of radio tagged fish within that reach and GPS coordinates of fish will be noted at the location of each fish as will their location on aerial photograph of the river. As with the lower canyon, location of radio tagged fish will be used to identify suspected spawning locations of translocated fishes. Six to 12 submersible PIT antennas will be placed at strategic locations around suspected spawning aggregations and at variable distances upstream of the PNM weir that will help identify movements into suspected spawning habitats. The occurrence of larval razorback suckers below spawning habitat will be sampled and assessed from annual larval fish monitoring by ASIR.

Budget justification

Funds are requested for personnel needed for field crews, travel to survey locations, sampling gear and basic maintenance.

Task 4: Riverwide distribution of razorback sucker tagged with radio transmitters (NMGF budget)

It is possible, and highly likely, that fish tagged with transmitters will move outside of our focal reaches above the two barriers (i.e., downstream of the waterfall and upstream of Sand Island; as well as downstream of PNM weir and upstream of Bloomfield, NM). Thus, we propose that New Mexico Department of Game and Fish will survey the entire San Juan River, including the sections of the San Juan River above the confluence with the Animas for fish with radio transmitters by airplane. Flights will be conducted during months when flows are expected to be high (May and June) as well as in September, when fish are likely to be more dispersed. These flights will not only allow us to examine long-distance movement away from the barriers, but will provide additional data on observed locations of fish during the spawning period. We are assuming detection probability from the aircraft is 100% because radio signals are strongest immediately above the transmitter. However, we can confirm detection probabilities based on opportunistic PIT antenna and physical captures to account for potential bias in detection probabilities associated with altitude, flight direction and depth (Watkins et al. 2019).

Budget justification

The majority of funds for this task will be for personnel (1 biologist) to fly and track fish once per month in May, June, and August. Funding covers the cost of the biologist to fly for two days and two days for trip preparation and data summary for the flight (4 days total). The cost of the pilot and plane will be provided in-kind by the New Mexico Department of Game and Fish.

Task 5: Estimating reproductive contribution of translocated Razorback Sucker (*Xyrauchen texanus*) in the San Juan River

Translocation of animals has been used to repatriate extirpated populations, increase genetic variation and/or population size, move individuals out of the way of human development, and assist migration around unnatural impediments (Dresser et al. 2017; Mulder et al. 2017). Despite the increased, broad-scale use of this management action, effects of translocations are rarely assessed and only a handful of those have been deemed successful (Fischer and Lindenmayer 2000; Tarszisz et al. 2014; Dresser et al. 2017). A successful translocation program may require both the survival of relocated individuals and their reproductive contribution to the next generation; however, contribution of offspring can be difficult to evaluate when translocated animals are placed into a reproducing resident population. Fortunately, genomic analyses may provide managers a way to evaluate the conservation benefits of a translocation program despite difficulties faced within this management activity.

Every living organism has a genetic blueprint (herein, genome) that constitutes a combination of genetic signatures passed on from their parents and previous ancestors; if reproductively successful, a subset of their genome will be passed on to their offspring and future generations. Due to this fact, inheritance of parental genomic DNA provides the opportunity to reconstruct genealogical relationships among parents and their offspring. While the technology to accomplish these assessments has been available over the last few decades, this capacity has been further improved through recent advances in genetic methodologies. Recent technology termed “next-generation sequencing” (NGS) has provided a cost-effective means of quantifying massive amounts of genetic data from individuals through the identification of thousands of single nucleotide polymorphism (SNPs). These SNPs are analogous to microsatellite markers, however, SNPs can quantify an order of magnitude more loci (i.e., specific locations of DNA) compared to microsatellites (i.e., SNP = thousands of loci, microsatellites = 10 – 30 loci), functionally increasing our resolution of genetic variation among individual genomes. This increase in genomic markers not only improves confidence assignments for parental reconstruction (Thrasher et al. 2018), but SNPs also offer other benefits over traditional microsatellite methods due to lower error rates and broader genome coverage (Smouse 2010; Hauser et al 2011). Therefore, SNPs have the potential to evaluate translocation success (i.e., contribution of offspring) within reproducing resident populations by reconstructing relationships using genomic data for both translocated individuals and putative offspring. It is of particular interest to know whether or not these individuals contributed offspring to the San Juan River population. While this currently remains unknown, SNP analysis could inform managers about the effectiveness of fish translocation around significant migration barriers and clarify the importance of these animals to the recovery of the San Juan River razorback sucker population.

Methods

Fin clips will be collected from all razorback sucker translocated above PFW and the PNM weir and stored in 95% ethanol. Any corresponding data (e.g., PIT tag, length) will be recorded with the tissue for potential downstream comparisons (i.e., measures of individual reproductive success). The current goal is to move approximately 200 fish upstream of each barrier (PFW = 200; PNM weir = 200); however any animals moved in excess of this target will be fin clipped and included in all genomic analyses.

Larval fish surveys are conducted annually along a 140 mile section of the San Juan River between Shiprock, NM, and Clay Hills, UT. Larval fish are preserved and maintained in 95%

ethanol making them suitable for genomic analyses. The number of larval Razorback Sucker has varied considerably among years with as few as 272 (Brandenburg and Farrington 2009) to as many as 1,834 collected in 2018 (M. Farrington, pers comm.). Therefore, larval collections will include a maximum of 900 individuals; if larval collections exceed this threshold, 900 larvae will be randomly selected from the total collection. Tissue subsamples from the posterior portion of each specimen will be obtained for genomic analyses and heads will be retained for potential future otolith examination. Prior to tissue collection, length and stage data will be recorded for each larvae.

Genomic DNA will be extracted from tissues following standard protocols used at Southwestern ARRC. Preparation of double digest Restriction-Site Associated DNA (ddRAD) libraries will follow Peterson et al. (2012). Restriction digest of 1µg genomic DNA/sample will be performed in 50µl reactions containing 5µl New England BioLabs CutSmart Buffer and 20 units each PstI and MspI. Samples will be digested at 37°C for 18 hours then purified using Agencourt AMPure XP beads (Beckman Coulter, Inc.).

Barcoded samples (100 ng DNA each) will be pooled in sets of 48 following Illumina adapter ligation, then size-selected to retrieve DNA fragments between 350 and 400 bp in length (Bangs et al. 2018; Chafin et al. 2018) using the Pippin Prep System (Sage Science). Size-selected DNA will be subjected to 10 cycles of PCR amplification using Phusion high-fidelity DNA polymerase (New England Bioscience), according to manufacturer protocols.

Four indexed libraries (192 samples) will be pooled per lane for 100bp single-end sequencing on an Illumina HiSeq 4000 (University of Oregon Genomics & Cell Characterization Core Facility). Data will be de-multiplexed and filtered in STACKS (Catchen et al. 2013) to discard reads with uncalled bases or low Phred quality scores (<10), while simultaneously attempting to recover those reads with ambiguous barcodes (=1 mismatched nucleotide). The *de novo* assembly of ddRAD loci will be accomplished in STACKS (Catchen et al. 2013) with clustering parameters being determined by the methods of Rochette & Catchen (2017). Only loci appearing in 95% of individuals will be retained for analysis. SNPs will be filtered to retain one per ddRAD locus.

SNPs will be evaluated for linkage disequilibrium (LD) and Hardy-Weinberg Equilibrium (HWE) using PLINK 1.9 (Purcell et al. 2007). Parentage will be assessed using COLONY (Jones and Wang 2010). This program uses maximum likelihood methods to reconstruct parentage via sibship analysis (i.e., the reconstruction of family groups from genotypic data when no known sibling groups have been identified: Smith et al. 2001). These methods will allow for the identification of putative parents if they are present among the sampled adults.

Larval samples collected in 2020 must first be identified prior to data collection for this project. Larval ID is typically completed in the fall of that sampling year. Given the extent of this scope (i.e., N = 900 larvae) genomic data collection and analysis will require multiple months before the project can be completed. Unfortunately, this will be delayed from the standard deadline for draft and final reports to the San Juan River Basin Recovery Implementation Program.

Budget justification

The majority of funds requested for this task are for laboratory consumables required for library preparation and genome sequencing. Additional funds are requested to cover personnel costs for two biologist to conduct the laboratory work and parentage analysis.

Task 6: Synthesis (Kansas State University)

All data on PIT tagged fish such as length, weight, location (coordinates), and translocation date will be collected and entered in the STReaMS – Endangered Fishes Database. To facilitate coordination among different agencies, personnel from Kansas State University will assist with other tasks as much as possible. Distribution of translocated fish based on PIT tags and radio tracking will be visualized using GIS software. Summary statistics will be used to quantify metrics such as retention time above barriers, timing of migrations up or downstream of barriers and distances traveled. Data from this study will be synthesized in a manuscript that will be submitted to a peer-reviewed journal.

Data analysis

The primary data analysis will involve quantifying five main aspects of razorback sucker ecology. Below we list those aspects and potential approach to quantification:

1) The duration that translocated fish remain in the river after translocation (PFW and PNM) - The average and variance in time translocated fish with PIT tags remain in the river above these barriers will be based on when those fish appear at PIT antennas immediately below the barriers. Although detection probabilities are not 100%, we assume fish detected below the barrier will represent a random distribution of fish moving back downstream. In addition, we can obtain estimates of average time and variance based on radio telemetry fish that will be detected by directional antenna at those structures.

2) Distance moved upstream of the barriers – Tagging studies most often use graphical summaries to represent movement patterns of fish, and can be used to represent average distances and range of distances moved (Pine et al. 2002). Coordinates for observations of tagged fish (radio transmitter detections, PIT antenna detections and physical captures) will be entered in a GIS platform and used to develop summary graphics representing dispersal patterns of tagged fish. We will also consider available software to evaluate animal movements to quantify our results (e.g., Hooge et al. 2001).

3) Location of aggregations or spawning habitats – A combination of airplane and raft telemetry tracking efforts will be used to identify aggregation of fish. These data will be visualized in a GIS platform.

4) Differences in retention above barriers across years (including data collected in 2016 – 2019 for PFW) – Our team will integrate data from previous years translocations at PFW with the current study to evaluate if different water years results in differences in retention. These analysis will only be conducted for fish translocated at PFW to include enough years and exploratory correlation analysis will test association of retention rates and annual and seasonal flow metrics.

5) Estimate river-wide reproductive contribution of translocated fish to annual razorback sucker larval production – Assuming our collection of larval razorback suckers is a random sample of the population, the genetic analysis will tell us which fish are the result of translocated fish. Thus, we will get an estimate of the proportion of larvae contributed by translocated fish. By analyzing 900 larvae, we expect to test the majority of larval razorback suckers captured in each year. If >900 larvae are collected, we will analysis a subset that will maximize distribution along the river to assure a random sample from the population.

Yearly Timeline (Tasks will be repeated in Year 1 and 2)

Table 1. General time line for activities described above with agency involvement (**bold indicates lead unit**).

Task	March (2020)	April (2020)	May (2020)	June (2020)	July (2020)	Sept (2020)	March (2021)	April (2021)	May (2021)	June (2021)	July (2021)	Sept (2021)	Sept (2021)
Translocate fish; implant radio transmitters (**KSU**, UDWR, USFWS, NNDFW)	X						X						
Track fish above barriers (**UDWR, USFWS**, KSU)	X	X	X	X		X[a]	X	X	X	X		X[a]	
Telemetry flight (**NMGF**)			X	X		X[b]			X	X		X[b]	
Deploy mobile PIT antennas is suspected spawning locations above barriers (**UDWR, USFWS**, KSU)	X	X	X	X			X	X	X	X			
Larval fish sampling below suspected spawning locations (UDWR, ASIR)		X	X	X	X			X	X	X	X		
Maintain remote radio antenna (**KSU**, NNDFW)	X	X	X	X	X	X	X	X	X	X	X	X	
Genetic analysis of tissues and larvae (**SNARRC**)					X	X	X	X	X	X	X	X	X

a River-wide tracking from Farmington to Clay Hills

b Flight will most likely occur in August, but will occur before river-wide float trip.

Deliverables

Annual reports will be produced for each field season (February – September) and completed by February the following year; prior to SJRBIP Biology Committee Meeting. A final report summarizing result of the study will be provided to the SJRBIP within 90 days after the completion of the project.

Budget – Total: $303,578

KSU FY2021 Budget

Task 1 Razorback Sucker use of the San Juan River below the Piute Farms Waterfall and San Juan Arm of Lake Powell		
-	-	
Task Description		Total
Task	**Item**	
Salaries		
Project PI: Advise student and coordinate graduate project	0.5 months	10,815
Graduate Student	1 year	29,525
Research Assistant	6 months	21,630
Fringe benefits		
Project PI	30.00%	3,150
Graduate Student	6.00%	1,720
Research Assistant	30.00%	6,300
Travel		
Field work	Per diem (63 days x $20/day x 2 people)	2,520
	Lodging-Bluff, UT and Farmington, NM ($100/night x 22 nights)	2,200
	Vehicle mileage (0.55/mile; 2000 miles round trip Manhattan, KS to Bluff, UT and travel to field sites x 5 trips)	5,800
BC annual meeting	Airfare (Manhattan, KS to Durango, CO)	1,000
	Hotel ($105/night x 3 nights)	315
Supplies		
Field Sampling Gear	Misc field gear and repairs	1,000
	Radio tags ($175 each X 80)	14,000
Graduate Student Tuition and Fees-Spring	KSU Tuition and Fees for Graduate student course work (no overhead)	8,381
	Total direct costs - Task 1	**108,356**
	17.5% MTDC F&A	**17,496**
	Total costs - Task 1	**125,852**

NMDGF FY 2021 Budget

New Mexico Department of Game and Fish FY 2021 budget for assisting in the "Facilitated fish passage for enhancing populations of endangered fishes in the San Juan River" scope of work.

Sampling - July Trip

Tasks - Monitoring for radio tagged Razorback Sucker in the San Juan River from Bloomfield, NM to Clay Hills, UT and the Animas River in May, June, and October; 2 days of pre-flight planning (8 hrs day), 2 days of flights (12 hrs day), and 1 day post-flight clean-up (8 hrs day) = 48 hrs total (40 hrs regular and 8 hrs overtime) per flight = 144 hrs total for 3 flights

Personnel		
Project Leader (1)		
24 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$	1,146
Project Biologist (1)		
96 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))	$	3,671
24 hrs overtime @ $57.36/hr ($38.24/hr * 1.5 (time-and-a-half))	$	1,377
Monitoring Sub-total	$	6,194

FY2021 Total

Project Sub-total	$	6,194
IDC @ 23.77%	$	1,472
NMDGF Project Total	**$**	**7,666**

FY 2021 Draft Budget

Facilitated fish passage for enhancing population of endangered fishes in the San Juan River

Utah Division of Wildlife Resources

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2021 Costs for UDWR- Moab

San Juan River Razorback Sucker Translocation, Movement, and Reproduction Study

Task 1. Waterfall Translocation (2 people, 7 days, 2 trips; March)

Labor: salary + benefits + applicable overtime

	Rate	Hours		Cost
Project Leader	$38.10		10	$381
Biologist	$33.91		240	$8,138
Technician	$17.08		240	$4,099
		subtotal		**$12,618**

Food and Transport

	Rate	Quantity		Cost
Monthly fleet rental (1 truck)	$199.37		2	$399
Mileage (1 truck x 350 miles x 2 trips)	$0.40		700	$280
Food (2 people x 7 days x 2 trips)	$35.00		28	$980
		subtotal		**$1,659**

Equipment

	Rate	Quantity		Cost
Camping gear repair/replacement:				$250
Sampling gear repair/replacement:				$500
Boating gear repair/replacement:				$500
		subtotal		**$1,250**

	Task 1 Subtotal:	**$15,527**

Task 2. Reproductive Ecology of RZ- Lower Canyon (4 people, 7 days, 4 trips; March-June)

Labor: salary + benefits + applicable overtime

	Rate	Hours		Cost
Project Leader	$38.10		120	$4,572
Biologist	$33.91		580	$19,666
Technician	$17.08		1120	$19,130
		subtotal		**$43,368**

Food and Transport

	Rate	Quantity		Cost

	Rate	Quantity	Cost
Monthly fleet rental (2 trucks)	$199.37	8	$1,595
Mileage (2 truck x 350 miles x 2 trips, 100 extra)	$0.40	2800	$1,120
Food (4 people x 7 days x 4 trips)	$35.00	112	$3,920
Shuttle (2 trucks x 4 trips)	$180.00	8	$1,440
		subtotal	**$8,075**

Equipment

	Rate	Quantity	Cost
Camping gear repair/replacement:			$1,500
Sampling gear repair/replacement:			$3,000
Boating gear repair/replacement:			$2,000
		subtotal	**$6,500**
		Task 2 Subtotal:	**$57,943**

Task 6. Data Entry, Analysis, Reporting

Labor: salary + benefits + applicable overtime

	Rate	Hours	Cost
Project Leader	$38.10	60	$2,286
Biologist	$33.91	160	$5,425
Technician	$17.08	20	$342
		subtotal	**$8,053**

Total Expenses	**$81,522**
Administrative Overhead (16% on all personnel services)	**$10,246.15**
UDWR-Moab Total	**$91,768**

GJFWCO 2021 Budget

Personnel/Labor Costs (Federal Salary + Benefits)

Description		
Principal Biologist (GS-11/7) – 244 hours		
San Juan sampling - spring:		
(1 person X 3 days/trip X 4 trip – work from hotel)	$53.84	
(+ 3 hours overtime each)	$53.84	
Bio. Tech. Crew Leader (GS-6/3) - 131 hours		
San Juan sampling - spring:		
(1 person X 3 days/trip X 2 trip – work from hotel)	$27.74	
(+ 3 hours overtime each)	$41.62	
Biological Technicians (GS-5/1) – 361 hours @ $23.02/hr		
San Juan sampling - spring:		
(1 person X 3 days/trip X 2 trip – work from hotel)	$23.40	
(+ 3 hours overtime each)	$35.10	
PERSONNEL/LABOR TOTAL		$8,729.76

Permitting; Coordination; Data Input, Analysis, Management & Presentation; Report Writing; Office & Administrative Su

Administrative Officer (GS-9/8) – 24 hours		
Principal Biologist (GS-11/7) – 24 hours		
Project Leader (GS-14/6) – 16 hours		
PERMITTING, DATA INPUT, ETC		$3,644.80

Travel and Per Diem (Based on Published FY-2017 Federal Per Diem Rates)

Hotel Costs		
2 people X 3 nights X 4 trips (in Farmington, NM)	$94.00	$2,256.00
Per Diem (Hotel Rate)		
3 days X 4 people (in Farmington, NM)	$55.00	$1,320.00
TRAVEL/PER DIEM TOTAL		$3,629.64

Equipment and Supplies

Vehicle Maintenance & Gasoline (@ $365/month lease = $12.17 per day based on 30 days in an “average” month + $0.4

Vehicle Mileage

San Juan River sampling - spring:

Grand Junction to Farmington: 2 Trucks X 4 Trips	$0.43	$102.31
Sampling around Farmington: 2 Trucks X 4 Trips	$0.43	
VEHICLE LEASE		
San Juan River sampling - spring:		
Sampling around Farmington: 2 Trucks X 4 Trips	$12.35	
Generator Gasoline		
San Juan River sampling - spring: 2.5 Gallons/day	$2.51	
Vehicle Maint. & Gasoline		$1,682.16
SUBTOTAL		**$17,686.36**

Equipment Maintenance, Repair, & Replacement

Exact use of the money in this section of the budget will vary from year to year depending on what equipment needs to of these funds for a “typical” field season for one study COULD include the following:

Raft trailer maintenance	
Annual trailer maintenance & safety inspection	$788.20
Replace/repair trailer suspension, trailer lights, winch handle/straps/gears, trailer jack stand, wheel bearings	
Replace trailer tires – 2 per year @ $77 each	$154.00
Signal light pigtail adapters – 2 @ $15 each	$30.00
Generator maintenace	
Spark plugs for generators – 5 at $2.20 each	$11.00
Synthetic oil for generators - 5 quarts at $6.30 each	$31.50
Generator repair/tune-up - 9 hrs @ $70/hr = parts	$703.79
Sampling gear (needs to be regularly replaced)	
Hip boots – 2 pair at $75/pair	$150.00
Breathable chest waders - 2 pair @ $120/pair	$240.00
NRS Type IV life jackets – 2 @ $130 each	$260.00
Electrical Gloves - 3 pairs @ $75/pair	$225.00
Dura-Frame electrofishing dip nets – 1 @ $630 each + freight	$630.00
Raft frame &/or boat hull repair	
Aluminum welding – 7 hours @ $95/hr	$665.00
Raft repair kits	
Raft glue (urethane/hypalon) – Four 4-oz. cans @ $24.95/can	$100.00
NRS raft patch material – 5 feet @ $37/ft	$185.00
Toluene – 1 qt @ $17.95/qt	$18.00

Equipment tie-downs - NRS HD-brand tie-down straps, each boat needs:	
Ten 2-ft straps - 10 @ $4.20 each	$42.00
Five 3-ft straps - 5 @ $4.30 each	$21.50
Ten 4-ft straps - 10 @ $4.70 each	$47.00
Five 6-ft straps 5 @ $5.05 each	$25.25
Five 9-ft straps 5 @ $5.70 each	$28.50
Five 12-ft straps 5 @ $6.15 each	$30.75
Raft rigging materials, each boat needs:	
D-style carabiners - 10 @ $8.25 each	$82.50
Mesh rig bag – 1 @ $50 each	$50.00
Yeti 125-quart coolers – 1 @ $500 each	$550.00
5-gallon plastic gasoline jerry cans – 5 @ $40 each	$200.00
20 lb. propane tanks – 1 @ $55 each	$55.00
Eddy Out Aluminum Dry Box (36L x 16H x 16D) - 1 at $375.00	$375.00
Cans for 1st aid & tool kits, raft repair kits, etc. - 20 @ $19 ea.	$380.00
Rafting oars, oar blades, and oar rowing sleeves	
Carlisle 10-foot oar shafts – 2 @ $100 each	$200.00
Carlisle Oars blades – 4 @ $65 each	$260.00
Oar sleeves – 4 @ $18 each	$72.00
Camping Gear	
NRS Canyon Dry Box (kitchen cook kit storage) - 1 at $165.00	$165.00
NRS campsite counter (18"W X 68" L X 40" H) - 1 at $299.95	$299.95
Roll-A-Table (32" X 32" table, 27" legs) - 2 at $99.95 each	$199.90
2-man tent (1/person), ~ 1 year life-span - 6 at $99.99 each	$599.94
Partner Steel 16" 4-burner camp stove - 1 at $359.00	$359.00
River bags	
NRS 3.8 heavy-duty Bill's Bag 110L – 1 @ $160 each	$160.00
NRS Tuff Sacks 25L - 5 @ $ 35 each	$175.00
Pesola brand spring scales	
# 20010 Micro-Line 10 gram – 1 @ $68.75	$68.75
# 20030 Micro-Line 30 gram – 1 $61.60	$61.60
# 20100 Micro-Line 100 gram – 1 @ $61.60	$61.60
# 40300 Medio-Line 300 gram – 1 @ $73.15	$73.15
# 40600 Medio-Line 600 gram – 1 @ $73.15	$73.15
# 42500 Medio-Line 2,500 gram – 1 @ $71.45	$71.45
# 41002 Medio-Line 1,000 gram – 1 @ $73.15	$73.15

# 80005 Macro-Line 5 kg – 1 @ $150.15	$150.15
# 80010 Macro-Line 10 kg – 1 @ $155.65	$155.65
NRS E-160 Self-Bailing Raft - 1 at $6,125.00	

Equipment Maintenance, Repair, & Replacement Subtotal

Requested 2020 Equipment	
6% of costs of above subtotal	**$1,061.18**

Other potential uses for these same funds include replacing hand tools (ratchet and sockets, screw drivers, vise grips, pliers, Allen wrenches, crescent wrenches, hammer, etc.), WD-40, bailing wire, duct tape, electrical supplies (12 and 14 gage wire for the boats, junction boxes, extra male & female plugs, wire nuts, fuses, Ohm meter, electrical tape), batteries (C, AA and AAA), lanterns, lantern mantles, small "pony" propane bottles for lanterns, Gott 5-gallon water jugs, shovels, 5-gallon buckets, cargo nets, fix chips or cracks in vehicle windshields, bulbs, lenses, and wiring to fix trailer lights and pigtails, new electrofishing spheres, wire rope for replacing stainless steel electrofishing cathodes, camping kitchen gear (anodized dutch ovens X 2, plates, cups, bowls silverware, pots, pans, griddle), data books, pre-printed Rite-In-The-Rain data sheets, pencils, repair/replace river maps, etc.

SUMMARY OF PROPOSED COSTS

Name of Servicing Agency:	U.S. Fish & Wildlife Service - Southwestern Native Aquatic Resources and Recovery Center
Project Name:	Estimating reproductive contribution of traslocated Razorback Sucker (Xyrauchen texanus) in the San Juan River 2020

		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL
Enter the BEGINNING dates for each year ------>		2019-10-01		2020-10-01								
		Through		Through		Through		Through		Through		
Enter the ENDING dates for each year ------->		2020-09-30		2021-09-30								
DIRECT LABOR AND FRINGE BENEFIT COSTS:		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL
Direct Labor - Hourly		$ 14,884.81		$ 15,479.46		$ -		$ -		$ -		$ 30,364.27
Fringe Benefits - Hourly		$ 9,640.41		$ 9,785.02		$ -		$ -		$ -		$ 19,425.43
Subtotal of Direct Labor & Fringe Benefits:		**$ 24,525.22**		**$ 25,264.48**		**$ -**		**$ -**		**$ -**		**$ 49,789.70**
OTHER DIRECT COSTS:		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL
Materials and Supplies		$ 31,269.95		$ 31,999.52		$ -		$ -		$ -		$ 63,269.47
Travel Costs		$ -		$ -		$ -		$ -		$ -		$ -
Equipment		$ -		$ -		$ -		$ -		$ -		$ -
Contractors		$ -		$ -		$ -		$ -		$ -		$ -
Subtotal of Other Direct Costs:		**$ 31,269.95**		**$ 31,999.52**		**$ -**		**$ -**		**$ -**		**$ 63,269.47**
INDIRECT/OVERHEAD COSTS:		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL
Subtotal of Labor and Other Direct Costs:		**$ 55,795.17**		**$ 57,264.00**		**$ -**		**$ -**		**$ -**		
Total dollars exempt from indirect/overhead base:		$ -		$ -		$ -		$ -		$ -		
Reduced USFWS Indirect Cost Recovery Rate	3.00%	$ 1,673.86	3.00%	$ 1,717.92	3.00%	$ -	3.00%	$ -	3.00%	$ -		$ 3,391.78
Total dollars exempt from indirect/overhead base:		$ -		$ -		$ -		$ -		$ -		
<Enter Description of Indirect/OH Cost #2>		$ -	0.00%	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ -		$ -
Subtotal of Indirect/Overhead Costs:		**$ 1,673.86**		**$ 1,717.92**		**$ -**		**$ -**		**$ -**		**$ 3,391.78**
		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		TOTAL
GRAND TOTAL:		**$ 57,469.03**		**$ 58,981.92**		**$ -**		**$ -**		**$ -**		**$ 116,450.95**

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