FISCAL YEAR 2021
BUDGET AND
STATEMENTS OF *WORK*

Final Approved by the

Coordination Committee

27 July 2020

SJRRIP FY2021 AWP Budget Actual

SOW	Title	Agency	2021 Annual Funds	BOR Capital/NFWF Funding	Partner In-Kind Funding	FCPP Funded Projects	2021 Grand Totals
	Element 1 - Management and Augmentation of Populations and Protection of Genetic Integrity						
7	Horsethief Canyon Ponds O&M at Ouray NFH	GJFWCO				$39,037	**$39,037**
8	Stocking & Acclimation of Age-0 CPM & Age-1+ RBS	NMFWCO	$42,568				**$42,568**
9	Colorado Pikeminnow Fingerling Production (combined with 10)	SNARRC	$118,318				**$118,318**
10	Rearing Razorback Suckers (combined with 9)	SNARRC	$94,426				**$94,426**
11	RBS Augmentation/NAPI Pond Management	NN	$144,260				**$144,260**
12	SJRIP PIT Tags (purchase)	BR	$40,000				**$40,000**
43	Stocking Razorback Sucker in Lake Powell	GJFWCO	$18,076				**$18,076**
45	Colorado Pikeminnow broodstock collection from the Green and Colorado Rivers, Utah	UDWR, ASIR	$52,558				**$52,558**
	Subtotal		**$510,206**	**$0**	**$0**	**$39,037**	**$549,243**
	Element 2 - Protection, Management, and Augmentation of Habitat						
13	Maintenance and Operation of SJR Hydrology Model	BR-SLC	$70,480				**$70,480**
14	Stream Gaging and Flow Measurements	BR	$9,270				**$9,270**
15	Operation of PNM Fish Passage Structure	NN	$137,250				**$137,250**
16	San Juan and Animas Rivers Temp Gauges	BR	$24,000				**$24,000**
C-1	Capital Projects Management	BR		$50,000			**$50,000**
C-2	Repair of Capital Projects (e.g., fish passage, fish weir)	BR	$50,000				**$50,000**
	Subtotal		**$291,000**	**$50,000**	**$0**	**$0**	**$341,000**
	Element 3 - Management of Non-Native Aquatic Species						
17	SJR Nonnative Species Monitoring and Control	NMFWCO				$87,830	**$87,830**
	Subtotal		**$0**	**$0**	**$0**	**$87,830**	**$87,830**
	Element 4 - Monitoring and Evaluation of Fish and Habitat in Support of Recovery Actions						
18	UCR and SJR Centralized PIT tag database	CSU-CNHP	$10,000				**$10,000**
19a	Demographic Monitoring for CPM and RBS	GJFWCO, NMFWCO, UDWR	$239,516				**$239,516**
19b	Spring Age-1 Razorback Sucker Study[1]	GJFWCO	$0				**$0**
20	YOY/Small-Bodied Fish Monitoring	NMDGF	$94,383				**$94,383**
21	RBS/CPM Larval Surveys (Combined SOW)	ASIR	$274,507				**$274,507**
21a	RBS/CPM Larval Surveys - Upstream Expansion of Study Area	ASIR	$22,249				**$22,249**
22	Specimen Curation/Identification	UNM	$46,171				**$46,171**

SJRRIP FY2021 AWP Budget Actual

SOW	Title	Agency	2021 Annual Funds	BOR Capital/NFWF Funding	Partner In-Kind Funding	FCPP Funded Projects	2021 Grand Totals
25	Habitat Assessment	ERI	$138,408				**$138,408**
1	Backwater productivity assessment (3 of 3-yr project)	Pitt State	$18,420				**$18,420**
2	Nb and genetic diversity	SNARRC	$40,691				**$40,691**
32	PIT Tag Antennas O&M & Evaluation of Data	BR, FWS	$24,400				**$24,400**
32b	PIT Tag Antenna Install[2]	UDWR, BioMark	$14,893	$81,127			**$96,020**
41	Facilitated fish passage in San Juan River (2 of 2-yr project)	KSU, NMDGF, SNARRC, UDWR, GJFWCO	$303,578				**$303,578**
42	Enhancing channel complexity and low-velocity habitat (2 of 2-yr project)	NN, NMDGF, NMFWCO	$96,125				**$96,125**
44	Physical and biological monitoring and evaluation of Phase III habitat restoration	FWS-ABQ, ASIR, NN, NMFWCO	$19,516				**$19,516**
	Subtotal		**$1,342,857**	**$81,127**	**$0**	**$0**	**$1,423,984**
	Element 5 - Program Coordination and Assessment of Progress Toward Recovery						
35	Base Funds and Contract Management BOR	BR, SLC	$223,255				**$223,255**
36	Peer Review	BR, FWS	$30,000				**$30,000**
37	Program Management FWS	FWS, ABQ	$336,037		$193,295		**$529,332**
38	Remote Biologist	NMFWCO	$98,417				**$98,417**
FCPP	SJRRIP Biologist (FCPP/NMEP)	FWS	$0			$126,000	**$126,000**
	Subtotal		**$687,709**	**$0**	**$193,295**	**$126,000**	**$1,007,004**
	Element 6 - Information and Education						
39	Education and Outreach (funds transfer to UCRRIP)	FWS, ABQ	$27,375				**$27,375**
	Subtotal		**$27,375**	**$0**	**$0**	**$0**	**$27,375**
	SJRRIP Total		**$2,859,148**	**$131,127**	**$193,295**	**$252,867**	**$3,436,437**
	FY21 BOR Appropriations Requested Amount (Base-$2.88M)		**$2,880,000**				
	FY21 Proposed AWP Request		**$2,859,148**				
			$20,852				
	Notes						
	1-indicates capital expenses covered with FY20 Funds						

Habitat Characteristics and Resource Availability in Secondary Channel and Mainstem Backwaters of the San Juan River: Implications for Environmental Flows Management and Imperiled Fish Conservation

21 July 2020

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Background

Backwaters are the preferred habitat of early life stage (i.e., larvae and juvenile) Razorback Suckers (*Xyrauchen texanus*) (Minckley et al. 1991; Mueller 2006). For example, in the San Juan River larvae were captured at higher densities in backwaters when compared to other mainstem habitats such as low velocity runs (Farrington et al. 2016). Furthermore, the only juvenile Razorback Sucker captured from the San Juan River in the last 18 years during small-bodied fish monitoring was from a large backwater in fall 2015 (Zeigler and Ruhl 2016). Backwaters are important habitat for early life stages of other imperiled fishes as well. Of the juvenile Colorado Pikeminnow (*Ptychocheilus lucius*) captured in 2016, approximately 48% were captured in large backwaters compared to 17% captured in the main channel and 35% in secondary channels (Zeigler and Ruhl 2016). The importance of backwater habitat to early life stages of imperiled fishes has made the restoration of this habitat an important management goal throughout the Colorado River Basin (CRB) (USFWS 2002a; USFWS 2002b). As in other parts of the CRB, backwater formation in the San Juan River has been reduced by flow regulation and concomitant geomorphic changes in the river channel (Holden 1999).

Razorback Sucker can spawn successfully in the San Juan River, as larvae are present in the river and its backwaters during April through June (Farrington et al. 2016). However, these young-of-year (YOY) fishes (i.e., both larvae and juvenile age-0 fishes) are largely absent from the river by August, suggesting some environmental factor or factors are limiting recruitment to the juvenile stage of the population (i.e., a recruitment bottleneck) (Farrington et al. 2016). Several hypotheses may explain this impediment to recovery, including a lack of backwater nursery habitat for development, inadequate physicochemical conditions in backwaters, starvation, and/or predation in backwaters. Identifying the environmental factor(s) responsible for the recruitment bottleneck of Razorback Suckers has important management implications, because once the source of a roadblock is identified, actions can be taken to alleviate that problem.

Although backwaters are important habitat for the early life stages of imperiled fish, there is a high degree of variability among backwaters in terms of habitat characteristics. For instance, Bliesner and Lamarra (2000) demonstrated that geomorphological characteristics and resource availability varied in backwaters along the longitudinal gradient (i.e., upstream to downstream) of the San Juan River. Backwaters positioned more upstream tended to have the highest resource

availability, although their upstream location resulted in higher gradient and water velocity in the adjacent mainstem, which presumably prevented larvae from settling in these backwaters (Bliesner and Lamarra 2000). Although Bliesner and Lamarra (2000) examined longitudinal and temporal changes in backwaters generally, they did not investigate differences among different types of backwaters. Long-term habitat mapping in the San Juan River has identified three types of backwaters, including: 1) backwaters associated with secondary channels, 2) island backwaters, and 3) point bar backwaters (Fig. 1; Lamarra et al. In prep). Secondary channels are narrower and receive less flow than the main channel, and when they stop flowing, form secondary channel backwaters that are connected to the main channel at their downstream end, but are disconnected at their upstream end (Fig. 1A; Landers et al. 2002; Yager et al. 2013). Island backwaters are zero-velocity habitats that form in off-channel habitats between an island and the river bank, or at the downstream end of an island (Fig. 1B). Point bars are formed by alluvial deposits on the inside bend of a river (Legleiter et al. 2011). When zero-velocity habitats form on the downstream end of a point bar, a backwater is formed (Fig. 1C). Island and point bar backwaters exhibit high connectivity with the main river channel, whereas secondary channel backwaters are less connected to the main channel (Lamarra et al. In prep). Furthermore, backwaters associated with secondary channels increase in size with increasing base flows, but total backwater area does not change since there is an associated reduction in island and point bar backwaters (from hereon, main channel backwaters) as base flow increases (Lamarra et al. In prep). Thus, changes in base flow result in variation in the size, stability, and type of backwater, meaning the amount and type of backwater habitat in the San Juan River is dependent on flow regulation (Lamarra et al. In prep).

It is currently unclear whether early life stages of imperiled fish exhibit a preference for secondary channel over mainstem backwaters. For instance, age-0 fish may prefer secondary channel backwaters because they function as refugia from flow fluctuations because of their lower connectivity to the mainstem. As such, secondary channel backwaters are less prone to scouring events during the monsoon season in July through September (Adams and Comrie 1997), a time period when nearly all age-0 Razorback Sucker disappear from the river. High-velocity monsoonal flows in main channel backwaters could displace imperiled YOY fish to the main channel where they would experience higher mortality (Robinson et al. 1998; Valdez et al. 2001; Gido and Propst 2012). Further, mainstem backwaters that experience a greater frequency of silt-laden monsoonal flows may have higher turbidity, total suspended solids, and siltation compared to secondary channel backwaters (Bliesner and Lamarra 2000; Heins et al. 2004). High turbidity may hinder YOY feeding because of poorer water clarity (De Robertis et al. 2003; Manning et al. 2014), plus high suspended sediment loads can clog and damage gills, thus interfering with respiration (Sutherland and Meyer 2007; Clark Barkalow and Bonar 2015). In fact, larval Razorback Sucker exhibit a preference for clear water over turbid water (Johnson and Hines 1999). However, nonnative predators feed more effectively on age-0 Razorback Sucker in clear water compared to turbid water, thus, higher turbidity may also benefit YOY fish by reducing predation (Johnson and Hines 1999).

More-frequent and higher magnitude monsoonal flows in mainstem backwaters compared to secondary channel backwaters may cause lower resource availability, which could influence the recruitment success of imperiled fishes (Papoulias and Minckley 1990; Bestgen 1996). For instance, monsoonal floods could scour the substrate and water column of benthic and pelagic invertebrates, respectively, more often in main channel compared to secondary channel backwaters (Speas 2000). Benthic (e.g., chironomids) and pelagic (e.g., cladocerans and copepods) macroinvertebrates are the most frequently occurring prey items in the diets of YOY Razorback Sucker (C. Pennock unpublished data), leaving them potentially more prone to starvation in main channel backwaters. Furthermore, differences among backwaters in water clarity and substrate size may limit basal productivity in main channel versus secondary channel backwaters. More stable secondary channel backwaters would exhibit lower turbidity that allows for greater light penetration that could stimulate photosynthesis of phytoplankton and periphyton, and may also have greater substrate size (e.g., pebble and cobble rather than silt and sand) that provides a stable attachment surface for periphyton (Burkholder 1996; Hillebrand 2002). In turn, greater algal productivity in secondary channel backwaters may exert bottom-up control on the availability of benthic and pelagic macroinvertebrates, as algal productivity is a primary factor influencing invertebrate secondary production (Wotton 1988; Whitney et al. 2014).

Secondary channel backwaters are located nearer the riparian zone and channel margin of the San Juan River, and as such they may receive greater shading from canopy cover and canyon walls. More shading may result in more benign physicochemical conditions in secondary channel backwaters compared to main channel backwaters that receive more direct sunlight. For instance, direct solar radiation in main channel backwaters could cause water temperatures to exceed the upper thermal limit of imperiled age-0 fishes, resulting in hyperthermia, heat stress, and heat-induced mortality (Sweeney 1993; Smale and Rabeni 1995; Poole and Berman 2001; Kappenman et al. 2010; Deslauriers et al. 2016). Further, higher water temperatures may result in hypoxia and anoxia that could suffocate fish (Carlson and Siefert 1974; Fontenot et al. 2001), since the solubility of oxygen decreases as water temperatures increase. Both hyperthermia and hypoxia could results in greater YOY mortality in main channel compared to secondary channel backwaters.

Water temperature may interact with basal resource availability to influence YOY recruitment success. Warmer water temperatures result in greater fish metabolic rates (Fry 1947), meaning fish need more food at warmer temperatures relative to cooler temperatures (Houde 1989). Fish can also attain higher growth rates at warmer temperatures (Houde 1989), but only if enough food is available to sustain their growth (Bestgen 2008). As such, fish in warm water with high rates of resource productivity may exhibit extremely high growth rates, but fishes in warm water with lower productivity may be more prone to starvation (Houde 1989). Investigating resource availability and its relationship with backwater type may inform conservation. For instance, if it is found that low resource availability from frequent monsoonal flooding coupled with high temperatures from direct sunlight occur in main channel backwaters, this unsuitable age-0 habitat could be reduced by increasing base flows (Lamarra et al. In prep). Higher base flows creates

more secondary channel backwaters (Lamarra et al. In prep), which may have greater resource availability because of infrequent flooding and cooler temperatures from riparian and canopy shading.

Predation pressure is a final explanation for the variation in recruitment and abundance of YOY Razorback Suckers among backwaters. For instance, several small-bodied nonnative fishes occur in backwater habitat and can prey heavily on native age-0 fishes, including Red Shiner (*Cyprinella lutrensis*), Fathead Minnow (*Pimephales promelas*), and Western Mosquitofish (*Gambusia affinis*) (Tyus and Haines 1991; Ruppert et al. 1993; Brandenburg and Gido 1999; Tyus and Saunders 2000). In fact, Bestgen et al. (2006) concluded that predation by Red Shiners interacting with environmental factors limited the recruitment success of Colorado Pikeminnow in the Green River. These small-bodied nonnative predators are abundant in secondary channel backwaters in the San Juan River, although their densities decreased in between 1999 and 2012 (Franssen et al. 2015).

A lack of large, stable, zero-velocity nursery habitat without large-bodied nonnative predators is one explanation for the recruitment bottleneck of Razorback Suckers in the San Juan River. However, even if this ideal nursery habitat were present in the San Juan River, it is currently unclear whether Razorback Sucker larvae could successfully recruit from the larval to juvenile stage. To test this hypothesis, the Phase III Habitat Restoration Project is proposed to be implemented in 2019 to create more quality nursery habitat via the construction of a ~1 hectare artificial wetland near river mile (RM) 107 (Gori et al. 2018). The Phase III project also aims to measure physicochemical conditions and larval predation pressure (i.e., via small-bodied fish monitoring) in the constructed wetland, but does not plan to measure resource availability. If benthic and/or pelagic algae and macroinvertebrates are scarce in the artificial wetland relative to demand, this lack of food for imperiled larval fishes could hinder the success of this project. Monitoring is needed to assess resource availability in the Phase III wetland.

We have provided several explanations for why secondary channel backwaters may be superior habitat for imperiled YOY fishes relative to main channel backwaters, although high abundances of nonnatives in secondary channel backwaters could reduce their quality. However, it is currently unknown whether stability, habitat quality, resource availability, and/or predation pressure actually differ between backwater types. As such, differences between secondary channel and mainstem backwaters are in need of investigation before environmental flows management can be implemented, as it would be ineffective to increase the area of secondary channel backwaters via elevated base flows if this is not better habitat than main channel backwaters (Lamarra et al. In prep). If secondary channel backwaters do indeed exhibit greater habitat quality and resource availability for imperiled fishes, then environmental flows management (Tharme 2003; Propst and Gido 2004) could be used to increase the coverage of this habitat because of the positive relationship between base flows and amount of secondary channel backwaters (Lamarra et al. In prep).

Objectives and Hypotheses

The objective of the proposed work is to compare stability, physicochemical characteristics, resource availability, and small-bodied predator density between secondary channel and main channel backwaters (i.e., island and point bar) in the San Juan River. To accomplish this objective we will test five hypotheses and their associated predictions (Fig. 2).

Hypothesis and Prediction #1: Stability differs between secondary channel and mainstem backwaters because secondary channel backwaters exhibit lower connectivity with the San Juan River mainstem; secondary channel backwaters will exhibit greater stability compared to main channel backwaters because they experience less frequent, lower magnitude, and shorter duration monsoonal flows.

Hypothesis and Prediction #2: Shading differs between secondary channel and mainstem backwaters because secondary channel backwaters are located nearer the margin of the San Juan River mainstem; secondary channel backwaters will exhibit greater shading compared to main channel backwaters because of greater canopy cover and canyon wall influence.

Hypothesis and Prediction #3: Physicochemical characteristics differ between secondary channel and mainstem backwaters because of differences in stability and shading; secondary channel backwaters will have lower turbidity, larger substrate, cooler water temperatures, and higher dissolved oxygen concentrations because of greater stability and shading.

Hypothesis and Prediction #4: Resource availability differs between secondary channel and mainstem backwaters because of differences in stability and shading; secondary channel backwaters will have greater algal and macroinvertebrate biomass because of greater stability. Also, we will test for differences in resource availability among the Phase III artificial wetland, secondary channel, and mainstem backwaters as part of this hypothesis.

Hypothesis and Prediction #5: The density of small-bodied nonnative predators differs between secondary channel and mainstem backwaters; secondary channel backwaters will have more nonnative predators (Franssen et al. 2015).

Study Area, Site Selection, and Sampling Regime

This study will be conducted in backwaters of the San Juan River located between RM 149 (Shiprock, NM) and RM 93 (Montezuma Creek, UT) (Fig. 3). This stretch of river was chosen because it contains a high density of secondary channel backwaters (Lamarra et al. In Prep). Within this 56-mile stretch we will attempt to sample 10 secondary channel and mainstem backwaters per sample trip (20 total backwaters per sample trip). Potential backwater sites will be scouted using recent habitat maps and surveys in April-May. Furthermore, we will add an initial float trip to scout for potential study sites at the beginning of the field season. During early July before sampling for this project starts, we will float our sample reach to visit every backwater habitat. Every backwater visited will be categorized as secondary channel or mainstem (island and point bar) and will then have its surface area and depth (both mean and maximum) measured. Following this initial scouting trip, the 10 largest secondary channel and

mainstem backwaters (20 total) will be selected as sample sites during a study year. The largest backwaters will be selected since they will likely be more permanent and have a lower probability of drying up over the course of the field season. We will also sample resource availability (i.e., Hypothesis #4) in the Phase III artificial wetland at RM 107, in addition to all of the other study backwaters. Ten backwaters per category per sample trip (i.e., 20 total) was chosen because Lamarra et al. (In Prep) indicated that this is a realistic estimate of the total number of available backwaters in our study reach during late spring, summer, and early fall. However, given the dynamic and ephemeral nature of backwaters and their dependence on flow in the mainstem (Bliesner and Lamarra 2000; Lamarra et al. In Prep), the total number of backwaters sampled per trip may differ from 10 per category. Also, the variable nature of backwaters may result in some backwaters being sampled only once while others get sampled repeatedly. This will be an issue for the testing of Hypothesis #1 since it relies on deployed data loggers (see below), but will not be an issue in testing Hypotheses #2 - #5. So long as we have replication of each backwater type regardless of the identity of any individual backwater, our study design will allow us to test Hypotheses #2 - #5. Sampling will commence when discharge of the San Juan River falls below ~1,500 cubic feet per second (cfs), as most secondary channel backwaters will likely be flowing when discharge is greater than this. As such, sampling will typically start around July 15th, but may be earlier or later depending on flow conditions. Sample trips will then be conducted every 14 days until the end of September, resulting in ~6 sample trips per year in 2019 and 2020. If flows become elevated above 1,500 cfs during our sample period because of monsoonal rainfall or otherwise, a sample trip will be delayed until flows drop back below 1,500 cfs threshold. During each sampling trip we will raft from backwater to backwater collecting data as described below. Each sample trip will take ~5 days to complete.

The length and area of sample sites will depend upon backwater size. A general recommendation in stream sampling is to survey a reach length equal to 40 times the average width to provide a representative sample, with a maximum length of 300 m for a sample reach (Klemm and Lazorchak 1994; Lazorchak et al. 1998). We will follow these guidelines when sampling San Juan River backwaters. In a database containing information on 332 secondary channel and 2,057 main channel backwaters (2,389 total) in the San Juan River, the mean length and width of secondary channel backwaters was 240 m (median = 169 m; range = 13 – 1,442 m) and 3.2 m (2.72 m; 0.22 – 10.10 m), respectively, while that of main channel backwaters was 58 m (29 m; 1 – 1,161 m) and 1.3 m (0.92 m; 0.10 – 8.03 m), respectively (N. Franssen; unpublished data). Therefore, since most of the backwaters in the San Juan River are of a smaller size, our size criteria will result in a large proportion of total backwater area being sampled for most backwaters, allowing us to accurately characterize backwater conditions.

Materials and Methods

Hypotheses #1: Backwater Type and Stability

In each backwater a HOBO MX2001 data logger (Onset Company, Bourne MA) will be deployed in the deepest part of the backwater excluding the mouth, with the deepest point determined via an initial depth survey. The logger will be set to record water level every 30

minutes. To reduce the influence of the mainstem, the logger will be deployed some distance from the backwater mouth, with that distance dictated by backwater length. The logger will be housed in a PVC casing and will be attached to a t-post to lessen the chance that it will be displaced during high flows. When possible, data loggers will be placed in inconspicuous locations to decrease the probability of being noticed and potentially vandalized, although depth will be the primary determinant of logger placement. Additionally, we will measure the frequency and duration of flow from the mainstem into backwaters using electrical resistance sensors (Jaeger and Olden 2012). Based on the change in relative conductivity, these sensors (i.e., customized Onset TidbiT Temperature Data loggers) can determine whether the logger is dry (low relative conductivity) versus submersed by water (high relative conductivity) where the sensor is deployed in the substrate (Blasch et al. 2002; Goulsbra et al. 2009). We will deploy a sensor such that it will be able to detect when water is flowing from the mainstem into the backwater. For secondary channels this location will be near the upstream head of the backwater, and in mainstem backwaters the sensor will be located in the backwater mouth. Sensors will be placed in the lowest elevation point in-between the main channel and the backwater (determined visually) to ensure a flow connection is recorded when present. Electrical resistance sensors will be housed in a PVC casing and will be attached to a t-post to prevent them from being displaced during high flows. When possible, resistance sensors will be placed in inconspicuous locations to decrease the probability of being noticed and potentially vandalized. Data from water level loggers and resistance sensors will be downloaded every sample trip. From the continuous measurements collected by electrical resistance sensors we can calculate the frequency and duration of flow into backwaters, and with the water level loggers we can calculate the magnitude and variability (using coefficient of variation) of flow events from changes in water level. Finally, we will also deploy an electrical resistance sensor by the water level logger in the deepest part of a backwater located some distance from the backwater mouth (depending on backwater length) to assess whether or not a backwater dries completely in-between sampling events.

Hypotheses #2 and #3: Shading and Physicochemical Variables

Several habitat variables will be quantified along equally-spaced transects in a backwater. The distance between transects will equal 10% of backwater length (i.e., in a 300 m backwater, transects will occur every 30 m), and as such will result in 10 transects per backwater (Klemm and Lazorchak 1994; Lazorchak et al. 1998). To limit the influence of the mainstem on habitat measurements, transects will not be positioned in the mouth of the backwater where it connects to the mainstem (if applicable). Shading resulting from canopy cover and canyon walls will be quantified at each transect midpoint in a backwater using a spherical concave densiometer, providing an estimate of percent canopy coverage. The wetted surface area (m^2) of a backwater will be calculated by multiplying backwater length (m) by the mean wetted width (m) of a backwater measured at each transect. Also, along each transect five measurements of depth (measured with a Hach topset wading rod) and substrate (e.g., clay, silt, sand, gravel, pebble, cobble, boulder, and bedrock) will be taken. The five locations per transect will be at river right (#1), then 25% (#2), 50% (i.e., transect midpoint; #3), and 75% (#4) of the distance from river

right to river left, and then finally at river left (#5) (Klemm and Lazorchak 1994; Lazorchak et al. 1998). The substrate at a transect location will be determined with visual and tactile examination. If there is a mixture of substrates at a location, the location will be assigned the category of whichever substrate is dominant. These measurements will generate an estimate of mean depth, maximum depth, and percent coverage of fine (clay + silt + sand) and coarse substrates (gravel + pebble + cobble + boulder + bedrock) for each backwater. Mean backwater depth (m) will also be multiplied by backwater surface area (m^2) to calculate backwater volume (m^3). Water temperature in a backwater will be measured every two hours using the HOBO MX2001 data logger, which records temperature in addition to water level. Backwater turbidity in nephalometric turbidity units (NTUs) will be measured using an Aquaflor handheld fluorometer (Turner Designs, San Jose, CA), and dissolved oxygen (mg/l and % saturation) will be measured using an Extech heavy duty dissolved oxygen meter (FLIR Commercial Systems, Nashua, NH).

Hypothesis #4: Resource Availability

Algal biomass will be measured by quantifying pelagic and benthic chlorophyll *a* concentrations. Phytoplankton concentrations will be measured by taking a 500 ml water sample from each backwater. The water sample will be collected at approximately 8 cm depth in the water column at multiple backwater locations until a 500 ml Nalgene collection jar is filled, thus providing a representative sample. The water sample will then be filtered through a Whatman glass microfibre filter (grade GF/C), with chlorophyll *a* then extracted from the filter by submersing it in 95% ethanol for 12 hours. Chlorophyll *a* concentration (µg/L) will then be measured using an Aquaflor handheld fluorometer followed by correction for sample volume (Wetzel and Likens 2000; Rice et al. 2017). In fine substrates (i.e., silt and sand) benthic chlorophyll *a* samples will be collected using a core sampler (3.2 cm inside diameter), and in coarse substrates (i.e., gravel, pebble, and cobble) whole rocks will be collected. Benthic samples will be collected from six habitat transects per backwater (approximately every other transect); three replicates will be collected along each transect near river right, river left, and the transect midpoint, with either whole rocks or core samples pooled into the same transect Whirl-Pak. The composition of the pooled transect sample (e.g., transect #1 = 2 cores + 1 whole rock; transect #3 = 3 whole rocks) will be recorded in the field notebook. Samples will be kept in the dark in a cooler with dry ice, and then transported back to the lab where they can be frozen. 95% ethanol will be used to extract chlorophyll *a* from benthic samples for 12 hours, with chlorophyll *a* concentration ($\mu g/cm^2$) determined with a fluorometer followed by correction for sample surface area (core size or rock size) (Sartory and Grobbelaar 1984; Steinman et al. 2017). This sampling will be performed in backwaters and in the Phase III artificial pond.

The availability of larval prey will be estimated by collecting benthic and pelagic backwater macroinvertebrates. Benthic macroinvertebrates residing in fine-textured benthic substrate (i.e., clay, silt and sand) will be sampled using an Eckman grab, whereas benthic macroinvertebrates residing coarser substrates (i.e., gravel, pebble, cobble, and boulder) will be sampled by scrubbing whole rocks in a bucket (Hauer and Resh 2017). If large woody debris (LWD) is present in a backwater transect, it will be sampled by enclosing a subsection of LWD

and then removing macroinvertebrates from it (Whitney et al. 2014; Whitney et al. 2015). Benthic macroinvertebrate samples will be taken from six habitat transects per backwater (approximately every other transect); three replicates will be collected along each transect near river right, river left, and the transect midpoint, with whole rocks, core samples, and LWD samples pooled into the same transect bucket, which will then be sieved and stored in 10% formalin in a Whirl-Pak. The composition of the pooled transect sample (e.g., transect #1 = 2 cores + 1 whole rock; transect #3 = 2 whole rocks + 1 LWD) will be recorded in the field notebook. Pelagic macroinvertebrates (e.g., Copepods and Cladocerans) will be sampled using a Wisconsin plankton sampler equipped with a mechanical flow meter that will measure the volume of water sampled (De Bernardi 1984), with three pelagic macroinvertebrate samples collected per backwater per sample date. Macroinvertebrates will then be identified, enumerated, and measured for total length in the laboratory under a dissecting microscope. Published length-mass relationships (Burgherr and Meyer 1997; Benke et al. 1999; Sabo et al. 2002) will then be used to estimate biomass in grams of dry mass (DM) for each macroinvertebrate taxon, then biomass of macroinvertebrate taxa will be summed separately for benthic and pelagic samples to provide estimates of benthic and pelagic resource availability. This sampling will be performed in backwaters and in the Phase III artificial pond.

Hypothesis #5: Small-Bodied Nonnative Predators

The abundance of potential predators in each backwater will be assessed using a combination of backpack electrofishing with 1-2 dipnetters (Smith-Root LR-20B backpack electrofisher) and seining (4.6m wide X 1.8 m tall; 3.2 mm mesh). To prevent escape of fishes from our sample reach, we will use blocknets to separate our sample reach from the mainstem if necessary, and in longer backwaters, from the section of the backwater not sampled. All potential larval predators will be identified to species, measured for total length, and then returned to the backwater from whence they came. Any native fishes captured by this sampling will also be identified, measured, and released. The density of backwater larval predators for each species and in total will be calculated by dividing the number of individuals caught by backwater area sampled (m^2), giving an estimate in $\#/m^2$.

Our ability to capture fishes may vary among backwaters because of differences in habitat characteristics related to depth, turbidity, and substrate size (Tyre et al. 2003; Gu and Swihart 2004; Falke et al. 2010). As such, differences in sampling efficiency among backwaters could result in different fish density estimates among backwaters independent of the effect of backwater environmental characteristics on fish presence and abundance. To account for differences in sampling efficiency among backwaters, we will perform depletion sampling during one sample trip per month (i.e., every other trip). Depletion sampling will involve sampling each backwater site with multiple repeated passes; after each pass all captured fishes will be retained and won't be released until all passes have been completed. This design will allow for the calculation of absolute population size ($\widehat{N}$), catchability (q; Hayes et al. 2007) and detection probability (p; MacKenzie et al. 2002), which can then be modeled according to habitat characteristics (e.g., depth, turbidity, substrate size). If capture efficiency is found to vary among

backwaters, we will use our catchability and detection probabilities to correct our fish density estimates, thus making estimates comparable among backwaters.

Data Analysis

Our interrelated hypotheses operate through several intermediary pathways of cause and effect relationships, and contain multiple predictor and response variables (Fig. 2). As such, covariance structure analysis, otherwise known as structural equations modeling, is conducive to statistically testing our hypotheses (Bollen 1989; Shipley 2000; Infante and Allan 2010). Covariate structure analysis (CSA) is a multivariate technique that allows for the modeling of relationships among sets of direct and indirect predictors and response variables. This technique is similar to multiple regression analysis or canonical ordination, but differs in the fact that it accounts for interrelatedness of predictor variables and indirect effects. In order to model relationships, a priori hypotheses describing the structure among variables and direct and indirect effects must first be completed. These a priori hypotheses (i.e., Fig. 2) are then combined with collected sample data to model relationships via path analysis, which then provides output describing model fit and the strength of relationships. Model fit will be examined using chi-squared analysis, root mean squared error approximation, and the normed fit index, whereas strength and direction of relationships will be evaluated using multiple correlation and slope coefficients (Burcher et al. 2007; Perkin et al. 2014). Covariate structure analysis will be done with the flexible partial least squares approach (PLS; Perkin et al. 2014) using the functions in the plspm package (Sanchez et al. 2017) in program R version 3.3.3 (R Core Team 2017). Results will be displayed using a path diagram.

We will use one-way multivariate analysis of variance (MANOVA) to test for differences in resource availability among secondary channel backwaters, main channel backwaters, and the Phase III wetland. The three categories of wetland or backwater will serve as the predictor variable, and response variables will include phytoplankton biomass (chlorophyll *a* in μg/L), periphyton biomass (chlorophyll *a* $\mu g/cm^2$), benthic macroinvertebrate biomass (g DM/m^2), and zooplankton biomass (g DM/L). The MANOVA assumptions of multivariate normality and equality of variance-covariance matrices will be tested using a Shapiro-Wilk test of multivariate normality and Box's M test, respectively. If assumptions are violated, Box-Cox transformations will be applied to the data. If the MANOVA detects significant differences, we will use separate one-way ANOVAs coupled with Tukey's honest significance difference (HSD) to determine which resource availability variables actually differ among predictor variable categories.

Deliverables

An annual report will be provided each year of the study using the same timeline as reports required for the San Juan River Basin Recovery Implementation Program (SJRIP) and Reclamation. Likewise, an annual oral report will be given at the SJRIP Annual Biology Committee (BC) meeting in February. At the completion of the project a final report will be delivered to both the SJRIP and Reclamation. Finally, when the project is completed all data files will be provided to the Program Office in digital format.

Acknowledgments

I would like to thank my collaborators on this Scope of Work (SOW), including Scott Durst, Nathan Franssen, and Eliza Gilbert with the USFWS SJRIP Program Office. Discussions with

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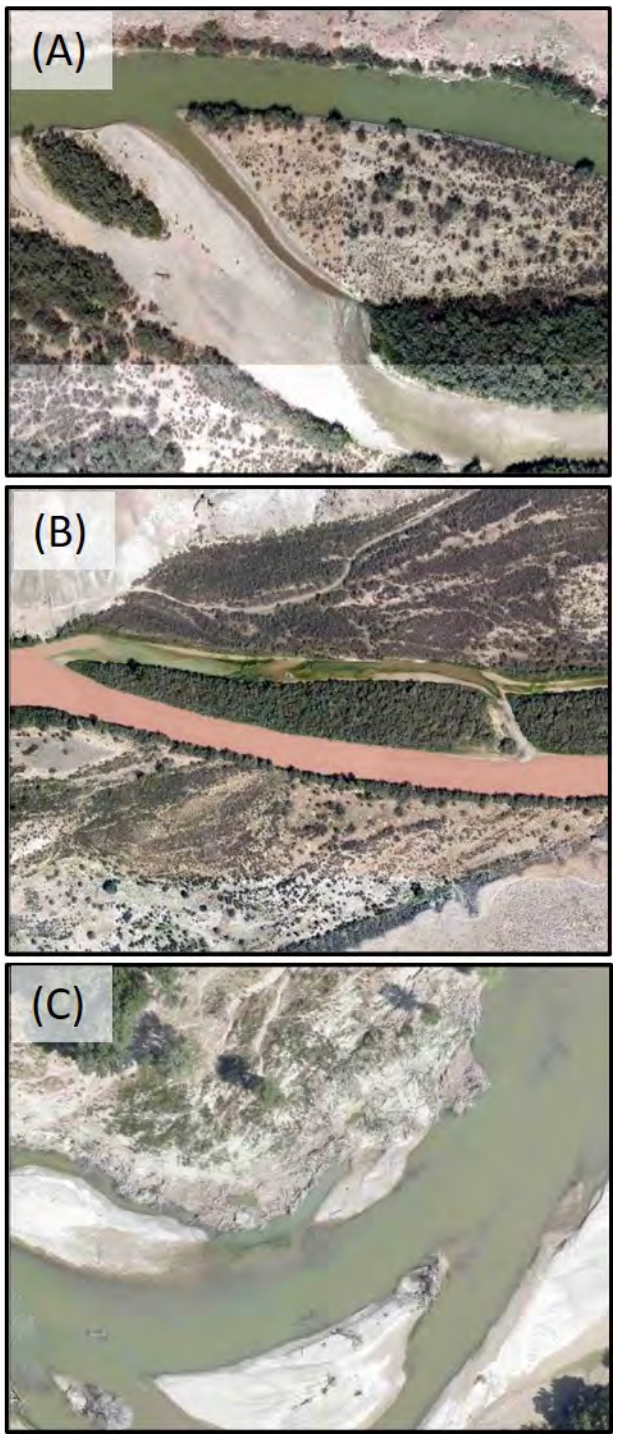

Figure 1. Examples of secondary channel (A), island (B), and point bar (C) backwaters in the San Juan River. Island and point bar backwaters are two types of main channel backwater. (Photos courtesy of Dan and Vince Lamarra).

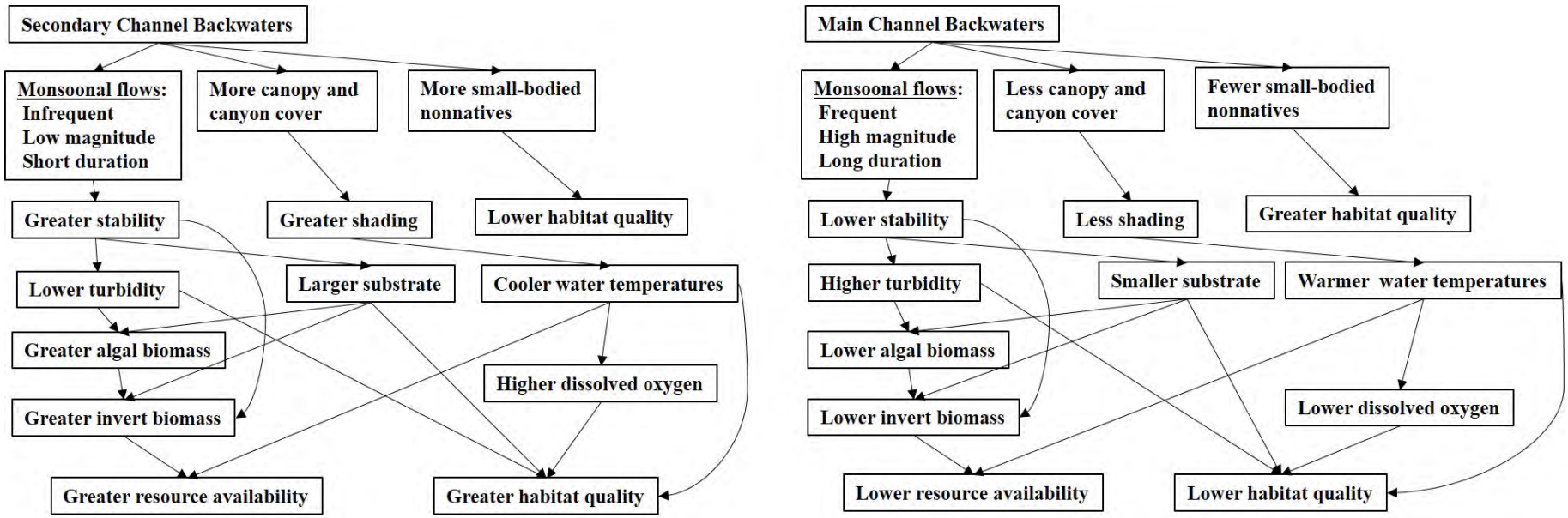

Figure 2. Conceptual model illustrating pathways and hypothesized differences in habitat quality, resource availability, and nonnative (NN) small-bodied predators between secondary channel and main channel backwaters in the San Juan River.

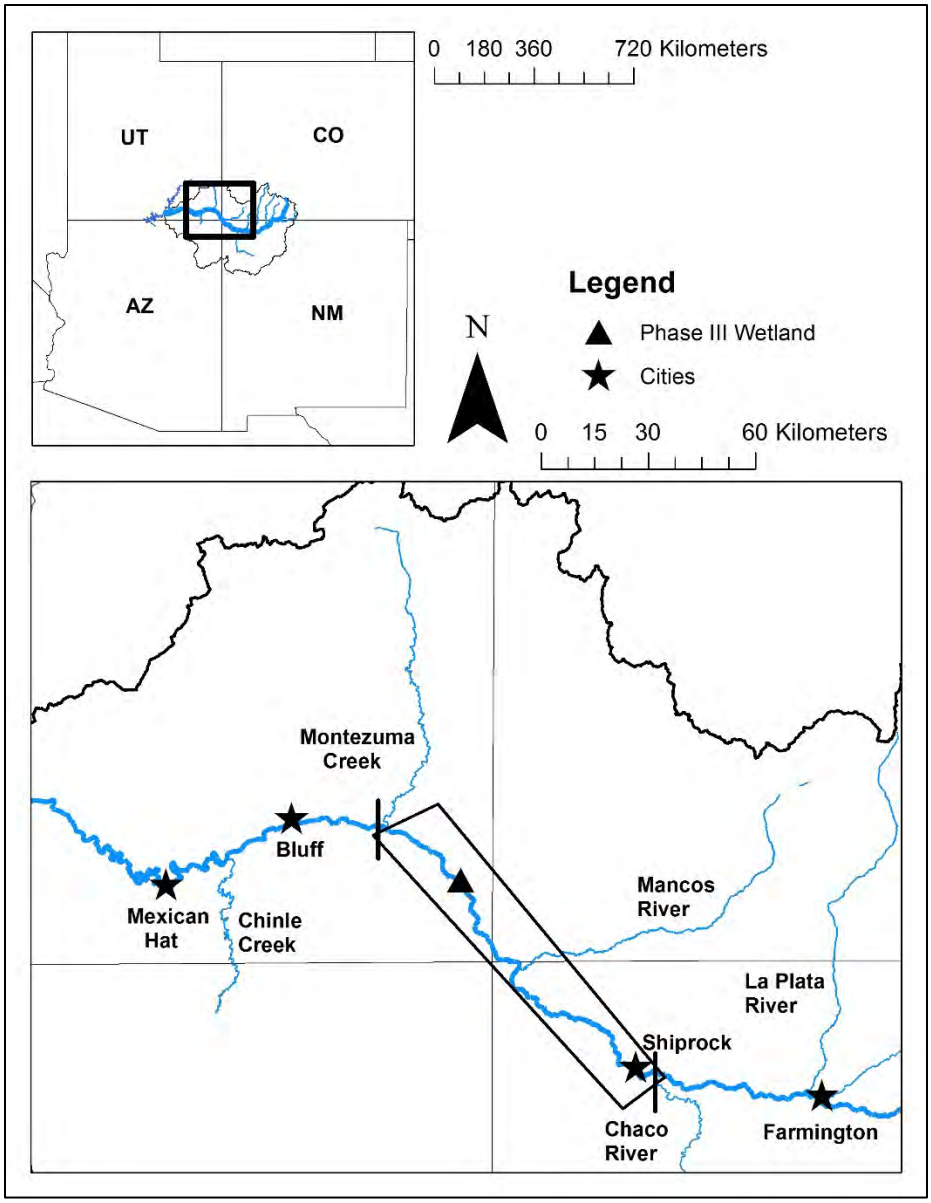

Figure 3. Map of the San Juan River Basin (broad extent) and the section of the San Juan River where backwaters will be studied for this project (fine extent), with Shiprock denoting the upstream end of the study reach and the confluence with Montezuma Creek marking the downstream end of the study reach.

Table 1. Detailed budget for fiscal year 2021 (year 3) of the project. GS = graduate student.

Category	Type	Expense	Explanation
Personnel	GS Stipend	$10,000.00	6-month stipend working 0.5 time (20 hrs/week; $19.23/hr)
	GS Fringe	$433.60	GS stipend *0.04336
Travel	SJRIP BC Meeting	$2,000.00	2 people; $1200 airfare; $400 rental car; $400 hotel
Supplies	None	$0.00	
Equipment	None	$0.00	
Other	Tuition and fees	$4,161.00	$4,161.00/semester for the GRA
Total Personnel		**$10,433.60**	
Total Overhead		**$1,825.88**	Overhead rate = 17.5% on personnel costs
Total Travel		**$2,000.00**	
Total Supplies		**$0.00**	
Total Equipment		**$0.00**	
Total Other		**$4,161.00**	
Grand Total		**$18,420.48**	

Budget Justification

Personnel – Funds are requested to support a graduate research assistant in year 3 such that they can complete data analysis and write up the results of the project.

Travel –Funds are requested in year 3 for the graduate student and PI to travel to the SJRIP Biology Committee (BC) Meeting.

Indirect Costs – The overhead rate at Pittsburg State University is 47% on personnel costs, but PSU is going to charge 17.5% on personnel costs in year 3 of the project.

Response to BC Comments

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

A deliverable for this SOW does not list the delivery of all data files in digital format to the Program Office. Preservation of the original data files for all projects is needed in all Scopes of Work. This is the third year for funding this project and no work has yet been completed due to contracting issues. It was originally proposed as a three year project so the deliverable needs to include the final report. The annual report to the BC should be at the winter meeting not the May meeting. The scope should be revised to update the deliverables and presentation of annual results.

Response: *We have added a sentence at the end of the Deliverables section stating that "when the project is completed all data files will be provided to the Program Office in digital format." Also, we changed the Deliverables section to indicate that an annual report will be given to the Biology Committee during the winter meeting rather than in May.*

What is this SOW's contribution to recovery?

It has the potential to provide data on productivity of low velocity habitats.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

The background section of the SOW is impressive with a substantial use of literature. The need to understand differences between secondary channel and main channel backwaters is well developed.

The application of hypotheses (H) and predictions is an impressive component of the proposal. They are essentially null hypotheses with specific alternative hypotheses upon rejection of the null. The five hypotheses and associated predictions are well stated. Predictions associated with H 1-4 all predict secondary channel backwaters to be more stable, have more shade, have better physicochemical conditions, and have higher biological productivity, than main channel backwaters and to be more conducive to better survival of larvae and juveniles fishes. However, the prediction associated with H 5 is that secondary channel backwaters will have higher densities of nonnative predators than main channel backwaters. If the predictions are true, it is unclear how insights obtained for the project may lead to management strategies for enhancing backwaters or managing discharge from Navajo Dam that benefit Razorback Sucker or Colorado Pikeminnow.

Response: *If the predictions for H1-H4 all turn out to be true while the prediction for H5 proves false, releases from Navajo Dam could be manipulated to increase the availability of secondary channel backwaters to the potential benefit of Razorback Sucker and Colorado Pikeminnow. However, some or all of the predictions for H1-H4 could be incorrect, while that of H5 could be true, limiting the efficacy of using environmental flows management with regards to secondary channel backwaters as a conservation strategy. However, we will not know whether any of these predictions are true until we actually collect the data, which is the purpose of conducting the study in the first place. Furthermore, if all predictions prove true, the magnitude of difference between secondary channel and mainstem backwaters will dictate how useful environmental flows management is to native fish conservation. If nonnative fish densities are only slightly higher in secondary channel compared to mainstem backwaters, then the benefits to native fishes of residing in secondary channel backwaters (e.g., greater food availability; more benign physicochemical conditions) may far outweigh the costs associated with nonnative fish predation. But if nonnative densities are much higher in secondary channel versus mainstem backwaters, then the predation costs to native fishes of living in these habitats may be too high, limiting their conservation value. But, the study needs to be completed before we will know the answer to these questions.*

The description of the study design raises many questions.

1. It is unclear how the sampling sites for secondary channel and main channel backwaters will be selected. The description indicates that 10 of each category may be near the total number available in the study reach, but the number may more or less. Will all of the sites of each category encountered during the first sampling trip be identified and sampled? Or, will it be the first 10 encountered of each category? If there are substantially more than 10 sites in a category within the study reach, how will a random sample be selected? As discharge varies over the sampling season, will all of the sites identified on the first trip be assessed and sampled if water is present? There is indication in the SOW that additional sites will be added during the sampling season. What does this do to the sampling design and ability to conduct statistical analyses?

Response: *The dynamic and ephemeral nature of backwater habitats definitely complicates study site selection for this project. As such, we have decided that we will add an initial float trip to scout for potential study sites at the beginning of the field season. During early July before sampling for this project starts, we will float our sample reach to visit every backwater habitat. Every backwater visited will be categorized as secondary channel or mainstem (island and point bar) and will then have its surface area and depth (both mean and maximum) measured. Following this scouting trip, the 10 largest secondary channel and mainstem backwaters (20 total) based on surface area and depth will be selected as*

sample sites during a study year. The largest backwaters will be selected since they will likely be more permanent and have a lower probability of drying up over the course of the field season. We have indicated this change in study site selection in the statement of work.

2. The definition of a suitable sampling site is not clear. The SOW indicates that "a general recommendation for stream sampling is to survey a reach length equal to 40 times the average width to provide a representative sample." Backwaters are not streams with riffles, pools, runs, etc. Habitat heterogeneity within secondary channel or main channel backwaters is unlikely to be as diverse as streams, but it is also likely to change in a systematic manner from the head to the mouth of a backwater. It is stated that a surface area of > 30 m2 will be a criteria for sample site selection. A much more objective and systematic set of criteria for identification and selection of both secondary channel and main channel backwaters is needed to assure the reader that the sites sampled are representative of the universe of available sites within the study reach.

Response: *See the previous response for our updated sample site selection protocol. Our study site selection procedure is not random since we are selecting the largest, most permanent backwaters. However, this study site selection strategy is necessary to ensure that we are able to sample repeatedly the study sites we select during a given year.*

3. The descriptions of sampling designs, sampling methods, computation of variables, and statistical analyses are unclear, incomplete, and confusing. Some of the most prominent concerns include:

(a) For H 1, the location of HOBO loggers will be at the "deepest" point in the backwater but some distance from the mouth. This seems to be a contradiction given that the deepest point is likely to be at the mouth of most of these backwaters. How will the deepest point be identified? Further, the loggers are to be located at "inconspicuous" sites. How, is this compatible with being in the deepest spot? How will monsoons, vandalism, and sample-site drying affect the likelihood of systematic data being obtained through the sampling seasons? What are the metrics describing "stability" that will be computed from the logger data and use in statistical analyses?

Response: *The logger will be deployed in the deepest part of the backwater excluding the mouth. The deepest part of the backwater will be determined using an initial depth survey. When possible, data loggers will be placed in inconspicuous locations to decrease the probability of being noticed and potentially vandalized, although depth will be the primary determinant of logger placement. Stability will be calculated using the coefficient of variation calculated from changes in water level. Some loggers may or may not be lost due to*

unpredictable forces like flooding and vandalism, but the deployment of multiple loggers and replication will help us overcome these challenges.

(b) For H 1, it is intriguing that electrical resistance will be measured using modified loggers and enable identification of flow through backwaters. The ability to effectively utilize this method depends on identifying the "lowest elevation poing in-between the main channel and the backwater." How will this specific location be identified in the field when the first trip is made in July when relatively high flows are likely to occur? What are the metrics to be computed from these data?

Response: *The lowest elevation point will be determined visually. The frequency and duration of flow connections between the main channel and a backwater will be calculated with these data.*

(c) For H 1, modified loggers will be located in the deepest point to identify if or when a backwater dries up. Will these be the same locations as in (a) above?

Response: *Yes.*

(d) For H 2 and 3, the transect sampling design is unclear. The number and spacing of transects appears to vary among sampling sites and within sampling sites among trips. Given the criteria that transects will be 10 m apart in backwaters < 150 m in length, some backwaters may only have a single transect sampled. How can a representative sample of a backwater by be assured? How many points (and where) on a transect will be sampled? What will be measured at each point? How will time of day affect the sampling of physicochemical features? What are the metrics that will be computed and used in the statistical analyses?

Response: *We have modified our transect sampling design such that the distance between transects will always be 10% of backwater length, resulting in 10 total transects for every backwater. Number of transect points, point location, and variables measured are described later on in the paragraph being commented upon. Time of day will have minimal influence on transect measurements.*

(f) For H 2 and 3, five transects will be sampled to determine extent of shade. How will these transects be located? Why are transects used for physicochemical sampling not used for sampling shade? How will shade be measured? How will time of day affect shade measurements?

Response: *Percent canopy coverage as measured using a densiometer will be quantified at 10 transects, and these will be the exact same transects as the depth and substrate transects. Time of day does not affect percent canopy cover.*

(g) For H 4, chlorophyll a will be measured in a single 500-ml sample obtained from various depths. How will the depth composition affect the estimate? Sampling at a consistent depth would provide a more precise estimate to enable comparisons among sites and over time. How much spatial variation occurs in a backwater and how will that affect the estimates? Benthic chlorophyll a will be sampled using a core sampler and whole rocks. Samples from cores and rocks will be pooled for analysis? What is the metric that will be computed and how precise will it be? Similarly, macroinvertebrates will be sample using an Eckman dredge, by scrubbing rocks, isolating sections of large woody debris. Again, sample for various sources will be pooled. What kind of metric will be attaind and how precise will it be?

Response: *We have changed our phytoplankton sampling protocol such that water collection will occur at approximately 8 cm depth in all backwaters. Since water will be collected from multiple backwater locations, that will help account for spatial variation within backwaters. Pooling of chlorophyll a samples will occur at the transect level, such that there will be six replicates per site per sample period. This replication will allow us to calculate precision (e.g., calculating standard deviation) of chlorophyll a biomass in units of μg/cm^2. Similarly, we'll have six macroinvertebrate replicates per site per sample period, which will allow us to calculate precision of macroinvertebrate biomass in g of dry mass per m^2.*

(h) For H 5, small bodied fish will be sampled by electrofishing and seining. The two techniques differ substantially in their selectivity. What kind of sampling design will be used using each gear? It is stated that sample with the gears will be pooled and density (number/m2) will be used as the metric for density. How precise will the estimate be given the differences in selectivity and difficulty in computing the area sampled with each gear? It is stated the depletion sampling will be conducted to calibrate the electrofishing and seining samples. Insufficient information is provided to enable an assessment of how this will be achieved.

Response: W*e acknowledge that seining and backpack electrofishing target different components of a fish community. It is specifically because of this reason why pooling together electrofishing and seining data is more accurate that treating each sampling technique independently. We are not interested in comparing the sampling efficiencies of these two different gears, but rather we are trying to accurately determine the total population size of nonnatives in backwaters.*

4. Overall, the metrics to be computed from the sampling data have not been described. The accuracy and precision of various metrics are questionable given the sampling designs that are described. Given the error that is likely in the measurements of many of the variables, statistical testing of the hypotheses is likely to be affected.

What is this SOW's contribution to recovery?

It is unclear how insights obtained for this project may lead to management strategies for enhancing backwaters or managing discharge from Navajo Dam that benefit Razorback Sucker or Colorado Pikeminnow.

Using Molecular Techniques to Determine Effective Number of Breeders (N_b) for Razorback Sucker and Colorado Pikeminnow in the San Juan River

Fiscal Year 2021 Scope of Work

June 23, 2020

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June 2020

Title: Using Molecular Techniques to Determine Effective Number of Breeders (N_b) for Razorback Sucker and Colorado Pikeminnow in the San Juan River

Principal Investigator: Steve Mussmann and Melody Saltzgiver, Southwestern Native Aquatic Resources and Recovery Center, Dexter, NM

Introduction & Justification

Recent advances in population-level genetic analyses are increasingly helping biologists monitor and adaptively manage the recovery of endangered populations (Hartl & Clark 2007). Recovery plans for many endangered fishes include the production and release of hatchery-reared individuals to augment populations with two major objectives: increase population size and promote genetic diversity (Miller & Kapuscinski, 2003). Survival, reproduction, and recruitment of wild and augmented individuals must occur at a sustainable scale in order to meet these recovery criteria. However, factors that limit success in achieving self-sustaining populations can be difficult to identify. This frequently requires long-term datasets to provide insight into population responses that might hinder recovery. Long-terms datasets include utilizing genetic monitoring to understand complex ecological, demographic, and genetic factors that can impede the establishment of self-sustaining populations (Schwartz et al. 2006; De Barba et al. 2010).

Augmentation of endangered fish populations in the San Juan River using captive-reared Razorback Sucker (*Xyrauchen texanus*) and Colorado Pikeminnow (*Ptychocheilus lucius*) began in the mid-1990s and continues as a recovery action (USFWS 2005; USFWS 2015). Annual monitoring of survival, reproduction, and recruitment of these populations has been supported through the San Juan River Basin Recovery Implementation Program (SJRRIP). Mark-recapture data on PIT tagged individuals have enabled estimation of survival for both stocked species (Franssen & Durst *unpublished data*; Clark et al. 2018), which in turn has prompted additional research investigating ways to increase survival. Larval fish surveys have documented successful reproduction of both species in the river (Farrington et al. 2015), but recruitment to the adult stage is extremely limited. Successful recovery requires a significant portion of the reestablished population to reproduce annually to both increase population sizes and ensure maintenance of genetic diversity. Therefore, quantifying the number of individuals that reproduce annually provides data to make informed management decisions to aid in the reestablishment of self-sustaining populations.

Population-level spawning success (i.e., number of reproducing adults) is innately difficult to quantify from field studies, especially for highly fecund species where few individuals can produce a large number of offspring. Furthermore, there is substantial evidence that shows reproductive output can depend on environmental conditions and age- or size-related factors (Lauer et al. 2005; Lambert 2008). Both temporal and spatial variation in spawning effort has been detected for Razorback Sucker. Adults may vacate a spawning area early in the season

and return to spawn again later that year (Marsh et al. 2015), with individuals visiting multiple sites during the same spawning period (Modde & Irving 1998). Such reproductive strategies further compound the difficulty in determining individual contribution to cohorts over a reproductive season; however, this question can be addressed by estimating the effective number of breeders (N_b) using genetic analyses. Colorado Pikeminnow and Razorback Sucker have defined seasonal reproductive bouts, thus making N_b an extremely useful metric for understanding population-level spawning success despite these species having life history traits (i.e., long-lived, highly fecund, and iteroparous with overlapping generations) that typically confound similar analyses (Waples et al. 2013; Waples et al. 2014). Single cohort N_b estimates can reliably quantify the number of individuals that contribute to a given cohort (Waples et al. 2014). Obtaining annual N_b estimates for the endangered fishes of the San Juan River provides insight into how management activities (i.e., increasing passage, managing flows) affect population-level reproduction, thus, improving the opportunity to manage the San Juan River to favor spawning success.

Objectives:

1. Continue N_b monitoring for both Razorback Sucker (N = 120) and Colorado Pikeminnow (N = 120) collected in the mainstem San Juan River during 2021.

Methods

Larval fish surveys are conducted annually along a 140-mile section of the San Juan River between Shiprock, NM, and Clay Hills, UT. Up to 120 larval samples per species representing the spatial and temporal distribution of these sampling efforts will be examined to calculate N_b estimates. Tissue subsamples will be taken from the posterior portion of Razorback Sucker and Colorado Pikeminnow larvae collected during 2021. The anterior portion of all specimens will be saved for otolith studies. Rare collections will be targeted while sites with high larval densities will be proportionally reflected in samples in order to ensure N_b estimates are not artificially lowered due to limited spatial representation of samples. Larval Razorback Sucker are collected during much of the sampling season. Early larval stages (e.g., protolarvae to mesolarvae) will be targeted throughout larval collections under the assumption that these individuals are from recent spawning events; thus ensuring sampling is representative of the temporal spawning season. Conversely, Colorado Pikeminnow are collected later in the sampling season, making it relatively easy to ensure captured individuals reflect the entire seasonal spawning period of adults. Samples collected below the waterfall will be used to evaluate larval emigration or adult contribution downstream of the waterfall.

Previous N_b estimates have been obtained using multi-locus microsatellite markers (Diver & Wilson 2018); however, the field of population genetics has shifted to utilize massively parallel “next-generation sequencing” (NGS) methods. This technology provides a cost-effective and efficient means for sampling large quantities of genetic data from individuals through “reduced representation” genomic sequencing (Campbell et al. 2018). These methods sequence a small fraction of an organism’s genome to identify thousands of single nucleotide polymorphisms (SNPs) that are analogous to microsatellite markers for conservation genetic applications. However, SNPs quantify an order of magnitude more loci compared to microsatellites (i.e., SNPs = hundreds or thousands of loci, microsatellites = 10 – 30 loci) which will functionally increase our resolution of genetic variation among individual genomes. Application of SNP-based methods for determining relatedness and N_b estimates has increased as microsatellite-based studies have reduced in number (Flanagan & Jones 2019). SNPs have been successful in reconstructing multi-generational pedigrees in the absence of known parental relationships (Levine et al. 2019). Comparative studies have found that SNP-based methods provide improved

confidence intervals and equal or greater power for determining relationships among individuals (Thrasher et al. 2018; Lemopoulos et al. 2019; Galla et al. 2020). SNP data also promote other analyses of interest in aquatic conservation, including, but not limited to, the assessment of hybridization in complex systems (Chafin et al. 2019). Finally, SNPs offer benefits over traditional microsatellite methods due to lower error rates and broader genome coverage (Smouse 2010; Hauser et al. 2011). Therefore, N_b estimates for 2021 will continue to be collected using these methods.

Genomic DNA will be extracted from tissues following standard protocols used at Southwestern ARRC. NGS data will be prepared using double digest Restriction-Site Associated DNA (ddRAD) libraries (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 18-24 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 using the Pippin Prep System (Sage Science) to retrieve DNA fragments between 350 and 400 bp in length for Razorback Sucker and 325 to 425 for Colorado Pikeminnow (Bangs et al. 2018; Chafin et al. 2018). Size-selected DNA will be subjected to 12 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 2 (Rochette et al. 2019) 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 2 (Rochette et al. 2019) with clustering parameters being determined by the methods of Rochette & Catchen (2017). Only loci appearing in 90% of individuals will be retained for analysis. Data will be filtered to retain one SNP per ddRAD locus. A second researcher will perform a 10% quality assurance/quality control of samples to ensure accuracy.

SNPs will be evaluated for linkage disequilibrium and Hardy-Weinberg Equilibrium (Raymond & Rousset 1995; Purcell et al. 2007). N_b will be estimated using the sibship-assignment (SA) method in COLONY version 2.0.4.0 (Jones & Wang 2010). This software uses a maximum likelihood method to estimate relationships among offspring belonging to a single cohort by identifying full and half-sibling families while considering genotyping error rates and allowing for inferences related to the mating strategy of the organism. Analysis will be conducted separately for each year to estimate N_b, the number of adults that contributed at least one offspring, number of sampled offspring produced by each parent, and the number of parental pairs. For both species, male and female polygamy will be assumed and parameter settings (i.e., dioecious, diploid, inbreeding, medium run length, full-likelihood with medium likelihood precision, no sibship prior, and updated allele frequencies) will be maintained across years.

Schedule:

Completion of genetic analysis	March 30, 2022
Final Report	June 30, 2022

Deliverables:

Dissemination of the results will include a final report and presentation of project results at the San Juan Researcher's meeting.

FY21 - Detailed Spending Plan

1. PERSONNEL	
A. Laboratory Work	
1 Bio/Geneticist (GS-11-2; 200 hours – 2 pay periods) @ $44.58/hr	$8,916.84
B. Data Analyses and Report Writing	
1 Bio/Geneticist (GS-11-3; 320 hours - 4 pay periods) @ $46.12/hr	$14,758.75
C. Travel	
2 Trips to San Juan Meeting (4 days each; with travel) @ $664.50/trip	$1,329.00
1 Trip to Museum of Southwestern Biology to obtain larval samples (4 days; including travel) @ $576.50/trip	$576.50
Subtotal Personnel	**$25,581.09**
2. MATERIALS/SUPPLIES/SEQUENCING	
A. Extractions	$1,274.00
B. Library Prep	$3,991.00
C. Library Quantification/QAQC	$2,280.00
D. Sequencing	$3,112.00
E. Other (tubes, tips, etc.)	$1,795.00
Subtotal Supplies	**$12,452.00**
Southwestern ARRC Utilities	
-Electrical, (approx. 4,259 KW/h @ 0.34569 per KW/h) =	$1,472.29
Total	**$39,505.38**
Administrative and Overhead Costs Regional Office @ 3%	$1,185.16
Project Total FY2021	**$40,690.54**

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Responses to Comments:

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

This SOW is a continuation of the previous Nb work completed for the San Juan River. Can this method be applied to the 2019 genetic material if that material has not been processed? It seems the newer methodology may provide more definitive result.

Response:

Thank you for the comments. We are currently funded through the San Juan program to analyze the 2019 samples using microsatellite data. However, we are funded in FY2020 to analyze larval samples collected during 2020 to provide a direct comparison between the two data types. This will be done to assess impacts of the two genetic methods on estimation of Nb in the San Juan River, which will provide additional context to this study and others as we continue to monitor the reproductive contribution of endangered fishes in this system.

Program Office

How can the technical aspects of this SOW be improved?

It appears ASIR will not be sampling below the waterfall in FY2021. If this is the case, then you will likely need to reduce the number of samples you propose to process by half.

Response:

We have revised the SOW and associated budget to reflect this by removing the proposed below-waterfall sampling for FY2021.

Rearing Endangered Fish at the Horsethief Canyon Native Fish Facility Ponds for Stocking into the San Juan River

Draft Fiscal Year FY 2021 Project Proposal
Updated: 25 March 2020

Submitted to
Bureau of Reclamation

From

U. S. Fish and Wildlife Service
Ouray National Fish Hatchery – Grand Valley Unit
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Dale Ryden and Brian Scheer
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Current Contract or Agreement number(s):
R17PG00084 for USFWS – Grand Junction, CO

1 October 2020 to 30 September 2021

Introduction

Along with the workplan entitled, "Razorback Sucker Augmentation/NAPI Pond Management," this workplan is intended to supply the San Juan River Basin Recovery Implementation Program (SJRBRIP) with a reliable source of endangered Razorback Sucker (*Xyrauchen texanus*) with which to help restore a self-sustaining population via annual fall stocking events.

The Ouray National Fish Hatchery – Grand Valley Unit (NFH-GVU) consists of several distinct facilities located in and around Grand Junction, CO. One of these facilities is the Horsethief Canyon Native Fish Facility (HCNFF) pond complex (about 7½ miles west of the main hatchery building) near Fruita, CO. The other facility used for this workplan is the 24-Road Hatchery, an intensive water reuse hatchery building, utilizing a municipal water source, thus insuring good water quality, clarity, and freedom from parasites.

The HCNFF consists of 22 ponds, ranging in size from 0.1 to 0.5 surface acres, with a total surface acreage for the entire facility of 6.2 acres. Each pond is 5-6 feet deep and is equipped with a fabric liner to prevent seepage. Each pond also has a concrete kettle and drain structure to facilitate draining and concentrating of fish for ease of harvest. This facility is a multi-species broodstock, production, and rearing facility dedicated to rearing three of the endangered Colorado River fishes: Razorback Sucker, Humpback Chub (*Gila cypha*), and Bonytail (*Gila elegans*).

Until 2012, the operation and maintenance (O&M) of the entire Ouray NFH-GVU complex (Project 29a: Operation and Maintenance of Ouray National Fish Hatchery – Grand Valley Unit) was funded by Upper Colorado River Endangered Fish Recovery Program (UCREFRP). On 25 March 2010, the Coordination Committee of the SJRBRIP voted to cost-share 1/6 of the operation and maintenance costs for the HCNFF pond complex. This equates to a total of one surface acre of pond rearing and production space (either two 0.5 acre ponds, or four 0.25 acre ponds).

Methods

Currently, the one surface acre of grow-out ponds allotted to the SJRBRIP is being used to rear Razorback Sucker that are progeny of 15-20 paired matings of appropriate genetic lineage, produced annually from Razorback Sucker broodstock being held at HCNFF. Spawning takes place at the HCNFF each spring around mid-April, depending upon ambient water temperatures. After spawning, fertilized eggs are transported to the 24-Road Hatchery building where they are reared in flow-through egg jars until they hatch into larvae. Several weeks after spawning, larval Razorback Sucker are then stocked back out into grow-out ponds at HCNFF for the remainder of their age-0 growing season. At the end of their age-0 growing season, the Razorback Sucker grow-out ponds are drained and the young fish are transported back into the 24-Road hatchery building where they continue to be fed and reared in a warm, climate-controlled, indoor environment overwinter, thus allowing fish to continue to grow even during the coldest months of the year.

Several months after they have been brought back into the hatchery, young Razorback Sucker are implanted with PIT tags. This usually happens at 100-200 mm TL (usually in late January or early February). PIT-tagging young Razorback Sucker several months after they are transferred to the hatchery building (i.e., after they have settled down from

being moved into the hatchery building from the HCNFF grow-out ponds) helps reduce stress on these animals and allows them to have abundant time to heal in the hatchery building after being PIT-tagged, but prior to being stocked back into the HCNFF grow-out ponds for their age-1 growing season (which usually happens in late March). Prior to being PIT-tagged, fish are taken off of feed for at least 48 hours and aren't fed again for at least 24 hours following PIT-tagging. This helps reduce stress as well as allowing the fish's intestinal tract to empty and retract, thus reducing the possibility of accidentally puncturing an intestine during PIT tag implantation. After PIT-tagging, fish are monitored in circular hatchery tanks for both PIT tag loss and delayed mortality (both tag loss and mortality due to PIT-tagging are very low, averaging < 0.5% annually).

During the spring of their age-1 year these Razorback Sucker, now about 200 mm TL, are released back into the grow-out ponds. They are not handled again until the fall of that same year. When ponds are harvested, every individual Razorback Sucker is measured and scanned for a PIT tag (a subset are also weighed). This happens at the end of the age-1 growing season (October/November), just prior to stocking. Harvest operations consist of taking fish off of feed 48 hours before harvest, draining grow-out ponds and passively gathering fish into the concrete kettles as the pond drains, anesthetizing fish (using MS-222), measuring fish (all fish), weigh fish (a subset of fish from each pond; minimum of 50 fish per pond), and checking fish for PIT tags. If a PIT tag is found to be missing at this point (which is relatively rare), then a new PIT tag is implanted prior to the fish being loaded for transport and stocking into the San Juan River. Fish are lifted from grow-out ponds to the stocking truck using a fish bucket suspended on the terminal end of a Palfinger brand knuckle boom crane. They are then transported to the appropriate stocking site, tempered following appropriate USFWS protocols, and stocked as either a hard- or soft-release, as per directions from the SJRBRIP and the U. S. Fish and Wildlife Service's New Mexico Fish and Wildlife Conservation Office (NMFWCO).

Daily operation and maintenance (O&M) of the HCNFF ponds and the 24-Road hatchery includes regularly checking and making appropriate adjustments to water quality (dissolved oxygen, pH, nitrates/nitrites, etc.), maintenance, cleaning, and replacement of air distribution systems (air stones, air pads, oxygen cylinders), calculating proper feed ratios and distributing proper types and sizes of feed based on fish life stage, size, and pond/tank densities, cleaning of fish ponds/tanks, checking fish for diseases and applying appropriate treatments for sick/infected fish when necessary, maintenance of pumps, filters (e.g., fluidized sand, drum, UV), and air distribution systems, maintenance of vehicles, equipment and grounds, scheduling and performing USFWS and state-mandated annual fish health inspections and Aquatic Invasive Species (AIS) inspections, applying for and obtaining state fish importation permits, collection and QA/QC of PIT tag database files, submission of data files to the SJRBRIP, preparation of annual reports, etc.

Products/Deliverables

PIT tag files will include all Razorback Sucker handled and scanned at time of pond harvest (including all fish that were re-tagged), immediately prior to transport and stocking. Following QA/QC of the data, this file is submitted the SJRBRIP and the NMFWCO. The SJRBRIP has eliminated stocking any Razorback Sucker that are < 300 mm TL. However, the SJRBRIP is actually getting age-1 fish (i.e., after 2 full growing seasons = approx. 18 months old) from HCNFF that are meeting the Upper Colorado River Basin's minimum size requirements of $\geq$ 350 mm TL. The stocking size of most

Razorback Sucker sent to the San Juan River from HCNFF is considerably larger than the minimum 300 mm TL target.

It is anticipated that 2,000-4,000 Razorback Sucker (all ≥ 300 mm TL) can be reared annually in the one surface acre of ponds allotted to the SJRBRIP. Razorback Sucker of the appropriate target stocking size will be made available to the SJRBRIP in October/November of each calendar year for stocking (after the annual fall fish community monitoring studies are completed). All stockings of Razorback Sucker will be coordinated with personnel from the SJRBRIP office and the NMFWCO.

In fall 2019, a total of 2,209 Razorback Sucker from the HCNFF were stocked into the San Juan River. Their mean total length at stocking was 322 mm. There have now been five years (representing the fall 2013-2017 stockings) during which Razorback Sucker stocked from the HCNFF have been available for recapture during the annual fall Sub-Adult and Adult Large-Bodied Fish Community Monitoring ("Adult Monitoring") study. During the fall 2017 Adult Monitoring study, Razorback Sucker from HCNFF accounted for 47% of all Razorback Sucker collected (the fall Adult Monitoring study was not performed in 2018 or 2019).

Changes in Future Management Strategies for HCNFF

The SJRBRIP will have the option to change the management approach and species being reared in their one surface acre of pond space as they see fit, but will need to coordinate such changes with Ouray NFH-GVU hatchery staff, allowing enough lead time to prepare for changes in importation/exportation permitting, purchasing of feed proper for the sizes and species of fish being reared, etc. Changes in numbers or sizes of fish desired, species being reared, etc. may lead to adjustments in future years' budgets. For instance, if the SJRBRIP decides to rear Colorado Pikeminnow (a species not currently being held on station at Ouray NFH-GVU), appropriate lead time will be needed to arrange obtaining young fish from another facility.

Cost Share with Upper Colorado River Endangered Fish Recovery Program

The SJRBRIP's Coordination Committee voted to cost-share 1/6 of the O&M costs for the HCNFF pond complex. However, the O&M of the HCNFF ponds is in reality part of a much larger picture of the overall O&M of the Ouray NFH-GVU itself. So, the following staffing breakdowns were used to determine the overall O&M of the entire Ouray NFH-GVU:

1) 24-Road Hatchery building will require 100% staffing for 6 months of the year

2) 24-Road Hatchery building will require 50% staffing for the other 6 months of the year

3) The HCNFF ponds will require 40% staffing for 6 months of the year
    a. One-sixth of the O&M of the HCNFF ponds will be paid for by the SJRBRIP

So, for areas where there are shared costs at the HCNFF ponds, an example of a $100 cost/year to the UCREFRP, would cost the SJRBRIP:

- $100 (full year cost) X .50 (the ½ year that the HCNFF ponds operate) = $50
- $50 (the ½ year that the HCNFF ponds operate) X .40 (40% staffing) = $20
- $20 (1/2 year at 40% staffing) X 0.167 (1/6 cost to SJRBRIP) = $3.34

So, the dollar cost to SJRBRIP is $3.34 per $100 (3.34%) of UCREFRP Project 29a. In other words, take the actual dollar cost to UCREFRP of Project 29a X 0.0334 for all shared costs.

NOTE: There are also costs included in the budget that are unique to the SJRBRIP alone. These costs will not be prorated, but charged at 100% rate to the SJRBRIP (see budget for details).

Possible Outyear Cost Adjustments

If the SJRBRIP decides to change stocking strategies (species, sizes, times of year at which fish are being stocked, etc.) outyear budgets may need to be adjusted to account for this. The costs presented in this workplan represent the best estimates we can develop, based on the species, numbers, and timing of fish to be stocked from our facility to the San Juan River.

FY-2021 Budget: **SJRBRIP SOW # 7: Rearing Endangered Fish at the Horsethief Canyon Native Fish Facility Ponds for Stocking into the San Juan River**

(Based on an anticipated FY-2021 costs)

Costs Shared by UCREFRP and SJRBRIP (i.e. O&M Costs)				**UCREFRP Project 29a** Extended Cost to UCREFRP	**SJRBRIP SOW 7** SJRBRIP Cost	**Notes**
Personnel/Labor Costs (Federal Salary + Benefits)	# People	# Hours/Person	Rate/Hr			
Principal Biologists (GS-11)	2	1,960	$53.84	$211,053	$7,049	Approx. 130 total hours cove
Biological Technician (GS-7)	1	1,960	$32.46	$63,622	$2,125	Approx. 65 total hours covere
Biological Technicians (GS-5)	1	1,960	$23.40	$45,864	$1,532	Approx. 65 total hours covere
Overtime:						
Biological Technician (GS-7)	1	120	$48.69	$5,843	$195	Approx. 4 total hours of over
Biological Technician (GS-5)	1	120	$35.10	$4,212	$141	Approx. 4 total hours of over
Labor Subtotal				**$330,593**	**$11,042**	

Permitting; Coordination; Data Input, Analysis, Management & Presentation; Report Writing; Office & Administrative Support (Federal Salary + Benefits)	# People	# Hours/Person	Rate/Hr	Extended Cost to UCREFRP	SJRBRIP Cost	
Project Leader (GS-14)	1	320	$82.57	$26,422	$883	Approx. 10.7 total hours cove

Administrative Officer (GS-9)	1	320	$42.98	54	$459	$13,7
Suopport Staff Subtotal				**$40,176**	**$1,342**	

Operations (Fish Food, Chemicals and Fertilizer, Hatchery Supplies, Fuel and Vehicles)

Fish Food (see Notes for details)	Lbs	Price/lb	Extended Cost to UCREFRP	SJRB RIP Cost	Based on a quote from Range order will last us ~90 days. W
Rangen # 0 Starter	1,000	$1.35	$1,350	$45	
Rangen # 1 Starter	1,600	$1.35	$2,160	$72	
Rangen # 2 Starter	2,400	$1.35	$3,240	$108	
Razorback Diet (1.2 mm)	8,000	$1.11	$8,880	$297	
Razorback Diet (2.0 mm)	16,000	$1.03	$16,480	$550	
Razorback Diet (3.0 mm)	48,000	$0.97	$46,560	$1,555	
Fish Food Subtotal			**$78,670**	**$2,628**	

Chemicals and Fertilizer (see Notes for details)	Quantity	Price/Unit	Extended Cost to UCREFRP	SJRB RIP Cost	Exact use of the money in th a given year. Funds for a "typ
Sodium Bicarbonate (pH increaser)	80	$70	$5,600	$187	50-lb bags
Copper Sulfate (pellets)	10	$95	$950	$32	50-lb bags
Copper Sulfate (10% solution)	50	$77.50	$3,875	$129	Gallons
Spartan Sparquat 256 Germicidal Cleaner	10	$30	$300	$10	Gallons
Chloram-X (dechlorinater)	16	$90	$1,440	$48	10-lb buckets

Finquel brand MS-222 (fish anesthetic)	2	$450	$900	$30	1-kg bottles
Chloramine-T (controls bacterial gill disease)	2	$440	$880	$29	55-lb containers
Formalin/Parasite-S (parasite controller)	4	$275	$1,100	$37	55-gallon drums
Specialized Haz-Mat Shipping	1	1,000	$1,000	$33	Specialized Haz-Mat Shipping
Denatured ethyl alcohol	8	$95	$760	$25	5-gallon jugs
Distilled water	10	$30	$300	$10	2-gallon jugs
Stress Coat (slime coat replacement)	2	$145	$290	$10	5-gallon containers
No-Foam De-Foamer	6	$35	$210	$7	Gallons
Weed killer (2,4-D)	40	$35	$1,400	$47	Quarts of concentrate
Weed killer (Roundup)	10	$180	$1,800	$60	Gallons of concentrate
Aquashade (water colorant)	50	$60	$3,000	$100	Gallons
Dimilin 25W (for anchor worm control)	20	$250	$5,000	$167	5-lb boxes
Chemicals and Fertilizer Subtotal			**$28,805**	**$962**	

Hatchery Supplies and Equipment Repair and Replacement (see Notes for details)	Quantity	Price/ Unit	Extended Cost to UCREF RP	SJRB RIP Cost	Exact use of the money in thi
Egg hatching jars	5	$85	$425	$14	Model J30
24-hr belt feeder	10	$270	$2,700	$90	Repair/replace 10 units annu
Waders	3	$75	$225	$8	Replace 3 pair annually
Duraframe dip nets	5	$300	$1,500	$50	Replace 5 annually
Digital scale repair, replace battery, recalibrate	3	$500	$1,500	$50	Digital scale repair, replace b
YSI brand water chemistry meters	1	$2,000	$2,000	$67	Measures dissolved oxygen,
Hatchery building HVAC system service	1	$1,200	$1,200	$40	One service annually
Service fish food cooler refrigeration unit	1	$750	$750	$25	One service annually
Service hatchery building backup generator	1	$700	$700	$23	One service annually

Portable water pump maintenance/service	1	$1,700	$1,700	$57	Labor & parts to rebuild/repl
One hatchery motor/pump set/year service	1	$4,000	$4,000	$134	Labor & parts to rebuild/repl
Fluorescent hatchery lights	1	$2,200	$2,200	$73	One service annually to repla
One purchase of tank cleaning supplies	1	$235	$235	$8	Scotch-Brite pads, scrubbing
Replace hand tools used for maintenace	1	$400	$400	$13	Replace tools as needed: Scre
Plumbing supplies	1	$2,000	$2,000	$67	Numerous purchases through
Refill compressed oxygen cylinders	50	$50	$2,500	$84	Refill 50 compressed oxygen
Buy new 0.4” air stones	20	$50	$1,000	$33	Replace twenty 0.4” air stone
Buy new tubing, couplers, hose clamps	1	$500	$500	$17	Buy new tubing, couplers, ho
New pond screens	10	$300	$3,000	$100	Buy PVC lumber and metal m
New pond flash boards	100	$7	$700	$23	New redwood pond boards (
Purchase new Koch rings	1	$500	$500	$17	Purchase new Koch rings for
Fine grain sand	1	$2,000	$2,000	$67	One pallet (twenty 80-lb bag
Hatchery Supplies Subtotal			**$31,735**	**$1,060**	

Office Supplies	Quantity	Price/ Unit	Extended Cost to UCREF RP	SJRB RIP Cost	Staples, copier paper, pencils
Office Supplies Subtotal	1	$1,500	**$1,500**	**$50**	

Vehicles (maintenance & repair) and fuel	Quantity	Price/ Unit	Extended Cost to UCREF RP	SJRB RIP Cost	Vehicles: GSA-lease rate. Bas
Hatchery pickup truck vehicle lease charges	12	$365	$4,380	$146	12 months vehicle lease X $3

Hatchery pickup mileage charges	16,425	$0.42	$6,899	$230	24-Road Hatchery building to
Diesel fuel for Kubota tractor	1	$250	$250	$8	One 55-gallon drum of diesel
Diesel fuel For back-up generator at hatchery	25	$4	$100	$3	25 gallons annually @ $4.00/
Repair/replace shocks, struts, brakes	1	$800	$800	$27	One service/repair annually =
Vehicles and Fuel Subtotal			**$12,429**	**$415**	
Overall Operations Subtotal			**$153,139**	**$5,115**	
Subtotal for All Shared Costs			**$523,908**	**$17,499**	

Costs Unique to SJRBRIP (Harvest, PIT-Tagging & Stocking Costs)				**SJRBRIP SOW 7**	**Notes**
Personnel/Labor Costs (Federal Salary + Benefits)					
Pond Harvest, PIT-Tagging, Stocking and Database Management	Total Numer of Man Hours	Rate/Hr		SJRBRIP Cost	
Principal Biologist (GS-11)	80	$53.84		$4,307	1) 2 days X 2 people/day for f
Biological Technician (GS-7)	136	$32.46		$4,415	1) 2 days X 1 person for fish h
Biological Technician (GS-5)	320	$23.40		$7,488	1) 2 days X 3 people/day for f
Labor Costs Unique to SJRBRIP Subtotal				**$16,210**	

Lodging and Per Diem (Based on Published FY-2020 GSA Per Diem Rates)	# People	# Nights (or Days)	Rate Per Night (or Day)	SJRBRIP Cost	
Lodging	2	5	$124.00	$1,240	5 nights lodging in Cortez, Co
Per Diem	2	10	$61	$1,220	10 days hotel rate (Cortez, CO
Lodging and Per Diem Subtotal				**$2,460**	

Fuel	Quantity	Price/ Unit	SJRBRIP Cost	
Diesel fuel for stocking truck	413	$4	$1,652	Stocking truck (gets ~8 miles
Fuel for water pump for tempering fish	20	$4	$80	91 Octane fuel for water pum
Fuel Subtotal			**$1,732**	

Subtotal for Costs Unique to SJRBRIP	**$20,402**

Total of All Costs Incurred by SJRBRIP	
USFWS-Ouray NFH-GVU (Grand Junction, CO) Total	**$37,900**
USFWS-Interior Region 7 Administrative Overhead (3.00%)	**$1,137**
USFWS-Interior Region 7 Total	**$39,037**

Cost/Fish Comparison	Quantity	Price/Fish
Workplan total cost in FY-2021 = $39,037		
Estimated production = 2,000-4,000 fish		
For 2,000 fish produced/delivered	2,000	$19.52
For 3,000 fish produced/delivered	3,000	$13.01
For 4,000 fish produced/delivered	4,000	$9.76

Colorado Pikeminnow and Razorback Sucker Augmentation in the San Juan River Basin: Fiscal Year 2021 Project Proposal

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Background

Colorado Pikeminnow (*Ptychocheilus lucius*) and Razorback Sucker (*Xyrauchen texanus*) are federally-listed endangered fishes found in the San Juan River. The San Juan River Recovery Implementation Program (SJRIP) was initiated in 1992 to protect and recover populations of both species in the San Juan River Basin (Basin) while water development proceeds in compliance with all applicable federal, state, and tribal laws (SJRIP 2014). Delisting of Colorado Pikeminnow, as described in the recovery goals, is dependent on the maintenance of a wild population of at least 2,600 adults in the Green River sub-basin and at least 700 adults in the Upper Colorado River sub-basin, as well as a target of 1,000 age 5+ (>300 mm TL) in the San Juan River sub-basin. Delisting criteria include a self-sustaining population that either exceeds 1,000 adults in the Upper Colorado River sub-basin or a self-sustaining population of at least 700 adults in the Upper Colorado River sub-basin and one of at least 800 adults in the San Juan River sub-basin. Razorback Sucker recovery criteria are dependent on the establishment of four self-sustaining populations of 5,800 adult fish each: two populations in the Upper Colorado River Basin (one population in the Green River sub-basin, the other in either the Colorado River or San Juan River sub-basins) and two populations in the Lower Colorado River Basin (SJRIP 2014).

Fish community monitoring during the SJRIP's seven-year research period, 1991-1997, collected few wild Colorado Pikeminnow. This prompted investigations into augmenting the population with hatchery-reared fish. Based on their results, Utah Department of Wildlife Resources experimentally stocked Colorado Pikeminnow in 1996 with the purposes of evaluating dispersal and retention of stocked Colorado Pikeminnow (Ryden 2008). This experimental stocking, along with subsequent stockings of larval, sub-adult, and adult fish, resulted in the recapture of hatchery-reared fish. In 2003, *An Augmentation Plan for Colorado Pikeminnow in the San Juan River* was finalized (Ryden 2003). This plan, and later amendments, called for the annual stocking of ≥ 300,000 age-0 and ≥3,000 age 1+ fish in the San Juan River until 2009. In early 2010 a revised plan, *Augmentation of Colorado Pikeminnow (Ptychocheilus lucius) in the San Juan River: Phase II, 2010-2020* (Furr 2010), was developed to direct the continuation of stockings through 2020. The Phase II augmentation plan reflected changes requested by the SJRIP Biology Committee that discontinued the stocking of Passive Integrated Transponder (PIT) tagged age-1+ Colorado Pikeminnow in exchange for stocking increased numbers of age-0 fish (n≥ 400,000). In 2020, the SJRIP Biology Committee recommended changing the Colorado Pikeminnow stocking strategy. Beginning in 2021, the SJRIP will release annually PIT tagged (n = 20,000) Colorado Pikeminnow. These fish will allow for researchers to identify wild vs hatchery produced Colorado Pikeminnow, and allow other augmentation related research questions to be addressed.

Similarly, after the failure to collect any wild Razorback Sucker in the San Juan River during three years of intensive studies (1991-1993), the SJRIP Biology Committee initiated an experimental stocking program for Razorback Sucker (Ryden and Pfeifer 1994). Subsequently, Critical Habitat for Razorback Sucker and Colorado Pikeminnow was designated between the Hogback Diversion structure (RM 158.6) downstream to Neskahai Canyon (RM -35.0) in Lake Powell; approximately 35 river miles below the waterfall which demarcates RM 0.0 on the San Juan River (USFWS 1994). In 1996, 942 Razorback Sucker were stocked at four stocking sites. Based on the successes of the experimental stocking study, a full-scale augmentation effort for Razorback Sucker was initiated in 1997 following the *Five-Year augmentation plan for razorback sucker in the San Juan River* (Ryden 1997). In February 2003, the SJRIP Biology Committee extended the augmentation effort for Razorback Sucker with *An augmentation plan for razorback sucker in the San Juan River: An addendum to the five-year augmentation plan for razorback sucker in the San Juan River* (Ryden 2003). However, due to changes in

augmentation protocols and difficulties in producing requested numbers of fish, initiation of the eight-year addendum to the original plan was delayed until 2009. That augmentation plan, in effect from 2009-2016, called for the stocking of 91,200 Razorback Sucker over an eight-year period, or ≥11,400 fish per year, from a combination of sources including the Ouray National Fish Hatchery – Grand Valley Unit (Ouray NFH-GVU), the Southwestern Native Aquatic Resources and Recovery Center (Southwestern Native ARRC) and grow-out ponds on Navajo Agricultural Products Industry (NAPI) land stocked with fish from Southwestern Native ARRC. A Final *Augmentation Plan for Razorback Sucker in the San Juan River Basin* was submitted to the SJRIP Biology Committee in 2020. This plan recommends that the Program continue to stock all available Razorback Sucker into the San Juan River with a goal of stocking ≥4,800 fish (≥300mm TL) at all sites previously stocked, both in and outside of critical habitat.

The augmentation programs for the Colorado Pikeminnow and Razorback Sucker populations in the San Juan River are specifically addressed in the following Elements, Goals, Actions, and Tasks of the 2016 SJRIP Long Range Plan (LRP).

Element 1. Management and Augmentation of Populations of Colorado Pikeminnow and Razorback Sucker

- **Goal 1.1 - Establish a Genetically and Demographically Viable, Self-Sustaining CPM and RBS Populations.**
    - **Action 1.1.1** Develop plans for rearing and stocking CPM and RBS.
        - **Task 1.1.1.1** Review and update augmentation plan for CPM and adjust stocking goals as needed.
        - **Task 1.1.1.2** Review and update augmentation plan for RBS and adjust stocking goals as needed.
    - **Action 1.1.2** Produce, rear, and stock sufficient numbers of CPM to meet stocking goals of augmentation plan.
        - **Task 1.1.2.2** Stock at least 400,000 age-0 CPM annually into the San Juan River . (Change in 2021 to 12,000 Age-1 CPM.
        - **Task 1.1.2.3** Opportunistically stock available CPM in excess of those described above.
    - **Action 1.1.3** Produce, rear, and stock sufficient numbers of RBS to meet stocking goals of augmentation plan.
        - **Task 1.1.3.2** Produce RBS in three Navajo Nation Agricultural Products (NAPI) grow-out ponds (3,000-3,500 fish per pond, > 200 mm TL) and stock into the San Juan River.
        - **Task 1.1.3.4** Stock at least 91,200 RBS (> 300 mm TL) during eight year stocking period or 11,400 per year.
        - **Task 1.1.3.5** Opportunistically stock available RBS in excess of the 11,400 described above.

The USFWS's Fish and Wildlife Conservation Offices is the primary office for satisfaction of policy requirements and to ensure compliance with needs relative to fish health, stocking requests and priorities, deviation from approved stocking requests, pre-stocking treatments (e.g. nonnative fish removal from stocking sites), and applicable environmental regulation. New Mexico Fish and Wildlife Conservation Office is the pertinent field office for processing of SJRIP stocking requests.

The Southwest Regional Policy for Stocking of Fish and Other Aquatic Species specifies regional policy for these actions. Stocking of fish reared at USFWS hatcheries in the Southwest Region are subject to Regional Policy No. 03-06, "Stocking of fish and other aquatic species". This policy applies to production, transport, and stocking for USFWS hatchery production and incorporates guidance and requirements from USFWS Fish Health Policy (713 FWM 1-5). Specifically, the policy's main objectives are to 1) recover fish and other aquatic resources population protected under the Endangered Species Act, 2) restore declining fish and other aquatic resource populations before they require listing under the Endangered Species Act and 3) Maintain healthy, diverse fish and other aquatic resource populations.

Objectives for Fiscal Year 2021

1. Annually stock a minimum of 12,000 PIT tagged age 1 Colorado Pikeminnow. *The time estimate to meet this objective is ten days. We anticipate travel to Southwest Native ARRC and to the San Juan River to meet objective goals.*
2. Stock all available Razorback Sucker (≥ 300 mm TL), with the intent to stock ≥4,800* fish per year until the population reaches the minimum population size of 5,800 adult RBS. (No RBS <300 mm TL will be stocked to help identify wild recruiting juvenile fish). *The time estimate to meet this objective is 15 days. We anticipate travel to Southwest Native ARRC and to the San Juan River to meet objective goals.*
3. Collect and analyze Razorback Sucker and Colorado Pikeminnow recapture data to calculate both survival and population estimates. We will use these analysis to modify or update plans for both as needed (see methods for details). *The time estimate to meet this objective is one month.*
4. Coordinate with the San Juan Program Office to quantify success of augmentation (see methods for details). *The time estimate to meet this objective is five days.*

*The target number of Colorado Pikeminnow and Razorback Sucker to be stocked can be adjusted (increased or decreased as appropriate) in response to known population changes (e.g., a known level of recruitment, observed changes to apparent survival, increased retention and distribution, etc.). We will only make changes to augmentation numbers after discussion and agreement with the Biology Committee.

Methods and Approach

- Objective 1. Coordinate with Southwestern Native ARRC to procure and stock Colorado Pikeminnow according to guidelines set forth in *Augmentation of Colorado Pikeminnow (Ptychocheilus lucius) in the San Juan River 2020-2025. (New Mexico FWCO in preparation).*

  The SJRIP Biology Committee has recommended that starting in 2021 Southwestern Native ARRC will shift production from 400,000 Age-0 Colorado Pikeminnow to Age-1 PIT tagged Colorado Pikeminnow. The Program has requested a minimum stocking target of 12,000 fish; this target number will likely increase. New Mexico FWCO will assist with PIT tagging all Colorado Pikeminnow at Southwest Native ARRC, and assist with stocking fish into the San Juan River.

Fish will be released in the post irrigation season, to reduce the risk of entrainment into irrigation canals. Stocked age-1 Colorado Pikeminnow will be acclimatized to the physical water chemistry of the river at the time of stocking. We will monitor a small subset of stocked fish for stocking related stress-induced mortality within an *in situ* enclosure (aka, soft release) for up to 48 hours prior to release into the San Juan River Basin.

- Objective 2. Coordinate with Southwestern Native ARRC, Navajo Nation Department of Fish and Wildlife (NNDFW), and Ouray NFH-GVU to procure and stock Razorback Sucker according to guidelines set forth in *Augmentation Plan for Razorback Sucker in the San Juan River Basin* (Furr 2020).

  - Southwestern Native ARRC will continue with a production target of 10,500 Razorback Sucker (150-250 mm TL) into the NAPI ponds (3,500 fish/pond). Navajo Nation DFW will receive, grow out and stock all fish annually. The New Mexico FWCO will assist with fish harvest and stocking from NAPI, and these activities are covered in this SOW. The Ouray NFH-GVU will provide the SJRIP Augmentation Program with ~2,000-4,000 Razorback Sucker (≥300 mm TL) annually. We assist Ouray with pre-stocking water quality readings, as well as timing and location of stocking. New Mexico FWCO will assist with stocking Razorback Sucker into the San Juan River. All fish will be stocked into existing sites to eliminate the risk of fish entrainment in irrigation canals. Stocking sites may be adjusted upon request by the Program Office. Furthermore, actively-harvested NAPI fish ≤299 mm TL will be held until they reach ≥300 mm TL, and then stocked into the San Juan River, or used for other purposes. Therefore, only ≥300 mm TL PIT tagged Razorback Sucker will be stocked into the San Juan River. This will help distinguish wild recruiting Razorback Sucker as any untagged fish captured that is <300 mm TL will be considered as a wild produced fish. Any opportunistically-acquired Razorback Sucker available to the SJRIP will be tagged and stocked on a case-by-case basis. Finally, New Mexico FWCO maintains a database of all PIT tag numbers from each stocking. This database is supplied to the Program Office.

  - We will continue to work to finalize construction and begin testing a flow conditioning on-site recirculating holding tank at NAPI ponds. Once constructed, the tank will be used to run all passively harvested fish that are **<300 mm TL** from the NAPI ponds through flow conditioning prior to stocking into the San Juan River. The goals and objectives for this project will be determined through experiment. The test period for running fish through the flow conditioning tanks will begin once the system is complete, and we will be able to determine the number of test runs that can be done annually. **Note: this project was considered non-essential and was postponed until at least FY 2021, because of current and potential future travel restrictions and health concerns of COVID-19.**

- Objective 3. The New Mexico FWCO will collect and report stocking information such as the timing, location, and physical water chemistry at time of fish releases. We will also report the number and size range of fish released. Once recapture data is available, we will calculate and report survival rates and population estimates from each cohort of released fish. We will use recapture data from annual demographic monitoring trips and remote PIT tag arrays for analysis and data reporting. These data will then be provided in annual reports and incorporated into long term plans for both Colorado Pikeminnow and Razorback Sucker. The New Mexico FWCO will

conduct all requested data analysis and reports will be submitted to the Program Office for review by the Biology Committee. We propose evaluating augmentation success through: meeting augmentation target goals for each species, using demographic monitoring results for adult survival and population estimates, using N_b estimates to track trends in genetic integrity, and small bodied monitoring to evaluate recruitment. These analyses will be integrated from other reports and studies. Additional analysis will be considered if requested by the Program Office, but are not covered by this SOW, and will be included in future SOWs.

- Objective 4. The New Mexico FWCO will communicate with the Program Office to ensure that augmentation goals and required analysis are understood and are being met. If the Program Office requests specific analysis from New Mexico FWCO we will determine our abilities to do the analysis and respond to the Program Office.

In support of these objectives, the New Mexico FWCO will identify new or alternative suitable stocking sites throughout the basin (e.g., tributaries, secondary channels, etc.) if we lose access to stocking sites or if we are requested to seek additional or alternate release sites. Site selection for Colorado Pikeminnow stockings will follow the *Stocking plan and protocol for the augmentation of Colorado Pikeminnow (*Ptychocheilus lucius*) in the San Juan River* (Furr and Davis 2009), until it is replaced by other guidance. Stocking locations and protocols for Razorback Sucker will be outlined in *Augmentation Plan for Razorback Sucker in the San Juan River Basin* (Furr 2020). Modifications to protocols and plans will be made to reflect new data as it becomes available.

Products/Schedule

An electronic data file will be provided for inclusion in the centralized database by 31 December 2021. A draft summary report detailing findings will be submitted to the SJRIP Biology Committee, by 31 March 2021. Revisions will be completed and a final annual report will be submitted by 1 June 2021. Any inability to meet deadlines will be communicated to the Program Office, and we will negotiate a compromise deadline.

Budget Justification

The budget for Colorado Pikeminnow and Razorback Sucker augmentation now includes our proposed work as augmentation lead for the Program, and for the Razorback Sucker NAPI pond harvest and stocking each year. We re-calculated the travel associated with each project and the management costs for each project, and by doing this we decreased the funds we are requesting for the combined scopes of work.

FY 2021								
Razorback Sucker and Colorado Pikeminnow Augmentation								
Labor Cost								
Position	**Grade/Step**	**ry w/ Ben**	**Hours/Day**	**Total Days**			**Sub-total**	
Fish Biologist	GS 9/7	$47.16	8	45			$16,977.60	
Fish Biologist	GS 9/4	$41.72	8	40			$0.00	$ 13,350.40
Supervisory Fish Biologist	GS 13/4	$71.12	8	10			$5,689.60	
Adminstrative Officer	GS 9/9	$46.93	8	5			$1,877.20	
Supervisory Fish Biologist	GS 14/2	$80.24	8	5			$3,209.60	
Fish Biologist	GS 11/7	$52.04	8	5			$2,081.60	
Bio. Science Techs (2 people)*	GS 5/1	$18.67	8	10			$1,493.60	
					Total Labor		**$31,329.20**	
Travel and Per Diem*	**Days**	**Rate**					**Sub-total**	
Hotel Costs	36	$96.00					$3,456.00	
Hotel tax	36	$12.00					$432.00	
Per Diem (Travel Day)	32	$41.25					$1,320.00	
Per Diem (Full Day)	32	$55.00					$1,760.00	
Concur Fee	36	$14.75					$531.00	
					Total Travel/Per Di		**$7,499.00**	
Equipment	**Miles/Qty**	**Total Miles**	**Rate**				**Sub-total**	
1 truck x 10 trips - ABQ to Farmington, NM - 366mi RT + 150mi/trip local commute	516	5,160	$0.54				$2,786.40	
Remote biologist savings	$ 13,350.40				**Equipment**		**$2,500**	
		Sub-total for Augmentation - NMFWCO only					**$41,328.20**	
		Overhead 3%					$1,239.85	
		Grand Total					$42,568.05	
* Travel and per diem costs include NAPI pond harvest, field work and assistance tagging fish at Southwest Native ARRC.								

FIGURE 1. COLORADO PIKEMINNOW AND RAZORBACK SUCKER AUGMENTATION/NAPI POND HARVEST AND STOCKING BUDGET FOR FY 2021.

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U.S. Fish and Wildlife Service. 2002. Colorado pikeminnow (Ptychocheilus lucius) Recovery Goals: amendment and supplement to the Colorado Squawfish Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

Line 47-49 states 20,000 age 1 Colorado Pikeminnow. The number discussed at the BC meeting was 12,000 based on capacity at SNARRC and other considerations. The proposed number for stocking should agree with the current direction from the BC. Changed

Line 120: Objective 2 should be rewritten to state the intent to stock up to 4,800 fish. The statement "stock all available Razorback Sucker" is too general. Done

Line 170: Objective 3 should also include a review by the Biology Committee. Done

What is this SOW's contribution to recovery?

No comments

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

Line 48,49,119: This should be amended to "Beginning in 2021, the SJRIP will annually release 12,000 age-1 PIT tagged Colorado Pikeminnow". 20,000 Pikeminnow appears to be a mistake because Southwestern ARRC can only produce 12,000 age-1 CPM per year. Changed

What is this SOW's contribution to recovery?

Augmentation efforts have proven essential to Colorado Pikeminnow and Razorback Sucker recovery efforts in the San Juan River.

Program Office

How can the technical aspects of this SOW be improved?

- Objectives could be clarified to explain specifically how NMFWCO is helping Southwestern ARRC, NAPI ponds, and GJFWCO-Horsethief Canyon? What are the needs and how is NMFWCO filling those gaps. Attempted to provide answers to how augmentation provides support for each of the separate programs. New Mexico FWCO is listed as the augmentation lead for the SJRRIP; the funding we receive for augmentation provides funding to support the personnel responsible for augmentation, both through field activities and through coordination and planning.
- Detail the analyses that will be used for Objective 3 and provide a timeline for when these will be accomplished, otherwise remove the objective if it is expected that the PO will do these analyses. Done
- There seems to be a fairly standard stocking regime so it is difficult to understand what else needs to be figured out as far as stocking locations are concerned. Explaining what those gaps are and how they will be addressed would be useful. Not sure where this comment applies, perhaps I had changed wording from a previous document. We will continue to stock fish at established stocking locations, but if requested or we lose access to a stocking site we can add or change stocking locations.
- It would help to understand how this SOW is integrated with that from NAPI Ponds, Southwestern ARRC, Horsethief Canyon, and Remote Biologist SOWs. We separated the SOW for the Remote Biologist- it is now a stand alone SOW, the duties of the Remote biologist are defined in that SOW. Our budget for the NAPI ponds SOW is contained in this SOW, and was removed from the Navajo Nations SOW. the Augmentation SOW contains the work that pertains to our role as the augmentation lead for this program, and field work associated with all stockings, and travel to Southwest Native ARRC to assist with tagging both species. We provided brief details on how we will assist Southwest Native ARRC and Grand Junction FWCO with augmentation.

Editorial:

Objectives for FY21 states they are stocking 20,000 PIT tagged age-1 CPM. Southwestern ARRC plans to stock 12,000 fish. Changed.

What is this SOW's contribution to recovery?

Stocking is one of the primary management actions that directly contributes to increased numbers of fish in the river.

COLORADO PIKEMINNOW PRODUCTION and RAZORBACK SUCKER REARING at SOUTHWESTERN ARRC, Dexter, NM
San Juan River Recovery Implementation Program

April 01, 2020

FY 2021 SOW

Submitted to
Bureau of Reclamation

From
Principal Investigator- William Knight
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U.S. Fish and Wildlife Service
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In October of 2012 Dexter National Fish Hatchery and Technology Center's name was officially changed to the Southwestern Native Aquatic Resources and Recovery Center (Southwestern ARRC). The facility is located in the Pecos River Valley of southeastern New Mexico, 200 miles southeast of Albuquerque, 20 miles south of Roswell, and one mile east of Dexter on State Road 190.

Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*), once common throughout the Colorado River Basin, have declined from historic levels and are now found primarily in the Upper basin of the Colorado River. Various factors have contributed to the decline of the species including alteration of natural stream flows and temperature regimes, loss of habitat and habitat fragmentation as a result of water development and the introduction of nonnative fish species.

The following scope of work identifies the facilities and methodologies that will be used to produce 12,000 150mm age-1 Colorado pikeminnow (CPM); and 11,000, 200mm razorback sucker (RBS) for use by the San Juan River Recovery Implementation Program (SJRIP) to meet its augmentation objectives for the species in the San Juan River. The primary purpose of this work is the culture and distribution of CPM to the San Juan River and RBS to the Navajo Agricultural Products Industry (NAPI) grow-out ponds located on the Navajo Nation. Southwestern ARRC has developed production guides for both species based on historical growth rates and produces large numbers of each species for distribution throughout the upper and lower Colorado River Basin.

Relationship to Recovery Program Actions, Tasks and Goals

The main objective for the production and augmentation of CPM and RBS is to facilitate the establishment of self-sustaining populations of both species within the San Juan River, with the eventual goal of contributing to the recovery of the species (Ryden 1997, SJRIP 2016). The SJRIP Long-Range Plan (LRP) (SJRIP 2016) identifies the need to implement and assess the augmentation of Colorado Pikeminnow and Razorback Sucker populations in the San Juan River Basin (Basin). Several documents provide the necessary guidance for the production and augmentation requirements for each specie. The initial **Augmentation Plan for Colorado Pikeminnow in the San Juan River (Phase I)**, (Ryden 2003) called for annual stocking of age-0 fish over an eight year period (2002-2009). A modified work plan was developed and incorporated into the augmentation program in 2005. Under the amended plan; (Addendum #1 to Augmentation Plan for Colorado Pikeminnow in the San Juan River (Ryden 2005)), age-1 fish were produced at Dexter from 2006-2010 to augment the age-0 stockings in the San Juan River. The augmentation plan (**Phase I**) for age-0 and age-1+ Colorado pikeminnow ended in 2010. Augmentation efforts identified in the **Phase II** (2010 – 2020) **Augmentation Of Colorado Pikeminnow (*Ptychocheilus lucius*) In The San Juan River Plan,** (Furr 2009); focus primarily on culturing and stocking increased numbers of age-0 fish. Current facility and broodstock capabilities at Southwestern ARRC allow for age-0 and age-1 Colorado pikeminnow to be produced and stocked annually. In 2020 the SJRIP requested Southwestern ARRC to shift Colorado Pikeminnow production/augmentation efforts from stocking ~400,000 age-0 fish to

~12,000 age-1 fish. The shift in production is based on several factors aimed at increasing CPM retention in the river, including: (1) A recent Kansas State University diet study that demonstrates that channel catfish predominantly consume prey <150mm TL. (2) a means to more rapidly increase the number of adult Colorado Pikeminnow in the San Juan River, (3) larger fish will be PIT tagged to distinguish captive produced from wild-spawned fish, and (4) the effort will allow for experimentation to improve the efficiency of future Colorado Pikeminnow stocking efforts through the initiation of hatchery enrichment methodologies such as flow conditioning, and prey and predator training.

In 2016 Southwestern ARRC staff began participating in fish collection efforts to augment the captive CPM broodstock with wild caught individuals from the Green and mainstem Colorado Rivers. This action was prompted due to declining wild populations of Colorado Pikeminnow in the Upper Colorado River Basin, and the genetic make up and ageing broodstock at Southwestern ARRC. This multi-agency effort includes partners from the Upper and Lower Colorado River Basin and San Juan Recovery Program. Age-0 CPM are to be collected from the Colorado and Green Rivers over a 5-6 year period, transported to Dexter and maintained until they are adults. To maximize genetic diversity of the future broodstocks: 1) collections will be conducted over several years (2016-2021), 2) collection localities in each river will vary, and 3) the overall target number per broodstock will aim to collect a total of 1,000 individuals per river (Green and Colorado) over the multi-year timeframe. If a broodstock is needed for each Program (Upper Basin and San Juan), then the maximum number will be 2,000 per river, half of which would stay at Southwestern ARRC and the other half transferred to Upper Basin facilities after an initial multi-year (3-5 years) grow-out at Southwestern ARRC. Progress to date includes the collection of 144 juveniles from the mainstem Colorado River near Moab, UT in 2016; no fish were collected in 2017; 12 fish from the Green River in 2018 and 185 fish from the Green River in 2019. A more concentrated collection effort is planned for 2020 and 2021.

The proposed work helps address specific actions, tasks and goal requirements of the augmentation program for the Basin's Colorado pikeminnow and razorback sucker populations as identified in the 2016 LRP:

- **Goal 1.1 - Establish a Genetically and Demographically Viable, Self-Sustaining CPM and RBS Populations.**
    - **Action 1.1.2** Produce, rear, and stock sufficient numbers of CPM to meet stocking goals of augmentation plan.
        - **Task 1.1.2.2** Stock at least 400,000 age-0 (50–55 mm TL) and age-1 CPM annually into the San Juan River.

        - **Task 1.1.2.3** opportunistically stock available CPM in excess of those described above.

    - **Action 1.1.3** Produce, rear, and stock sufficient numbers of RBS to meet stocking goals of augmentation plan.
        - **Task 1.1.3.2** Rear and stock hatchery-reared RBS into three NAPI grow-out ponds (3,000-3,500 fish per pond, > 200 mm TL).
        - **Task 1.1.3.4** Stock at least 91,200 RBS (> 300 mm TL) during eight year stocking period or 11,400 per year.
        - **Task 1.1.3.5** Opportunistically stock available RBS in excess of the 11,400 described above.

- **Goal 1.2 - Identify and Implement Strategies for Improving the RBS and CPM Augmentation Program and Genetic Integrity.**
    - **Action 1.2.1** Implement methods to evaluate status and success of stocked RBS and CPM.
        - **Task 1.2.1.2** Identify, describe, and implement strategies for improving survival and retention of stocked razorback sucker and Colorado pikeminnow, including acclimation prior to stocking, size of fish stocked, time and location of stocking, physiological conditioning, and predator avoidance.

- **Goal 1.3 - Support Operations and Maintenance of Facilities to Support RBS and CPM Stocking Programs.**
    - **Action 1.3.1.** Support production and grow-out facilities.
        - **Task 1.3.1.1** Support operation and maintenance of hatchery facilities at SNARRC for CPM and RBS production.
        - **Task 1.3.1.3** Support operation and maintenance of Navajo Agricultural Products Industry (NAPI) grow-out ponds for RBS production.

<u>Facility Description:</u>

The U.S. Fish and Wildlife Service (USFWS) has developed extensive infrastructure and expertise at Southwestern ARRC to successfully contribute to recovery programs. The facility

has been totally devoted to the maintenance, propagation and culture of threatened and endangered fish species for forty years. During that period it has successfully cultured razorback sucker, bonytail, humpback chub and Colorado pikeminnow of the Colorado River system and currently maintains large genetically diverse broodstocks. Over the years staff have developed successful spawning, culture and distribution methodologies for the species that are still used today. The facility utilizes an abundant water supply to produce over 1.5 million fish annually.

Facilities

Situated on the northern fringes of the Chihuahua Desert, the elevation at Dexter is 3,500 feet; average rainfall is 12 inches, and the growing season of 180-200 days. Station facilities include: Administration/Laboratory Building; Fish Culture Building; Isolation/Quarantine Building; Maintenance/Shop Building; Vehicle Storage Building; Equipment Storage Building; Feed Building; General Storage Building.; three government houses; one mobile home, two RVs and one RV space.

Fish culture facilities in operation consist of 76 earthen/lined ponds ranging in size from 0.1-1.0 acres, four (6' X 40') fiberglass raceways, four (8' X 40') concrete raceways, Twenty (2' X 12') rectangular fiberglass tanks, forty (4') fiberglass circular tanks, fifty (3') fiberglass circular tanks and 80 ten-gallon and 20 forty-gallon aquariums. The facility utilizes three water reuse systems in the fish culture building. Phase III Facility Improvement Project was completed on June 5, 2003.

Water

An abundant supply of fish culture water is supplied by five shallow aquifer wells (150 feet in depth) capable of pumping a combined 2,000+ gallons per minute. The well water is a constant 64^0 F, pH of 7.5-8.5, total hardness of 2,100 ppm, and total dissolved solids of 3,500 ppm. Water rights, allocated through the New Mexico State Engineer's Office, total 2,185.5 acre-feet per annum or 10,927.5 acre-feet per five-year water period. Waste water from all fish culture operations collects in two sumps on the southeastern area of the facility and provides year round water to the wetlands.

I. Rearing Colorado Pikeminnow at Southwestern ARRC

Southwestern ARRC has been the leader in propagating and culturing CPM since 1981. The facility maintains several captive stocks as genetic reserves and has successfully produced fish for the Upper and Lower Colorado River Basin programs and the SJ RIP. The main emphasis has been on examining the reproductive biology of the species, broodstock development and culturing age-0, age-1 and adult fish. This work plan proposes the production of 12,000 age-1

fish (150 mm TL) annually for reintroduction in the San Juan River.

The funding requested also covers costs associated with proper care of the broodstock necessary to successfully carry out this project for future years and aide in restoration of the species. Stocking will require coordination with New Mexico Fish & Wildlife Conservation Office and Navajo Nation Department of Fish and Wildlife.

Objectives

(1) Produce 12,000 age-1 fish (150 mm) for stocking in the San Juan River annually from 2021- 2025

(2) PIT tag, transport and distribute 12,000 age-1 Colorado pikeminnow from Dexter, NM to the San Juan River.

(3) Maintain 400 Colorado pikeminnow broodstock for recovery efforts. In addition, develop new broodstock derived from wild fish collections from the upper Colorado River basin from 2016 -2021.

Methods

Broodstock consists of 200 (F1) and 450 (F2) adults. These fish are 1999, 2004 and 2006 year-class (YC) progeny from wild adults collected from the Yampa, Green and Colorado Rivers, respectively. In 2021 a maximum of 50 paired matings (1 female X 1 male) will be spawned from the 1999 YC broodstock. Given the past history of hormonal induced ovulation, 38 females (75%) should produce viable eggs during a given year. All members of the broodstock are PIT tagged and records of spawning pairs are maintained at Southwestern ARRC.

Spawning

Broodfish will be harvested from the culture pond in early May, males and females sorted and held indoor for spawning. Ovulation will be induced with intraperitoneal injections of common carp pituitary (CCP) at the rate of 4 mg/kg of body weight. When eggs can be expelled using slight pressure, a female will be stripped and milt added from one male. Each individual egg lot will be enumerated, incubated and kept separate in Heath Trays until hatching occurs, approximately 96 hours following fertilization at a constant water temperature of 72°F.

Rearing Ponds

To meet the production goal of 12,000 age-1 (150mm) fish, rearing ponds will be stocked at the

following densities:

Age-1 Growth: (June thru October – 1.5 years - approx. 550 day growing period)

Pond 1A-	.73	Surface acre lined	@ 20,000 fry
Pond 6B-	.35	Surface acre lined	@ 3,000 fingerlings
Pond 7B-	.35	Surface acre lined	@ 3,000 fingerlings
Pond 6D-	.25	Surface acre lined	@ 3,000 fingerlings
Pond 7D-	.25	Surface acre lined	@ 3,000 fingerlings

Rubber and plastic lined ponds will be used for production. Fertilization and slow filling of ponds will start 10 to 14 days prior to stocking. Staff will ensure that water quality is monitored. Temperature, dissolved oxygen and pH readings will be taken twice daily at 7:00am and 3:00 pm at the deepest part of the pond.

If the dissolved oxygen drops to < = 3 mg/I, supplemental aeration will be started. All feeding, fertilization and chemical applications will be stopped till adequate oxygen levels are restored. Aerators will be run all night for several days till the oxygen is back up to acceptable levels, (5-7 mg/1). Staff will avoid handling fish for 7 -10 days following a stress related circumstance.

Zooplankton and invertebrate insect populations are cultured with the proper fertilization regime. Four types of fertilizer will be used:

1) Alfalfa meal
2) Alfalfa pellets
3) Cottonseed meal
4) Super phosphate

Initial fertilization rates for ponds are 100 lbs. of cottonseed meal, 100 lbs of alfalfa meal or pellets and 3 lbs of super phosphate. Follow up rates are administered on Monday and Thursday with 10 lbs cottonseed meal, and 10 lbs, alfalfa meal or pellets.

Water temperature, dissolved oxygen (DO) and pH readings will be taken in all rearing ponds daily. All readings will be recorded on record charts. If morning DO readings are below 3.0 or above 13.0 all fertilization will be stopped until DO's are brought back to accepted levels. If pH readings are greater than 9.5 fertilization will be terminated.

Feeding Schedule

Fish will be sampled at the end of every month. Size, weight and over all condition will be recorded. Feed amounts will be adjusted and projected for the upcoming month. Trout #1 and #2 crumble,

2.0, 3.0 and 4.0 mm feed will be used and purchased from SKRETTING (formerly Nelson and Sons, Silver Cup), Murray, Utah. Age-0 and age-1 fish will be fed three times daily at approximately 9:00am, 12:00noon and 3:00pm.

Feeding rates are based on water temperature and fish densities in the ponds and will be calculated as follows:

- Water temp > = 80 ^{o}F feed 3 % BW per day, Mon, Wed and Fri.
- Water temp 61-78 ^{o}F feed 2 % BW per day, Mon thru Fri.
- Water temp < 60 ^{o}F feed 1.5 % BW per day, Mon and Thurs.

Staff will use the following guide to determine the proper particle size to offer the fish. Feed sizes will be mixed at ½ rations of each size when making the transition to the next larger size feed.

Fish Size	Particle Size
Fry	Starter
20mm	#1 crum
40mm	#2 crum
70mm	2.0 mm
100mm	3.0mm
125-150mm	4.0mm

Schedule

Broodfish will be spawned in May 2020 and age-0 fish reared in rubber and plastic lined ponds from June - October 2020 brought indoor for enumeration and stocked back out from November 2020 to October 2021.

Projected Harvest Dates and Delivery Date

Age -1 fish will reach the target size of 150mm by the end of October of each year once the production cycle is established. The fish will be harvested from the ponds in early October, PIT tagged, hauled and distributed into the San Juan River the first full week in November of each year.

Projected Duration Of Project:

This work is continuation of activities initiated in 2002 in support of the San Juan RIP Colorado pikeminnow augmentation effort (2002-2009) identified in the **Augmentation Plan for Colorado Pikeminnow (CPM) In the San Juan River**, (Ryden 2003). Current and future

augmentation targets for the species were listed in the Phase **II** Augmentation **Of Colorado Pikeminnow (*Ptychocheilus lucius*) In the San Juan River Plan,** (Furr 2009). Under Phase II, augmentation efforts focused on culturing and stocking ≥400,000 age-0 Colorado pikeminnow annually from 2010-2020 or as directed by the San Juan Recovery Implementation Program. In 2020 the SJRIP requested a shift in Colorado Pikeminnow production from age-0 to age-1 for a five year period (2021-2025) in order to evaluate its effect at increasing the Colorado Pikeminnow population in the San Juan River.

II. Rearing Razorback Sucker at the Southwestern ARRC

Razorback sucker (RASU) have been maintained and cultured at Southwestern ARRC since 1981. The captive broodstock represent the Lake Mohave population. Three separate broodstocks are maintained; the 1981, Paired Mated (PM) and Wild Caught (WC) broodstocks. The PM stock is comprised of 90 unique family groups produced from paired matings of wild caught adults spawned at Willow Beach NFH from 1994 to 2004. The WC broodstock consists of six year classes of larvae and juvenile wild-caught fish from Lake Mohave from 2000 to 2005. These fish were captured as fry from eight locations throughout Lake Mohave and given the designation of (WC) future broodstock.

From 2001-2013 production of subadult razorbacks at Southwestern ARRC has yielded excellent survival and growth. The overall survival for razorback sucker grown to 450mm is 90.5%, while 85% of the fish achieved the target growout size in two years. Spawning and growing season consists of fish being spawned in the early spring and fry stocked in to earthen or lined ponds and grown out-door from April to October. Total dissolved oxygen and temperature are monitored daily and fish feed on phyto and zooplankton produced in fertilized ponds for approximately 45 days at which time they are offered a prepared razorback sucker diet. Fingerlings are routinely held and cultured in the Fish Culture building during the months of January - March to prevent mortalities associated with outdoor over wintering. In the fall of the year when the fish reach target size they are harvested from the ponds and transferred to the Fish Culture building for sorting and tagging. Following a 7 to 10 day rest and recovery period they are loaded into distribution trucks and hauled to their stocking locations. Southwestern ARRC staff have successfully hauled 300+mm razorbacks to the San Juan River and razorbacks and Bonytail to Lake Mohave, Arizona, in the lower Colorado River. The distribution trips to the San Juan average 400 miles (8 hours) and the trips to Lake Mohave average 660 miles (12 hours) of hauling time in one direction.

Objectives:

The main objective of this proposed work is to spawn razorback sucker adults and rear up to 11,000, 200mm fish annually and deliver them to existing grow-out ponds located on the Navajo Nation.

Additional objectives of the work include:

(1) Improve, maintain and staff facilities at Southwestern ARRC to rear and distribute the target number of fish.

(2) Passive Integrated Transponder (PIT) tag all fish prior to stocking into the NAPI ponds. PIT tags will be provided by the SJRIP.

(3) Maintain razorback sucker captive broodstock for recovery efforts.

Methods

Captive propagation activities include spawning a minimum of 20 pairs of broodstock, incubating fertilized eggs, enumerating and stocking of swimup fry into rearing ponds, harvest of target sized fish from ponds, PIT tagging and distribution to the NAPI ponds near Farmington, NM on the Navajo Nation.

The project will utilize indoor and outdoor facilities. All spawning and incubation activities will be conducted indoor in the Fish Culture building. Razorback sucker will be initially reared in 2 earthen or lined ponds and in June of each year transferred to 3 ponds at surface acres of 0.79, 0.89 and 0.98.

Rearing Ponds

To meet the production goal of 11,000 (200mm) fish, rearing ponds will be stocked at the following densities:

Age 0 Growth: (April thru May - 60 day growing period)

Pond 1- .72 acre @ 12,000 fry
Pond 2- .79 acre @ 12,000 fry

Age I Growth: (June thru October - 150 day growing period)

Harvest Age I fish; enumerate and stock fingerlings into 3 ponds.

Pond 1- .79 acre @ 6,000 fingerlings

Pond 2- .89 acre @ 6,000 fingerlings
Pond 3- .98 acre @ 6,000 fingerlings

Earthen and lined ponds will be used for production. In earthen ponds the bottoms will be packed and graded prior to receiving fish. Non-level pond bottoms can hinder fish harvest and aquatic vegetation can entrap fish at harvest time. Fertilization and slow filling of ponds will start 10 to 14 days prior to stocking. Staff will ensure that water quality is monitored. Temperature, dissolved oxygen and pH readings will be taken twice daily at 7:00am and 3:00 pm at the deepest part of the pond.

If the dissolved oxygen drops to < = 3 mg/I, supplemental aeration will be started. All feeding, fertilization and chemical applications will be stopped till adequate oxygen levels are restored. Aerators will be run all night for several days till the oxygen is back up to acceptable levels, (5-7 mg/l). Staff will avoid handling fish for 7 -10 days following a stress related circumstance.

Pond Vegetation Control and Fertilization

Sonar, Diuron or Barrier will be used in earthen ponds to control rooted aquatic vegetation. Staff will use granular form when possible and broadcast the entire pond bottom at the recommended rates.

Diuron – 2.0 lbs. per acre (dry broadcast)
Barrier- 100 lbs. per acre (dry broadcast)

Copper sulfate (CUSo4) will be used to control floating filamentous algae blooms. Treatments will began approximately 45 days after fish are stocked into the ponds and repeated every 30 days. Application rates in ponds are 5 to 8 lbs per acre. A secondary benefit derived from using CUSo4 is its effectiveness in controlling external parasites.

Zooplankton and invertebrate insect populations are cultured with the proper fertilization regime. Four types of fertilizer will be used:

1) Alfalfa meal
2) Alfalfa pellets
3) Cottonseed meal
4) Super phosphate

Initial fertilization rates for earthen ponds are 100 lbs of cottonseed meal, 100 lbs of alfalfa meal or pellets and 3 lbs of super phosphate. Follow up rates are administered on Monday and Thursday with 10 lbs cottonseed meal, and 10 lbs, alfalfa meal or pellets.

Water temperature, dissolved oxygen (DO) and pH readings will be taken in all rearing ponds daily. All readings will be recorded on record charts. If morning DO readings are below 3.0 or above 13.0 all fertilization will be stopped until DO's are brought back to accepted levels. If pH readings are greater than 9.5 fertilization will be terminated.

Feeding Schedule

Fish will be sampled at the end of every month. Size, weight and over all condition will be recorded. Feed amounts will be adjusted and projected for the upcoming month. A prepared feed will be purchased from SKRETTING (formerly Nelson and Sons, Silver Cup), Murray, and Utah. Fish will be fed twice daily, once at 9:00am and at 2:00pm.

Feeding rates are based on water temperature and fish densities in the ponds and will be calculated as follows:

- Water temp > = 80 ^{o}F feed 3 % BW per day, Mon, Wed and Fri.
- Water temp 61-78 ^{o}F feed 2 % BW per day, Mon thru Fri.
- Water temp < 60 ^{o}F feed 1.5 % BW per day, Mon and Thur.

Staff will use the following guide to determine the proper particle size to offer the fish. Feed sizes will be mixed at ½ rations of each size when making the transition to the next larger size feed.

Fish Size	Particle Size
2-3"	1.0 mm
4-6"	2.0 mm
6-8"	3.0 mm

Schedule

Broodfish will be spawned in March and the fish reared in earthen ponds for their first growing season (April – October); held indoor during winter (November - March) and stocked into the NAPI ponds in April of 2021. Target sized fish are available for distribution in spring and fall of each year.

Projected Harvest Dates and Delivery Date

Year 2021 marks the sixteenth year of razorback production at Southwestern ARRC for distribution to the NAPI ponds. In 2007 a new single cohort fish rearing strategy was adopted by the San Juan RIP for the NAPI ponds. Since 2006, staff have stocked a total of 110,442 razorback's averaging 225mm in length into East and West Avocet and Hidden ponds and in 2012, 2016, 2017, 2018, 2019 and 2020 stocked an additional 1,000+ target sized RBS into the

San Juan River annually. An additional 11,000 fish will be stocked into the NAPI ponds in April 2021. Based on historical growth rates for razorback at Dexter, the production target of 11,000, 200mm fish will require a fifteen month growout period. Fish delivery will be in the spring of each year based on the new rotational production plan (single cohort). Approximately 11,000 fish will be stocked each trip and Dexter staff will coordinate the deliveries with the Navajo Nation Department of Fish and Wildlife, BIA and USFWS FWCO personnel. The estimated duration of the program is scheduled for a total of 18 years (2005- 2023).

PIT Tagging

Starting in 2012 all fish stocked from Dexter into the San Juan River and NAPI ponds are PIT tagged prior to stocking. The fish will be graded and sorted approximately 6 to 8 weeks before the scheduled stocking date. Fish that average 200mm will be PIT tagged and allowed to recover for a minimum of 10 to 14 days after each handling. The PIT tagged fish will be scanned for tag retention and any fish that lost a tag will be retagged prior to shipping.

Projected Duration Of Project:

This project was initiated in January 2005 in support of the SJRIP razorback augmentation effort (2004-2011) identified in the **Five-Year Augmentation Plan for Razorback Sucker in the San Juan River** (Ryden 1997, 2003). Current and future augmentation targets for the species are listed in the "draft" **Augmentation Plan for Razorback Sucker in the San Juan River Basin,** (Furr 2016). The rearing of razorback sucker subadults at Southwestern ARRC could potentially continue till 2023 (BOR RFP 04-SF-40-2250). Under the new plan, augmentation efforts focus on culturing and providing 11,000, 200mm sized razorback sucker to the Navajo Nation, NAPI ponds fish rearing project annually from 2016-2023 or as directed by the San Juan Recovery Implementation Program.

General Fish Husbandry Requirements and Conditions

Predator Control

Historically, Southwestern ARRC has not experienced excessive avian or mammal predation on fish stocks. Salamander, crayfish, frog and turtle infestation of ponds are nonexistent. On an annual basis specific ponds are covered with bird netting during the winter months to eliminate predation by migrating birds. An additional strategy employed by the staff is the harvest and holding of stocks of fish indoor during the winter months of November to March. Razorback suckers reared for this project will be maintained indoor in two 40,000 gallon systems during the winter months. These systems contain biofiltration, supplemental aeration, temperature control and alarm systems.

Handling and Transport Protocol

Transport of all fish will follow guidelines described in the USFWS Protocols for Biological Investigations developed by Dr. Gary Carmichael, retired U.S. Fish & Wildlife Service employee. The protocol is as follows:

1. When Colorado pikeminnow and razorback fingerlings, subadults and broodfish are handled they will be placed in a .5% salt bath to help in osmoregulation and reduce the effects of handling stress.

2. Temperature should be 5 degrees Fahrenheit lower in the hauling truck than in the river.

3. Drivers must be informed of and follow a specified route.

4. Transport water will contain 0.5 percent NaCl (18.9 grams per gallon).

5. Oxygen levels will be greater than 6.0 mg/L as determined with an oxygen meter.

6. Nets must be functional. Aeration equipment must be in place and must be used. A fish holding container will be a minimum of 5 gallons in size and fish densities will not exceed 1 lb of fish per gallon of water. Small delta mesh (1/8") will be present to transfer the fish from one container to another, although it is preferred to have water to water transfer. Oxygenation/aeration equipment will be in place and working.

7. Prior to transfer and after the fish are concentrated, they should be quickly placed in the transport tank. When using nets to place fish in transfer buckets or tanks, nets should not be overloaded. The fish on the bottom will be crushed. Using a wet transfer with buckets is preferable. When emptying the nets and buckets, care will be taken to avoid adding algae and mud to the transport tank. Before loading, dissolved oxygen levels should be at saturation.

8. Immediately after loading, all equipment on the transport vehicle should be re-checked and the vehicle should depart. Oxygen concentrations and temperatures should be monitored at a minimum of every hour.

9. During unloading tempering water should be present and functional, and thermometers should be used to match water temperatures. Hauling water temperatures should be equal to receiving water temperature.

***Acclimatizing the fish to the receiving water temperature will be conducted in increments of 2º F or (1ºC) towards equalizing per 30 minutes time. Due to the high alkalinity and TDS of Southwestern**

Native ARRC water, staff will temper and acclimate the transported fish to the receiving water quality for a minimum of 1 hour prior to release. This process will allow sufficient time for the fish to osmoregulate to the receiving water quality. Tempering can be accomplished in the shipping tank by adding receiving water to the tank at given intervals.

Fish Health Monitoring Protocols

All fish should be handled with the best animal husbandry practices available. A feeding schedule will be developed and followed daily. All tanks will be cleaned of uneaten food and feces daily. A daily log recording times of feeding, water temperature and comments on fish health will be maintained. If fish are maintained in a re-circulating system, all filters and pumps will be routinely cleaned and monitored. If fish are held in ponds O2 levels will be closely monitored. At least once a year, a fish health inspection will be conducted to examine fish for bacterial, viral and parasitic infections. Normally 60 fish per lot are sacrificed for an adequate sample. However, in the case of endangered or rare fish of genetic importance, numbers sampled may be less, depending upon availability. Non-lethal methods, if available, will be employed to obtain samples. Condition factors will be calculated on an annual basis and data added to a RBS database. Wet mounts will be examined for parasites and bacteria. Routine condition exams will be conducted and an examination will be conducted on all lots one month prior to delivery to the San Juan River and NAPI ponds on the Navajo Nation. Brood and refuge stock will have health checks annually and only when needed to minimize handling stress.

The U.S. Fish and Wildlife Service, Dexter Fish Health Program will provide bacterial and viral testing for razorback propagation and rearing activities. Treatment of disease will be the responsibility of the Southwestern ARRC fish culture staff. Fish health experts are available to advise on proper treatment, and to examine fish for infection.

Disposition of Fish

All fish propagated and cultured for this project are made available to the SJRIP for stocking and meeting augmentation requirements identified in the Phase II (2010 – 2020) **Augmentation Of Colorado Pikeminnow (*Ptychocheilus lucius*) In The San Juan River Plan ,** (Furr 2009) and the "draft" (2016-2023) **Augmentation Plan For Razorback Sucker In The San Juan River** (Furr 2016). In the case of catastrophic loss (>25% of the stock) at Southwestern Native ARRC, up to 1,000 individuals will be collected for testing and diagnosis to determine (if possible) reason for loss. A written statement describing the loss will be provided immediately to the US Fish and Wildlife Service (Service) Fisheries Division and the SJRIP Coordinator, Albuquerque, NM; followed by a detailed report of the diagnosis once results are available. Excluded from these reporting requirements are gametes and fish lost to natural attrition, including but not limited to non-viable eggs prior to hatch and incidental predation mortalities. As per the guidelines identified in the 2003 Memorandum of Understanding between the Service

and University of New Mexico, Division of Fishes, Museum of Southwestern Biology (MSB), fish carcasses (specimens) will be provided to the MSB who serves as the repository for vouchered specimens of native fishes. Any additional mortalities above the 1,000 mark will be recorded in the annual Threatened and Endangered Species report and disposed of by burial onsite or at a local land fill.

If any concerns are identified leading to potential questions about stocking of fish, in the instance of fish having cleared the Service's fish health testing for reportable pathogens and other agents of concern using established Fish Health Center SOPs and those of the American Fisheries Society – Fish Health Section Blue Book, the SJRIP has 30 days to formally respond with recommendations on the disposition of the fish. After 30 days, if no response is provided, in writing, the disposition action for the fish will be at the discretion of the Service.

Reporting

A draft annual progress report detailing fish culture and distribution activities will be completed and provided to the SJRIP by January 31, 2022.

Budget

RE: Colorado Pikeminnow Age-1 Production and Razorback Sucker Rearing of Adults and Subadults at the Southwestern ARRC, Dexter, NM. The following costs are associated with producing and stocking 12,000 age-1 CPM and 11,000, 200 mm subadults into the NAPI ponds on the Navajo Nation and the San Juan River in 2021. Identified costs also include maintaining CPM and RBS broodstock for recovery efforts.

Budget -Detailed Spending Plan 2021

I. Colorado Pikeminnow Fingerling Production

O&M Labor Costs

The labor costs identified for 2021 are broken down as follows, and include fringe benefits and payroll additives for each position identified:

Southwestern Native Aquatic Resources and Recovery Center

(1) Fish Biologist (1,280 hours -16pay periods) - GS 482-9 @ $36.38/hr. = $46,566

* Supervision, spawning, fish health and water quality monitoring, feeding, harvest and prep for distribution.

(1) Admin. Officer (240 hours- 3pay periods) - GS 341-9 @ $35.59/hr. =$ 8,542

* Budget tracking, purchasing, data base management & reporting.

Subtotal = $55,108

Equipment and Supplies:

Liquid oxygen and compressed oxygen 12 cylinders @ $91.60	$ 1,099
Airgas	
Spawning Supplies	$ 1,101
Hormones (CCP 5 vials @ $220.18 per 10ml/vial)	
Fish health sampling prior to stocking	$ 2,375
Lab supplies for bacti, viral and parasite testing.	
Culture equipment (nets, seines, screens, etc.)	$ 2,422
Eager, Memphis Net & Twine	
Pond management supplies, Barrier $307.43/50# bag (20 bags)	$ 6,149
Van Diest	
Fish feed, 1.85/lb., 6,000 lbs.	$11,100
SKRETTING	
Cyclical Maintenance costs for:	$ 1,738
Tractors, mowers, gators, sweepers	
used in pond maintenance	
Subtotal	**$ 25,984**

Utilities:

Pumping costs	
Electrical 200,257 kwh @ .10568	$21,163
Heating water for hatching eggs to swim-up	
Natural gas 1,525 ccf @ 1.112	$ 1,696
Subtotal	**$22,859**

Reintroduction Costs:

Salaries	
GS-9 Fish Biologist	
24 hrs. @ $36.38	$ 873
GS-7 Fish Biologist	
24 hrs. @ $27.04	$ 649
WG-7 Maintenance Worker	
24 hrs. @ $24.64	$ 591
WG-5 Bio Science technician	
24 hrs. @ $18.44	$ 443

Lodging &Per Diem $126/day (Dexter to Farmington, NM and return)
$126.00/trip x 2 trips x 4 employees = $1,008

Fuel costs and truck maintenance 1200 miles @ $6.130 $7,357
Subtotal **$10,921**

Annual subtotal (CPM)
(O & M Direct Costs) $ 114,872

II. Rearing Razorback Sucker at the Southwestern ARRC

O&M Labor Costs
The labor costs identified in the 2021 Scope of Work are broken down as follows, and include fringe benefits and payroll additives for each position identified:

Southwestern Native Aquatic Resources and Recovery Center

(1) Fish Biologist (1,040 hours -13pay periods) - GS 482-9 @$36.38/hr. = $ 37,835
* Supervision, spawning, fish health and water quality monitoring, feeding, harvest and distribution.

(1) Administrative Officer (160 hours- 2pay periods) - GS 341-9@$35.59/hr. = $ 5,694
* Budget tracking, purchasing, data base management & reporting.
Subtotal = $43,529

Materials and Supplies
Cost based on SNARRC's historical purchases:

Fish Health

Fish health sampling prior to stocking
Lab supplies for bacti, viral and parasite testing. $ 1,371

Fish Culture Supplies	
Nets, seines, tubs, screens.	$ 2,318
Wet lab supplies (pipets, petri dishes, slides, probes, markers)	$ 308
Theriputents- salt, Oxytetracycline, formalin, MS-222, stress coat	$ 737
Liquid and compressed oxygen for fish distribution	$ 246
Feed	
Fish feed from Skretting (2.0 tons) 4,000 lbs. $ 1.85 per lb.	$ 7,400
Spawning Supplies	
Hormones (HCG 10 vials @ $ 61.41 per 10ml/vial)	$ 614
Fertilizer	
Alfalfa pellets (1,000 lbs.) .314/lb.	$ 314
Inorganic - Super Phosphate (10 bags) 9.18/bag	$ 92
Chemicals- Aquatic Vegetation Control	
Barrier- (6 bags) $307.43/bag	$ 1,845
Diuron - (2 bags) $ 93.98/bag	$ 188
Subtotal =	**$15,433**
Services	
Utilities & Equipment Maintenance	
* Electrical, fuel and phone	$ 5,464
* Boiler system, heat exchanger maintenance	$ 1,229
*#1 well and water tower and pumping station maintenance	$15,162
Subtotal =	**$ 21,855**
Travel	
- Fish stocking/distribution.	
Dexter to Farmington (NAPI) & return- (1640 miles @ 6.314 per mile DX truck) =	$10,355
Fuel and routine vehicle maintenance.	
Perdiem- $126per day X 2 trips X 2 individuals. =	$ 504
Subtotal =	**$10,859**
Annual subtotal (RBS)	
O&M DIRECT COSTS	**$91,676**

	FY 2021 – SOW 9 & 10
I. Colorado Pikeminnow Age-1 Production	$114,872
II. Rearing Razorback Sucker Subadults at the Southwestern ARRC	$91,676
Annual total:	**$206,548**
3 % Administrative Overhead	**$ 6,196**
TOTAL REQUESTED FOR 2021	**$ 212,744**

Projected out year funding request:

FY 2022 - $219,126

Literature Cited:

Furr, W. D. 2009. Augmentation Plan, Augmentation of Colorado Pikeminnow (*Ptychocheilus lucius*) In the San Juan River, Phase II 2010-2020. U. S. Fish and Wildlife Service, Albuquerque, NM. 15 pages.

Furr, W. D. 2016. Augmentation Plan For Razorback Sucker In The San Juan River Basin 2016-2023. U. S. Fish and Wildlife Service, Albuquerque, NM. 16 pages.

Hamman, R. 1985. Induced spawning of hatchery -reared razorback sucker. Prog. Fish-Cult.. 47(3): 187-189

Ryden, D. W. 2003. An Augmentation Plan For Colorado Pikeminnow In The San Juan River. U. S. Fish and Wildlife Service, Grand Junction , Co. 63 pp. + appendices.

Ryden, D. W. 2003. An augmentation plan for razorback sucker in the San Juan River: An addendum to the five-year augmentation plan for razorback sucker in the San Juan River (Ryden 1997). U. S. Fish and Wildlife Service, Grand Junction, CO. 32 pp.

Ryden, D. W. 2005. *Draft* Addendum #1, Stocking Age-1 Fish To Supplement Ongoing Augmentation Efforts. An Augmentation Plan For Colorado Pikeminnow In The San Juan River. U. S. Fish and Wildlife Service, Grand Junction , Co. 3 pages.

Response to comments:

9 & 10	SOWs-9&10-Colorado Pikeminnow Production and Razorback Sucker Rearing at Southwestern ARRC	Knight; Dexter ARRC

Comment :

How can the technical aspects of this SOW be improved?

I know that cannibalism is a big problem, and that grading CPM is expensive in time and dollars. Are there any other hatchery techniques that could increase the number of CPM?

Response: Southwestern ARRC staff continue to examine methods to meet fish request targets. Adjustments are made on an annual basis to achieve consistent production results. Producing Age-1 fish will receive a similar process; adaptive management strategies are employed over time.

Comment:

How can the technical aspects of this SOW be improved?

The SJRRIP is anticipating the stocking size to shift from Age 0 to Age 1 Colorado Pikeminnow in 2021. Some initial work has shown that prey trained Colorado Pikeminnow appear to have better retention than the pellet fed fish. Is there an opportunity to have some of these Age 1 fish prey trained?

Response: Not at this time. Southwestern ARRC is not set up to do this. Facilities and forage needs to conduct large scale prey trained fish production will be determined and provided to the Program Office once the final analysis of previously released prey trained fish is completed and definitive results provide direction.

Comment:

How can the technical aspects of this SOW be improved?

I would suggest that half of the produced Colorado Pikeminnow be prey trained each year. This would allow the Program to assess the efficacy of prey training Colorado Pikeminnow as a hatchery enrichment protocol.

Response: Currently Southwestern ARRC is not set up to do large scale prey training of age-1 CPM. It is not part of the existing 2021 SOW. The additional facility and forage needs can be determined in the near future and provided to the SJRIP for review and consideration for funding.

Comment:

How can the technical aspects of this SOW be improved?

One objective for Colorado Pikeminnow production is development of a new broodstock between 2017 and 2021. It would be good for the proponents to describe in the SOW progress to date and activities planned for broodstock development in FY 2021. This aspect of work at SNARRC has been neglected in the SOW.

Planned *production and rearing of Razorback Sucker at SNARRC during FY 2021 are well documented in the SOW.*

Response: Information on the development of CPM broodstock from wild fish collections was added to the SOW.

Comment:

How can the technical aspects of this SOW be improved?

I have no suggestions for improvement. The document is highly detailed and thorough. Minor typos (highlighted text) lines 63 – 67

Response: There is no highlighted text on lines 63-67 of the SOW. The entire paragraph was reviewed by Southwestern ARRC staff for typos.

Comment:

How can the technical aspects of this SOW be improved?

Line 81: "…the effort will allow for experimentation to improve the efficiency of future Colorado Pikeminnow stocking efforts". Perhaps the author could provide some examples of experiments or factors to assess? Prey training? Rearing habitats with more structural heterogeneity?

Response: Information on hatchery enrichment of age-1 CPM prior to release was added to the SOW.

Fiscal Year 2021 Project Proposal

Principal Investigators: Jeffrey Cole, Jerrod Bowman and T. Kim Yazzie
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Razorback Sucker Augmentation at NAPI Grow-Out Ponds

Fiscal Year 2021 Project Proposal

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Background

The Long-Range Plan for recovery of endangered fishes in the San Juan River calls for propagation and augmentation of Razorback sucker, *Xyrauchen texanus,* (RBS). Avocet East and West and Hidden ponds on Navajo Agricultural Products Industry (NAPI) lands will grow out RBS for stocking into the San Juan River in 2021.

Avocet Pond was originally a single pond built for watering cattle. On March 2, 1998 Avocet was divided into 2 ponds known as Avocet East and West. Avocet West is 3.4 acres and holds 18 acre-feet of water. Avocet West has a siphon for draining the pond. Avocet East is 3.52 acres and holds 19.6 acre-feet of water. Avocet East had no siphon when the ponds were divided, so draining was accomplished by renting a battery of water pumps. A siphon was installed in Avocet East during FY 2008 and the water can now be managed independent of Avocet West and without the need for pumping.

In October of 1999, Hidden Pond was built to rear razorback sucker. Hidden Pond is 2.83 acres. The dam was breached due to a storm event and the fish were lost. The dam was re-built in FY 2000 and a toe drain and spillway were built to protect the dam. Hidden Pond was lined with bentonite and contoured and a kettle was installed to facilitate fish harvest. A siphon was installed in July 2003. A salamander fence was installed around the Hidden Pond perimeter in August of 2003 to exclude predatory tiger salamanders.

Responsibility for Management of the NAPI ponds was originally shared between the U.S. Fish and Wildlife Service (Service), Bureau of Indian Affairs (BIA), Keller-Bliesner Engineering and Ecosystems Research Institute. The Service was responsible for determining when and which ponds would receive RBS. In addition, the Service conducted sample counts and harvested the ponds with the assistance of the BIA. Keller-Bliesner was responsible for design and construction of the Six Pack ponds and re-construction of Hidden Pond. The BIA was responsible for monitoring water quality and Ecosystems Research was responsible for fertilization of the ponds and for developing a pond management plan.

Original pond management was for multiple cohorts to be raised in the ponds. Harvesting would be done passively with fyke nets so that the ponds would not be drained on an annual basis. In FY 2007, it was determined to change pond management direction. All of the ponds would be drained and harvested and single cohort management would replace the multiple cohort approach. During the first harvesting and draining of a Six-pack Pond, high mortality resulted when the number of fish remaining in the pond could not be removed before they succumbed to the rapidly warming water. Adjustments were made to reduce the mortality in future harvesting and draining events. The adjustments consisted of increasing the trapping effort prior to de-watering to reduce the number of fish remaining in the pond. In addition, the final fish removal would be accomplished with a higher pool of water to slow the warming of the water during the time of final harvest. This resulted in less mortality.

The Navajo Nation Department of Fish and Wildlife (NNDFW) was contracted to assume responsibility for daily management of the NAPI ponds in 2007. The Service assists the NNDFW with pond harvest (active and passive) as needed.

The ponds have been fenced and electric lines have been installed at each of the ponds. Aerators have been installed at each of the ponds to improve water quality. Water quality issues have caused fish mortalities in some of the ponds in the past. Water quality issues appear to have been much improved since the installation of the 2016 aerators and air lines.

Objectives

(NAPI Ponds Management)

Manage razorback sucker grow-out in East Avocet, West Avocet, and Hidden ponds to provide an additional source of RBS to supplement the augmentation program. Harvest, Passive Implant Transponder (PIT) tag, and stock razorback sucker from the three grow-out ponds into the San Juan River, in order to assist in fulfilling the tasks and objectives outlined in the current version of *An Augmentation Plan for Razorback Sucker in the San Juan River* (Ryden 2003).

1) Manage three grow-out ponds using a single cohort strategy; including passive and active harvest techniques. All three ponds will be in production for the 2021 season. Our passive harvest percentage is at 3% and active harvest number is at 100% of fish removed. Increasing Fyke net use for this year per pond from 2 to 4, this will aide with our passive harvest numbers percentage increase. Completion of the kettle at Hidden in early spring of 2020 was a tremendous help during active harvest. Winter of 2020 East Avocet had a kettle installed and both Hidden and East Avocet were setup with a new drain system. Aquatic Consultants came in and replaced the Siphon system with new drain piping. We are hoping to install a new drain and kettle at the West Avocet to assist with better harvest numbers.

2) Annually stock 3,500 (≥ 175mm) razorback sucker per pond.

3) Harvest all ponds on an annual basis.
    a. All Razorback Sucker will be scanned for a PIT tag and the number will be recorded. If tag cannot be detected, fish will be implanted with a PIT tag prior to stocking into the San Juan River.
    b. From recent conversations among the Biology Committee, it has been decided that stocking of any Razorback <300mm TL into the San Juan River will no longer be acceptable.
    c. Stock ~ 4,200 to 6,300 fish based on 40-60% return.
    3c. Investigate and utilize multiple stocking localities. Locations are determined by USFWS, but PNM release site is a constant location for stocking.

4) Prioritize ways to increase return rates of Razorback Suckers. Currently seeking ways to improve the efficiency of fish harvest to minimize stress and improve water quality.
    a. Continue to search for funding to install a harvest kettle and drain in West Avocet Pond.
    b. Continue to search for funding to remove siphons and replace with drains in West Avocet and Hidden Pond.
    c. Continue to search for funding to design and build a Fish Processing Center between East and West Avocet Ponds to be used for all NAPI Pond Fish Harvesting.
    d. Design and install pond cover to deter predators and provide shade from the sun.

Location

The RBS grow-out ponds are located in Block III of Region 2 on NAPI lands, south of Farmington, New Mexico. Avocet East and West are located NW of the intersection of N 4062 and N 4087, which is approximately 3 miles southwest of the Ojo Amarillo NHA Housing Subdivision. Hidden Pond is located SE of the intersection of N 4087 and N 4095 approximately 1-mile northwest of the NAPI Region II Complex.

Methods/Approach

The NNDFW will be responsible for overall management of the NAPI ponds regarding daily management duties, harvesting, and stocking. The Service, NMFWCO, will be responsible for coordinating the stocking of the ponds with Southwestern Native Aquatic Resource and Recovery Center and NNDFW per US Fish and Wildlife Service Region 2 stocking policy. The NNDFW will be responsible for daily management of the three grow out ponds on NAPI with assistance by the Service, Region 2. Harvesting, tagging, and stocking will be conducted by NNDFW, with assistance from the Service if additional personnel are needed. Associated data management and reporting for the project will be handled by staff from the NNDFW.

NMFWCO has been assisting with beginning of the season pond vegetation mowing to keep the willows and reeds from overgrowing and being a nuisance. The remote biologist has been assisting with pipe repairs, conditioning tank setup and operation, monthly sample counts and stocking both passive and active. A team from NMFWCO does come up for end of the season to assist with active harvest. They are responsible for selecting the stocking sites and number of RBS taken to each site from the three ponds.

Pond management requires that staff monitor and record water quality and quantity, and feed the fish on a daily basis. Water quality samples parameters include dissolved oxygen concentrations, pH, water temperature and conductivity. Measurements are taken twice a day from each corner of the ponds. Fish food calculations are calculated each month after sample counts have been conducted. Using the pond temperature, we are able to calculate the growth percentage and input that into the overall feed calculation and feeding rate. The calculation is [(lbs./fish) *growth rate*total number of fish in pond. In additional, staff manages water quantity to ensure that water quality is optimal. Maintenance includes operating and repairing valves, aerators and pipes, evaluating the pond perimeters for erosion problems, repairing fences, monitoring aquatic vegetation and maintaining a log book and database for management of the ponds.

During FY 2021, East Avocet, West Avocet, and Hidden ponds will be managed for a single cohort of RBS. NNDFW will implement passive harvest using fyke nets to trap, tag, and stock RBS into the SJR for several days or months prior to dewatering the ponds. As the ponds are dewatered, NNDFW and Service staff will work together to do the final RBS removal, tagging, and stocking into the SJR.

Aquatic Consultants has been apart of the project from getting the aeration system overhauled, kettle and drain installation and most recently the inlet water supply piping at the Avocet ponds. They come in once a month to perform pond vegetation treatments and aeration system management; they provide a brief report of what was done at each pond for every monthly site visit. They provide equipment and personnel when we are in need during active harvest or emergency repairs at the ponds.

Whenever the ponds are drained, they will be evaluated for structural stability. Areas away from ponds that may be impacted by dewatering will also be evaluated. Staff will identify and document any structural damage to the ponds and dewatering areas if necessary. Feasibility will determine whether improvements are made or not. This proposal does not include any maintenance or repair work that is major and requires mobilization of heavy equipment and is outside of the constraints of this budget.

Products/Schedule

In the spring of 2021, Southwest Native Aquatic Resources and Recovery in Dexter, NM will deliver 10,500 ≥ 175 mm RBS to the three NAPI grow-out ponds. In the fall of 2021, the NAPI ponds will be de-watered and the RBS, which are targeted to be ≥ 300 mm will be harvested and transported to the San Juan River for stocking. A database summarizing numbers of fish, stocking locations and PIT tag

numbers will be submitted to the USFWS. A draft report will be submitted by 31 March 2021 and finalized by 1 June 2021. This report will include the extra data collected during the season including Aquatic Consultant visits, Water Quality data, Feeding rates and sample count data.

Fiscal Year - 2021 NNDFW NAPI Ponds Budget	
Personnel	
Fish Biologist	$47,673.60
Fish Culturist, Seasonal 1040 hrs.	$4,986.80
Fringe Benefits Fish Biologist	$22,826.12
Fringe Benefits Fsih Culturist	$482.72
Sub-Total Personnel Expenses	**$75,969.24**
Travel	
GSA	$12,546.00
Per Diem Lodginbg and Meals	$3,725.00
Travel Sub-Total	**$16,271.00**
Operating Supplies	
3qty - Pulaski w/sheaths	$332.40
3qty – Shovel	$204.75
3qty - Tree Limb Saw	$637.38
3qty - Limb Saw Blades	$229.47
1qty - Dewalt radio/charging station	$219.00
2qty - Reciprocating Saw Dewalt	$344.00
2qty - Reciprocating Blades pk10	$79.97
6qty - Dewalt Battery extra	$539.91
3qty - HD limb loppers	$74.25
1qty - MS-311 Chainsaw	$489.95
1qty - Performance zip chaps - 6 layer	$109.99
Rangen Fish Feed (3mm and 4mm) 1,000 lbs	$1,300.00
Sub-Total Operating Supplies	**$4,561.07**
Consulting NAPI Pond Management	**$27,825.00**
Subtotal	**$124,626.31**
Indirect Cost 18.7% See Worksheet	**$19,633.63**
Total NAPI Ponds	**$144,259.94**

Response to questions:

Program Office

How can the technical aspects of this SOW be improved?

- It would be good to see all the data collected during the growing season (i.e., temporal data on water temperature, DO, feeding rates) in an annual report that is included in the description of this SOW's deliverables.

Response: The 2021 Annual report will include the extra data collected like our water temperature, DO and Feed rates.

- It would be useful to see a table of annual return rates over time to assess overall trends in efficiency.

Response: The 2021 Annual report will have a table included to see the return rates of the previous years to assess efficiency of the NAPI ponds.

- It seems that the current need is to increase return rates and the SOW should prioritize ways to increase those rates since increasing that would likely be the most cost-effective means of getting more fish into the system.

Response: Currently seeking ways to improve the efficiency of fish harvest to minimize stress and improve water quality.

a. Continue to search for funding to install a harvest kettle and drain in West Avocet Pond.
b. Continue to search for funding to remove siphons and replace with drains in West Avocet and Hidden Pond.
c. Continue to search for funding to design and build a Fish Processing Center between East and West Avocet Ponds to be used for all NAPI Pond Fish Harvesting.
d. Design and install pond cover to deter predators and provide shade from the sun.

- Since Aquatic Consultants Inc. is being contracted to help with the ponds it would be useful to understand their involvement and what they are doing.

Response: Aquatic Consultants has been a part of the project from getting the aeration system overhauled, kettle and drain installation and most recently the inlet water supply piping at the Avocet ponds. They come in once a month to perform pond vegetation treatments and aeration system management; they provide a brief report of what was done at each pond for every monthly site visit. They provide equipment and personnel when we are in need during active harvest or emergency repairs at the ponds.

- Provide a description of the support provided by the NMFWCO for this SOW.

Response: NMFWCO has been assisting with beginning of the season pond vegetation mowing to keep the willows and reeds from overgrowing and being a nuisance. The remote biologist has been assisting with pipe repairs, conditioning tank setup and operation, monthly sample counts and stocking both passive and active. A team from NMFWCO does come up for end of the season to assist with active harvest. They are responsible for selecting the stocking sites and number of RBS taken to each site from the three ponds.

What is this SOW's contribution to recovery?

- Stocking is one of the primary management actions that directly contributes to recovery.

Response: Harvest all ponds on an annual basis. All Razorback Sucker will be scanned for a PIT tag and the number will be recorded. If tag cannot be detected, fish will be implanted with a PIT tag prior to stocking into the San Juan River. From recent conversations among the Biology Committee, it has been decided that stocking of any Razorback <300mm TL into the San Juan River will no longer be acceptable. Stock ~ 4,200 to 6,300 fish based on 40-60% return. Investigate and utilize multiple stocking localities. Locations are determined by USFWS, but PNM release site is a constant location for stocking.

SJRIP PIT TAGS
2021 Project Proposal

Mark McKinstry UC-735
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Phone 801-524-3835
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BACKGROUND:

PIT tags are used to individually mark fish for use in movement studies and for mark-recapture estimates in the San Juan River Basin. PIT tags are not specific to any particular project, but are used by several different projects. PIT tags and readers purchased for the SJRIP will be combined with the purchase made for the UCRIP to save money by purchasing larger quantities and save expenses associated with administering the contract. All PIT tags and readers will be shipped to USFWS in Grand Junction C/O Travis Francis at:

U.S. Fish and Wildlife Service
Colorado River Fishery Project &
Ouray Nat'l. Fish Hatchery - Grand Valley Unit
445 West Gunnison Ave., Suite 140
Grand Junction, Colorado 81501-5711
(970) 628-7204

TASKS – 2021

1. Purchase PIT tags and readers and distribute to end-users

In FY2021, $40,000.00 is allocated in the workplan to purchase PIT tags and associated equipment (readers, antennas, implanters, etc.).

FY 2021 BUDGET

Funding source		**Projected expenditure in FY2021**
FY2021 Annual funding		$40,000.0
Total		**$40,000.00**

FY 2021 Project Proposal
San Juan River Basin Hydrology Model
Operation and Maintenance

Susan Behery
Bureau of Reclamation
185 Suttle St. Suite 2
Durango, CO 81303
Phone 970-385-6560
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Relationship to SJRIP: Supports Program goals and management by developing, operating and maintaining a hydrology model of the San Juan Basin. The model is key to hydrological analysis of water development scenarios or other scenarios in relation to the flow recommendations.

Background:
The San Juan Basin Hydrology Model (SJBHM) is a hydrologic model of the San Juan River Basin. The SJBHM consists of a series of models including evapotranspiration models, a natural flow model in StateMod, and a simulation model in Riverware. Revisions and modifications to the models and supporting data have occurred through a multi-year model development and validation phase. The FY2021 scope of work includes updates to data as available, annual operation and maintenance of the model and data management. FY2021 activities will also include continued streamlining of model processes as new Riverware updates and methods allow. The Bureau of Reclamation has the primary responsibility for model development and O&M. Reclamation continues to use Precision Water Resources Engineering to do the bulk of the modeling work, as their skillsets as specialists in Riverware make more efficient use of available resources.

The model is available to generate and analyze runs associated with Section 7 Consultations and/or special requests from the Biology or Coordination Committees related to the flow recommendations or other hydrological aspects of the Program.

Objective:
The objective for this work is to ensure that the San Juan Basin Hydrology Model is available for run requests. This will be accomplished by adjusting model configurations or operating rules to incorporate new data and/or scenarios when requested, and evolving the data set forward through time. The FY2021 request also includes funds to continue coordination and interaction with the Program participants and their technical designees.

Deliverables:
An annual hydrology meeting detailing the accomplishments of the model development, data development and model runs will be held for program participants. A report of the meeting will be provided to the coordination committee. In addition, data, documentation and reports from model runs will be provided throughout the model run process. The modified model(s) and supporting data and scripts will also be delivered / made available via Dropbox from PWRE.

Task Descriptions:

Task 1: Model Modifications Implement and document any requested changes to the model from the SJRIP. This may include modifications for analysis of operational optimization scenarios, further requested climate change scenarios, inclusion of the Utah tribal water rights settlement, and improvement of Animas-La Plata operations as described below:

Utah Settlement: The recent Utah settlement affords 84 kaf to the Navajo Nation in Utah from the San Juan River. The model will be used to analyze the potential impacts of this future water use.

ALP Operational Revision: Currently, ALP demands are simulated identically every year with an average annual depletion of 57,100 AF. This does not do a great job of representing reality, as actual ALP operations and realized net depletions to the river system will depend on the year's hydrology. Conceptually, wetter years should see higher net depletions as ALP will store more than it releases. Conversely, drier years should see lower net depletions, as ALP will release more than it stores. Incorporating a more realistic operation at ALP will still result in a long-term average annual depletion of 57,100 AF. The representation of M&I users may also require revision or enhancement in this ALP improvement, as ALP is a significant supplementary source to M&I.

Task 2: Model Maintenance Includes maintenance of the actual model as well as the supporting data and software. Maintain data to evolve the data set forward through time. This includes an annual update (when available) of USGS data, Reclamation data, New Mexico non-irrigation data, New Mexico irrigation data, Arizona and Utah depletions, Colorado depletions, climate data, and natural flow data. Data must be obtained from various sources and processed for compatibility with the multiple data loaders. Load updated data into the model, run and test the new data. Adjust model configuration, methodologies, or assumptions, as needed. New Riverware updates and versions include streamlined methods that will be adopted when appropriate. Update and expand documentation to reflect current state of model. Update and maintain data management interfaces and other software associated with the data and models. Apply all Riverware updates and patches as they become available. Provide technology transference to Fish and Wildlife Service staff in the details of maintaining the data and models. Technology transfer will continue as model, data and software updates take place to ensure that several people are trained in the maintenance of the model.

Task 3: Model Runs and Analyses Generate and analyze requested model runs associated with the implementation of a revised hydrologic baseline, revised flow recommendation scenarios, Section 7 consultations or special requests from the Biology and/or Coordination Committees and/or special work groups. A consultation or scenario run usually requires model reconfiguration and the implementation of operating criteria.

Task 4: Coordination Attend or provide reports for Coordination Committee meetings, as needed, to update the committee on the model status and model results. Conduct any necessary Hydrologic Baseline Workgroup meetings to provide model status updates, present results, and work on developing the revised hydrologic baseline. Conduct an annual hydrology meeting of Program participants to review and solicit input on accomplishments and activities relating to the model for the previous year, status of the model, and proposed activities for the coming year; and provide a report on the meeting to the Coordination Committee for their review and approval. Develop the FY2022 budget and track FY2021 expenditures.

Task Descriptions:

All comments received during the peer review of a prior version of this SOW were incorporated into the "Deliverables" section of this revised version of the SOW.

Budget Summary FY 2021

Model Modifications	$32,040
Model Maintenance	$15,600
Model Runs	$12,480
Program Management	$10,360
Grand Total	**$70,480**

FY-2022	**$72,600**	†
FY-2023	**$74,800**	†
FY-2024	**$77,000**	†

† Assumes ongoing model maintenance, model runs, tech transfer, documentation updates and program management and includes ~3% adjustment.

Task 1 Model Development				$130	salary total per hour	
			Task	**days**	**hours**	**Total**
	A) Labor	1	Model changes and updates	19	152	$19,760
		2	Tech Transfer	5	40	$5,200
	B) Travel	1	Meetings with SJRIP	2	16	$2,080
	C) Other	1	Riverware Technical Support	na	na	$5,000
						$32,040
Task 2 Model Maintenance						
	A) Labor	1	Data updates as available	7	56	$7,280
		2	Software Updates	3	24	$3,120
		3	Methodology updates as needed	5	40	$5,200
						$15,600
Task 3 Model Runs						
	A) Labor	1	Model Runs and Analyses	12	96	$12,480
			as requested			$12,480
Task 4 Program Coordination						
	A) Labor	1	Meetings and Coordination	8	64	$8,320
		2	Budget	1	8	$1,040
	B) Travel	1	Meetings with SJRIP	2	16	$1,000
						$10,360
					TOTAL	**$70,480**

Improve Stream Gaging and Flow Measurements
San Juan River Basin Recovery Implementation Program
Fiscal Year 2021 Project Proposal

Susan Behery
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Durango, CO 81303
Phone 970-385-6560
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Background:

There are five United States Geological Survey (USGS) streamflow gaging stations on the main stem of the San Juan River that are very important to management of the river and the operation of Navajo dam to implement the San Juan Recovery Implementation Program (SJRIP) flow recommendations. Stream gaging data on the San Juan River are necessary to reliably implement and revise the SJRIP flow recommendations.

Study Area:

San Juan River Basin in New Mexico

Objective:

Provide funding to the USGS to take additional flow measurements as needed at the four San Juan River gages in New Mexico. The four gages are San Juan near Archuleta, San Juan at Farmington, San Juan at Shiprock, and San Juan at Four Corners. (Note: Base cost for operation of the stations is paid for by non-Program funds.)

Products:

1. Improved flow measurement and more accurate gage readings.

2. Technical report at the end of the year from USGS summarizing the activities completed and the value of obtaining additional readings.

Budget FY-2021:

Objective: Provide funding to USGS for 12 additional flow measurements at the four San Juan River Gages in NM.	Staff days	Labor	Travel	Equipment and supplies
Personnel	7.5	7,400		
Travel			1,870	
Equipment and supplies				0
Total				$9,270

Estimated Outyear Funding (Based on 3% adjustment for inflation)

Fiscal Year 2022	$9,550
Fiscal Year 2023	$9,840
Fiscal Year 2024	$10,100

Operation of Public Service Company of New Mexico Fish Passage Structure

Fiscal Year 2021 Project Proposal

Principal Investigators: Jeffrey Cole, Jerrod Bowman and T. Kim Yazzie
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Operation of Public Service Company of New Mexico Fish Passage Structure

Fiscal Year 2021 Project Proposal

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Box 1480 Window Rock, AZ 86515
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Background

The Power Company of New Mexico (PNM) Diversion Dam was constructed in 1971. The 3.25-foot high diversion dam (weir) is located on the San Juan River about 12 miles downstream of Farmington, New Mexico near the town of Fruitland at River Mile 166.6. Facilities at the diversion include a concrete weir, a series of screened intake structures, an intake channel, a settling channel, and a pump house.

Water flows over the dam into a stilling basin created by a concrete apron. The stilling basin is the width of the river. The presence of the dam and the basin creates a barrier to fish potentially moving upstream. As flows increase, the difference in the upstream and downstream water levels is decreased, therefore the fish barrier is temporarily less of a challenge to cross over. Although water levels are reduced, water velocities increase and the weir provides an impediment to upstream fish movement. Recovery studies conducted as part of the SJRRIP have shown that some fish are able to move upstream past the weir but their specific method of movement is not known and the number of fish discouraged from upstream movement by the presence of the weir is an unknown. One possible method of upstream movement could occur during high river flows. When the flow in the San Juan River is above 7,000 cfs, some of the flow goes around the dam making it possible for fish to go around the dam at these higher flows.

A need has been identified by the San Juan River Basin Recovery Implementation Program (SJRRIP) to restore endangered fish passage upstream past the PNM Diversion Dam. The purpose of establishing fish passage was to protect and recover native Colorado pikeminnow (*Ptychocheilus lucius)* and Razorback sucker (*Xyrauchen texanus*) populations in the San Juan Basin while water development proceeds in compliance with all applicable Federal and State laws, including fulfillment of Federal trust responsibilities to the Southern Ute Indian Tribe, Ute Mountain Ute Tribe, Jicarilla Apache Nation and the Navajo Nation. In addition, other native fish species would benefit from restored passage. The facility has been operated and maintained by the Navajo Nation Department of Fish and Wildlife (NNDFW) since it was built in 2003. The U.S. Fish and Wildlife Service (Service), Bureau of Reclamation (BOR), Bureau of Indian Affairs (BIA), Navajo Indian Irrigation Project (NIIP), Navajo Agricultural Products Industry (NAPI), and PNM have provided the NNDFW with technical assistance, planning assistance, environmental clearance, maintenance assistance and improvements to the facility and its access points.

The fish passage has facilitated movement of Pikeminnow and Razorback suckers upstream into a 50 mile stretch of river, which is historical habitat of these species.

Study Area

Public Service Company of New Mexico Diversion Dam is located at RM 166.6.

Methods/Approach

The Fish Passage facility will be operated from March 1 to May 31, 2021 as a flow through system. This was decided by the biology committee during the February 2018 BC meeting. Pressure sensors at the south channel, entry point and last boulder before passage were installed to keep record of flow during this pass thru system utilizing the south channel. A new PIT tag antenna was installed at the river-side inlet attached to the debris beam to collect additional data for fish usage and passing thru the passage channels. Installation of a game camera was also installed to give a time-lapse of the passage in seasonal operation.
In preparation for the south screen flow-thru, firstly is to remove and secure the south channel automatic brush system and lift and remove both top and bottom screens to provide complete unrestricted water flow thru the south channel passage. The north channel river door will be closed, restricting water flow, leaving the south channel river door open for water flow down the channel and the ladder.

The Fish Passage facility will resume normal operation from June 1 to October 31, 2021. The fish passage traps fish attempting to move upstream thru the facility. All fish that are caught in the trap are transported to a sorting table. All fish are identified and enumerated. Non-endangered native fishes are released alive

upstream of the facility. Rare native fishes are scanned for a pit tag, weighed and measured, marked with a pit tag if they do not have one and released alive upstream of the facility. All non-native fishes are removed from the river system permanently.

Daily operation and maintenance include cleaning of all screened-surfaces and submerged trash, debris, silt, and river-born algae from the trash racks and bar screens in the fore-bay of the fish passageway, and aluminum spindle screens in the channel fish trap. The quantity of algae, debris, trash, and sediment that accumulates daily at this site is seasonally variable, depending upon flow magnitude and water volume during the water year. Maintenance can also include rust–resistant spray painting as necessary to reduce corrosion on open metal surfaces, apply food grade lubrication on all machine equipment, and checking fluid levels in gearboxes and cooling radiators, as necessary. Representatives from the NNDFW, BOR, PNM and the Service will perform an inspection of the facility every 3 years. In the event of a significant flood event, representatives from the NNDFW will notify BOR, PNM and FWS and appropriate parties will inspect the facility for damage, as necessary.

The Fish Passage Program maintains a database of all fish processed through the facility. Staff that operate this facility also have initiated a public outreach and education program that will continue in FY' 2021. School groups visit the facility to learn about the purpose of the facility and the endangered fish program on the San Juan River.

Objectives of this project are as follows:

1. Determine the use of the fish passage by juvenile and adult native and nonnative fishes.
2. Identify any Colorado pikeminnow congregations that may be related to the spawning period in the San Juan River.
3. Operate and maintain the facility in a manner that assures long-term benefit.

This proposal does not include any maintenance or repair work that is major and requires mobilization of heavy equipment and is outside of the constraints of this budget.

Products/Schedule

The Fish Passage facility will be operated from March 1 to October 31, 2021. During the operation season the passage is operating 24 hours a day, 7-days a week. Each channel is checked daily and are sorted for Native and Non-natives.

Data will include definitive numbers of species, numbers per species, and seasonal use and distribution by species. Our numbers on Razorback Suckers seem to be greater before the high flow regime and later in the season when flows taper out. The 2016 numbers were 42 before the high flow period (March to May) and 30 at the end of the season (Sept. and Oct.). As for the Colorado pikeminnow they seem to have peak after the monsoon season flow spikes. The 2016 data showed 129 species to move thru the facility during the months of July and August. Identification of Colorado pikeminnow congregations will be observed and noted based off flow regime and monsoon season trend. As 2016 showed our pikeminnow numbers occurred at the tail-end of the monsoon season for San Juan County. As of 2019 we seen an increase in untagged juvenile CPM coming thru the passage. We can only assume this will likely happen again in the 2020 as the water from run off tends to warm up and clear up, we can only record data from this CPM small spike in young of the year fish.

NNDFW has supported the ongoing tissue collections from various non-tribal partners. NMGF has collected whole body native fishes. This was conducted in the summer of 2016 after the Gold King Mine Spill to study the effects or changes to native fish tissues. Specific fish size, species, and number of fish were collected during the summer months. NNDFW staff also collected fin clips from CPM >300 mm

during the 2019 season for genetic analysis as well as UDWR needing muscle plugs summer 2019 from fish obtained thru the fish passage during the regular operating season. KSU as well as CSU have tagged Channel catfish with both PIT and Floy tags to determine fish movement seasonally.

NNDFW staff will prepare and submit monthly reports and one draft and final annual report. USFW Service staff will assist NNDFW with data analysis and draft and final report preparation, if needed.

Data from the PNM Fish Passage will be inserted into the shared template and sent to the Service by December 31, of the end year.

NNDFW staff will attend SJRRIP Biology Committee meetings and provide reports as needed throughout the year.

Fiscal Year 2021 NNDFW Fish Passage Budget	
Personnel	
Fish Biologist	$47,673.60
Fish Culturist, Seasonal 1040 hrs.	$4,986.80
Fringe Benefits Fish Biologist	$22,826.12
Fringe Benefits Fsih Culturist	$482.72
Sub-Total Personnel Expenses	**$75,969.24**
Travel	
GSA	$12,546.00
Per Diem Lodginbg and Meals	$3,725.00
Travel Sub-Total	**$16,271.00**
Operating Supplies	
Limiting Switch (2)@ 125 ea	$250.00
C2080SS Chain 320ft @ $45/ft	$14,400.00
Nylon Bristle Brush 28ft @ $70/ft	$1,960.00
Chain Track 280 ft @ $22/ft	$6,160.00
2080 Half Moon Idler 4 @$225 ea	$900.00
4025 -Tube H1 Quinplex Food Machine Lube 3 @ $20.17 ea	$60.51
Electricity Cost	$1,000
Uniforms	$500
Printing/Binding/Photocopying	$100
Repairs and Maintenance	$1,000
Operating Supplies Sub-Total	**$26,330.51**
Subtotal	**$118,570.75**
Indirect Cost 18.7% See Worksheet	**$18,679.64**
Total PNM Fish Passage	**$137,250.39**

Response to questions:

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

- The products should also include a digital copy of all data for the passage delivered to the Program Office by December 31, 2021. The dates for delivery of the draft and final report should be added to the document

Response: A digital copy of the data from the passage will be submitted to the program office by December 31st of the fiscal year. A draft annual report will be submitted in February and a finalized copy be sent in May with comments for the final draft inputted.

Program Office

How can the technical aspects of this SOW be improved?

- Objectives should be clarified. For example, "2. Identify any Colorado pikeminnow congregations that may be related to the spawning period in the San Juan River." What is that and how is it being addressed? If this is not occurring then it should be deleted.

Response: As of 2019 we seen an increase in untagged juvenile CPM coming thru the passage. We can only assume this will likely happen again in the 2020 as the water from run off tends to warm up and clear up, we can only record data from this CPM small spike in young of the year fish.

- The PNM fish passage provides support for a lot of projects so these other objectives that are occurring should be highlighted. For example, tissue collection for genetic analyses and support of the facilitated fish passage SOW.

Response: NNDFW has supported the ongoing tissue collections from various non-tribal partners. NMGF has collected whole body native fishes. This was conducted in the summer of 2016 after the Gold King Mine Spill to study the effects or changes to native fish tissues. Specific fish size, species, and number of fish were collected during the summer months. NNDFW staff also collected fin clips from CPM >300 mm during the 2019 season for genetic analysis as well as UDWR needing muscle plugs summer 2019 from fish obtained thru the fish passage during the regular operating season. KSU as well as CSU have tagged Channel catfish with both PIT and Floy tags to determine fish movement seasonally.

What is this SOW's contribution to recovery?

PNM is a complete barrier to fish moving upstream and providing connection to upstream reaches during spawning season could increase reproductive success by providing access to more suitable habitat and providing more river for larvae to drift and recruit.

Budget Increase Justification

Operating supply cost from $13,402.52 to $26,330.51 is due to the operating of the Inline Screen Cleaner that was installed in 2015 by Aqua systems 2000. There are four 320 ft. steel chains that run the brush off a motor as well as a chain track that keeps the chain from binding or coming off gears and running straight. Two limiting switches were also included on the budget to help run the system to count the intervals on which it runs. The Half Moon Idler was also included for the continued running of the chain as it drops at the bottom to keep the motion of the moving chain running the nylon brush cleaning the screens. Over time the chains have stretched and are meeting the limit of the adjustment on the upper sprocket.

The change if the Indirect Cost Rate was changed by the Nation from previously at 15.65% to now 18.7%.

SJRIP San Juan and Animas Rivers Temperature Gauges
2021 Project Proposal

Mark McKinstry, Ph.D. UC-735
Bureau of Reclamation
125 South State Street, Room 8100
Salt Lake City, UT 84138-1147
Phone 801-524-3835
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mmckinstry@uc.usbr.gov

BACKGROUND:

Temperature information is required at several gauges in the San Juan River at the following locations:
09355500 - San Juan River near Archuleta, NM - Real time on web
09365000 - San Juan River at Farmington, NM - Real time on web
09364500 - Animas River at Farmington, NM - Stand alone temperature probe until we can get access to install a wired probe.
09381010 - San Juan River at Four Corners, CO - Real time on web (after we configure our database on Monday).

METHODS:

River Temperature Gauges

The USGS has installed and maintains 4 temperature probes in the San Juan basin per our agreement. Probes were installed at:

09355500 - San Juan River near Archuleta, NM - Real time on web
09365000 - San Juan River at Farmington, NM - Real time on web
09364500 - Animas River at Farmington, NM - Stand alone temperature probe until we can get access to install a wired probe.
09381010 - San Juan River at Four Corners, CO - Real time on web
Data will be displayed real time via the USGS NWISweb.

The probes are maintained by USGS with the following contact:

Jay Cederberg
Albuquerque Field Office Chief
USGS, New Mexico Water Science Center
5338 Montgomery Blvd., NE, Suite 400
Albuquerque, NM 87109
505.830.7924 | fax: 505.830.7986
cederber@usgs.gov

web: http://nm.water.usgs.gov

TASKS – 2021

1. Operate and maintain water temperature probes at four different locations in the San Juan River Basin

FY 2021 BUDGET

Task	**Expenditure in FY2021**
Temperature probes @ $5500/ea	$24,000
Total	**$24,000**

[1] This total budget represents a 0% increase over the FY2020 Budget.

Projected funding:
FY-2022 $24,500.00

FY 21 Channel Catfish Management on the San Juan River

Prepared by

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Overview

The establishment of nonnative fishes including Channel Catfish (*Ictalurus punctatus*) and Common Carp (*Cyprinus carpio*) has been identified as a detriment to the recovery of Colorado Pikeminnow (*Ptychocheilus lucius*) and Razorback Sucker (*Xyrauchen* texanus) (USFWS 2002a, b). Reducing the impacts of nonnative fishes has specifically been identified as a management element in the San Juan River Basin Recovery Implementation Program's Long Range Plan (SJRBRIP 2015). However, the level of threat that Channel Catfish pose on endangered fishes remains unknown. In the absence of rigorous evaluation, Channel Catfish are thought to pose a threat to native fishes in multiple forms such as: predation, competition for resources, and as a choking hazard to the piscivorous Colorado Pikeminnow. In an effort to quantify the threat nonnative fish pose to recovery, a two-year study assessing the predatory effect of Channel Catfish on endangered fishes was initiated in 2018.

It was determined that work in 2018 and 2019 by the New Mexico Fish and Wildlife Conservation Office (NMFWCO) and Utah Division of Wildlife Resources (UDWR) would support efforts, as identified in Kansas State University's (KSU) SOW 18-26 *Incidence and consumption of endangered fishes by Channel Catfish (Ictalurus punctatus) in the San Juan River,* to quantify the predatory effects Channel Catfish have on the two endangered fishes in the San Juan River. Additionally, it was determined that mark-recapture would be initiated for Channel Catfish to generate more precise population estimates, detection probabilities, and annual survival rates. Data from both stomach content analysis (i.e., percent predation) and abundance/survival estimates (number of predatory fish), when used in concert, will aid the SJRBRIP in the development of a future nonnative fish management program commensurate with the level of threat.

Preliminary results after the 2018 sampling by the NMFWCO and UDWR, estimated the adult Channel Catfish population in the sampling area at 22,149 individuals. A population estimate was not calculated in 2019 due to such few recaptures of tagged fish. In 2018-2019, 4,649 adult Channel Catfish stomachs were evaluated for contents by KSU, of which 7.7% contained identifiable fish (Hedden et al. 2020). Of those fish identified in Channel Catfish stomachs, 54% were native fish, with two being Colorado Pikeminnow. Even with the low occurrence of Colorado Pikeminnow found in Channel Catfish stomachs, a high adult Channel Catfish population could still have a detrimental effect on juvenile Colorado Pikeminnow survival. Hedden et al. also estimated Channel Catfish biomass in the San Juan River using the 2018 population estimate, Channel Catfish size structure, and length-weight relationship. In addition, the biomass of each prey species was estimated. Estimated total fish consumption (wet weight) by the Channel Catfish population was estimated to be 23.5 (19.0-29.2) kg/rkm in 2018 and 10.9 (8.8-13.5) kg/rkm in 2019. Estimated biomass of fish consumed =

16.73 grams (g) wet fish weight per 100 g catfish x San Juan River Channel Catfish biomass. There was an estimated 3,900 (3,150-4,845) native fish consumed in 2018 and 1,759 (1,420-2,185) native fish consumed in 2019 per rkm by the San Juan River Channel Catfish population. Observed fish consumption was two times higher in 2018 largely because of turbid water events that occurred during the warmer summer months, giving sharp rises in fish consumption, compared to 2019 when turbid water events occurred largely in the cooler spring months. Hedden et al. estimated that 19,250 grams of Colorado Pikeminnow were consumed in 2018 by Channel Catfish, which would equate to an average of 795 Colorado Pikeminnow individuals. They also estimated that removing 25% of the Channel Catfish population annually would potentially result in 3,114 grams of Colorado Pikeminnow biomass from being not being consumed by Channel Catfish.

Until a detailed review of the data from the two-year diet study is completed to aid the SJRBRIP in the development of a future nonnative fish management program, we proposed in FY20 a concentrated effort of nonnative removal focusing on removing large adult Channel Catfish from the San Juan River during winter months when flows and turbidity are low, maximizing efficiency and sampling conditions. Previous years data has shown that raft-mounted electrofishing in the San Juan River is negatively impacted by turbid water, usually caused by rain events causing sand washes to flood in to the river increasing turbidity and resulting in lower catch rates for Channel Catfish due to limited visibility in the water. Higher flows make it harder for netters to effectively capture Channel Catfish due to the raft moving too fast downstream as Channel Catfish are in full tetany and take longer to float to the surface of the water. Sampling during winter months should result in more desirable sampling conditions as flows and turbidity should be low and more predictable.

Preliminary results from FY20 winter sampling suggests that targeting Channel Catfish in this section and time of the year was successful and resulted in higher exploitation rates than previously observed in the San Juan River. Sampling was completed from January 21,2020 – March 12,2020. The marking pass resulted in 921 adult Channel Catfish being tagged and released back into the river. The next three subsequent removal trips resulted in 4,193 adult Channel Catfish being removed from the river with most fish being captured greater than 400 mm total length (TL). Exploitation rates were calculated by size class of adults as 17% for fish 300-399 mm TL, 28.5% for fish 400-499 mm TL, and 31% for fish $\geq$500 mm TL and a total exploitation rate of 22.8% for all adult Channel Catfish. All trips were completed under the set protocol that river flow would be less than 1000cfs and turbidity would be greater than 250mm Secchi Disk. One trip was started but canceled and rescheduled due to conditions not meeting the sampling protocol.

While it is encouraging to observe total exploitation rates over 20% with only three removal passes encompassing 42 river miles, we feel that the exploitation rates would have continued to rise with more removal passes. Movement of Channel Catfish in the San Juan has shown to negatively impact exploitation rates, however we feel that during the winter months these fish are not moving as much in the river and by focusing trips in this section during the winter and under optimal sampling conditions we have positively increased our efficacy resulting in favorable exploitation rates.

We propose to continue with this sampling during the winter months for another year, FY21. We will be adding an additional removal pass in FY21 compared to the three removal passes in FY20. We feel conducting a marking pass prior to removal passes is still important to be able to quantify exploitation rates and population estimates. By adding one more removal pass it could potentially raise exploitation rates and potentially result in additional 1,500 large adult Channel Catfish being removed from the San Juan River. In the diet study by KSU large Channel Catfish consumed substantially more fish than small individuals. For example, a 300 mm TL Channel Catfish, averaged across all water turbidity levels, had a 12% (range 3-28%) chance of having a fish prey present in its stomach, compared to a 600 mm fish with a 50% (21-80%) chance (Hedden et al. 2020).

Objectives

1.) Conduct a marking pass to tag fish in order to quantify annual exploitation rates and population estimates of adult Channel Catfish.

2.) Mechanically remove adult Channel Catfish during four removal trips in the winter to maximize sampling efficacy.

Methods

Study Area

Sampling will take place from Four Corners Bridge (River Mile 119) to Sand Island, Utah (River Mile 76.5) using raft-mounted electrofishing. Two rafts will be used on adjacent shorelines and sample 12-15 river miles per day. One marking pass and four removal trips will be conducted during the winter months (November – March). All trips will be completed when sampling conditions are optimal to maximize sampling efficacy of collecting adult Channel Catfish. Trips will only be conducted when flows are less than 1,000 CFS and turbidity is low (>250mm Secchi disk).

Tagging Protocol

Channel Catfish ≥300 mm total length (TL) captured during the marking pass will be fitted with an individual numerical T-bar anchor tag and released back to the river. Tag data, length (mm) and mass (grams) will be recorded for every tagged fish. Tagging of Channel Catfish will allow us to generate exploitation rates during the sampling period as well as generate Lincoln-Peterson population estimates.

All Channel Catfish ≥300 mm TL captured on the subsequent removal trips after the marking pass will be removed the river. All fish will be measured to the nearest millimeter for total length, weighed to the nearest gram, and examined for a tag before being removed from the river. As the main focus of this project is removing large predatory adult Channel Catfish from the San Juan River, due to the timing of the trips and the geomorphic reach, we do not expect to see large numbers of juvenile Channel Catfish during these sampling trips, however if juvenile Channel Catfish or any other nonnative fish is observed, they will be collected and removed from the river.

Rare Fishes Captures

Due to the demographic monitoring of Colorado Pikeminnow and Razorback Sucker already taking place in the fall on the San Juan River, rare fishes will not be collected during nonnative removal efforts.

Deliverables

Data will be entered, analyzed, and presented to the SJRIP Biology Committee. A draft report will be submitted to the Program Office by 31 March 2022 and a final report will be completed by 1 June 2022. All data will be submitted to the Program Office by 31 December 2022.

Budget Justification

The increase in budget compared to the previous year is based on an additional non-native fish removal pass, and in our need to fully account for the costs incurred on all projects. These increased costs mainly come from the hourly salary rate with benefits, annual cost of living increases, and mandatory overtime for non-exempt employees.

FY 2021								
Nonnative fish removal - 5 trips, Four Corners Bridge, UT. to Sand Island, UT. NMFWCO supplying 5 people per trip								
Labor Cost - Field Work (5 trips x 5 days/trip)								
Position	**Grade/Step**	**Salary w/**	**Hours/Da**	**Total Days**			**Sub-Total**	
Fish Biologist	GS 11/7	$52.04	8	25			$10,408.00	
Fish Biologist	GS 9/7	$47.16	8	25			$9,432.00	
Remote Biologist	GS 9/4	$41.72	8	25			$0.00	$8,344.00
Biological Tech	GS 5/1	$18.67	8	25			$3,734.00	
Biological Tech	GS 5/1	$18.67	8	25			$3,734.00	
5 days. 53 hours per trip								
Overtime Hours (weekend or >9 hour work days	**Grade/Step**	**Salary w/**	**Hours/Da**	**Total Days**				
Fish Biologist	GS 11/7	$52.04	2.75	25			$3,577.75	
Fish Biologist	GS 9/7	$62.93	2.75	25			$4,326.44	
Remote Biologist	GS 9/4	$56.18	2.75	25			$3,862.38	
Biological Tech	GS 5/1	$27.34	2.75	25			$1,879.63	
Biological Tech	GS 5/1	$27.34	2.75	25			$1,879.63	
Administrative, Reporting, Planning								
Fish Biologist	GS 9/7	$47.16	8	35			$13,204.80	
Remote Biologist	GS 9/4	$41.72	8	35			$0.00	$11,681.60
Supervisory Fish Biologist	GS 13/4	$71.12	8	5			$2,844.80	
Adminstrative Officer	GS 9/9	$46.93	8	5			$1,877.20	
Biological Tech	GS 5/1	$18.67	8	25			$3,734.00	
Biological Tech	GS 5/1	$18.67	8	25			$3,734.00	
					Total Labor		**$68,228.61**	
Travel and Per Diem	**Days**	**Rate**						
Lodging Costs (House Rental)	5	$600.00					$3,000.00	
Per Diem (Travel Day)	50	$41.25					$2,062.50	
Per Diem (Full Day)	75	$55.00					$4,125.00	
Concur Fee	50	$14.75					$737.50	
					Total Travel/Per Die		**$9,925.00**	
Equipment	**Miles/Qty**	**Total Mil**	**Rate**					
Floy Tags	2000		$0.70				$1,400.00	
Vehicle Fuel								
1 trucks X 4 trips - ABQ to Sand Island, UT 574 mi RT								
1 truck X 4 trips- Farming. To Sand Island, UT 216	574/216	3,950	$0.58				$2,291.00	
Generator Fuel	150		$2.85				$427.50	
30 gallons/trip x 4 trips								
Maintenance, repair, replace							$3,000.00	
(i.e. life jackets, waders, generator repair, dip nets, etc.)								
					Equipment Total		**$7,118.50**	
Remote Biologist Savings	$20,025.60							
				Total for 4 trips NNR. - NMFW			**$85,272.11**	
				Overhead 3%			$2,558.16	
				Grand Total			$87,830.28	

Literature Cited

Hedden, S. and K. Gido. 2020. Incidence and consumption of endangered fishes by Channel Catfish (*Ictalurus punctatus*) in the San Juan River. Kansas State University. Unpublished data.

San Juan River Basin Recovery Implementation Program. 2015. Long-range plan. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2002a. Colorado pikeminnow (Ptychocheilus lucius) Recovery Goals: amendment and supplement to the Colorado Squawfish Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

U.S. Fish and Wildlife Service. 2002b. Razorback sucker *Xyrauchen texanus* Recovery Goals: amendment and supplement to the Razorback Sucker Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

Response to comments

17	SOW-17-FY 21 Channel Catfish Management on the San Juan River	Duran; NMFWCO

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

In comparing scenario 1 to scenario 2, exploitation rate will certainly go up with an additional pass if that pass catches any catfish at all. More to the point, how large an increase is needed to justify the extra pass? Would be good to work that out in advance & then see if the extra pass achieves it (assuming scenario 2 is closen). Exploitation rates would only increase if we recaptured tagged Channel Catfish. On the last removal trip of the sampling period (trip 4) we removed 1,522 adult Channel Catfish and 65 of those were tagged. Theoretically if we had done one more trip, we estimate we would have removed about the same amount of Channel Catfish. For example, if we recaptured 50 tagged fish during that extra pass, exploitation rates would jump from 22.8% to 28.2%.

What is this SOW's contribution to recovery?

Electrofishing preferentially removes larger catfish, which we know from the KSU study account for a large percentage of predation by catfish of all sizes. Therefore, the removal project may substantially reduce predation on endangered fish, even though exploitation rates are nowhere near high enough to actually control the catfish population.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

The SOW could include a plan to collect turbidity measurements in order to establish a relationship between water clarity and CPUE. This relationship could be used to determine a bench mark for turbidity levels that are too high to effectively remove channel catfish. If this is done it would require moving this work to an evaluation of sampling efficiency which would mean removal efforts would continue despite turbidity levels. Which may not be desired. While it is not stated in the SOW, we did take Secchi disk readings every morning and multiple times throughout the day if conditions changed. We also took multiple readings on the trip that we rescheduled due to increased turbidity. We will be able to plot these Secchi disk readings on top of the hydrograph from Four Corners gauge and see if there's a noticeable threshold of turbidity and flows and if spikes on the USGS gauge equals spikes in turbidity in the river. The Secchi disk readings compared to the USGS gauge FNU readings will help us determine the

relationship between FNU's and actual visibility in the river.

What is this SOW's contribution to recovery?

This SOW will facilitate Colorado Pikeminnow recovery by removing large Channel Catfish individuals, which represent a disproportionately high component of endangered fish consumption.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

I can see the logic of having another removal trip based on the exploitation rates measured in 2020. However, I do question the continued need to measure that rate each year. That first (marking trip) did have 921 fish in hand. Maybe we only need to document the rate and population size of catfish every third or fourth year? That is a very good point that generated some good discussion during the BC meeting. Since this is the second year of sampling during the winter, generating exploitation rates would give us a way to measure the efficiency of sampling and allow us to compare it to the first year's results.

What is this SOW's contribution to recovery?

No comment

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

The technical aspects of this SOW appear sound and sufficient to accomplish the objectives.

What is this SOW's contribution to recovery?

Implementing this SOW should improve the survival rates and improve recovery for endangered fish in the San Juan River.

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

No Comment

What is this SOW's contribution to recovery?

The KSU study made an argument that Channel Catfish predation could severely impact Colorado Pikeminnow if left unchecked. This refined non-native removal effort is the culmination of many years of removal experience and seems to avoid many of the pitfalls identified from previous efforts. A scope of this nature requires flow and turbidity to be within range and therefore some leeway and extensive system knowledge to complete successfully.

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

It appears that exploitation rates of larger catfish is actually pretty goo for this work and seems to be more effective than summer removal.

1) It would be good to see what the expected exploitation rate would be with an extra trip? They estimate 1,500 more fish would be removed, with a current exploitation rate of 22.8% with three removal trips. What would it be with another trip. On the last removal trip of the sampling period (trip 4) we removed 1,522 adult Channel Catfish and 65 of those were tagged. Theoretically if we had done one more trip, we estimate we would have removed about the same amount of Channel Catfish. For example, if we recaptured 50 tagged fish during that extra pass, exploitation rates would jump from 22.8% to 28.2%.

2) I agree that keeping the marking trip is important to evaluate the removal rates. Agreed.

3) There is some evidence that catfish, maybe even bigger ones, congregate in lower stretches of the river during the winter. Would it be worth a trip during this time of year to investigate that? I realize it would be a camping trip, but…might be worth trying it. I will talk to Brian Hines since they use to sample in the lower canyon during this time period and see what he thinks. It seemed like there were plenty of large adult Channel Catfish in the section we sampled.

4) It would be good if the authors acknowledged the Pennock et al. (2018) publication in this SOW. It is a pretty critical piece of research that has led to this work being modified over the years and should be referenced (maybe multiple times) in this SOW. I will incorporate Pennock et al. for the report for this SOW. We will use Casey's paper when comparing exploitation rates to previous years sampling and what his models showed about the effect of various levels of exploitation

5) I would support another removal trip after more discussion with BC and looking at the budget. Perhaps money saved from 2020 work not being done could be used to do this extra trip? The SOW has been modified to add one more removal pass after the discussion at the last BC meeting.

What is this SOW's contribution to recovery?

Control of NNF is likely important at some level. This project seems like a good compromise between removing what we think are the problem fish, i.e., larger CCF, and level of effort toward this goal.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

There are a few grammatical and editorial corrections needed. The preliminary exploitation rates seem to indicate that this time of year is better than summer for removal. I am concerned that if the fourth trip is added it will conflict with the monitoring for wild age 1 Razorback in SOW 19b. I recommend not electrofishing much past early March to avoid impact to any Razorback Suckers that may be staging for spawning. Agreed. We will move up the sampling dates to make sure we are done electrofishing before early March.

What is this SOW's contribution to recovery?

No comment

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

Lines 71-74: Has this been proven or is this an assumption? Could this be a metric of habitat availability (or lack thereof in 2018), concentrating fish would tend to favor predators. This was an assumption Sky made based on stomach contents in 2018 vs 2019 when comparing turbid conditions at time of stomach collection.

Lines 91-92: Do you mean tetany? Full taxis would have the fish swimming at the anode taking the speed of the current out of the equation. Yes, I meant "tetany". Thank you for catching that error.

Line 135: Why was this area selected? Is there past data that would point to a better section of river to be removing nonnatives? While there is not much data on this exact time of sampling in any part of the river, I chose this area based on the spring Razorback Sucker trip that was done in 2019 and crews did not observe Channel Catfish until after Four Corners bridge. I also used observations Sky and I made during February sampling of 2018 for the diet study which resulted in observations of high abundance of adult Channel Catfish in the area. I think our results support that we chose an area that could produce large numbers of adult Channel Catfish.

Line 141: "…positively increased our efficacy resulting in favorable exploitation rates." Compared to what rates? Rates observed during the diet study or previous nonnative removal, would these account for seasonality or difference in spatial sampling (river miles)? I believe that higher catch rates would be expected given that there hasn't been a catfish removed from the river in the past two years. We have not compared exploitation rates to all other years of tagging data prior to this winter sampling yet. This project was completed two weeks before the SOW was due. A FY20 report will compare this project to previous data to compare exploitation rates and catch rates.

What is this SOW's contribution to recovery?

Management or removal of a predator in a system is one of a few management actions that we as a program can do for help recovery of T&E fish. While the quantitative level of predatory threat of catfish on CPM or RBS is still up for debate, the fact is that catfish are still a threat and this SOW is removing a threat.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

While the proposal is clearly and concisely written, I question the need to repeat the catfish population estimates each and every year. Previous years' work has shown us our exploitation rates are quite high for the larger size classes of catfish we want to remove. I suggest we put all the effort into removing these fish and not spend valuable resources counting and re-counting them every year. I can see your side of the argument and it is hard to throw back 900+ fish back in the river when you have them in hand. This topic generated some good discussion during the BC meeting. Since this is the second year of sampling during the winter, generating exploitation rates would give us a way to measure the efficiency of sampling and allow us to compare it to the first year's results. If we continue doing this project and can replicate high exploitation rates in multiple years then maybe we can transition to strictly removing fish and cease the tagging efforts.

What is this SOW's contribution to recovery?

The KSU catfish diet study has given us some guidance on the quantitative aspects of predation on native fishes, including the endangered species. While catfish removal may not give us the most "bang for the buck", it is one management tool we have that can provide at least some level of quantifiable positive results in terms of recovery..

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

Line 108-110: Provide exploitation rates by pass for winter 2020 removal efforts. Obviously another pass would have resulted in additional fish removed and an increase in the exploitation rate. However, the important thing is how much more exploitation would have occurred given the effort it would have required. Exploitation rates are not linear with effort expended. Exploitation rates by pass and comparison of data from this sampling and previous years tagging efforts will be explained in more detail in the report. This SOW was due two weeks after this project was completed. Yes exploitation rates are not linear and it all depends on how many fish are recaptured during that pass. On all three passes we recaptured more than 50 fish per trip. Just as an estimate if we were to have completed one more trip and recapture 50 Channel Catfish, exploitation rates would have increased from 22.8% to 28.2%.

Line 110-114: Provide empirical evidence that movement rates of Channel Catfish are lower during winter months. This data analysis was not completed by the time the SOW was due but out of all the recaptured Channel Catfish during the winter sampling, average movement between tagging and recapture was 2.7 miles downstream. Range of movement was one fish that moved 11 miles downstream and one fish that moved 11 miles upstream.

Lines 118-121: Where does the 1,500 additional large Channel Catfish come from? You reported in the SOW that on all 4 trips (including the tagging trip) a total of 5,114 Channel Catfish were captured which is an average of 1,279 fish per trip. If only the removal trips are used, then an average of 1,398 fish were removed per trip. Also what is considered a "large adult Channel Catfish" and how many of these were removed during the three trips? Yes the average was around 1,400 fish per trip but I went off of the last trip which was finished right before this SOW was due. On that last trip we removed 1,522 adult Channel Catfish and 65 of those were tagged. Theoretically if we had done one more trip, we estimate we would have removed about the same amount of Channel Catfish. I consider a large Channel Catfish to be > 400mm TL. Number of fish >400mm TL removed during the three removal trips were 1) 481, 2) 902, 3) 759.

Line 136-137: Please provide information that supports the reasoning for removal in this section of river versus another section. While there is not much data on this exact time of sampling in any part of the river, I chose this area based on the spring Razorback Sucker trip that was done in 2019 and crews did not observe Channel Catfish until after Four Corners bridge. I also used observations Sky and I made during February sampling of 2018 for the diet study which resulted in observations of high abundance of adult Channel Catfish in the area. I think our results support that we chose an area that could produce large numbers of adult Channel Catfish.

Line 169: Has the Program agreed to conducting a workshop to just go over this data? Thanks for the catching that. That was part of the FY20 SOW that was not deleted as there was talk about conducting a nonnative fish management discussion during the May meeting before the COVID situation.

What is this SOW's contribution to recovery?

There have been multiple studies assessing the effects of nonnative removal on both endangered species in the San Juan River. None of those studies have provided any evidence of a positive effect. If the Program deems Channel Catfish to be a significant threat to the recovery of Colorado Pikeminnow and Razorback Sucker in the San Juan River, then rigorous evaluation of results from all recent studies needs to be conducted so that nonnative removal benchmarks can be developed. Failure to develop any benchmarks will only result in the continued expansion of nonnative removal until it again utilizes a

significant portion of the Programs resources with no measurable contribution to recovery. Expanding nonnative removal efforts above their current levels should not be considered until benchmarks are developed. In addition to developing benchmarks, the Program needs to investigate novel ideas for eradicating Channel Catfish from the San Juan. Until the species is completely eliminated from the system, an unnecessary amount of resources will be expended in an attempt to control their population.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

The proponents experienced substantial success in removing adult Channel Catfish from a 42 mile reach of the SJR between January 21 and March 12, 2020. The average exploitation rate was 22.8%, but varied by length class among adult fish. The proponents should be commended in the development of summary statistics for inclusion in the FY 2021 SOW within a few days of completion of field work.

The SOW for FY2021 is to conduct a similar control effort, but to add one additional removal trip and to begin earlier in the winter. This seems to be a reasonable modification.

There is a need to utilize the data from FY2020 and FY2021 in association with the findings from the KSU research to further assess long-term Channel Catfish removal efforts in the SJR. What would be the effect of long-term annual removal of adult channel catfish during winter throughout the SJR on the abundance and size structure of Channel Catfish? Considering growth of Channel Catfish from winter through the following summer, what is the potential effect of long-term removal on Channel Catfish population abundance and structure, and potential predation on Colorado Pikeminnow? Is it feasible to fund and conduct a long-term Channel Catfish removal effort that will have measurable benefits to Colorado Pikeminnow and Razorback Sucker in the SJR? Given modification of Colorado Pikeminnow stocking from 400,000 age-0 fish to 12,000 age-1 fish annually, how should Channel Catfish removal be approached in the future? Using results from FY 2021 and additional modeling based on KSU data, insights may be attained that can direct future Channel Catfish management actions. The PO should probably plan for a substantial data analysis, modeling, and decision-making effort utilizing expertise beyond the NMFWCO following completion of FY2021 removal efforts. Agreed. This SOW will give researchers more knowledge and data that will help the BC make management decisions regarding nonnative fish management. I agree that data from KSU diet study, Casey Pennock's publication and two years of winter nonnative removal, plus all additional years of different approaches to nonnative removal need to be integrated and rigorously evaluated to direct a clear path forward in regard to nonnative fish management in the San Juan River.

What is this SOW's contribution to recovery?

This project is providing data that will be important in determining if long-term Channel Catfish suppression efforts can/should be maintained in the SJR to benefit recovery of the endangered species.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

Think about removing a bunch of large catfish that are competing for resources (e.g., space, food) with and eating small catfish. Why won't this accelerate growth rates of small catfish so that they to recruit to larger sizes quicker? If that's true, it's just wash, rinse, repeat.

79- "additional 158 (0 -461) Colorado Pikeminnow surviving annually" The confidence interval contains zero! Having zero in one's confidence interval implies that a treatment effect (catfish predation) could have a positive or negative effect on the outcome of interest. I would remove this calculation. When a peer reviewed paper comes out on Hedden et al. work then you could include what they say there. But in my opinion, he's misinterpreted (or ignored) what the confidence intervals are telling us. Removed from the SOW and will include in the report after more data analysis has been reviewed.

123- "12% (range 3-28%) chance of having a fish prey present in its stomach, compared to a 600 mm fish with a 50% (21-80%) chance" These confidence intervals overlap indicating there no difference in fish consumption between the two sizes. Again, ignoring what the CIs are telling us. It also suggests he didn't find enough catfish with fish in their stomachs (low power) to detect differences if they do exist. I am leaving this in the SOW for right now until I can have further discussions with Sky Hedden and I will remove or clarify for the report.

Minor typos (highlighted text)
66

What is this SOW's contribution to recovery?

I still don't really know. What are these e-fishing passes doing to endangered fish?

Program Office

How can the technical aspects of this SOW be improved?

- Paragraph starting on line 95: it would be helpful to compare these exploitation rates to previous years (i.e., did changing to winter sampling increase exploitation rates?). The PIs may need to calculate them similar to Pennock et al. 2018. Those comparisons and incorporating Pennock's publication will be included in the report. This SOW was due two weeks after the completion of our

last sampling trip and I calculated exploitation rates to show the preliminary results from the project. A more detailed analysis and discussion will be included in the report.

- Line 109: it is likely exploitation would always continue to rise with more removal passes, but what is the goal and what number of passes are required to reach that target? We did not set an exact goal for exploitation rates. I think anything over 20% would be a positive achievement. We can use the FY20 data to compare to the models Casey Pennock used in his publication when looking at that effect different levels of exploitation rates would have on the Channel Catfish population.
- A different way to think about what this SOW's goal is would be to quantify how many Colorado Pikeminnow were "saved" by the number of Channel Catfish removed in the winter 2020. Then indicate how many or what percent of the population of Colorado Pikeminnow this SOW is aiming to "save." That is a good suggestion and we will work on that for the report that comes out for the FY20 work that was completed.
- Line 120: suggests an additional 1,500 adult catfish would be removed if an additional pass is conducted (from 3 to 4). How was that number derived? It was just an estimate of fish we felt could be removed with one more pass based off the average of fish removed on all three removal passes (1,398) and the number of fish removed on the last removal pass of the project (trip 4; 1,522).
- 141: It is not clear how to make the decision of three or four passes. A graph with the cumulative trip exploitation may be helpful to figure out how to make this decision (i.e., what is the cumulative exploitation over successive passes compared to the increased cost?). We have revised the SOW to remove the option of two scenarios and will move forward with adding an additional pass to the proposed work.
- Line 169: "Data will be entered, analyzed, and presented to the SJRIP Biology Committee at a workshop following the field season." It would be helpful to describe how the data will be analyzed. After the completion of the FY20 we will have a better explanation of what data analysis was done.

What is this SOW's contribution to recovery?

Reducing the densities of large, predatory Channel Catfish likely reduces the predatory impact to endangered fishes in the San Juan River.

RECOVERY PROGRAM Recovery Program Project Number: 170
FY 2021 SCOPE OF WORK for:

Development and Maintenance of a Centralized PIT tag Database for the San Juan and Upper Basin Recovery Programs

Reclamation Agreement number: New 5 year agreement in progress (existing agreement through FY19 is R14AC00084)
Reclamation Agreement term: Anticipated term Oct 1, 2019 – Sept 30, 2024

Note: Recovery Program FY20-21 scopes of work are drafted in May 2019. 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: Colorado Natural Heritage Program
Submitted by: Amy Greenwell and David G. Anderson
Colorado Natural Heritage Program
Colorado State University
1475 Campus Delivery
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Fort Collins, CO 80523-1475
Date Last Modified: 8/27/2020 3:47:00 PM

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

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

I. Title of Proposal: Development and Maintenance of a Centralized PIT tag Database for the San Juan and Upper Basin Recovery Programs (Recovery Programs)

II. Relationship to RIPRAP: Conduct interagency data management program to compile, manage, and maintain all research and monitoring data collected by the Recovery Programs.

III. Study Background/Rationale and Hypotheses: STReaMS, the central database of the Recovery Programs, creates a consolidated system to assist researchers and stakeholders with uploading, managing, editing and accessing data. Data support the recovery of endangered species and removal of nonnative fishes, assessment of effects of non-native fish removal, effects of new flow and temperature regimes based on the fish community response, and effects of continued water development.

IV. Study Goals, Objectives, End Product(s): Investigators of the Recovery Programs have been collecting large quantities of data on stocked and wild endangered fishes. These data are stored in the STReaMS database, which makes it easy to identify individual fish and capture histories and integrate data from various active capture projects as well as Passive Interrogation Arrays (PIAs). The sharing of data between investigators and stakeholders is streamlined to improve

efficiency of data entry and retrieval, and to prevent duplication of records and efforts between and among the various investigations. The master database standardizes content and provides convenient, easy access to all available data.

V. Study Area: STReaMS will house data from the entire Upper Colorado and San Juan River Basins, including Lake Powell.

VI. Study Methods/Approach: CNHP and the data managers use standard data management and assessment techniques to ensure data are accurate and as complete as possible.

VII. Task Description and Schedule:

CNHP will continue to maintain the STReaMS database and enhance existing features during the Federal FY20-24. Tasks are broken out below.

Task 1: Server Maintenance

- Maintain the server, server security, and perform regular database backups
- Maintain the test server and development environment
- Perform necessary software installs and upgrades including Windows operating system, Windows updates, MS SQL Server, MS TFS, and PHP. Ensure all code performs as expected following updates.
- Assess overall performance and optimize resources
- Maintain Database Manager credentials to access SQL Server
- Replace hardware (e.g. server, hard drives, RAM, etc.) as needed and configure new hardware

Task 2: Website Maintenance and Feature Enhancements

- Enhancements to existing tools as funding allows
    - Batch uploads
    - QC tools
    - Calculated fields
- Work with key recovery program staff to ensure complete PIA data in STReaMS
    - Shift units from Loggernet process to new Biologic FTPS upload process as they are upgraded
    - Needs assessment and training with key staff
    - Add and remove PIAs to the automatic upload system as needed
- Work with Database Managers to develop any necessary custom queries, including non- tagged fish queries
- Bug fixes
- Internal testing and stress tests
- Update online help, data dictionary, user manuals, Data Managers user guide, and system documentation
- Train Recovery Program participants on features and enhancements
- Other priorities identified by Recovery Program Database Managers

Task 3: Project Management

- Prepare annual reports
- Perform project management and CSU compliance
- Maintain regular communication with Database Managers

FY21 also includes the purchase and installation of a new server to run the database and website.

VIII. Deliverables, Due Dates, and Budget by Fiscal Year:

Name of Servicing Agency:	Colorado Natural Heritage Program - Colorado State University
Project Name:	Development and Maintenance of a Centralized PIT tag Database for the San Juan and Upper Basin Recovery Programs

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
Enter the BEGINNING dates for each year ------>	**10/1/2019**	**9/30/2020**	**10/1/2021**	**10/1/2022**	**10/1/2023**	
	Through	Through	Through	Through	Through	
Enter the ENDING dates for each year -------->	**9/29/2020**	**9/30/2021**	**9/30/2022**	**9/30/2023**	**9/29/2024**	
DIRECT LABOR AND FRINGE BENEFIT COSTS:	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**TOTAL**
Direct Labor - Hourly	$ 16,860.17	$ 18,600.89	$ 15,614.95	$ 15,927.25	$ 16,245.79	$ 83,249.05
Fringe Benefits - Hourly	$ 11,616.01	$ 12,808.48	$ 10,760.02	$ 10,975.22	$ 11,194.72	$ 57,354.45
Subtotal of Direct Labor & Fringe Benefits:	**$ 28,476.18**	**$ 31,409.37**	**$ 26,374.97**	**$ 26,902.47**	**$ 27,440.52**	**$ 140,603.50**
OTHER DIRECT COSTS:	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**TOTAL**
Materials and Supplies	$ 291.00	$ 2,422.94	$ 1,585.45	$ 1,615.78	$ 2,638.52	$ 8,553.69
Travel Costs	$ -	$ -	$ -	$ -	$ -	$ -
Equipment	$ -	$ 6,925.00	$ -	$ -	$ -	$ 6,925.00

Percentage of dollars contracted for:
4.93%
3.95%

Contractors		$ -		$ -		$ -		$ -		$ -		$ -	0.00%
Subtotal of Other Direct Costs:		**$ 291.00**		**$ 9,347.94**		**$ 1,585.45**		**$ 1,615.78**		**$ 2,638.52**		**$ 15,478.69**	**8.88%**

INDIRECT/OVERHEAD COSTS:		**YEAR 1**		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
Subtotal of Labor and Other Direct Costs:		**$ 28,767.18**		**$ 40,757.31**		**$ 27,960.42**		**$ 28,518.25**		**$ 30,079.04**		
Total dollars exempt from indirect/overhead base:				$ 6,925.00								
CSU CESU Rate	**17.50%**	$ 5,034.26	**17.50%**	$ 5,920.65	**17.50%**	$ 4,893.07	**17.50%**	$ 4,990.69	**17.50%**	$ 5,263.83		$ 26,102.51
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:		**$ 5,034.26**		**$ 5,920.65**		**$ 4,893.07**		**$ 4,990.69**		**$ 5,263.83**		**$ 26,102.51**

		YEAR 1		**YEAR 2**		**YEAR 3**		**YEAR 4**		**YEAR 5**		**TOTAL**
GRAND TOTAL:		**$ 33,801.43**		**$ 46,677.96**		**$ 32,853.49**		**$ 33,508.94**		**$ 35,342.87**		**$ 182,184.69**

Year 2 includes a new server with the latest operating system and software. New software and operating system have a different pricing model based on annual fees. Annual fees for software and operating system are included in Years 3-5.

IX. Budget Summary:

FY2020: $33,801.43	San Juan: $10,000	Upper Basin: $23801.43
FY2021: $46,677.96	San Juan: $10,000	Upper Basin: $36677.96
FY2022: $32,853.49	San Juan: $10,000	Upper Basin: $22853.49
FY2023: $33,508.94	San Juan: $10,000	Upper Basin: $23508.94
FY2024: $35,342.87	San Juan: $10,000	Upper Basin: $25342.87

X. Reviewers:

Dave Speas
Fish Biologist
U.S. Bureau of Reclamation
Upper Colorado Regional Office
C/O Western Colorado Area Office
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FY2021 – Demographic Monitoring of Colorado Pikeminnow and Razorback Sucker

Principal Investigators:

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This SOW proposes the third year of a three-year effort to generate age-specific demographic parameters for Colorado Pikeminnow and Razorback Sucker in the San Juan River. This proposal is aimed at satisfying several data and recovery needs of the San Juan River Basin Recovery Implementation Program (SJRIP): 1) age-specific capture and survival probabilities of endangered fishes, 2) age-specific abundance estimates of endangered fishes, 3) effects of limited handling on the endangered fishes, and 4) development of a new post-2023 endangered fish monitoring program. Specifically, the proposed work will focus strictly on the two endangered fishes but with increased effort in order to track demographic parameters of both endangered fishes. Similar to the Upper Colorado River Endangered Fish Recovery Program, we propose this demographic-based sampling occur in a 3-year on, 2-year off fashion in order to allow periods of limited handling stress to the recovering populations. Conducting this work in 2021 would represent the final year of the 3-year "on" cycle. Annual sub-adult/adult monitoring could occur during the "off" cycle to maintain long-term monitoring dataset established during previous sampling.

Following the Recruitment Bottleneck Workshop on 22 February 2018, the SJRIP decided to limit the capture of Colorado Pikeminnow and Razorback Sucker during summer sampling in order to minimize the apparent detrimental effects of the capture event on juvenile Colorado Pikeminnow survival (Clark et al. 2018). At this point the mechanisms contributing to these capture effects are unknown, but stress-related factors such as electrofishing, handling, tagging, live well housing, and other environmental conditions could be negatively affecting survival. Thus, the SJRIP would likely be unable to evaluate the effects of reduced handling of juvenile Colorado Pikeminnow in the summer without conducting this proposed work.

The negative effect of capture on juvenile Colorado Pikeminnow was documented via analysis of annual survival (Clark et al. 2018). Thus, continued use of the same parameter to measure the response of changing management appears most appropriate (i.e., not capturing juvenile Colorado Pikeminnow during summertime sampling). Clark et al. (2018) reported relatively high capture probabilities for juvenile Colorado Pikeminnow based on the entirety of the SJRIP's sampling efforts (annual mean range: 0.31-0.42). However, single-pass Fall Monitoring capture probabilities of juvenile Colorado Pikeminnow are typically lower (annual mean range: 0.0173-0.0483 from 2011-2015; SJRIP 2017), limiting recaptures needed for precise annual survival estimates. In an effort to increase capture probability for reliable annual survival estimates, we propose conducting three passes in this Demographic Monitoring SOW of four rafts each from Shiprock, NM to Sand Island, Utah in fall 2021 (RM 147.9-77.7). Only endangered fish would be captured during this Demographic Monitoring effort and additional care would be carried out to minimize fish stress (e.g., salting live wells and using aerators). We propose conducting Demographic Monitoring for three of five years (on 2019-2021, off 2022-2023). Three years of Demographic Monitoring will allow for annual, age-specific survival estimates and capture probabilities for both endangered species (and in the future, estimates of wild-spawned versus hatchery-reared fish). Additionally, multiple in-year passes over three years allows for the use

of Pollock's robust design (Kendall et al. 1997) and estimation of age and species-specific annual abundance. The Demographic Monitoring proposal increases sampling effort during the fall; however, because temperatures are cooler in fall compared to summer (when catch rates of endangered fishes were previously highest), physiological stress and mortality should be reduced.

The following is an outline for the proposed work:

- Three passes (4 rafts each pass) separated by one week
- Each river mile will be a sample unit
- Sampled reach is between Shiprock and Sand Island (RM 147.9-77.7)
- Start mid-September, end early October
- Capture only endangered fishes
- All previous PIT tagging protocols will be in place
    - o All captured fish will be checked for a PIT tag
    - o All fish lacking a PIT tag and >130mm will be implanted with a new PIT tag

- Analysis will be mark-recapture robust design (same analysis used by Upper Basin)
    - o Estimate age-specific capture probability (per pass)
    - o Estimate age-specific survival (annual)
    - o Estimate age-specific abundance (annual)

Data Analysis

Data collected during the proposed Demographic Monitoring effort in 2021 would complete the three year cycle of this monitoring effort. The first two interim reports will incorporated with the third year's analyses in a final report following the completion of data collection.

Following data collection in 2020 and 2021, we will use Pollock's robust design (Kendall et al. 1997) implemented in Program MARK (White and Burnham 1999) to estimate demographic parameters of interest. The use of this model is particularly advantageous because it integrates both closed and open population models to estimate several demographic parameters. For example, within year sampling occasions will take place at closely spaced temporal intervals (3 passes over 6 weeks) to estimate *within year age-specific abundance* with closed models. This level of within-year sampling across consecutive years will then allow for the estimation of *between year age-specific survival* using open population models. Additionally, the robust design allows for the estimation of *capture/recapture probability by pass*. A suite of competing models including the effects of variation in factors such as fish size (TL), year, pass-specific capture/recapture probability, temporary emigration, and reach will be evaluated with AICC (Burnham and Anderson 1998) for Colorado Pikeminnow and Razorback Sucker.

Deliverables

A draft final report will be submitted to the Program Office by 31 March 2022 and a final report will be completed by 30 June 2022. All data will be submitted to the Program Office by 31 December 2021.

References

Burnham, K.P., and D.R. Anderson. 1998. Model selection and inference: a practical information-theoretic approach. Springer-Verlag, New York.

Clark, S.R., M.M. Conner, S.L. Durst, and N.R. Franssen. 2018. Age-specific estimates indicate deleterious capture effects and low survival of stocked juvenile Colorado Pikeminnow (*Ptychocheilus lucius*). North American Journal of Fisheries Management. doi/pdf/10.1002/nafm.10214.

Kendall, W.L., J.D. Nichols, and J.E. Hines. 1997. Estimating temporary emigration using capture-recapture data with Pollock's robust design. Ecology 78(2):563-578.

San Juan River Basin Recovery Implementation Program (SJRIP). 2017. Population abundance estimates for Colorado Pikeminnow and Razorback Sucker in the San Juan River. San Juan River Basin Recovery Implementation Program, U.S. Fish & Wildlife Service, Albuquerque, NM.

White, G.C., and K.P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 (supplement):120-138.

Disclaimer: There was a transposing error between MS Excel and MS Word where labor costs of around $22,600 were dropped from FY2020 Demographic Monitoring. These labor costs were included in the FY2021 Demographic Monitoring SOW which resulted in a large increase from FY2020.

Task 1: Demographic Monitoring – total budget: $239,516

Personnel/Labor Costs (Federal Salary + Benefits)

Objectives 1-3: Logistics, Electrofishing, Removal of Nonnative Fish

Description	Rate/HR	TOTAL
Principal Biologist (GS-11/7) – 320 hours		$17,228.80
(1 person X 10 days planning & organization)	$53.84	
San Juan River sampling - fall:		
(1 person X 8 days/trip X 1 trip – camping)	$53.84	
(+ 16 extra hours)	$53.84	
Bio. Tech. Crew Leader (GS-7/4) - 120 hours		$9,738.00
San Juan River sampling - fall:		
(1 person X 10 days/trip X 1 trip – camping)	$32.46	
(+ 40 hours overtime)	$48.69	
Bio. Tech. Crew Leader (GS-6/3) - 120 hours		$16,646.40
San Juan River sampling - fall:		
(1 person X 10 days/trip X 1 trip – camping)	$27.74	
(+ 40 hours overtime)	$41.62	
	PERSONNEL/LABOR TOTAL	**$43,613.20**

Permitting; Coordination; Data Input, Analysis, Management & Presentation; Report Writing; Office & Administrative Support (Federal Salary + Benefits)

	Rate/HR	TOTAL
Administrative Officer (GS-9/8) – 360 hours	$42.98	$15,472.80
Principal Biologist (GS-11/7) – 480 hours	$53.84	$25,843.20
Project Leader (GS-14/6) – 320 hours	$82.57	$26,422.40
	PERMITTING, DATA INPUT, ETC	**$67,738.40**

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

Hotel Costs	RATE	TOTAL
5 nights (in Cortez, CO)	$124.00	$1,488.00
Per Diem (Hotel Rate)		
1 days X 5 people (in Cortez, CO)	$61.00	$732.00

Per Diem (Camping Rate)

	10 days X 4 people	$36.00	$3,024.00
		TRAVEL/PER DIEM TOTAL	**$5,244.00**

Equipment and Supplies

Vehicle Maintenance & Gasoline (@ $365/month lease = $12.17 per day based on 30 days in an "average" month + $0.42/mile)

Vehicle Mileage		Mileage Rate	TOTAL
San Juan fall sampling			
	Grand Jct. to Cortez to Hogback to Sand Island to Grand Jct.	$0.43	$671.42
VEHICLE LEASE		Lease/day	
San Juan fall sampling	Grand Jct. to Cortez to Hogback to Sand Island to Grand Jct.	$12.35	$296.46
Shuttle Service		$253.75	$2,030.00
Generator Gasoline		GAS $/GAL	
	San Juan River sampling	$2.51	$350.99
	Vehicle Maint. & Gasoline		**$3,399.10**

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 be maintained, repaired, or replaced, but use 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	$6,125.00
Equipment Maintenance, Repair, & Replacement Subtotal	$15,483.43
6% of Personel, Permitting, Travel, and Vehicle Maint.	**$7,199.68**

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.

USFWS-GJFWCO Total	**$127,194.39**
USFWS R6 Admin Overhead (3.00%)	**$3,815.83**
USFWS Region 6 Total	**$131,010.22**

Demographic monitoring. New Mexico Fish and Wildlife Conservation Office							
Labor Cost - Field Work (3 trips x 6 days/trip) 5 people per trip							
Position	**Grade/Step**	**Salary w/be**	**Hours/Day**	**Total Days**			**Sub-Total**
Fish Biologist	GS 11/7	$52.04	8	18			$7,493.76
Fish Biologist	GS 9/7	$47.16	8	18			$6,791.04
Remote Biologist	GS 9/4	$41.72	8	18			$0.00
Biological Tech	GS 5/1	$18.67	8	18			$2,688.48
Biological Tech	GS 5/1	$18.67	8	12			$1,792.32
Supervisory Fish Biologist	GS 13/4	$71.12	8	6			$3,413.76
6 days. 67.25 hours per trip							
Overtime Hours (weekend work)		Salary w/be	Hours/Day	Total Days			
Fish Biologist	GS 11/7	$52.04	4.5	18			$4,215.24
Fish Biologist	GS 9/7	$62.93	4.5	18			$5,097.33
Remote Biologist	GS 9/4	$56.18	4.5	18			$4,550.58
Biological Tech	GS 5/1	$27.34	4.5	18			$2,214.54
Biological Tech	GS 5/1	$27.34	4.5	12			$1,476.36
Supervisory Fish Biologist	GS 13/4	$71.12	4.5	6			$1,920.24
Administrative, Reporting, Planning							
Fish Biologist	GS 9/7	$47.16	8	45			$16,977.60
Remote Biologist	GS 9/4	$41.72	8	20			$0.00
Supervisory Fish Biologist	GS 13/4	$71.12	8	5			$2,844.80
Adminstrative Officer	GS 9/9	$46.93	8	5			$1,877.20
Biological Tech	GS 5/1	$18.67	8	20			$2,987.20
Biological Tech	GS 5/1	$18.67	8	20			$2,987.20
					Total Labor		**$69,327.65**
Travel and Per Diem	**Days**	**Rate**					
Hotel Costs	12	$96.00					$1,152.00
Hotel tax	12	$12.00					$144.00
Per Diem (Travel Day)	27	$41.25					$1,113.75
Per Diem (Full Day)	60	$29.00					$1,740.00
Concur Fee	15	$14.75					$221.25
					Total Travel/Per Die		**$4,227.00**
Equipment	**Miles/Qty**	**Total Miles**	**Rate**				
Shuttle Costs	9		$200.00				$1,800.00
3 trucks x 3 trips							
Vehicle Fuel							
3 trucks X 3 trips - ABQ to							
Sand Island, UT 574 mi RT	574	5,166	$0.58				$2,996.28
Generator Fuel	120		$2.85				$342.00
40 gallons/trip x 3 trips							
Maintenance, repair, replace							$3,000.00
(i.e. life jackets, waders, generator repair, dip nets, etc.)							
					Equipment Total		**$8,138.28**
				Total for 3 trip pop est. - NMFW			**$81,692.93**
					Overhead 3%		$2,450.79
					Grand Total		**$84,143.72**

FY 2021 Draft Budget
San Juan River Endangered Fish Demographic Monitoring
Utah Division of Wildlife Resources

Submitted by Katie Creighton and Brian Hines
katherinecreighton@utah.gov, bhines@utah.gov
435.259.3780, 435.259.3782

FY 2021 Costs for UDWR- Moab

San Juan River Endangered Fish Demographic Monitoring

Task 1. Endangered Fish Monitoring: Shiprock to Sand Island (2 people X 6 days X 2 trips)

Labor: salary + benefits + applicable overtime (personnel services)

	Rate	Hours	Cost
Project Leader	$38.10	20	$762
Biologist	$33.91	320	$10,850
Technician	$17.08	220	$3,758
		subtotal	**$15,370**

Food and Transport (current expense)

	Rate	Quantity	Cost
Truck Rental (2 trucks)	$199.37	4	$797
Mileage Costs (2 trucks X 350 miles X 2 trips)	$0.40	1500	$600
In-state per diem (during trip)	$43.00	24	$1,032
Out-of-State per diem (before trip)	$46.00	4	$184
Hotel (before trip)	$105.00	4	$420
Shuttle (2 trucks X 2 trips)	$150.00	4	$600
		subtotal	**$3,633**

Equipment (current expense)

	Rate	Quantity	Cost
Camping gear repair/replacement:			$500
Sampling gear repair/replacement:			$1,000
Boating gear repair/replacement:			$1,000
Fuel for generators (50 gallons/pass)	$4.00	100	$400
		subtotal	**$2,900**

Total Expenses	**$21,903**
Administrative Overhead (16% on all personnel services)	**$2,459**
FY 2021 Total	**$24,362**

Documenting the occurrence, spatial distribution, and incidence of introgression in wild age-1 Razorback Sucker in the San Juan River 2021

Principal Investigator:

Benjamin Schleicher
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Contract or Agreement number:

R17PG00084 for USFWS –Grand Junction, CO

Introduction

A higher than usual Razorback Sucker recruitment was observed in the San Juan River from fish spawned in 2018 that overwintered into 2019. In 2018, a total of 164 wild early juvenile Razorback Sucker were collected by ASIR; with an additional 42 juvenile Razorback sucker by NNFWS, KSU, UDWR, and NMFWCO. Larval Razorback Sucker were collected as high as River Mile (RM) 180.0 (Farrington et al. 2018), but the vast majority of the wild juvenile fish (87%) were collected between RMs 120.0-50.0, potentially due to the higher level of sampling that occurred in this reach. In the spring of 2019, a single pass sampling effort from RM 149.9-3.0 collected an additional wild 44 age-1 Razorback Suckers between RMs 119.0-17.0, documenting overwinter survival of this cohort. Because the observed reproductive success of the wild Razorback Sucker cohort in 2018-2019 was unprecedented in the San Juan River, many questions remain about environmental causes of this strong year-class, current levels of natural annual recruitment, and the reproductive ecology of the species, in general, in this repatriated system.

While it is rare for populations of Razorback Sucker anywhere to demonstrate natural recruitment past the larval stage, factors that led to successful recruitment in the San Juan River remain elusive. Overwinter survival of wild-spawned age-0 Razorback Sucker have been detected in Lake Mead as well as intermittently in the upper Colorado River Basin both on the Colorado and Green Rivers, however, never at levels observed in the San Juan River in 2018-2019. Because several management activities occurred concurrently in 2018 (e.g., transplanting Razorbacks Sucker adults over the waterfall and increased passage rates at PNM weir) as well as 2018 being an extremely low water year, it is difficult to identify a single cause of this reproductive success. The collection of wild age-1 fish in the spring of 2019 indicated this size of Razorback Sucker are susceptible to capture by electrofishing rafts, are distinguishable from similar-sized Flannelmouth Sucker (although only with close scrutiny), and that they were present in some, but not all reaches of the river. The current water year (2020) looks to be more similar to that of 2018 rather than 2019 with low soil moister, average snowpack, and no spring peak release forecasted from Navajo Reservoir. Reproductive success was observed in 2019, with 656 Razorback Sucker larvae collected between Shiprock, NM to Clay Hills, UT which is around average for ASIR's monitoring (Farrington per comm.). We think it is imperative to attempt to collect wild age-1 Razorback Sucker to further aid our understanding of natural recruitment in the system and how reproductive success may relate to the river's hydrology given the success in the spring of 2019 sampling.

It is important to sample wild age-1 Razorback Sucker~~s~~ in the spring before any potential snow-melt driven runoff may cause actual or apparent mortality through fish movement and emigration, electrofishing in turbid spring runoff water is less effective than clear base flow water as well. In order to track the relative abundance and lifespan of these individuals, biologists will need to implant PIT tags into as many of these fish as possible. However, based on the growth rates of wild fish we observed in 2019, our 'window' may be relatively short to

tag known wild fish before they reach the 300 mm TL size limit of our stocked fish. For example, the average size of wild age-0 fish in fall 2018 was nearly 150 mm TL. If they experience similar growth rates next summer (~1 mm/day), these wild fish could be >300 mm TL by fall 2019. Total length of wild age-1 fish captured in spring 2019 would suggest little overwinter growth occurred which would be expected. Looking forward, there is limited recapture data of these fish to assess growth of age-1 Razorback Sucker through their second summer of life. Two fish recaptured during Demographic Monitoring the fall of 2019 after they were tagged in the spring of 2019 showed growth from 155mm total length (TL) in March to 245mm TL in October (a Razorback Sucker), and from 165mm TL in March to 275mm TL in October (a Razorback Sucker X Flannelmouth Sucker hybrid). We will need a much better understanding of the growth rate of these fish if we are to assess the ability of our current sampling periodicity to discern wild from hatchery Razorback Sucker.

While we were confident wild age-1 Razorback Sucker were positively identified during the spring trip in 2019, identification required very close inspection as some of the smaller individuals looked very similar to age-1 Flannelmouth Sucker. One fish identified as a Razorback Sucker in spring 2019 was recaptured later in 2019 and identified as a Razorback Sucker X Flannelmouth Sucker hybrid. A recapture of another fish identified as a Razorback Sucker in spring 2019 was consistent with the identification in the fall. We propose that a genetic assessment is needed to quantify any putative hybridization as well as a more definitive check on identified Razorback Sucker of this size. We proposed to photograph and fin clip every Razorback Sucker <300 mm for genetic analyses using single nucleotide polymorphisms (SNPs) obtained using next-generation sequencing. These analyses should allow for the identification of purebred Razorback Sucker and Flannelmouth Sucker as well as any F_1 or F_2 crosses. These samples can be added to the already planned larval Razorback Sucker parental assignment analyses at the Southwestern Native ARRC from the KSU translocation scope of work.

Finally, we know relatively little about the occurrence and spatial distribution of wild juvenile age-1 Razorback Suckers in the San Juan River because there have not been dedicated efforts targeting them in the spring when their smaller size would distinguish them from hatchery stock. While 2018 was a low water year, it still is not clear if a typical or above average water year will produce age-1 fish, largely because we have not been sampling during this springtime period. Therefore, a sampling pass that covers nearly the entire river would lend insight to the spatial distribution of juveniles and assess the likelihood that there is more wild recruitment than we have been aware, as well as help identify reaches of the river that may be more conducive to recruitment.

Based on our reasoning above, we propose a sampling trip in 2021, similar to the 2019 spring trip, aimed at addressing the following questions:

1. At what level, using catch per effort, is the endangered fish population in the San Juan River experiencing annual, age-1 recruitment?

- Assessing degree of overwinter survival, regardless of water year, would inform the potential time-frame to recovery in the San Juan River as well as other management actions.

2. What is the size variation of wild age-1 Razorback Sucker in the spring and what is the likelihood individuals will be >300 mm TL by fall?
    - Our capacity to track the success of wild cohorts will rest on our ability to identify wild fish, especially when they surpass 300 mm TL.
    - If age-1 wild fish will likely be >300 mm TL by late summer or fall, the Program may need to shift sampling temporally to increase the number of tagged 'known' wild fish.

3. Does the spatial distribution of wild age-1 Razorback Sucker and Colorado Pikeminnow, as well as wild Age-2 Colorado Pikeminnow indicate spatial variation in recruitment success?
    - Gaining insights into reaches of the river that support wild age-1 Razorback Sucker and wild age-1 and 2 Colorado Pikeminnow would potentially lend insight into habitat requirements of wild fish.

4. Are putative wild age-1 Razorback Sucker purebred in origin?
    - Assessing levels of any potential hybridization and introgression should be a first step in assuring these recruits will provide for biologically viable and self-sustaining population of Razorback Sucker in the San Juan River.

    - Matching photographs of individuals with their genetic evaluation and assignment will help field crews increase their ability to recognize age-1 Razorback Sucker.

5. What is the survival of the wild 2019 Colorado Pikeminnow cohort?
    - The program decided not to stock age-0 Colorado Pikeminnow in the fall of 2019. We would be able to identify any overwinter survival from age-1 to age-2 wild Colorado Pikeminnow.

Methods

To address the questions above, the methods in this SOW are similar to the SOW for Wild Age-1 Razorback Sucker Monitoring in 2019. Specifically, we propose to conduct a single pass (two electrofishing rafts) in the spring (March or April) 2021 during clear and low flows between Shiprock, NM and Clay Hills, UT (RM 147.9-2.9). Each river mile will serve as a sample unit. Due to the apparent difficulty in distinguishing age-1 Razorback Sucker and Flannelmouth Sucker, all sucker individuals <300 mm TL will be netted and closely examined. In addition to Razorback Sucker <300 mm TL, all Colorado Pikeminnow will be netted as well. Endangered fish (>130 mm TL Razorback Sucker) without a PIT tag will be implanted with one. All Razorback Suckers <300 mm TL will be photographed on a gird board on lateral and dorsal sides

as well as an anterior photo. Razorback Sucker will also have a small fin clip taken to assess their genetic status (see Genetics Analysis below). Additional data will include: total and standard length (mm), weight (g), PIT tag number, recapture or new tag, location (river mile), mesohabitat collected in (when possible), time captured, effort (in hours), turbidity (secchi depth), as well as any physical abnormalities. All fish will then be returned within their river mile of capture.

Genetics Analysis

Putatively pure adult Razorback and Flannelmouth Sucker will be sourced from the San Juan River, in addition to the samples being evaluated for hybrid status. Double digest RAD sequencing methods will follow those outlined in SOW 41 (translocation SOW). The pure individuals will first be evaluated using the program ADMIXTURE (Alexander et al. 2009) to confirm the non-hybrid status of the samples (i.e., fish having Q-scores >0.95 will be considered 'pure').

Two approaches will be used to evaluate the hybrid status of all samples. Our first approach will be to calculate a hybrid index (Buerkle, 2005) for each sample using the introgress R package (Gompert & Buerkle, 2010). Secondly, we will use the Bayesian clustering program NewHybrids v1.1 beta 3 (Anderson & Thompson, 2002) to categorize each sample as pure, or as first- or second-generation hybrids.

Deliverables

A draft report will be submitted to the Program Office by 31 March 2022. All data will be submitted to the Program Office by 31 December 2021.

Budget

This SOW will be funded with FY2020 carry-over and no additional funds are requested to complete this work.

References

Alexander, D. H., Novembre, J., & Lange, K. (2009). Fast model-based estimation of ancestry in unrelated individuals. Genome Research, 19(9), 1655–1664.

Anderson, E. C., & Thompson, E. A. (2002). A model-based method for identifying species hybrids using multilocus genetic data. Genetics, 160(3), 1217.

Buerkle, C. A. (2005). Maximum-likelihood estimation of a hybrid index based on molecular markers. Molecular Ecology Notes, 5(3), 684–687.

Farrington, M.A., R.K. Dudley, S.P. Platania and G.C. White. 2018. Colorado Pikeminnow and Razorback Sucker Larval Fish Survey in the San Juan River During 2018. Interim Progress Report (Draft Final Report) 1 April 2019.

Gompert, Z., & Buerkle, C. A. (2010). INTROGRESS: a software package for mapping components of isolation in hybrids. Molecular Ecology Resources, 10(2), 378–384.

19b	SOW-19b-Documenting the Occurrence, Spatial Distribution, and Incidence of introgression in wild age-1 Razorback Sucker in the San Juan River 2021	Schleicher; GJFWCO

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

Seems like a good approach to address the questions listed in the SOW. As noted in the intro., 2018-19 were unprecedented for age-1 production. If 2020 doesn't come close, this sampling may encounter very few age-1 fish. Would be good to identify "fallback" data that could be collected to enhance the trip's value in that case. Ideally, this study would collect data that could discriminate between hypotheses about the cause of the big 2019 cohort. Likely wouldn't answer that question with this one study but we should be intentionally working toward that, since the recruitment bottleneck is our biggest puzzle. Having the luxury of looking at what kind of water year 2020 will be now vs when your question was asked, it looks to be a low warm water year more similar to 2018. However you bring up a good point, I would consider the information gained from a riverwide look at the CPM make up in the spring to be additional or "fall back" data.

What is this SOW's contribution to recovery?

Explaining (and then fixing) the recruitment bottleneck is key to recovery.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

This SOW could include additional details on the importance of capturing and PIT tagging juvenile and subadult Colorado Pikeminnow during a time of year when water temperatures are low and handling mortality is likely to be reduced. Tagging these fish will have major ramifications on future analyses of Colorado Pikeminnow movement and survival. Do we want to electro-fish before the RBS spawn? Could this disrupt the RBS spawn? This trip would be done prior to RBS spawning and should not disrupt the spawn. Electrofishing is used as a sampling method in the RBS survey of Lake Powell targeting spawning fish and successful spawns still occur.

What is this SOW's contribution to recovery?

It is important to document overwinter survival of age 1 Razorback Sucker because this is a known recruitment bottleneck in the San Juan River.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

I think that this proposal should be incorporated into the annual monitoring program. It gives the program temporal resolution between the larval monitoring

in the previous spring with the small bodied monitoring from that fall. By documenting the magnitude of overwinter survival, it helps in the determination of potential bottlenecks. Although it seems to be focused on RBS, the project should put equal emphasis on CPM (Question 5, line 135) In addition, the mesohabitat where captures occur should be documented when possible (IE riffles, shoals, pocket waters, etc). This has been added to the methods section where we will attempt to document specific mesohabitat of captured fish.

What is this SOW's contribution to recovery?

No comment.

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

The technical aspects of this SOW are well researched and thorough.

What is this SOW's contribution to recovery?

Track the status and trends of endangered and other fish populations in the San Juan River; Collection of wild age-1 RBS can further understanding of natural recruitment in the system and of how reproductive success may relate to river hydrology:

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

No Comment

What is this SOW's contribution to recovery?

Consistent long-term monitoring is a hall mark of sound fisheries management. In this case collecting information to refine monitoring for a group of fish of special interest to the program. I am especially concerned by the possible findings of Question #4 "Are the putative wild age-1 Razorback Sucker purebred in origin". As Razorback Suckers become more abundant and/or spawning in higher densities across larger spatial extents in the system the possibility for introgression and hybridization increases, and could imperil their potential recovery despite the positive signals we are currently seeing.

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

Are there specific habitat types that these fish are collected in? If so, would it be possible to stop the raft and try to hit these areas with a seine or backpack electrofisher? Maybe in the spring these fish ae n specific areas and could be targeted to try and capture more of them. This year we will attempt to document mesohabitats that the fish are present. Future years, a sein haul could be used if the habitat is suitable or seining. A single backwater that produced wild age-0

fish in the fall of 2018 was seined in the spring of 2019 with no success on endangered fish, only non-native fish were found. A sein will be on the trip in 2021 however it was not intended to be used in the data analysis, merely a test to see if it will work in the future.

1) You might think about including a couple of graphs in the report and SOW that track long-term water temps and flows. I suggest this because you will likely start using these metrics to predict spawning and recruitment success if this project is continued long-term. When we start talking about managing the river for low, slow, and warm water in years when runoff is predicted to be low, this type of information would be useful to track response of the fish. Future years' SOW of work will include graphs, as of now we have a single year that has been sampled, 2020 is shaping up to be similar to that of 2018 but maybe not that dry, the ability to compare contrasting years would make the graphs (and study for that matter) stronger if and when mother nature provides those conditions.

What is this SOW's contribution to recovery?

Documenting wild RBS recruitment from larval to smaller size classes is important and good guide management, especially flows if it is determined that low flows in summer could yield higher RBS recruitment from larvae. The collection of tissues for genetic analysis is a good addition since knowing the rate of hybridization with FMS is important.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

Colorado Pikeminnow are also being collected during this study. Questions 1, 2(with modified size estimate), and 3 could also apply to Colorado Pikeminnow. Since the majority of work being proposed for FY2021 are primarily focused on Razorback Sucker, adding analysis for Colorado Pikeminnow is recommended. I have incorporated these comments into questions 1 and 3. I do not disagree with adding CPM to question 2 however, at this point I am unsure of what size we are hoping to achieve (300mm TL was set to distinguish between wild and stock fish since stocking has a minimum of 300mm for RBS). This will most likely aid in growth rates, and possible correlation to growth within specific years, or water years, for CPM. If this becomes and annual or biennial sampling effort, a more specific question will be asked for CPM. Regardless, CPM captured in spring sampling will be compared to recaptures in the fall.

What is this SOW's contribution to recovery?

I will provide data that could potentially be used to address recruitment bottlenecks.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

This SOW is well-written and addresses an important information need regarding recruitment of razorback sucker. The technical aspects of the study appear sound.

What is this SOW's contribution to recovery?

This proposed work addresses an important identified need of the Program, that being recruitment bottlenecks for young endangered fish. In the past two years we have finally begun to document razorback sucker recruitment to the juvenile stage, something that has only been rarely done throughout the Colorado River system. While I doubt we will need this study to continue in perpetuity, I feel it is important to our basic knowledge of recovery to continue for at least the short-term.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

Why is this SOW apparently attached as part b of demographic monitoring? I believe the origin is from the money used for 2019 spring age-1 RBS sampling came from the cancelation of 2018 Adult Monitoring. This is a question for the program office. I would agree that a different SOW number would be warranted if this project continues as a standalone project.

Line 34: Small-bodied fishes monitoring collected a single wild age-0 Razorback Sucker in 2016. Noted

Line 62-65: The author states that "it is imperative to attempt to collect age-1 Razorback Sucker to further aid our understanding of natural recruitment in the system and how reproductive success may relate to the river's hydrology given the success in the spring of 2019 sampling", which seemingly ignores the fact that juvenile Razorback Sucker were sufficiently detected when present (Summer and Fall 2018). Is it the author's assumption that Razorback Sucker may be recruiting to juvenile stages in average water years and current monitoring efforts are missing this recruitment? Sufficiently detected would be a relative term up for debate. A STReaMS query with all Razorback Sucker captured in 2018 shows only 42 fish under 300mm TL captured between 5 projects, the biggest contributor is non-native removal capturing 36 of the 42. Our current small bodied monitoring, <u>dedicated</u> to capturing age-0 and age-1 fish, only captured two small razorback sucker (albeit a truncated sampling effort).

Line 71: On line 77-79 you provide evidence that age-1 fish do not reach 300 mm TL by the fall. Can additional data from Demographic Monitoring be used to support or refute the claim that wild age-1 Razorback Sucker will exceed 300 mm TL by the fall? Not enough data to confirm or deny with a sample size of a single fish. How many untagged Razorback Suckers captured fall Demographic Monitoring were less than 300 mm TL, how many between 300 and 350 mm TL.

Line 75: Were any wild Razorback Sucker tagged in summer or fall 2018 recaptured in spring 2019, thereby providing information on growth? Also, why would it be expected that Razorback Sucker would exhibit any significant growth over the winter? Noted and changed

Line 107: What additional information will this project provide on annual age-1 Razorback Sucker recruitment that annual fall monitoring (Demographic and Sun-adult/Adult) will not? Adult and sub adult monitoring is not designed to directly target age-1 razorback sucker, the study is designed to look more at the Sand Juan River's adult fish community.

Line 123-124: The sampling protocol for this SOW will not allow for the assessment of any habitat requirements for wild age-1 Razorback Sucker. Only a reach level assessment could be conducted. This should probably be changed to occurrence and distribution of age-1 Razorback Suckers may elucidate reach level differences that support or detract from recruitment and overwinter survival. I disagree. While direct small scale habitat requirement is not measured with this project, a larger scaled habitat requirement can be gleaned from the data when comparing spatial location and numbers with current habitat monitoring.

Line 126: Can this question be answered during fall monitoring? Potentially however this project would add more samples

Line 135: This question can be answered with demographic monitoring. I disagree, Demographic monitoring documents annual survival.

Line 147: Given the findings of Scott Clark's work and that Demographic Monitoring is trying to assess if reduced capture and handling will increase survival of Colorado Pikeminnow, I see no benefit of netting all Colorado Pikeminnow. There should not be any collection of Colorado Pikeminnow during this trip. Noted, however this author disagrees, as the number of times a Colorado Pikeminnow would be handled in 2021 (potentially 3) would be only during the fall, this spring sampling is done at colder water temperatures compared to fall sampling and would be less stressful to the fish according to Scott Clarks work, which also was addressing handling fish in the warmer months of summer.

Line 149: Methods for photographs are insufficient. Please provide information on how photographs are going to be taken. It may be useful to review the thesis by P. Wolters, Investigations into Razorback Sucker-Flannelmouth Sucker hybrid viability and identification using shape. Information was provided on how photograph will be taken.

Line 155: I appreciate the well thought out questions developed for this SOW. However, there is no information on how data collected during this study will be

analyzed to address the questions. How will the survival of wild 2019 Colorado Pikeminnow be assessed? What type of analysis will be conducted to gain insight into habitat requirements of wild age-1 Razorback Sucker.

What is this SOW's contribution to recovery?

The PI for this SOW develop several good questions that need to be assessed, but it seems evident that most of these questions can be answered during Demographic or off year Adult monitoring. Without questions that could only be specifically answered during this spring trip, I am not sure it is beneficial to continue conducting it. Also, the results from Scott Clark's work indicates that capture and handling of Colorado Pikeminnow decreases survival. While a similar analysis has not been conducted for Razorback Sucker, the results would probably be similar. Additional trips to capture and handle both these species may decrease their survival, further delaying the time to recovery.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

There are two 19b SOWs. The first is for the third year of a 3-year project. Small modifications to the original SOW have been made to address survival problems. There are no obvious needs for additional modifications. Completion of the project is needed to enable evaluation of the design and facilitate future monitoring.

The second 19b SOW is "Documenting the occurrence, spatial distribution, and incidence of introgression in wild age-1 Razorback Sucker in the Jan Juan River 2021." This SOW has several purposes including determining if fish visually identitiy as age-1 Razorback Suckers are genetically pure, assessing the extent of introgression of Razorback Sucker with Flannelmouth Sucker, and evaluating the ability to identify hybridized fish in the field. The SOW only describes field sampling protocols. Description of laboratory methods and data analyses is limited to the statement, "samples can be added to the already planned larval Razorback Sucker parental assignment analyses at the Southwest Native ARRC from the KSU translocation scope of work." A review of the SOWs identified SOW 41, Facilitated fish passage for enhancing populations of endangered fishes in the San Juan River, as the SOW referenced in SOW 19b. Task 5 (lines 263-353) of SOW 41 describe the methods for determination of parentage of larval Razorback Sucker given knowledge of the genomes of adult Razorback Sucker translocated above the waterfall. The description does not identify methods for assessment of genetic purity of Age-1 Razorback Sucker samples described in SOW 19b. The proponents of SOW 19b need to collaborate with researchers at SNARRC to develop a full description of laboratory methods and analyses to be applied to the problem of genetic purity and introgression. Additional information had been added to describe the methods and analyses for the genetic portion of this SOW.

What is this SOW's contribution to recovery?

Knowledge of age-specific abundance and survival of the two endangered species is important for monitoring success of restoration activities. Assurance that fish visually identified as Razorback Sucker in the field are genetically pure fish is critical in described monitoring protocols.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

Line 107- At what level is the Razorback Sucker population in the San Juan River experiencing annual, age-1 recruitment?

I'm assuming you'll use CPUE (fish/h) as an index of abundance but you should state that. Also you propose assessing "incidence of recruitment". What does that mean? Perhaps you mean "degree of overwinter recruitment using CPUE (fish/h)" Noted and changed to reference CPUE

Line 113- "what is the likelihood individuals" How will you measure "likelihood"? Is it a probability model or survival estimates? You should give the reader some idea of how this will be done. I understand what you are saying and agree with your comment, however at this point in the project this is a question of can they reach 300 mm TL by fall with an answer of "yes or no". If this project continues for multiple years, a more in depth look will take place at factors that cause age-1 RBS to reach 300 mm TL by the fall (ie. Flow, temperature, previous years' nonnative removal efforts to name a few).

What is the impact on this SOW if you cannot sample this spring? Perhaps you should address any issues that might present in your analyses of the data with 2020 missing. My agency is all but shutdown so the probability seems high you will not be on the river this spring. I hope that's not the case.

Minor typos (highlighted text)
61
78
78-79
90
101
109

What is this SOW's contribution to recovery?

I strongly support this work. It's relation to recovery is obvious. It's assessing wild spawned Razorbacks and survival to age-1, a perceived bottle neck to survival

Program Office

How can the technical aspects of this SOW be improved?

- While there is a risk that wild age-1 Razorback Sucker in the fall would exceed 300 mm TL (the size that fish are stocked into the San Juan River), in the cases of the two recaptures (spring to fall) that occurred in 2019, neither exceeded 300 mm and would have been identified as "wild" had they only been captured in the fall. Explaining why it is necessary to continue to conduct this assessment is needed if these fish can be identified during three passes of demographic monitoring. This comment is based on a sample size of a single Razorback sucker and another sucker later identified as a hybrid, all of which is stated in the SOW. I am not sure why we would definitively state that wild fish would not reach 300mm TL by fall with a single sample.
- What evidence do we have that there is potential hybridization? There are two fish captured in the 2019 spring that were previously stated in this scope of work which would allude to hybridization in the San Juan. There have been numerous other accounts reported in prior years which also suggest the same evidence.
- It is unclear why Colorado Pikeminnow over-winter survival needs to be determined separately from what would be determined from Demographic monitoring. Overwinter survival derived from Demographic monitoring encompasses survival through the spring and summer as well. Spring sampling would specifically look at over winter survival and may elucidate when the system loses CPM either over the winter or through the warmer months prior to Demographic Monitoring.
- Given that this effort did not occur in 2020, can the funds of this SOW be carried over from to conduct the work in 2021 (i.e., the SJRIP would incur no cost to conduct this work in 2021)? Yes

What is this SOW's contribution to recovery?

Continuing to identify overwinter survival of wild recruits will aid our ability to track progress towards recovery.

SMALL-BODIED FISHES MONITORING IN THE SAN JUAN RIVER

FY 2021 SCOPE OF WORK

TO

BUREAU OF RECLAMATION

FROM

New Mexico Department of Game and Fish
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SUBMITTED

27 March, 2020

FOR

Title of Agreement: Small-bodied Fishes Monitoring on the San Juan River
Agreement Number: R19AC00022

REPORTING DATES:

10/01/2020 through 9/30/2021

This scope of work (SOW) is for Small-bodied Fishes (SBF) Monitoring within the San Juan River for FY2021. This long-standing project aims to provide the highest quality data and quantitative assessment on the effects of management actions on the survival of post-larval early life stages of native and nonnative fishes and their recruitment into subsequent life stages and use this information to recommend appropriate modifications to recovery strategies for Colorado Pikeminnow and Razorback Sucker in the San Juan River.

NEED

The San Juan River Basin Recovery Implementation Program (SJRIP) Long-Range Plan specifies that monitoring and evaluation of fish is a necessary element for assessing the recovery of federally endangered Colorado Pikeminnow *Ptychocheilus lucius* and Razorback Sucker *Xyrauchen texanus* in the San Juan River (Element 4; SJRIP 2016). Task 4.1.2.2 of the SJRIP's Long-Range Plan specifies the need for juvenile and small-bodied fishes (SBF) monitoring to locate areas and habitats used for rearing and to determine if young fish are surviving and recruiting into adult populations (SJRIP 2016). Data collected during annual SBF monitoring is used to assess recovery of Colorado Pikeminnow and Razorback Sucker, as well as evaluate the influences of SJRIP management actions on the river's fish community as a whole (Gido and Propost 2012; Franssen et al. 2015; Zeigler and Ruhl 2017).

GOAL

The goal of SBF monitoring is to quantitatively assess the effects of management actions on survival of post-larval early life stages of native and nonnative fishes and their recruitment into subsequent life stages and use this information to recommend appropriate modifications to recovery strategies for Colorado Pikeminnow and Razorback Sucker in the San Juan River (SJRIP 2012).

MONITORING OBJECTIVES

The specific objectives for SBF monitoring include:

1. Annually document occurrence and density of native and nonnative age-0/small-bodied fishes in the San Juan River.
2. Document mesohabitat use by age-0 Colorado Pikeminnow, Razorback Sucker, and Roundtail Chub, as well as other native and nonnative fishes in the primary channel, secondary channels, and backwaters.
3. Obtain data that will aid in the evaluation of the responses of native and nonnative fishes to different flow regimes and other management actions.
4. Track trends in native and nonnative fish populations.
5. Characterize patterns of mesohabitat use by native and nonnative small-bodied fishes.

STUDY AREA

The spatial extent of small-bodied fishes monitoring has changed since 2003 (Figure 1). Until 2011, sampling occurred every year from River Mile (RM) 180.6 (Animas River confluence) downstream to RM 2.9 (Clay Hills Crossing, UT). Sampling below RM 76.4 (Sand Island, UT) occurred once every five years after 2010, primarily because the fish fauna in geomorphic Reaches 1 and 2 was mostly (~80%) nonnative fishes and had shown little change since the initiation of SBF monitoring (Zeigler and Ruhl 2016). Sampling was extended upstream to RM 196.0 (Bloomfield, NM) in 2012. Beginning in 2017, sampling area was determined using a flexible schematic where different sections of the river were sampled based on the number of wild age-0 Colorado Pikeminnow or Razorback Sucker captured during sampling from RM 147.8 (Shiprock, NM) downstream to RM 52.7 (Mexican Hat, UT). Due to the shifts in sampling extent, only Reaches 3 – 6 have been routinely sampled since 2003.

Sampling in 2021 will occur from RM 180.6 (Animas River confluence) downstream to RM 3.0 (Clay Hills Crossing, UT) (Figure 2). Recent captures of wild age-0 endangered fishes in downstream reaches (2– 4) indicates that sampling Reaches 1– 6 consistently may be more advantageous to meeting the SBF monitoring objectives and project goals (Zeigler and Ruhl 2017; Zeigler and Wick 2019).

Additionally, no endangered fish have ever been captured upstream of RM 180.6 during SBF monitoring. Sampling from RM 180.6 downstream to RM 3.0 will ensure the continuity of the long-term data set for Reaches 3 – 6 and will align SBF monitoring with observed patterns of larval endangered fish densities while maintaining sampling within areas that have produced the highest wild Age-0 Colorado Pikeminnow captures (Farrington et al. 2018; Figures 1,3). The proposed section of river to be sampled will cover both the entire reach sampled during the Demographic Monitoring project and be congruent with the proposed post-2023 sampling regime. The spatial extent of area sampled could be expanded to include other areas (e.g. Lake Powell, Animas River, etc.) on a yearly basis based on new evidence of increased endangered species presence in the areas above or below the sampling area.

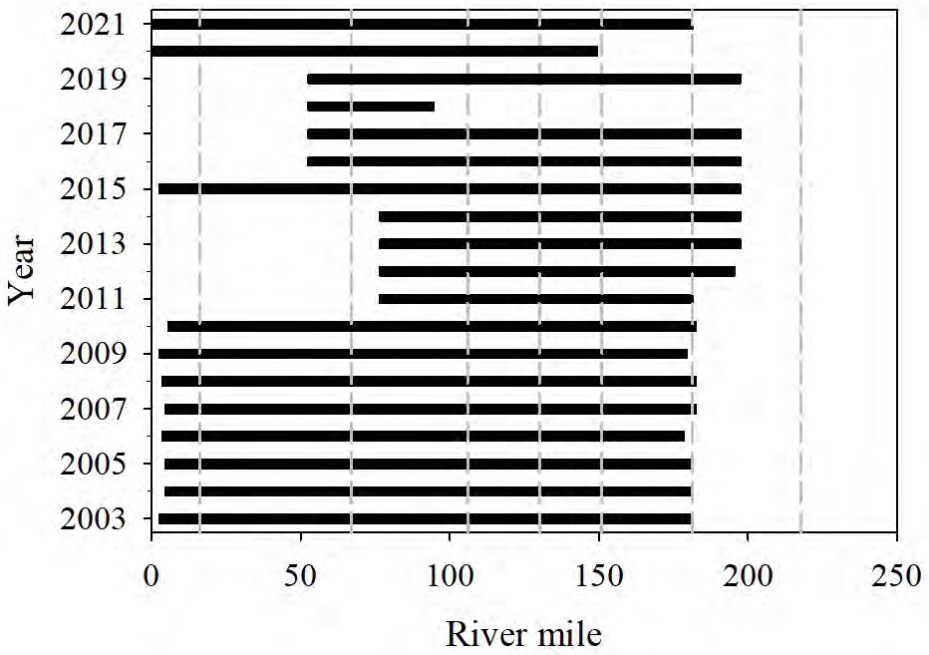

Figure 1. Spatial extent of sampling during small-bodied fishes monitoring on the San Juan River since 2003. The spatial extents of sampling in 2020 and 2021 are proposed. Note that river miles begin at the inflow of Lake Powel in Utah (River Mile 0) and end at Navajo Dam in New Mexico (River Mile 224).

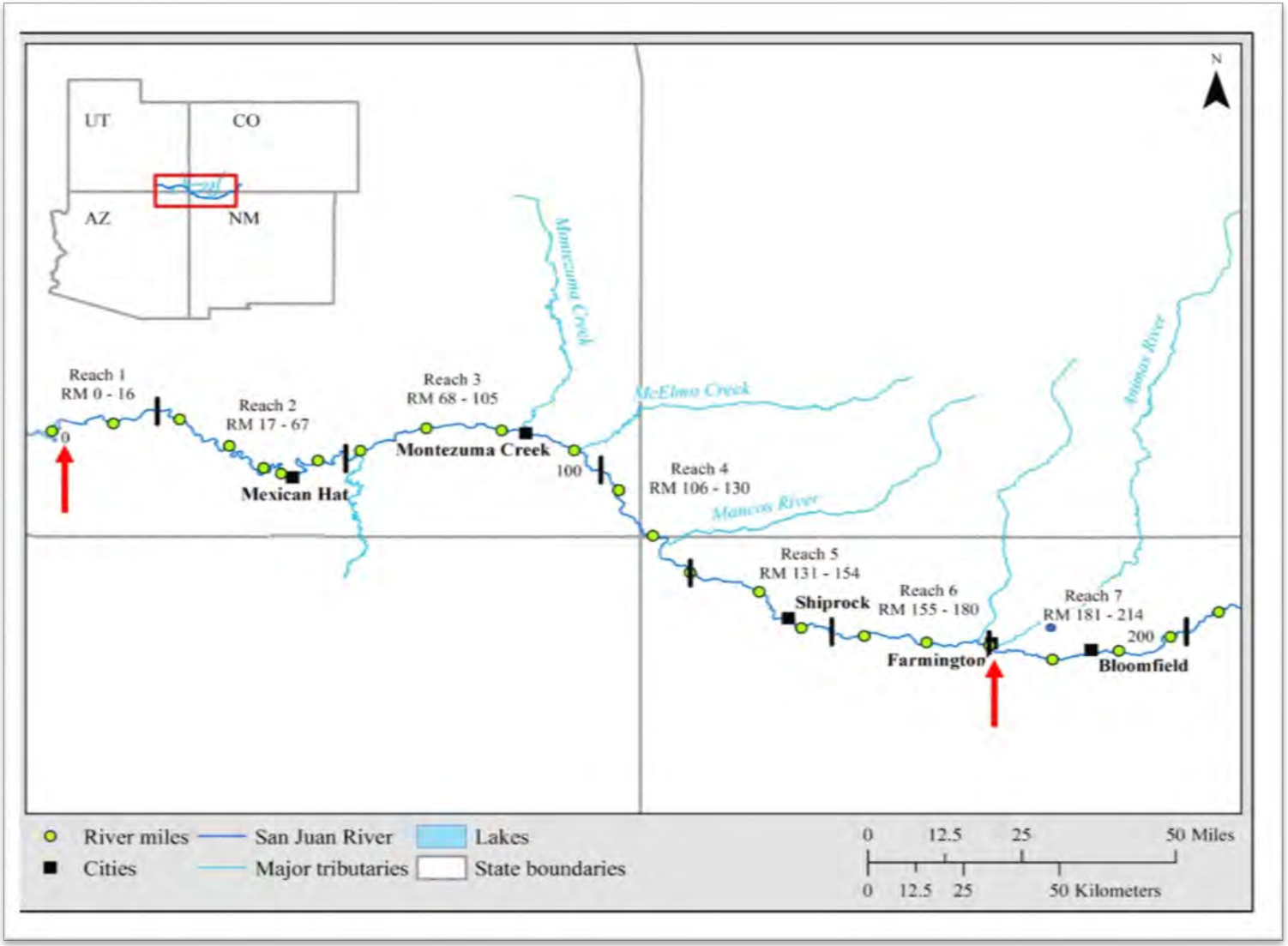

Figure 2. The San Juan River in New Mexico, Colorado, and Utah with river miles and geomorphic reaches indicated. The section between the red arrows will be sampled during 2021 small-bodied fishes monitoring (Animas River confluence downstream to Clay Hills Crossing, UT). Inset indicates location of San Juan River in Colorado, New Mexico, and Utah.

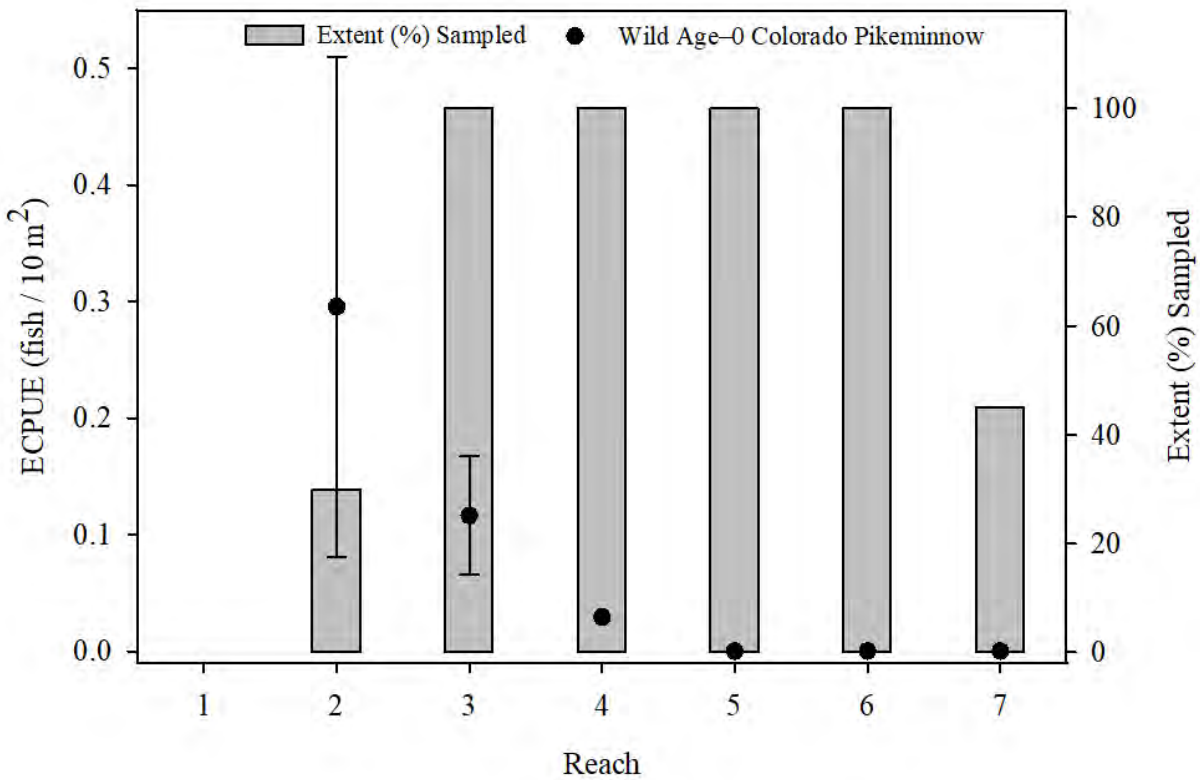

Figure 3. The expected catch-per-unit-effort (ECPUE, fish/10 m^2) of wild age-0 Colorado Pikeminnow in Reaches 1 – 7 in 2016, 2017, and 2019 overlaid on the extent in percent of total Reach length sampled in the same years. Note that Reach 1 was not sampled. Circles represent mean ECPUE estimates and bars represent 95% confidence interval; gray bars indicate percent of extent sampled within each reach.

METHODS

Small-bodied fishes monitoring is designed to sample habitats which have the greatest likelihood of supporting age-0 large-bodied fishes and all age classes of small-bodied fishes. Sampling will occur at designated 3-mile intervals in the primary channel, and at all secondary (less than 20% of total flow) and zero velocity channels (i.e., backwaters and embayments; ≥ 30 m^2) when encountered (SJRIP 2012). Sample reaches will be approximately 200 m long (measured along the shoreline) at primary channel sample sites and, depending upon the extent of surface water, 100 – 200 m long at secondary and zero velocity channel sample sites.

In the fall of 2012, six secondary channels were modified during the Phase I River Ecosystem Restoration Initiative (RERI) habitat restoration efforts through excavation of sediment and removal of nonnative plants. These channels are located at RM 132.2, 132.0, 130.7A, 130.7B, 128.6, and 127.2. An additional channel located at RM 136.5 was restored during Phase II habitat restoration efforts in 2014. These restoration sites will be visited during annual SBF monitoring and sampled if flowing following the protocols described below.

River mile, geographic coordinates (UTM NAD83), and water quality parameters (dissolved oxygen, conductivity, and temperature) will be recorded at each sampling site. All mesohabitats (e.g., riffle, run, pool) present within a site (except large zero velocity channels) will be sampled in rough proportion to their availability using a 3.0 x 1.8 m (3.0 mm heavy duty Delta untreated mesh) drag seine. Seine hauls will be made in at least eight different mesohabitats at each site; however, if habitat heterogeneity is low at a site, as few as five seine hauls will be made. At least two seine hauls, one across the mouth and one parallel to its long axis will be made at each large zero velocity channel unless the mouth is too narrow, in which case only one seine haul, parallel to its long axis, will be made.

All captured fishes will be identified to species and enumerated. Small-bodied fishes (e.g., Fathead Minnow *Pimephales promelas*, Red Shiner *Cyprinella lutrensis*, and Speckled Dace *Rhinichthys osculus*) will be counted and up to 25 age-0 large-bodied fishes (e.g., Bluehead Sucker *Catostomus discobolus*, Channel Catfish *Ictalurus punctatus*, and Flannelmouth Sucker *Catostomus latipinnis*) in a single seine haul will be measured for total length (mm TL). Any captured endangered or rare species (i.e., Colorado Pikeminnow, Razorback Sucker, and Roundtail Chub *Gila robusta*) will also be weighed (g) and, if ≥ 130 mm, injected with a 12 mm PIT tag. All native fishes will be released and nonnative fishes removed from the river. Fishes too small to easily identify in the field will be fixed in 10% solution of formalin and returned to the laboratory for identification.

Following each seine haul, the sampled width and length of each mesohabitat will be measured to the nearest 0.1 m and recorded. The depth and dominant substrate at five generalized locations, and any cover (e.g., boulders, debris piles, large woody debris) associated with the mesohabitat will also be recorded. Retained specimens will be identified and measured (TL and SL) in the laboratory to the nearest 0.1 mm and accessioned to the University of New Mexico Museum of Southwest Biology (MSB), Division of Fishes.

After data collection, all original field notes will be checked for errors and missing data. Data will be entered into Excel spreadsheets with a similar template as a project specific database. All entered data will be cross-checked with the original field notes by a different biologist. Data from the Excel spreadsheets will be imported into the database. Specific conditions for each data field in the database prevent the entry of incorrect data and typographical errors. Database queries will be used to identify and rectify any additional errors. Following the submission of the final report original field notes will deposited to MSB Division of Fishes.

DATA ANALYSIS AND REPORTING

Analyses will be based on density (i.e., catch-per-unit-effort, CPUE) of individual species, calculated by seine haul, as the number of fish captured per square meter sampled (width x length). To account for the significant number of zeros and highly skewed data, density for each species will be analyzed using a Delta-GLM approach which combines two separate components: (1) a logistic model estimating the probability of presence ($CPUE_{0/1}$) fitted using a GLM with a binomial distribution and logit link, and (2) a model for CPUE only when the species is present ($CPUE^{+}$) fitted using a GLM with a lognormal distribution (Fletcher et al. 2005; Acou et al. 2011; Vasconcelos et al. 2013). The predicted density, E(CPUE), is then obtained by (3) multiplying the response variables predicted by the binomial and lognormal models for each individual seine haul. This approach models the two aspects of the data (i.e., presence/absence and positive density) separately, allowing for evaluation of how covariates influence the two separate processes. Furthermore, the approach is much simpler and easier to interpret

than other methods such as mixture models (Fletcher et al. 2005). Calculation of density will be limited to those species which have greater than 3% of all seine hauls (2003 – 2020) with at least one capture.

Several models using a combination of covariates will be used in both the logistic and positive lognormal model. Both abiotic and biotic covariates will be investigated for their use in each model (Table 1). The negative log-liklihood from both models will be combined to calculate Akaike's Information Criterion with a correction for finite sample sizes (AIC_c). The combined model with the lowest AIC_c will then be used to model the final binomial and lognormal models for each species. Residual plots will be examined to ensure that the final positive lognormal model meets the assumptions of normally distributed and equal variance residuals.

Table 1. Name and description of abiotic and biotic covariates which may be used in both the logistic and lognormal models to predicted expected density (E(CPUE)).

Covariate Name	Description
sampYear	Year in which the sample was taken.
Reach	Geomorphic reach in which the sampled was taken.
RiverMile	The river mile where the sample was taken.
ChannelType	The channel type in which the sampled was taken.
Mesohabitat	The mesohabitat in which the sample was taken.
sampDis	Discharge at time the sample was taken.
NNC_1_Den	The density of nonnative competitors in the Reach where the sample was taken. Calculated as the total density of Fathead Minnows, Red Shiners, and Western Mosquitofish captured during annual small-bodied fishes monitoring.
NNC_2_Den	The density of nonnative competitors in the Reach where the sample was taken. Calculated as the total density of Channel Catfish, Fathead Minnows, Red Shiners, and Western Mosquitofish captured during annual small-bodied fishes monitoring.
NNC_3_Den	The density of nonnative competitors in the Reach where the sample was taken. Calculated as the total density of Channel Catfish captured during annual small-bodied fishes monitoring.

Final binomial, log-normal, and Delta-GLM models will be assessed for goodness-of-fit and predictive capability. The predictive accuracy for the binomial model will be tested using the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC). The ROC analysis involves plotting the proportion of known presences predicted against the proportion of known absences predicted (Peterson et al. 2008). The values of the AUC of the ROC curve range from 0.5 to 1.0 with 0.5 indicating no fit and a 1.0 a perfect fit (Fielding and Bell 1997). For the positive lognormal and Delta-GLM models, a linear regression between observed (x-axis) and predicted (y-axis) CPUE will be used to test predictive ability. The coefficient of determination (R^2) of this relationship shows the proportion of the linear variation in y (predicted values) explained by the variation in x (observed values), the intercept of this linear regression model describes bias, and the slope describes consistency.

Data collected from the six RERI and the Phase II secondary channels will be reported for each year since these channels were restored. Information for the RERI and Phase II secondary channels will include if the channel was sampled, reasoning for why it was not sampled, and number of endangered, native, and nonnative species captured.

An annual report will provide a summation of data obtained in FY2021, a synthesis of data across years to document/assess species populations' trends, and a summary of mesohabitat associations. Separate data summaries and analyses will also be conducted for any wild age-0 CPM and RBS, if needed. All data collected will be recorded on electronic spreadsheets and provided to USFWS Program Office by the principal investigator, along with the annual final report, by 30 June 2022.

Budget Justification

The increase in requested funds, from recent years, is primarily due to the extension in the study area, other cost increases are associated with a slight increase of the negotiated indirect costs rate. The 2021 study area will span a total of 177 RM, representing a 22% increase (approx. 30 RM) relative to 2019 and 2020 study areas. We feel that the proposed study area will both help SBF monitoring achieve project goals and objectives while maintaining continuity of the long-term data set. It is our intention to provide all personnel and gear for this monitoring effort, however, personnel and gear may be requested from the Program office as necessary.

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FY 2021 Budget

Sampling - Animas River to Shiprock, NM

Personnel

Tasks - Annual monitoring of small-bodied fishes in the San Juan River from the Animas River confluence to Shiprock, NM; 1 day trip preperation (8 hrs day) and 4 field days (12 hrs day) = 56 hours (40 hrs regular and 16 hrs overtime).

Project Leader (1)		
40 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$	1,909
16 hrs overtime @ $71.60/hr ($47.73/hr * 1.5 (time-and-a-half)	$	1,146
Project Biologists (3)		
40 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits)) * 3	$	4,589
16 hrs overtime @ $57.36/hr ($38.24/hr * 1.5 (time-and-a-half)) * 3	$	2,753
Sub-total	**$**	**10,397**

Per Diem

4 days @ $85/day (standard NM in-state rate) * 4 biologists	$	1,360
Sub-total	**$**	**1,360**

Vehicles

Round-trip to Shiprock, NM – 500 miles @ $0.55/mile	$	275
Sub-total	**$**	**275**

Animas River to Shiprock Sampling Sub-total	**$**	**12,032**

Sampling - Shiprock, NM to Clay Hills Crossing, UT

Personnel

Tasks - Annual monitoring of small-bodied fishes in the San Juan River from Shiprock, NM to Mexican Hat, UT; The Nature Conservancy RERI Phase I and Phase II sites; 3 days trip preperation (8 hrs day) and 15 field days (12 hrs day) = 204 hours (144 hrs regular and 60 hrs overtime).

Project Leader (1)		
144 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$	6,873
60 hrs overtime @ $71.60/hr ($47.73/hr * 1.5 (time-and-a-half)	$	4,296
Project Biologist (3)		
144 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits)) * 3	$	16,520
60 hrs overtime @ $57.36/hr ($38.24/hr * 1.5 (time-and-a-half)) * 3	$	10,325
Sub-total	**$**	**38,014**

Per Diem

3 days @ $85/day (standard NM in-state rate) * 4 biologists	$	1,020
12 days @ $115/day (stanadard NM out-of-state rate) * 4 biologists		5,520
Sub-total	**$**	**6,540**

Vehicles

Round-trip (2 vehicles) to Clay Hill Crossing, UT – 1,500 miles @ $0.55/mile	$	825
Sub-total	**$**	**825**
Shiprock to Clay Hills Crossing Sampling Sub-total	**$**	**45,379**

Field Equipment & Supplies

Water quality instrument maintence 2 @ $400	$	800
Life Jackets 5 @ $60	$	300
Raft maintenance	$	500
Whirlpacks (500) @ $50.00/per 500	$	50
Formalin (6 gal) @ $25/gal	$	150
Raft (16'), Frame, and Oars (funds not requested)	$	0
Sub-total	**$**	**1,800**
Sampling Sub-total	**$**	**59,210**

Specimen Management

Personnel

Tasks - Processing (sorting, identification, and data-entry); 12 days of in the laboratory (8 hrs day) = 96 hours.

Project Biologist (1)

96 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))	$	3,671
Specimen Management Sub-total	**$**	**3,671**

Data Management/Analysis and Report Preparation

Personnel

Tasks – Data management and QA/QC, data analysis and synthesis, table and graph preparation, report drafting and revision; Project Leader (120 hrs) and one Project Biologist (200 hrs each).

Project Leader (1)

120 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$	5,728

Project Biologist (1)

200 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))	$	7,648
Data Management/Analysis & Report Preparation Sub-total	**$**	**13,376**

FY 2021 Total		
Sampling Sub-total		$ 59,210
Specimen Management Sub-total		$ 3,671
Data Management/Analysis & Report Preparation Sub-total		$ 13,376
	Project Sub-Total	**$ 76,257**
IDC at 23.77		$ 18,126
	Project Total	**$ 94,383**

RESPONSE TO COMMENTS

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

No recommendations. It seems well-conceived to me.

RESPONSE—Thank you, Harry.

What is this SOW's contribution to recovery?

It's monitoring—it doesn't contribute to recovery per se but it is one of our major sources of information about whether our recovery actions are succeeding.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

This is a long term monitoring program with established methods and objectives. The only change to the proposed monitoring is to extend the monitoring downstream. This change was adequately justified. The data analysis is similar to the past and robust. We do not have any recommendations for improving this SOW. It was well written.

RESPONSE—Thank you, Steve. We will continue to strive for improvements to the sampling.

What is this SOW's contribution to recovery?

Long term monitoring data is essential to the recovery efforts. This SOW continues important long-term monitoring that is necessary to detect trends in abundance of juvenile Colorado Pikeminnow in the San Juan River.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

Agree with the spatial change

RESPONSE—Thanks Vince.

What is this SOW's contribution to recovery?

No comment

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

The technical aspects of this SOW are sound and well researched.

RESPONSE—Thanks Colin.

What is this SOW's contribution to recovery?

Track the status and trends of endangered and other fish populations in the San Juan River; High quality data regarding habitat and quantitative assessment on the effect of management actions on small fish survival rates and recruitment into subsequent life stages. Additional new area will be included for FY21. This data can be relied on for analysis and making recommendations to recovery strategies for endangered fish.

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

It seems reasonable given the capture of a larval Razorback in the Animas in 2019 that it might garner further attention in 2021? Or possible exploratory trips above the confluence as that singular data point may suggest the upstream extent of these fish seems to be differing from previous years?

RESPONSE—Razorback Sucker juveniles have been infrequently captured during Small-bodied Fishes Monitoring throughout the most frequently sampled areas that have higher densities of Razorback Sucker larvae. Increasing the

sampling to include areas within the Animas River would likely add to our understanding of the Animas River fish community and provide a section of river with no dam influences for comparison to sampling in the upstream San Juan River reaches (5–7). Despite these benefits, there is currently little to no justification for sampling the Animas River for juvenile Razorback Sucker based on the very low density of Razorback Sucker larvae. Sampling in the Animas would likely occur in the future if densities of larval Razorback Sucker increase or are captured more consistently.

What is this SOW's contribution to recovery?

Consistent long-term monitoring is a hall mark of sound fisheries management.

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

1) I wish it were easier to sample down below the waterfall and into Lake Powell to see what is going on down there. I wonder if we should investigate the use of mud boats or air boats to facilitate sampling? Even 1-2 days of work could yield some interesting information.

RESPONSE—We agree that sampling below the Waterfall would be very interesting, especially during and after odd water years (high and low discharge). The 2019 captures of many more larval Colorado Pikeminnow below the waterfall than previous year's captures points to the fact that there may be differences in what is transported below the waterfall in high and low discharge water years. Consequently, the next question to ask is does that environment support those larvae to the juvenile stage and are they capable of reaching age-1? We envision this information being valuable to the addition of some form of fish passage. Further investigation into effective small-bodied fish sampling methodologies within the critical habitat below the waterfall is certainly warranted. We would be supportive of sampling Lake Powell as long as the effort is well thought out and achievable.

I support sampling in the extended study reach, and I think that sampling the RERI sites and tracking those sampling efforts through time is a valuable piece of the project.

RESPONSE—Thanks Mark.

What is this SOW's contribution to recovery?

This proposal allows us to assess current and previous years' production and recruitment of endangered fish, which is a critical part of recovery.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

The proposal is technically sound and uses appropriate techniques to meet objectives.

RESPONSE—Thanks Bill.

What is this SOW's contribution to recovery?

Provides data to assist in determination of recruitment bottlenecks for endangered fishes.

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

Line 90: "spatial extent of area sampled could be expanded" is this at the cost of sampling being omitted elsewhere?

RESPONSE—Any increase to include areas outside of the proposed sampling area (e.g. Animas River, Reach 7, Reach 8, etc.) would be in addition to what is currently being proposed for 2021 (Reach 1 – 6), the costs associated with that increase would be included into any future SOW if this work were warranted. The spatial extent proposed for 2021 is ideally what will be sampled consistently into the future.

Will the Phase III site be sampled during this project?

RESPONSE—There is no plan to sample the Phase III site during Small-bodied fishes monitoring. There are plans in development by the Program Office for monitoring and it will be fully inventoried when it is harvested in a few weeks following small-bodied fishes monitoring. We would certainly be willing to sample Phase III if requested by the Program Office or the Biology Committee.

What is this SOW's contribution to recovery?

This SOW will aid in reviews of management actions to inform us if we are or are not getting the desired responses.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

This is a well-written, comprehensive SOW that in recent years has proven its' worth by identifying recruitment to the juvenile life stage by both endangered species. Given our emphasis on recruitment bottlenecks, this study is providing important information contributing to both our basic understanding of and management for alleviating such bottlenecks. The technical aspects of the study appear sound and the expansion of the study area is justified.

RESPONSE—Thanks Tom.

What is this SOW's contribution to recovery?

As with 19b above, this study is providing us with important information on recruitment of the endangered fishes and insights into possible recruitment bottlenecks. Continuation of this work is warranted, at least in the short-term, to allow us to assess our progress to recovery.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

No Comment.

What is this SOW's contribution to recovery?

No Comment.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

A review of this SOW was provided separately upon request of the PO. The technical aspects of the SOW appear to be appropriate.

RESPONSE—Thanks Wayne.

What is this SOW's contribution to recovery?

Small-bodied fish monitoring is important to assessment of recovery actions for the endangered fishes.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

I really support the analytical approach. These data are highly variable (as are most ecological field data). I think your on the right track. The SOW was well written and reflects a lot of thought.

RESPONSE—Thanks Mel.

What is this SOW's contribution to recovery?

SBM fills the "gap" between larval sampling and adult monitoring. It has shown that it's taken a long time to detect juvenile Pikeminnows and Razorbacks, but now we know some individual are reaching the juvenile. This frames how well the Program is doing on the road to recovery.

Program Office

How can the technical aspects of this SOW be improved?

- Given Reaches 3-6 are considered by the SOW as the long-term study site it is hard to discern the specific question being asked by adding Reaches 1 and 2. How long is that question going to take to answer, and what data will be used to evaluate that question?

RESPONSE—It is true that reaches 3–6 are the most consistently sampled reaches and thus are considered the long-term study area. This is only done to allow for interannual comparisons of estimated fish densities. The addition of reaches 1 and 2 specifically target areas where annual larval endangered fish densities are often highest. Larval surveys begin in late April and the last larval survey within reaches 1 and 2 of the San Juan River occurs in late July. Small-bodied sampling typically occurs in early-to-mid September. The most likely scenario for Colorado Pikeminnow and Razorback Sucker in early developmental stages within the San Juan River is continued downstream transport due to inconsistently available zero-velocity habitat, swimming performances, and the river channel's steep gradient. Downstream reaches are a likely area to detect the presence of early juvenile Razorback Sucker and Colorado Pikeminnow. The decision to inconsistently sample these reaches from 2011-2019 was likely a cost savings to the program but was not beneficial to the utility or the completeness of Small-bodied Fishes Monitoring data. There are certainly issues with adding or removing sampling areas within the context of a long-term data set, but this area has been sampled in years past and will increase the Program's understanding of the presence, retention, and recruitment of endangered fishes within the San Juan River in both the short and long term. Some questions that could be posed in the short term (1 year) by extending the small-bodied fishes sampling into Reaches 1 and 2 are:

1. Are Colorado Pikeminnow and/or Razorback Sucker juveniles (age-0 or age-1) present in Reaches 1 and 2 during early fall?
2. How does the density of endangered and common fish species found in Reach 1 and 2 compare to upstream reaches within a year?
3. How does the density of native and nonnative fishes within and between reaches in recent sampling years compare to earlier years (2003-2010)?
4. What is the availability of low velocity habitats in autumn? Are the long-term monitoring habitats that are sampled during larval monitoring still available in the fall?
5. How does the density and composition of native and nonnative fishes in reaches 1 and 2 compare to upstream reaches?

In the long term (beyond 2 years) the data set will allow for interannual comparisons from contemporaneously collected data. Continued and consistent sampling will allow for a comprehensive and reliable data set that informs managers on the status and trends of the San Juan River small-bodied and post-larval fish community.

- It seems that larval Razorback Sucker were present in the downstream reaches during 2003-2010, when small-bodied fishes were sampled in those reaches, but the data then suggested that sampling those reaches was not useful information. What has changed?

RESPONSE—The fact that larval Razorback Sucker were present during those years (2003-2010) but not found during small-bodied fishes sampling is a significant finding that is valuable to management. Presence of larvae and absence of juveniles indicates that endangered fish were not recruiting to the juvenile stage at detectable levels. To accurately and effectively evaluate management actions (e.g., stocking, water recommendations, etc.) it is imperative to collect the most comprehensive and complete data that will allow for assessment of a management action's effect. Further, Razorback Sucker larvae have been present in upstream reaches from 1999-2019 with very few years (n=2; 2016 and 2018) where juvenile Razorback Sucker were detected during Small-bodied Fishes Monitoring. Lastly, during 2003-2010 Colorado Pikeminnow larvae were only detected in low densities in 4 of 8 years, whereas, in more recent (2013–2019) years Colorado Pikeminnow larvae have been present in higher densities. The continued presence of Razorback Sucker larvae and increased presence of Colorado Pikeminnow larvae in reach 1 and 2 in addition to the most recent detections (2016–2019) of juvenile endangered fishes during Small-bodied Fishes Monitoring further upstream demonstrates the need to sample further downstream.

- Lines 85-88 and figure 3: it is hard to understand why include reaches 5-6 in the long-term monitoring and if they should continue to be included as part of the long-term study area if they haven't produced juvenile age-0 Pikeminnow.

RESPONSE—The basis of the designation of reach 3–6 being the long-term study area is out of convenience and simplicity. This section of the San Juan River has been consistently sampled from 2003 to 2019, which allows for straightforward interannual comparisons of estimated densities for fish species that are commonly collected there, including Age-1 Colorado Pikeminnow. Continuing to sample within Reaches 5 and 6 maintains the continuity of long-term data set and will allow for interannual comparisons between years and reaches into the future. Additionally, Razorback Sucker larvae are annually detected in Reach 5 and 6 and Colorado Pikeminnow larvae are detected in reach 5, thus there is potential to encounter age-0 endangered fishes. Further, in recent years there have been concerted efforts to expand Razorback Sucker and Colorado Pikeminnow distributions upstream of PNM weir. Lastly, reaches 5 and 6 have been and continue to be strongholds for native fishes and, "evaluating the relative abundance of native and nonnative fish species response to recovery actions and enhanced endangered fish populations" is an objective for the Program's monitoring activities as listed in the 2018 Program Document.

- It is mentioned that data from small-bodied fish monitoring has provided quantitative assessment of management actions and/or resulted in modifications to recovery strategies. It would be useful to have a section that describes what those have been, what questions have been answered by the data, what still need to be addressed from small-bodied monitoring, and what management actions have been improved due to those data.

RESPONSE—For clarity, we aren't sure where it is stated that data from Small-bodied Fish Monitoring (SBFM) "has provided quantitative assessment of management actions and/or resulted in modifications to recovery strategies." In an effort to address the comment we have identified a number of statements that are likely what is being referencing. The likely statements can be found:

1. in the brief intro to small bodied fishes management that is included on the cover sheet where it is stated **"**This long-standing project aims to provide the highest quality data and quantitative assessment on the effects of management actions on the survival of post-larval and early life stages of native and nonnative fishes and their recruitment into subsequent life stages and use this information to recommend appropriate modifications to recovery strategies for Colorado Pikeminnow and Razorback Sucker in the San Juan River."
2. in the Need section (lines 7-10) where it is stated "Data collected during annual SBF monitoring is used to assess recovery of Colorado Pikeminnow and Razorback Sucker, as well as evaluate the influences of SJRIP management actions on the river's fish community"
3. in the Goal section (lines 12-15) where it is stated "The goal of SBF monitoring is to quantitatively assess the effects of management actions on survival of post-larval early life stages of native and nonnative fishes and their recruitment into subsequent life stages and use this information to recommend appropriate modifications to recovery strategies for Colorado Pikeminnow and Razorback Sucker in the San Juan River."

All of the referenced statements above reflect the past and proposed SBFM efforts and are consistent with the SJRIP long range plan goals and tasks listed here:

1. GOAL 2.6 Manage the Native Fish Community to Assist in Recovery of the Endangered Species.
    a. Task 1.1 Use active capture techniques to assess native fish abundance.
    b. Task 1.2 Conduct annual review of native fish abundance and potential implications to recovery of the endangered fish.
2. GOAL 4.1 Monitor Fish Populations of the San Juan River.
    a. Task 2.2 Conduct juvenile and small-bodied fish sampling to determine if young fish are surviving and recruiting into the population and locate the areas and habitat used for rearing.

Additionally, the data collected during SBFM is used to support the following SJRIP Goals and tasks:

1. Goal 4.4 Integrate and Synthesize Monitoring Data and Information to Evaluate Fish Community and Ecosystem Response To Recovery Actions.
    a. Task 1.1 Document and quantify reproduction, survival, and recruitment.
    b. Task 2.2 Use previous and current data collected during ongoing investigations to characterize dynamics of native fishes and their response to management activities intended to improve status of listed species.
    c. Task 3.2 Use data and information gathered from fish surveys, hatchery augmentation, and survival studies to describe best strategies for establishing wild populations of endangered fish to maintain a healthy native fish community.
2. Goal 5.2 Ensure Integration and Synthesis of Information to Evaluate Program Progress Toward Recovery.
    a. Task 2.4 Use monitoring and research information to evaluate and use adaptive management strategies to modify recovery activities, as necessary, to ensure progress toward recovery.

The data collected during SBFM led to two peer reviewed manuscripts that are both cited within the SOW (line 10):

Franssen, N.R., E.I. Gilbert, and D.L. Propst. 2015. Effects of longitudinal and lateral stream channel complexity on native and non-native fishes in an invaded desert stream. Freshwater Biology 60:16-30.

Gido, K.B., and D.L. Propst. 2012. Long-term dynamics of native and nonnative fishes in the San Juan River, New Mexico and Utah, under a partially managed flow regime. Transactions of the American Fisheries Society 141:645-659.

Following the completion of Phase I and Phase II River Ecosystem Restoration Initiative projects in 2012 and 2014 respectively, SBFM has monitored the connectivity (dry vs. wet) and reported on the fish community found in the wetted restored channels during annual sampling. This work is important to evaluate the success of restored habitats and thus is included in the proposed 2021 work and has been reported in previously completed annual reports (2013-2019).

Small-bodied Fishes Monitoring provided recent evidence of recruitment to the juvenile stage by Colorado Pikeminnow during high discharge years (2016, 2017, and 2019) and lack of recruitment in a low discharge year (2018). This unprecedented evidence was the impetus for the development and submission of the Colorado Pikeminnow Adaptive Management Stocking Plan to the SJRIP Biology Committee (BC). The plan aims to provide an prevent the stocking of hatchery origin age-0 CPM when wild CPM are likely to be present and provide an adaptive management framework for Colorado Pikeminnow stocking in the San Juan River. The plan utilizes the best available information provided by SJRIP monitoring and research efforts including the information provided by SBFM. The BC reviewed the document and recommended it for submission to the Coordination Committee for adoption. Further, the collection of wild age-0 Colorado Pikeminnow in 2016 and 2017 provided key insights into the relationship between high spring discharge and Colorado Pikeminnow to the BC, who in response voted in favor of not producing or stocking Colorado Pikeminnow in 2019. This action will allow researchers to assess both the production and survival of the 2019 year-class of wild Colorado Pikeminnow. Both the decision to not stock Colorado Pikeminnow and the adoption of the Colorado Pikeminnow Adaptive Management Stocking Plan would not have been feasible without the information collected during SBFM.

- Clarify how many people NMDGF will provide and what is needed from the PO to conduct this sampling.

As stated within the SOW budget. NMDGF will provide up to 4 biologists for each sampling trip. Gear (raft and associated equipment) and personnel may be requested from the PO as necessary. For clarity, this statement has been added to the budget justification section:
Lines 161-163 “It is our intention to provide all personnel and gear for this monitoring effort, however, personnel and gear may be requested from the Program office as necessary.”

What is this SOW’s contribution to recovery?

This SOW provides an annual indication of recruitment from the larval life stage.

SAN JUAN RIVER LARVAL RAZORBACK SUCKER AND COLORADO PIKEMINNOW MONITORING

FISCAL YEAR 2021 SCOPE OF WORK

SUBMITTED TO THE U.S. BUREAU OF RECLAMATION

SUBMITTED BY

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1 OCTOBER 2020 - 30 SEPTEMBER 2021

SAN JUAN RIVER LARVAL RAZORBACK SUCKER AND COLORADO PIKEMINNOW MONITORING FISCAL YEAR 2021 PROJECT PROPOSAL

Project history

Surveys conducted in late 1980s documented small resident populations of Colorado Pikeminnow and Razorback Sucker in the San Juan River and the San Juan River arm of Lake Powell (Platania et al. 1991). Beginning in the mid-1990s, populations of these two species were augmented with annual hatchery stocking under the auspices of the San Juan River Basin Recovery Implementation Program (SJRRIP). Currently, populations of Colorado Pikeminnow and Razorback Sucker persist in the lowermost 180 river miles of the San Juan River (between the Animas River confluence and the inlet of Lake Powell Reservoir). Annual investigations into the early life history of Colorado Pikeminnow began in 1991 when passive drift-netting for larval and young-of-year (YOY) fish was initiated in the San Juan River. The primary objectives of the passive drift-netting study were to 1) determine the temporal distribution of San Juan River ichthyoplankton in relation to the hydrograph, 2) provide comparative analysis of the reproductive success of San Juan River fishes, 3) attempt to characterize downstream movement of ichthyoplankton, and 4) attempt to validate the presumed spawning period of Colorado Pikeminnow.

Two stationary sites were used for the drift-net surveys. The upstream site was located 4.6 miles upstream of the Mancos River confluence in New Mexico. A second site was established in Mexican Hat, UT. Over 70 river miles separated the two field stations. Results from eleven years of drift-net surveys (1991–2001) resulted in the collection of 11 larval Colorado Pikeminnow (Table 1) as well as information regarding the ichthyofaunal community of the San Juan River during the presumed spawning period of Colorado Pikeminnow (Platania et al. 2000, 2002).

In 1994, personnel from the U.S. Fish and Wildlife Service Colorado River Fishery Project (CRFP; Grand Junction, Colorado) stocked the first series of Razorback Sucker (n=672) in the San Juan River. Those fish, whose mean length and mass at the time of stocking were about 400 mm TL and 710 g, respectively, were released between Hogback, New Mexico and Bluff, Utah. In their 1995 report of activities, Ryden and Pfeifer (1996) suggested that most experimentally stocked 1994 San Juan River Razorback Sucker would achieve sexual maturity by 1996 thereby providing the potential for spawning during 1997–1998. The success of the experimental stocking study resulted in the development of a full-scale augmentation program for Razorback Sucker in the San Juan River.

At the November 1996 SJRRIP Biology Committee integration meeting, it was suggested that the Colorado Pikeminnow, larval fish drift study be expanded to document spawning of Razorback Sucker. However, because reproduction by Razorback Sucker (March-May) occurred considerably earlier than Colorado Pikeminnow (June-July), separate investigations of spawning periodicity and magnitude were deemed necessary. The initial attempt to document reproduction by Razorback Sucker stocked in the San Juan River took place in 1997. Low velocity monitoring sites were established in numerous locations adjacent to U.S. Hwy 163 and Utah State Hwy 262 (which parallels the San Juan River between Aneth and Bluff, UT) that appeared suitable for sampling with light-traps. Light-traps were set nightly in low-velocity habitats between Aneth and Mexican Hat from late March through mid-June 1997. Sampling success during the 1997 Razorback Sucker larval fish study was poor. While there were over 200 light-trap sets, those

sampling efforts produced only 297 fish and larval Razorback Sucker was not present. While there were probably several variables that accounted for the poor light-trap catch rate, a principal factor was limited access to suitable habitats. A primary result of the 1997 study was the realization that being bound to specific collecting sites was an inefficient means of collecting the large number of larval fish necessary to document reproduction of a rare species.

In 1998, the Razorback Sucker larval fish sampling technique was modified to allow for collections over a larger portion of the San Juan River and capture of a considerably larger number of larval fish. Navigation of the river by use of an inflatable raft provided the opportunity to sample habitats that were formerly either inaccessible or unobservable under the constraints of the 1997 sampling protocol. The primary collecting method was sampling low-velocity habitats with a fine mesh seine (0.8 mm mesh). The seining technique yielded over 13,000 specimens between river miles 127.5 and 53.3 with most these individuals (n=9,960) being larval catostomids. Included in the 1998 larval fish catch were two larval Razorback Suckers (Table 2). The success of this project became evident as documentation of reproduction by Razorback Sucker continued in successive years. Between 1998 and 2020 there have been both spatial and temporal expansions upon this project but sampling methodology has remained relatively consistent.

The most significant change to the larval Razorback Sucker survey was the incorporation of the spawning periodicity of Colorado Pikeminnow using the same methodology. Beginning in July 2002, personnel began an active sampling regime that mirrored the sampling protocol successfully used to document reproduction by Razorback Sucker. This temporal expansion of the larval fish survey resulted in the monitoring of reproduction by the entire ichthyofaunal community.

Following the 2002 expansion of the San Juan River larval fish survey to actively sample for larval Colorado Pikeminnow, 1,464 individuals have been collected. Over 95% (n = 1,412) of all larval Colorado Pikeminnow has been collected since 2014 (Table 1). Back-calculated spawning dates, based on Colorado Pikeminnow larvae, range from 30 June to 3 August and are associated with the descending limb of spring runoff and mean river temperatures typically above 18°C.

The results of the investigation into the early life history of Colorado Pikeminnow and Razorback Sucker is a foundation of work detailing the spawning periodicity of the entire ichthyofaunal community of the San Juan River. For the endangered fishes, catch data elucidates potential spawning areas, distribution, and displacement of propagules in the system and back-calculated spawning and hatching dates. The long-term data set (22 years) can track trends of the entire ichthyofaunal community by year, month, and river reach. The larval survey is also able to detect spawning by the rarest of the San Juan River fishes; Colorado Pikeminnow and Roundtail Chub, *Gila robusta*.

To date larval fish monitoring has collected and identified 12,962 larval or age-0 juvenile Razorback Sucker and documented reproduction by Razorback Sucker for 22 consecutive years (Table 2). Back-calculated hatching dates derived from individual Razorback Sucker larvae indicates spawning occurs prior to spring run-off often including the ascending limb of the spring hydrograph, and can persist into early summer (Farrington et al. 2017). Mean water temperatures during this period among all years ranged between 7.7–26.5°C. This minimum, maximum and subsequent range of temperatures at which successful spawning by Razorback Sucker has been documented is outside of the temperature range typically reported for this species (Bozek et al. 1990; Tyus and Karp, 1990; Muth et al. 1998; Bestgen et al. 2011)

Table 1. Summary of larval and YOY Colorado Pikeminnow collected in the San Juan River during larval drift-netting/larval seining (1991-2019) and back-calculated dates of spawning.

Year	*Sample Method*	*Study Area (River Miles)*	*N=*	*Length TL*	*Collection Date*	*Spawning Date*
1991-2001	Drift Netting	127.5, 53.3	11	8.5–9.2	26 Jul–03 Aug	15-18 Jul
2004	Larval Seine	141.5 – 2.9	2	14.2, 18.1	22, 26 Jul	4, 10 Jul
2007	Larval Seine	141.5 – 2.9	3	14.3-16.2	25, 27 Jul	8–13 Jul
2009	Larval Seine	141.5 – 2.9	1	25.2	27 Jul	13 Jul
2010	Larval Seine	141.5 – 2.9	5	12.6–21.4	20-23 Jul	2–6 Jul
2011	Larval Seine	141.5 – 2.9	29	10.0–21.3	20, 21 Jul, 10,11 Aug	2–27 Jul
2013	Larval Seine	147.9 – 2.9	12	14.1–28.7	17–30 Jul	1–16 Jul
2014	Larval Seine	147.9 – 2.9	312	8.5–20.8	13–28 Jul	17 Jun–5 Jul
2015	Larval Seine	147.9 – 2.9	24	8.6–9.7	28–30 Jul	11–14 Jul
2016	Larval Seine	147.9 – 2.9	548	8.8–14.7	24–28 Jul	30 Jun–12 Jul
2017	Larval Seine	180.6 – 2.9	174	9.0–21.5	23 Jul–16 Aug	16 Jun–17 Jul
2018	Larval Seine	180.6 – -17.0*	54	9.3–25.3	7–26 Jul	4–28 Jun
2019	Larval Seine	180.6 – -19.0**	300	8.9–37.0	17 Jul–19 Aug	30 Jun–3 Aug

* RM 17.0 is equivalent to Lake Mile 38 in the San Juan arm of Lake Powell.
** RM 19.0 is equivalent to Lake Mile 36 in the San Juan arm of Lake Powell.

Table 2. Summary of larval and YOY of Razorback Sucker collected in the San Juan River (1998 – 2019) and back-calculated dates of spawning.

Year	*Sample Method*	*Study Area (River Miles)*	*N=*	*Length TL*	*Collection Date*	*Spawning Date*
1998	Larval seine Light traps	127.5 – 53.3	2	12.1, 12.7	21, 22 May	NA
1999	Larval seine Light traps	127.5 – 2.9	7	10.2–18.6	4 May–14 Jun	9 Apr–14 May
2000	Larval seine Light traps	127.5 – 2.9	129	9.3–16.2	9 May–2 Jun	4 Apr–14 May
2001	Larval seine Light traps	141.5 – 2.9	50	10.1–28.8	16 May–14 Jun	7 Apr–8 May
2002	Larval seine Light traps	141.5 – 2.9	813	9.7–62.4	29 Apr–12 Jul	27 Mar–13 May
2003	Larval seine Light traps	141.5 – 2.9	472	9.2–37.3	16 May–18 Jun	18 Mar–12 May
2004	Larval Seine	147.9 – 2.9	41	8.7–25.9	15 May–15 Jun	17 Apr–2 Jun
2005	Larval Seine	147.9 – 2.9	19	10.8–25.3	14 May–3 Aug	16 Apr–26 Jun
2006	Larval Seine	147.9 – 2.9	202	8.9–22.5	23 Apr–30 May	2 Apr–16 May
2007	Larval Seine	147.9 – 2.9	200	6.7–31.9	19 Apr–26 Jul	22 Mar–11 Jun
2008	Larval Seine	147.9 – 2.9	126	8.3–18.7	21 May–21 Jun	15 Apr–31 May
2009	Larval Seine	147.9 – 2.9	272	10.1–30.2	19 May–19 Jun	27 Mar–28 May
2010	Larval Seine	147.9 – 2.9	1,251	9.4–30.0	17 May–20 Jul	13 Apr–4 Jun
2011	Larval Seine	147.9 – 2.9	1,065	8.6–34.2	16 May–19 Jul	21 Mar–27 May
2012	Larval Seine	147.9 – 2.9	1,778	6.1–31.8	14 May–14 Jun	20 Mar–30 May
2013	Larval Seine	147.9 – 2.9	979	9.5–70.0	17 May–18 Jul	23 Mar–2 Jun
2014	Larval Seine	147.9 – 2.9	612	8.8–57.6	22 Apr–17 Jul	19 Mar–30 Jun

Table 2 (cont.). Summary of larval and YOY of Razorback Sucker (Xyrtex) collected in the San Juan River (1998 – 2019) and back-calculated dates of spawning.

Year	*Sample Method*	*Study Area (River Miles)*	*N=*	*Length TL*	*Collection Date*	*Spawning Date*
2015	Larval Seine	141.5 – 2.9	1,205	9.6–22.4	19 Apr–21 May	19 Mar–4 May
2016	Larval Seine	141.5 – 2.9	824	9.3–48.4	21 Apr–25 Jul	19 Mar–30 Jun
2017	Larval Seine	180.6 – 2.9	360	9.2–43.0	20 Apr–26 Jul	23 Mar–9 Jun
2018	Larval Seine	180.6 – -17.0*	1,833	8.2–102.2	23 Apr–26 Jul	3 Mar–22 Jun
2019	Larval Seine	180.6 – -19.0**	722	9.1–37.9	25 Apr–1 Aug	19 Mar–19 Jul

* RM 17.0 is equivalent to Lake Mile 38 in the San Juan arm of Lake Powell.
** RM 19.0 is equivalent to Lake Mile 36 in the San Juan arm of Lake Powell.

Project Modifications

There have been numerous modifications to the field methodology of the larval fish survey over time as well as changes in reporting priorities, protocol, and format (Table 3). The extent of the study area and aspects of the longitudinal sampling have been modified to improve spatial comparisons. The study area was expanded in 1999, 2001, 2012 and 2017 by a total of 103.5 river miles (over double the length of the original study area) to include Reach 6 through Reach 1 (Farmington, NM to Clay Hills Crossing, UT). The expansions of the study area were a result of captures of larval Razorback Sucker at the top of the previous study area boundary. Within two years (and often the following year) of each study area expansion, larval Razorback Sucker was documented in the newly expanded study area. The most recent expansion occurred in 2018 when larval fish sampling was expanded downstream of the Paiute Farms waterfall (RM -1.0) to include riverine habitat in the San Juan arm of Lake Powell. Larval Razorback Sucker larvae were collected downstream of the waterfall in 2018 and 2019. Sampling done downstream within the “Expanded Study Area” (RM 168.4–180.6, Waterflow, NM to Farmington, NM) is considered to be independent of the work proposed in this SOW with discrete sampling dates, SOW, and budget submitted to the SJRRIP each fiscal year.

Beginning in 2003, the entire study area (excluded the aforementioned Expanded Study Area and Paiute Farms waterfall reach) was sampled in single uninterrupted trips (10–12 field days per trip) rather than in two temporally discrete sections as done in previous years (1998 – 2002). Because of the increasing numbers of larval Razorback Sucker collected (as well as detailed information regarding the native fish community), the SJRRIP Biology Committee voted to elevate the larval fish surveys from an “experimental” project to a monitoring program. This change allowed for comparisons of catch per unit effort (CPUE) data with the programs monitoring activities (i.e., small bodied fish, sub-adult and adult, habitat, etc.).

Conducting the larval Razorback Sucker and Colorado Pikeminnow surveys under this new protocol not only provided discrete reach information but also provided greater temporal resolution in respect to the longitudinal distribution of Razorback Sucker larvae and the ability to correlate potential environmental cues required by Razorback Sucker for spawning. These same advantages also apply to Colorado Pikeminnow. Disadvantages to this top to bottom approach were that the duration of the monthly sampling trips (10–12 field days) made them more subject to abiotic fluctuations (floods, flow spikes). Large flood events reduce sampling efficiency as many low velocity habitats become flooded by rising water levels thereby transporting larval and early juvenile fish downstream. In addition, large flood events have necessitated premature termination of some survey runs, reducing the temporal resolution of the single-continuous pass effort. Annually, at least one trip (an average) had to be cut short due to large flood events or low water events in the lower canyon. The abbreviated trips were subsequently resumed once conditions improved (usually 1–2 weeks later). Additional costs were incurred because of the need to return to the field to complete the sampling effort for that month.

To reduce the variability of abiotic conditions as well as gain even greater temporal resolution of the longitudinal distribution of Colorado Pikeminnow and Razorback Sucker larvae, the protocol was modified to survey the upper and lower halves of the study area simultaneously. This effort began in 2007 and utilized two fully equipped and autonomous crews (Table 3). Beginning in 2011, the September sampling trip was discontinued. The Biology Committee felt that the September survey did not provide enough data with respect to endangered fishes to warrant continuation.

In 2013 a new analysis of Colorado Pikeminnow and Razorback Sucker trend data was developed using mixture models (White, 1978; Welsh et al., 1996; Fletcher et al., 2005; Martin et al., 2005). Mixture models can be particularly effective at modeling ecological data with multiple zeros to estimate occurrence and abundance separately (e.g., combining a binomial distribution with a lognormal distribution). Data collection for this new approach meant each seine haul was preserved independently along with physical descriptors of each haul. Beginning in 2014, the mixture model analysis was expanded to include annual trends for many of the common species collected.

Objectives

This work is being conducted as required by the San Juan River Basin Recovery Implementation Program Monitoring Plan and Protocol (2012). The objectives of this specific monitoring effort are identified and listed below. Where applicable, these objectives are related to the specific tasks listed in the 2016 Long Range Plan set forth by the San Juan River Basin Recovery Implementation Program (SJRRIP).

1) Conduct larval fish sampling to determine if (Colorado Pikeminnow and Razorback Sucker) reproduction is occurring, locate spawning and nursery areas, and gauge the extent of annual reproduction. (Task 4.1.2.1)

2) Determine the spawning periodicity of Colorado Pikeminnow and Razorback Sucker (utilizing back-calculated spawning and hatching formulas) between mid-April and August and examine potential correlations with temperature and discharge.

Table 3. Summary of annual projects and project modifications of the larval fish surveys from 1997 to 2019.

Year	*Sampling method*	*Study area (River Miles)*	*Specimens collected*	*Field modification*	*Laboratory modification*
1997	Light Trap Drift-nets	99 – 75	297		
1998	Larval Seine Light Trap Drift-nets	127.5 – 53.3	13,608	study area expanded; active sampling	
1999	Larval Seine Light Trap Drift-nets	127.5 – 2.9	20,711	study area expanded; upper-lower reaches sampled separately; nonsynchronous	
2000	Larval Seine Light Trap Drift-nets	127.5 – 2.9	13,549		
2001	Larval Seine Light Trap Drift-nets	141.5 – 2.9	95,629	study area expanded; upper-lower reaches sampled separately; nonsynchronous	
2002	Larval Seine Light Trap	141.5 – 2.9	138,602	study period expanded to September. Drift-nets no longer used.	
2003	Larval Seine Light Trap	141.5 – 2.9	112,842	upper-lower reaches sampled monthly in one uninterrupted trip (11-12 day runs)	CPUE data used for integration in reporting
2004	Larval Seine	141.5 – 2.9	160,292		Reports merged, trend data reported
2005	Larval Seine	141.5 – 2.9	109,368		
2006	Larval Seine	141.5 – 2.9	50,616		
2007	Larval Seine	141.5 – 2.9	53,084	Two rafts-two crews; upper-lower reaches samples synchronous	Analyzed catch with habitat data
2008	Larval Seine	141.5 – 2.9	40,855		
2009	Larval Seine	141.5 – 2.9	72,404	Specimens preserved in 95% ethanol	
2010	Larval Seine	141.5 – 2.9	70,610		

Table 3 (cont). Summary of annual projects and project modifications of the larval fish surveys from 1997 to 2019.

Year	*Sampling method*	*Study area (River Miles)*	*Specimens collected*	*Field modification*	*Laboratory modification*
2011	Larval Seine	141.5 – 2.9	28,258	September survey dropped from the monitoring	
2012	Larval Seine	147.9 – 2.9	29,384	Study area expanded	
2013	Larval Seine	147.9 – 2.9	25,842	Individual seine hauls preserved independently	Mixture Model analysis used for trend data
2014	Larval Seine	147.9 – 2.9	20,508		Mixture Model analysis used for several common species
2015	Larval Seine	147.9 – 2.9	17,787		Multiple covariates used in all mixture models
2016	Larval Seine	147.9 – 2.9	12,973		Additional covariates used in CPM mixture models
2017	Larval Seine	180.6 – 2.9	31,587	Study Area expanded	
2018	Larval Seine	180.6 – -17.0*	44,611	Study Area expanded downstream to include riverine habitat below the waterfall.	Fall monitoring covariate changed from raw numbers to CPUE
2019	Larval Seine	180.6 – -19.0**	30,395		

* RM 17.0 is equivalent to Lake Mile 38 in the San Juan arm of Lake Powell.
** RM 19.0 is equivalent to Lake Mile 36 in the San Juan arm of Lake Powell.

Objectives (cont.)

3) Document and quantify reproduction, survival, and recruitment. (Task 4.4.1.1).

4) Document and track trends in the use of specific mesohabitat types by larval Colorado Pikeminnow and Razorback Sucker. (Task 4.2.3.2).

5) Analyze and evaluate monitoring data and produce Annual Fish Monitoring Reports to ensure that the best sampling design and strategies are employed. (Task 4.1.1.2)

6) Provide detailed analysis of data collected to determine progress towards endangered species recovery in the San Juan River. (Task 5.1.1.3)

7) Identify principal river reaches and habitats used by various life stages of endangered fish. (Task 4.2.4.1)

8) Deposit, process, and secure San Juan River fish specimens, field notes, and associated data at an organized permanent repository. (Task 4.1.2.5)

9) Provide annual updates on the rate of opercular deformities found in Razorback Sucker. (Task 4.1.7.2)

10) Monitor TNC's restoration sites for the presence of endangered species, and compare species composition and relative abundance of fishes captured in restoration sites to nearby control sites. (Task 4.3.2.1)

Hypotheses

When possible, the following hypotheses from the 2012 SJRRIP Monitoring Plan and Protocol will be annually evaluated. Exceptions are noted below in italics.

1) Densities of larval fishes will be influenced by specific mesohabitat types.

2) Relative abundance of larval fishes will be highest in mesohabitat types that contain cover, inundated vegetation and submerged debris, which provides protection from aquatic and avian predators.

Previous attempts to evaluate the effect of cover type on larval fish density have proven problematic. Even at the small scale (ca. 5–15 m^2) of the individual mesohabitats being sampled, cover type is rarely distributed throughout site. Therefore it is not possible to say with certainty that cover type is resulting in increased abundance of fish.

3) Elevated spring discharge increases relative reproduction of native fishes, as determined by annual relative abundance and distribution of native larval fishes.

4) Elevated spring discharge decreases reproductive success of non-native fishes, as determined by annual relative abundance and distribution of non-native larval fishes.

5) Modification of physical attributes of San Juan River by natural flow regime mimicry, mechanical creation of nursery habitats and decreased entrainment of adults into irrigation canals will result in increased relative abundance, expanded distribution, and multiple ontogenetic life stages of larval Colorado Pikeminnow and Razorback Sucker.

Attributing an increase in abundance, distribution, or presence of multiple ontogenetic stages to any one of the factors listed in Hypothesis 5 is difficult or not possible. A variety of management actions preclude the ability to specifically attribute a response in the fish community to any of

the factors listed in Hypothesis 5. For example, the stocking of thousands of adult Razorback Sucker, and hundreds of thousands of juvenile Pikeminnow annually could result in increases in abundance, distribution, or the presence of multiple ontogenetic stages. Monitoring of mechanically created habitats is ongoing, and details pertaining to that effort are listed within the methods section of this document.

6) Modification of biological attributes of San Juan River fish community (non-native removal and native fish stocking) will result in increased relative abundance, expanded distribution, and multiple ontogenetic life stages of larval Colorado Pikeminnow and Razorback Sucker.

See comments regarding Hypothesis 5.

Study Area

The study area encompasses the San Juan River between Shiprock, New Mexico (RM 147.9) and the Clay Hills Crossing boat landing (RM 2.9) just above Lake Powell in Utah (145.0 river miles). As in all post 1999 sampling efforts, the study will include making collections in reaches of the San Juan River under the jurisdiction of the National Park Service.

Methods

Field Work

Sampling to meet the study objectives of this SOW will be conducted in the San Juan River between RM 147.9 and RM 2.9 from mid-April through early August using sampling techniques that will provide sufficient numbers of fish necessary to meet study objectives 1–7, 9 and 10. Access to the river will be gained through the use of inflatable rafts equipped with all of the necessary equipment and provisions needed for trips of up to seven days. A day and a half is added before and after each field survey for field preparation, gear maintenance, clean up and specimen deposition. The study area will be divided into an “upper” section (Shiprock, NM, to Sand Island, UT) and a “lower” section (Sand Island, UT, to Clay Hills crossing, UT). Separate field crews will launch simultaneously in each of the two sections and proceed through their designated study area. The vehicle and raft trailer used by the field crew working in the upper section will be left at the Shiprock launch site and subsequently be shuttled to the Sand Island BLM ranger station, UT. The vehicle shuttle (with trailer) for the upper reach sampling effort was typically performed without cost by personnel from the Farmington Office of the Bureau of Indian Affairs Office. Between 2008 and 2010, personnel from the N.M. Fishery Resources Office stationed in Farmington performed this service. Beginning in 2011, ASIR personnel shuttled vehicles for the upper end crew (there is no cost for this service).

The sampling crew for the lower reach will launch from, and store their vehicle and raft trailer at Sand Island, UT, where a commercial shuttle will take the vehicle to Clay Hills crossing, UT. The cost for this service is included under the travel and per diem section of our budget.

Because crews sampling the lower section of the study area will be in a high use recreational area, advance reservations are required. All trips for 2021 must be scheduled by late January 2021 and submitted to the Bureau of Land Management (BLM) Office at Monticello, Utah. Designated camping permits for our lower reach sampling crews will be obtained and must

be strictly adhered to in addition to other BLM-San Juan River Recreation Area regulations (i.e., low impact and pack-out policies). Low flow conditions often prevalent during the study period make several sections of the river more difficult to navigate (especially in the lower reach). Our field crews are required to render assistance to boaters stuck in rapids or otherwise in distress and report all such encounters to the appropriate BLM personnel.

Sampling efforts for larval fish will be concentrated in low velocity habitats and employ small mesh seines (1 m x 1 m x 0.8mm) to collect fish. Individual seine hauls will be preserved independently at each site. Habitat designations will also be recorded by seine haul. Retained specimens will be placed in Whirl-paks containing 95% ethanol (EtOH) and a tag inscribed with unique alphanumeric code that is also recorded on the field data sheet. For each sample site, the lengths (to 0.1 m) of each seine haul and total number of hauls will be measures and recorded. Capture densities for seine samples will be reported as the number of fish per 100 m^2.

Native species large enough to be positively identified will be measured (standard length) and returned to the river. Post-larval endangered fish species collected during this study will be photographed, a small portion of tissue from the caudal fin clipped and retained in 95% EtOH (in the case of potential Razorback Sucker hybrids) and scanned with a PIT tag reader for the presence of a PIT tag. Specimens of sufficient size but lacking a PIT tag will be injected with a tag following the protocols established by the program (Davis 2010). All PIT tag information will be recorded in the field data sheet and subsequently forwarded to the SJRRIP for integration in the program's PIT tag database.

For each sampling locality, river mile will be determined to the nearest tenth of a mile using the most current SJRRIP Standardized Map Set. Universal Transverse Mercator (UTM) coordinates and zone will be determined with a Garmin Navigation Geographic Positioning System Instrument for each sampling locality. Mesohabitat type, length, maximum and minimum depths, water clarity (determined with a Secchi disc), and substrata will be recorded for each sampling locality. A minimum of one digital photo will also be taken of each specific habitat sampled.

Each of the six phase I River Ecosystem Restoration Initiative (RERI) sites located between river miles 132.2 and 127.2 will be the subject of repeated monthly monitoring. The goal of these collections is to detect the presence of endangered species, and compare species composition and relative abundance of fishes captured in restoration sites to nearby control sites. If a site cannot be effectively sampled (e.g. too deep or swift), photos will be taken, habitat conditions noted, and no collection made. Beginning in 2011, ASIR researchers defined 15 monitoring sites located in lateral washes and canyons throughout the study area to assess persistence of backwater habitats. Monitoring sites will be visited in each survey. If suitable nursery habitat exists at the time of visitation they will be sampled. If the sites are dry or contain isolated pools, photographs will be taken and field notes written detailing condition of the habitat. Conditions of all monitoring sites and RERI restoration sites will then be related back to discharge at time of visitation.

All collections that contain Razorback Sucker will be examined for frequency and severity of opercular deformities. The opercula are not fully developed until at least the post-flexion mesolarval stage of development. Because of this, only Razorback Sucker greater than 15 mm TL (the size at which the opercula should be fully developed) will be examined for opercular deformities. Individuals will be examined on both the left and right sides. Severity of shortening will be assessed and rated as level 0 (no opercular deformity), level 1 (slight shortening), or level

2 (severe shortening). Annual rates of opercular deformities will be plotted and compared to the long-term data set (1999-present).

Field Work, Safety

Personnel participating in fieldwork are required to successfully complete an International Rescue Instructors Association (IRIA) level 2 swiftwater rescue class and American Red Cross CPR/AED training. Type III personal flotation devices (PFD's) will be worn by sampling personnel at all times while working. As PFD's lose flotation capacity due to UV exposure, compression of material, and oil and grit impregnation, and since each crewmember's PFD will be used for approximately 60 days per season, the PFD's will be annually replaced. Simms Guideweight Gore-Tex waders and boots will be issued to all personnel along with 3 mm neoprene gloves (necessary in April and May). In addition to personal camping gear and rain suits, all personnel will be required to provide and use wide brimmed hats, sunscreen, and sunglasses (provided at no cost to the program).

All rafts used for this project will carry an extensively stocked first aid kit replete with items necessary for most minor medical situation. Additionally, the first aid kit will contain a suite of items (i.e., splints, neck braces, butterfly stitches, snakebite kits) needed to address more serious medical conditions. Because ethanol is used in the preservation of specimens, several vials of eyewash solution will be incorporated into each first aid kit. First aid kits will be inventoried after each sampling trip and used and/or expired items replaced. In the upper reach of the study area, personal cell phones will be used (at no cost to the program) to contact outside parties should a medical situation arise. In the lower study area reach (canyon bound; where cell phones do not have service) an Iridium 9505-satellite phone will be provided for sampling crews. Both sampling crews will be equipped with SPOT Satellite GPS Messenger units to be used in case of an emergency.

All preservation fluids will be transported in heavy-duty LPDE carboys. Extensive exposure to UV light makes the carboys susceptible to decomposition and cracking and requires that they be inspected monthly and not used for more than two years. Safety rope throw bags will be similarly inspected and retired from use accordingly. Rafts will be equipped with raft recovery (Z-line) kits, repair kits, extra oars and oar blades, and two spare hand pumps to help ensure that crews do not become stranded due to raft damage. BLM regulations also mandate that all boaters carry an extra PDF and emergency whistle.

Laboratory Work

Samples will be returned to the lab immediately after each field trip is completed and processed following a multi-step procedure. To maintain the larval fish in good condition (necessary to ensure accurate identification) the samples must be transferred from whirl-packs to glass jars and the field fluids replaced with new preservation fluids. Cyprinid and catostomid larvae are extremely small and transparent especially at early developmental stages. To minimize the potential loss of fish in individual seine hauls, it is best to retain the entire contents of each seine haul. A negative result of this technique is that, in addition to larval fish, whirl-pack samples usually contain considerable debris, detritus, and silt. Another important step in processing of individual samples is to separate fish from the detritus. This necessary portion of the process is labor intensive and can be quite tedious. During this process initial sorting of fish

based on age class (age 0 [larvae] and age 1+) occurs. Samples that contain a large number of larval fish, especially proto or mesolarvae, often must be sorted twice to ensure all larvae are located within a sample.

After the fish are separated from the debris, personnel with San Juan River Basin larval fish identification expertise will identify individual specimens to species. Stereomicroscopes equipped with transmitted light bases (light and dark field) and polarized filters (that enhance the delineation of myomeres, pterygiophores, and fin rays) will be used to assist with the identifications. Larval fish keys are referenced to assist in species specific determinations (e.g., Contributions to a guide to the cypriniform fish larvae of the Upper Colorado River System [Snyder 1981], Catostomid fish larvae and early juveniles of the Upper Colorado River basin, Morphological descriptions, comparisons, and computer interactive key [Snyder and Muth 2004], and Identifications of larval fishes of the Great Lakes Basin [Auer 1982]). Age-0 specimens will be separated from age-1+ specimens using published literature on growth and development (Snyder 1981, Snyder and Muth 2004).

Age classes will be enumerated, measured (minimum and maximum size [mm standard length] for each species at each site), and catalogued in the Division of Fishes of the Museum of Southwestern Biology (MSB) at the University of New Mexico (UNM). Both total length (TL) and standard length (SL) of Colorado Pikeminnow and Razorback Sucker will be obtained using electronic calipers and stereomicroscope mounted micrometers. The ontogenetic stage of Colorado Pikeminnow and Razorback Sucker obtained in this study shall be determined based on the definitions provided by Snyder (1981).

Quality Assurance and Quality Control

The qualifications of the investigators include extensive experience working on large data sets from multiple river systems over several decades. This experience has resulted in the implementation of numerous protocols that assure the quality of the finished data files. The field sampling crew is kept constant, which ensures that the collection of the raw data is standardized between trips and that errors are minimized. Field notes and raw data sheets will be checked for any errors prior to being entered into spreadsheet data files. Any errors will be corrected by crossing out the original data and writing the correct data on the sheet in pencil (all corrections will include the initials of the person making them). All data will be entered into spreadsheet templates designed for the particular type of data being entered (i.e., site locality and physical conditions data, sample size and habitat data, fish species and age-class data). These template files are customized using drop-down lists to facilitate more efficient data entry while also assuring that the correct values are entered (i.e., eliminates typographical errors) within each field. After all data is imported into the main database, all data values will be checked. Data checking will include cross-referencing the field notes and raw data sheets with the values entered into the main database. Upon completion of the quality assurance and quality control steps listed above, the data will then be analyzed and tabulated. All the computed results will be examined and cross-checked with the original data files. Outlying values will be identified by using advanced sorting features on multiple data fields. Missing or incorrect data will be identified by using advanced sorting features and by running multiple queries written for this purpose. Checking the cross-tabulation of data will ensure that the sum of values is in agreement with the individual values (e.g., total number is equal to the sum of the total number of each age-

class). Any corrections to the data will be made directly to individual tables within the main database.

Analysis

Modeling ecological data with multiple zeros can be particularly effective when using mixture models (e.g., combining a binomial distribution with a lognormal distribution) to estimate occurrence and abundance separately (White, 1978; Welsh et al., 1996; Fletcher et al., 2005; Martin et al., 2005). Long-term Razorback Sucker (1999–present) and Colorado Pikeminnow (2003–present) sampling-site density data will be analyzed using PROC NLMIXED (SAS, 2018), a numerical optimization procedure, by fitting a mixture model using the methods outlined in White (1978). Covariates specific to Razorback Sucker and Colorado Pikeminnow mixture models are listed in Tables 4 and 5 of this proposal. Logistic regression will be used to model the probability a site was occupied, and the lognormal model will be used to model the distribution of abundance given that the site is occupied. Models provide four parameter estimates for each year (δ = probability of occurrence, μ = mean of the lognormal distribution, σ = standard deviation of the lognormal distribution, and $E(x)$ = estimated density). Model parameter estimates will be annual plotted and compared to the long-term data set to address Objectives 1 and 3–7 of this proposal.

Additional samples (i.e.. each seine haul preserved individually) were taken between 2013 and 2019 to increase the overall sample size and provide supplemental information on habitats (i.e., habitat type and habitat location) to address Objectives 4 and 7 of this proposal. Field sampling efforts occurred in nine habitat types (backwater [BW], cobble shoal [CS], eddy [ED], embayment [EM], pool [PO], pocketwater [PW], run [RU], sand shoal [SS], and slackwater [SW]). These habitat designations follow those used by the SJRRIP as defined in Bliesner et al. (2008). Additionally, four categories were assigned to habitat depending on where the sample was taken. Shoreline (SH) indicates all samples taken along the land-water interface, open-water (OP) indicates samples taken away from the shoreline, and mouth (MO) or terminus (TR) indicates samples taken from those locations within a backwater or embayment.

Habitat-specific density data (i.e., providing information on habitat type and habitat location) have only been available since 2013. These data provide information on the specific habitat features used by Razorback Sucker and Colorado Pikeminnow. Habitat-specific density data are also analyzed using PROC NLMIXED (SAS, 2018), using the same methods outlined previously, to assess differences among models. A simplified list of five habitats (BW, EM, RU, LV [combining CS, PW, SS, and SW], and NZV [combining ED and PO]) is used for the purpose of statistical analysis since several habitats shared nearly identical low velocity (LV) or near zero velocity (NZV) conditions. General linear models will be used to incorporate covariates to model δ, μ, and σ. Covariates considered to model habitat-specific density data are year, reach, habitat type, and habitat location. Random effects models are used with the joint binomial and lognormal likelihood to provide random errors for the Site*Year combinations. Bivariate normal errors with mean zero and covariance are assumed for each Site*Year combination. A random error will be added to the logit of the binomial parameter δ, and a second random error was added to the log of the μ lognormal parameter. Adaptive Gaussian quadrature as described in Pinheiro and Bates (1995) is used to integrate out these random effects in fitting the model using the SAS NLMIXED procedure. Goodness-of-fit statistics (logLike and AIC_C) are generated to assess the relative fit of data to various models. The approach used to analyze

habitat data between 2013 and 2019, and scheduled for use in 2020, will be used in 2021 to further elucidate fish and habitat relationships and fulfill Objectives 4, 6 and 7 of this proposal.

The results in the annual report will pertain almost exclusively to age-0 fish (i.e., age-1+ are not "larval fish" and are not the focus of this effort, they are not included in analysis). The exception to this will be age-1+ augmented Colorado Pikeminnow. Capture data for all Colorado Pikeminnow are analyzed and trend data reported. The number of all other fish age-1+ collected during the study will be presented as an Appendix.

Hatching dates of Razorback Sucker larvae were calculated using the formula age = SL – 7.1058 + 0.0003(Q) + 0.0061(RM) – 0.0408(T)/ 0.2463, where SL is the standard length in millimeters, Q is mean April discharge, RM is river mile and T is the temperature on the collection date (Clark-Barkalow et al. 2019). Spawning dates for Razorback Sucker will then be calculated once hatching dates have been established using the negative exponential equation $y=1440.3e^{-0.109x}$ (Bestgen et al. 2011) where y is the temperature dependent incubation time (in hours), e is the base of the natural logarithm, and x is the mean daily temperature on the hatching date.

Hatching dates were calculated for larval Colorado Pikeminnow using the formula age = $0.0086SL^3 – 0.3781SL^2 – 30.7930$, where SL is the standard length in millimeters. Spawning dates are calculated by calculating the incubation time using the formula days = $315.42e^{-0.05(T\ hatch)}$ where T hatch is the temperature on the hatch date and e is the base of the natural logarithm; spawning date is then the age at hatch – the incubation time (Clark-Barkalow et al. 2019). Hatching and spawning dates for both endangered species will then be compared with the discharge and temperature data during that period within the study area in order to fulfill Objective 2 of this proposal.

This study will be initiated prior to spring runoff and completed during mid-summer (late July or early August). Daily mean discharge and temperature (mean, maximum, and minimum) during the study period is acquired from U.S. Geological Survey Gauge (# 09379500) near Bluff, Utah and Four Corners Bridge (#09371010).

Table 4. Covariates used in mixture models for Razorback Sucker.

Covariate	**Description**
Year	The calendar year in which the larval survey took place.
Reach	Each of the 5 geomorphic reaches (5–1) within the study area.
Mean March, April, and May temperature.	Daily mean temperature data was taken from USGS gage #09379500 near Bluff, Utah.
Mean March, April, and May discharge.	Daily mean discharge data (cfs) was taken from USGS gage #09379500 near Bluff, Utah.
Cumulative # stocked	The number of Razorback Sucker stocked during the period between 1998 and the year prior to the larval survey year. (e.g., 70,000 fish stocked between 1998 and 2020 would be used as a covariate for 2021 larval capture data).
Fall monitoring captures.	# of adult Razorback Sucker collected per hour of electrofishing effort. Fish collected during a given year were used as a covariate for larval captures during the following larval survey year (i.e. 1+ overwinter periods).

Table 5. Covariates used in mixture models for Colorado Pikeminnow.

Covariate	**Description**
Year	The calendar year in which the larval survey occurred.
Reach	Each of the 5 geomorphic reaches (5–1) within the study area.
Mean June and July temperature.	Daily mean temperature data was taken from USGS gage #09379500 near Bluff, Utah.
Mean June and July discharge.	Daily mean discharge data (cfs) was taken from USGS gage #09379500 near Bluff, Utah.
Cumulative # stocked	The number of age-0 Colorado Pikeminnow stocked during the period between 1998 and five years prior to the larval survey year. (e.g., 100,000 fish stocked in 2016 would be used as a covariate for 2021 larval capture data).
Fall monitoring captures 400+ mm TL.	# of Colorado Pikeminnow greater than 400 mm TL collected per hour of electrofishing effort. Fish collected during a given year were used as a covariate for larval captures during the following larval survey year (i.e. 1+ overwinter periods).

Reporting and Permitting

Beginning in 2004, data from the two San Juan River larval fish surveys (Razorback Sucker and Colorado Pikeminnow) were analyzed collectively and presented in a single report. This created a single picture of the reproductive activities of the entire ichthyofaunal community in the San Juan River employing the same criterion as other monitoring programs. The report will be disseminated as outlined by the program office.

In addition to the annual report of the study provided to the SJRRIP, reports summarizing fish collecting activities and specimens captured are also required annually under scientific collection permits provided by the U.S. Fish and Wildlife Service, New Mexico Department of Game and Fish, Navajo Nation Department of Fish and Wildlife, and Utah Division of Wildlife Resources. The aforementioned reports include (at a minimum) site localities, GPS coordinates, fish collected and deposition history of retained specimens. An annual report of activities is a BLM (Monticello Field Office) requirement under our access permit to the San Juan River below San Island (Bluff, UT) and designated camps in the lower reaches of the river. Annual Mussel-free permits are also acquired by all trip leaders for use in the Utah portion of the San Juan River and Glen Canyon National Park.

Deliverables

Meetings

In addition to participating in multiple conference calls, researchers are required to attend three meetings annually and report on annual monitoring projects. The two pre-set annual meetings (February and May) require researchers present PowerPoint presentations outlining the results and that years findings. Each meeting lasts about three days (which includes travel time).

Products

A draft report of the 2021 larval Razorback Sucker and Colorado Pikeminnow sampling activities will be prepared and distributed to the San Juan River Basin Biology Committee for review by 31 March 2022. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Basin Biology Committee by 30 June 2022 to meet Objective 5 of this proposal. Electronic copies of the 2021 collection data will be transferred to the San Juan River database manager. Fish collected from this study will be curated in the Division of Fishes, Museum of Southwestern Biology (MSB), Department of Biology, at the University of New Mexico under a MSB contract with the SJRRIP in order to fulfill Objective 8 of this proposal. Original field notes will be retained in the Division of Fishes and collection information electronically stored in a permanent MSB database program. These data and any maps generated from them will be available to the San Juan River Basin Biology Committee electronically and via hard-copy reports.

Literature Cited

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2021 BUDGET SAN JUAN RIVER LARVAL ENDANGERED FISH MONITORING
Based on five sampling trips per year

Personnel

Field Data Collection

Upper Reach (two staff, one raft) Shiprock to Sand Island; RM 148.0–76.0
Fisheries Biologist I (1 staff x 5 trips x 10 days x 8 hr/day at $63.89/hr) ..... $ 25,556
Fisheries Technician (1 staff x 5 trips x 10 days x 8 hr/day at $39.31/hr)..... $ 15,724

Lower Reach (two staff, one raft) Sand Island to Clay Hills; RM 76.0–2.9
Fisheries Biologist I (1 staff x 5 trips x 10 days x 8 hr/day at $63.89/hr) ..... $ 25,556
Fisheries Technician (1 staff x 5 trips x 10 days x 8 hr/day at $39.31/hr)..... $ 15,724

Lab Work

Upper and Lower Reach Samples Combined
Fisheries Biologist I (120 staff days/sampling year x 8 hr/day at $63.89/hr)..... $ 61,334
Tasks Laboratory identification, developmental staging,
specialized endangered fish processing, data entry, data query
and review, database development

Fisheries Technician (120 staff days/sampling year x 8 hr/day at $39.31/hr)..... $ 37,738
Tasks Post-trip sample processing, juvenile identification,
excise, mount and examine sub-sample of otoliths,
post-identification – processing, measures, review of counts

Office Work (Report Development)

Fisheries Biologist I (70 staff days year x 8 hr/day at $63.89/hr) ..... $ 35,778
Tasks Data analysis, draft report preparation, post-review redraft and
submission, development and submission of formal responses to reviewer
comments, development of presentation of study for annual meetings,
annual reporting related to state and tribal permitting of sampling activities

Senior Biostatistician (10 staff days year x 8 hr/day at $196.55/hr)..... $ 15,724
Tasks Mixture model development and analysis.

Project Oversight

Senior Fisheries Biologist (10 staff days year x 8 hr/day at $108.10/hr) ..... $ 8,648
Tasks Project coordination, project and data review, data
management, report review, permitting review

Personnel (Field, Lab, Office, Oversight) ..... Subtotal $ 241,782

SJRRIP Meetings

Three meetings/year required; 2 days/meeting

Fisheries Biologist I (6 staff days/year x 8 hr/day at $63.89/hr)	$	3,067
Senior Fisheries Biologist (6 staff days/year x 8 hr/day at $108.10/hr)	$	5,189
Personnel (Meetings) ..... Subtotal	**$**	**8,256**
Personnel ..... Subtotal	**$**	**250,038**
Personnel..... GSA General and Administrative Fee (IFF)	**$**	**1,875**
Personnel..... Total	**$**	**251,913**

Materials and Supplies

Safety dedicated first aid gear (open market items and includes PFD's)	$	2,069
Raft and rafting associated gear (open market items).....	$	1,676
Fish Sampling and associated electronic recording gear (open market items).....	$	1,458
Materials and Supplies ..... Total	**$**	**5,203**

Travel and Per Diem (published GSA rates at the time of travel will be used)

Field Data Collection

Shiprock to Clay Hills (five trips) - RM 148.0 - 2.9 (Using two rafts and two crews)

Travel - Albuquerque, NM to Clay Hills, UT (742 miles x $ 0.58/mile x 5 trips)....	$	2,152
Travel - Albuquerque, NM to Bluff, UT (576 miles x $ 0.58/mile x 5 trips).....	$	1,670
Per Diem - 6 field days per trip x 4 staff ($55/day GSA M&IE rate) x 5 trips	$	6,600
Per Diem - 1 hotel day per trip x 4 staff ($96/night GSA lodging rate) x 5 trips	$	1,920
Per Diem - 1 hotel day per trip x 4 staff ($55/day GSA M&IE rate) x 5 trips	$	1,100
Truck and Trailer Shuttle from Bluff to Clay Hills x 5 at $220.00 per trip.....	$	1,100
Travel and Per Diem (Field) ..... Subtotal	**$**	**14,542**

SJRRIP Meetings

Travel (one vehicle at 430 miles r.t. x 3 trips x $ 0.58/mile)	$	748
Per Diem (Durango CO.)		
(3 meetings x 2 staff x GSA lodging $104/night x 2)	$	1,248
(3 meetings x 2 staff x M&IE rate $71/day x 3)	$	852
Travel and Per Diem (Meetings) ..... Subtotal	**$**	**2,842**
Travel and Per Diem ..... Total	**$**	**17,390**

2021 Project Totals

Personnel	**Total**	**$**	**251,913**
Materials and Supplies	**Total**	**$**	**5,203**
Travel and Per Diem	**Total**	**$**	**17,390**
2021 Scope of Work	**GRAND TOTAL**	**$**	**274,507**

Projected Out-year funding (Adjusted by 3% annually)

FY 2022	**$**	**282,742**
FY 2023	**$**	**291,224**
FY 2024	**$**	**298,960**

Response to reviewers' comments.

Reviewer: Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

I see in the SOW where water temperature and flows (either ascending or descending limb of hydrograph) are used to explain when spawning occurs. Would it be possible to try and start to disentangle these two variables. With all of the data it might be possible to start looking at this. As an example, Pennock and I observed in spring of 2019 (which was a cold year) that although flows were up and increasing, our captures, detections and observations of RBS at the Piute Farms Waterfall were way down compared to previous years when we had warmer water. We have been discussing that this data would be a good test of the hypothesis of flows vs. temp in explaining spawning behavior, at least for RBS. There are likely other anomalous years where flow and temp are not coupled (2018 did not have a big runoff but we saw lots of RBS at the waterfall) and could be useful to look at this relationship, The ascending limb of the hydrograph is often used to explain spawning periodicity, but with all of the data that we have, including antenna detections at waterfall, McElmo, PNM, and possibly Hogback, along with the larval collection data, I think we can begin to argue, or at least determine, that temp plays a bigger role than flows. Just my opinion, but this would be valuable to know for managing the species. This work in itself would lead to a publication suitable for SWAN or another natural history journal.

Response: We agree that decoupling discharge and temperature is the next step in trying to further understand spawning behavior of adult Colorado Pikeminnow and Razorback Sucker. In our opinion, one of the necessary things needed to do this was to develop a San Juan River specific larval fish growth rate for both species, which we now have. This was an important first step in order to accurately understand the spawning period of adult Colorado Pikeminnow and Razorback Sucker.

A second necessary step was to post process all of the larval fish spawning data (1999-2019) and apply the new San Juan specific larval fish growth rates for each species. This step was completed in 2019. With this data now in hand, we will be able to independently examine temperature and discharge as they relate to spawning by adult Colorado Pikeminnow and Razorback Sucker. Of course, this would initially be done based on larval fish captures, but those results could be compared to, and incorporate, the various remote antenna detections.

If work is being done below Piute Farms Waterfall, it might be nice to try and collect larvae right at the "inflow" and possible out into the lake a little bit, just to pick up fish that have drifted down. Would it be possible to use larval light traps for this effort and just spend one night at the inflow area?

Response: During the initial survey year of 2018, sampling of the inflow area was done using larval seines in shallow coves, and other areas where seining was effective. This data was not included in the comparison of Reach 1, and the lotic habitats sampled below the

waterfall. A stated goal of the project was to try and make an "apples to apples" comparison of similar habitat types above and below the waterfall.
That being said, sampling of the inflow can absolutely be done again, and incorporate a limited number of light-traps (the use of a 12 foot raft for this project limits the amount of space available to deploy a large number of light traps). We would still keep this data separate from the lotic habitat data collected so we can continue to make comparisons between Reach 1 and the area below the waterfall, but the data would be available to answer other SJRRIP related questions.
Thank you for taking the time to review this Scope of Work.

Reviewer: **Program Office**

How can the technical aspects of this SOW be improved?

It would be useful to understand why the April sample continues to be necessary. It provides an annual idea of when spawning was initiated by why does that data continue to be needed?

Response: Over time, the April sampling has produced about 10% of all Razorback Sucker larvae collected. During some years (e.g. 2015), the April sampling has produced over 25% of all Razorback Sucker larvae collected during a given year. It is our opinion that in order to conduct a thorough investigation of Razorback Sucker spawning in the San Juan River, the appropriate time period includes the month of April. Also, while not the focus of the larval fish surveys, April is very important in understanding spawning by native Flannelmouth Suckers.
However, we fully understand that within an adaptive management program such as the SJRRIP, changes can and do occur. We will continue to structure the timing of sampling efforts based on the recommendations of the Biology Committee, and the needs of the SJRRIP.

It would also be useful to understand why the entire river needs to be sampled. What information is provided by river wide sampling that could not be provided by sampling a smaller core section of the river? I.e., how much spatial autocorrelation or heterogeneity is there in the data in a given year?

Response: It would be difficult to come up with a core section of river that would work for both Razorback Sucker and Colorado Pikeminnow. It is true that for Razorback Sucker, the lower reaches (1-3) of the San Juan River could conceivable be considered a core section for this species. However, recent years of data have seen diminishing densities within Reach 3, while densities in Reach 4 have markedly increased.
For Colorado Pikeminnow, there simply is no pattern to capture densities among reaches or across years. Granted, that is in large part due to the fact that for many years, densities of larval Colorado Pikeminnow have been generally low. Based on previous years data, if the study area were to be shortened, the exclusion of Reach 5 would probably make the most sense.
Sampling of the entire river has provided information on range expansion by both species, as well as the increasing spawning periodicity of Razorback Sucker (i.e. the

youngest larvae collected later in the year typically are found in the most upstream reaches). It has provided data on species that have been the target of intensive nonnative removal efforts, and provides genetic material for past, and ongoing studies. Riverwide larval fish data has been used by the SJRRIP to make decisions on each of the three (RERI phase I and II, and the Phase III wetland) habitat restoration projects undertaken by the SJRRIP. It currently is being used to document both the physical condition of the restored habitats, and their use by multiple life stages of San Juan River fishes.

Similar to comment regarding the continuation of the April sampling effort, we remain open to any recommendations by the Biology Committee regarding changes to the current study area.

Thank you for taking the time to review this Scope of Work.

SAN JUAN RIVER LARVAL ENDANGERED FISH MONITORING BETWEEN RM 180.6 – 168.4
(Animas River confluence to Hatch Brother's trading post)

FISCAL YEAR 2021 SCOPE OF WORK

SUBMITTED TO THE U.S. BUREAU OF RECLAMATION

SUBMITTED BY

AMERICAN SOUTHWEST ICHTHYOLOGICAL RESEARCHERS, L.L.C. (*ASIR*)
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CONTRACT # GS-10F-0249X-140R4018F0037

1 OCTOBER 2020 – 30 SEPTEMBER 2021

SAN JUAN RIVER LARVAL ENDANGERED FISH MONITORING BETWEEN RM 180.6 – 168.4 (ANIMAS RIVER CONFLUENCE TO HATCH BROTHER'S TRADING POST) FISCAL YEAR 2021 PROJECT PROPOSAL

Background:

During the February 2016 SJRRIP Biology Committee meeting in Durango Colorado, the option of expanding the study area upstream of Shiprock, NM for the larval fish monitoring program was discussed. Researchers hypothesized that as more Razorback Sucker adults are established in the San Juan River through augmentation efforts, and potentially through natural recruitment, larval Razorback Sucker should be present upstream of the current larval fish monitoring study area. This expansion was approved and first included in the SJRRIP fiscal year 2017 Annual Work Plan.

During the 2016 SJRRIP study "Evaluation of Larval Fish Entrainment in the Hogback Diversion Canal" larval Colorado Pikeminnow and Razorback Sucker were collected in drift-net samples taken in the San Juan River adjacent to the Hogback Diversion Canal. At the May 2017 SJRRIP Biology Committee meeting in Durango, Colorado, the Hogback Diversion Canal collection of larval Razorback Sucker prompted a discussion regarding conducting a larval fish survey trip upstream of Shiprock to target the collection of Colorado Pikeminnow. This change in protocol was unanimously approved. In 2017, three sampling trips were conducted between mid-June and early August with the intent of documenting upstream distributional boundaries of both Razorback Sucker and Colorado Pikeminnow (between Shiprock and the Animas-San Juan River confluence at Farmington, NM).

Both larval Colorado Pikeminnow and Razorback Sucker were documented in the expanded study area in 2017. Sampling of the San Juan River between Farmington and Shiprock, NM during 2018 documented larval Razorback Sucker up to river mile (RM) 179.8 (near the confluence of the Animas River) while a 2019 sample yielded larval Razorback Sucker in the Animas River. Colorado Pikeminnow were not collected in the extended study area during 2018. Beginning in 2019, at the request of the SJRRIP, this project was redesigned to specifically targeted the collection of larval Colorado Pikeminnow, with all sampling efforts occurring upstream of the Four Corners Power Plant pumping station at RM 163.7; this FY 2021 proposal specifically targets the collection of larval Colorado Pikeminnow above RM 163.7.

Project Justification:

Data from this monitoring effort can be used by the SJRRIP to determine when to implement Reasonable and Prudent Measures (RPM) necessary to avoid adverse impacts to the endangered fish species. Specifically, sampling in the proposed reach (RM 180.6 – 168.4) may trigger RPM #2, as outlined in the Biological Opinion for Four Corners Power Plant (Service, 2015). If larval Colorado Pikeminnow are collected upstream of RM 163.7 (Four Corners Power Plant pumping station), a feasible pumping plan that maintains the current operating configuration could be developed to help minimize entrainment risk.

Sampling in this proposed reach relies on annually securing private property access through the Hatch Brother's trading post. These landowners have allowed access to SJRRIP researchers in the past.

Methods:

Two sampling trips will occur after the presumed spawning and hatching period of Colorado Pikeminnow (July and early August). Results (i.e., raw numbers of larvae captured) from the long-term larval fish survey being conducted immediately downstream of Shiprock will help to inform specific sampling dates within the extended study area. This "adaptive sampling" approach will help ensure the collection of the large number of larval fish necessary to document reproduction of a rare species.

Access to the river will be gained through the use of inflatable rafts equipped with all of the necessary equipment to successfully sample nursery type habitats. Sample crews will consist of two people and two separate vehicles. The sampling of a discrete river reach requires the use of two vehicles to daily shuttle materials and personnel to the upstream and downstream end of study area. A schedule for each sampling trip follows:

- Day 1 Fieldwork preparation, travel from Albuquerque to Farmington NM.
- Day 2 Sample RM 180.6 – 168.4.
- Day 3 Travel from Farmington to Albuquerque NM. Clean and store field sampling gear and deposit specimens at the Museum of Southwestern Biology, UNM.

The collection and preservation of specimens, magnitude of sampling effort, habitat classification, gathering of physical data, field work safety, laboratory work, species-specific identifications, quality assurance and control, and data analysis will follow the methodology outlined for the San Juan River larval Razorback Sucker and Colorado Pikeminnow Monitoring program *(SOW 21)*. Larval fish monitoring project history, as well as goals and objectives of this project as they relate to the SJRRIP Long Range Plan, can also be found in the San Juan River larval Razorback Sucker and Colorado Pikeminnow Monitoring scope of work.

This sampling effort is independent of ongoing larval fish monitoring occurring below Shiprock, NM, but data can be integrating into the existing long-term larval fish monitoring database. Integration with the long-term larval fish monitoring data will be done in instances (e.g., back-calculated spawning dates) where integration does not affect analysis and interpretation of long-term trends associated with the current larval fish monitoring. Density estimates, frequency of occurrence, and other metrics associated with this expanded study area will be analyzed and presented independently of the long-term larval fish monitoring study.

2021 BUDGET: SAN JUAN RIVER LARVAL ENDANGERED FISH MONITORING BETWEEN RM 180.6 – 168.4 (Animas River confluence to Hatch Brother's trading post)

Personnel

Field Data Collection

Animas River confluence to Hatch Brother's trading post RM 180.6 – 168.4

Fisheries Biologist I (1 staff x 2 trips x 3 days x 8 hr/day at $63.89/hr)	$	3,067
Fisheries Technician (1 staff x 2 trips x 3 days x 8 hr/day at $39.31/hr).....	$	1,887

Lab Work

All Samples Combined

Fisheries Biologist I (15 staff days/sampling year x 8 hrs/day at $63.89/hr)	$	7,667

Tasks: Laboratory identification, developmental staging, specialized endangered fish processing, data entry, data query and review, database development

Fisheries Technician (15 staff days/sampling year x 8 hrs/day at $39.31/hr)	$	4,717

Tasks**:** Post-trip sample processing, juvenile identification, Post-identification – processing, measures, review of counts

Office Work (Report Development)

Fisheries Biologist I (3 staff days year x 8 hrs/day at $63.89/hr):.....	$	1,533

Tasks: Data analysis and integration into long-term larval fish monitoring database, inclusion of data in annual draft report, incorporate data into presentation of study for annual meetings, annual reporting related to state and tribal permitting of sampling activities

Project Oversight

Senior Fisheries Biologist (1 staff days year x 8 hrs/day at $108.10/hr):.....	$	865

Tasks: Project coordination, project and data review, data management, report review, permitting review

Personnel (Field, Lab, Office, Oversight): ..... Subtotal	**$**	**19,736**

SJRRIP Meetings

Three meetings/year required; 2 days/meeting. (Costs are covered under SOW 21)

Fisheries Biologist I (6 staff days/year):	$	0
Senior Fisheries Biologist (6 staff days/year):	$	0
Personnel (Meetings): ..... Subtotal	**$**	**0**
Personnel..... Subtotal	**$**	**19,736**
Personnel..... GSA General and Administrative Fee (IFF)	**$**	**148**
Personnel..... Total	**$**	**19,884**

Materials and Supplies

Safety dedicated first aid gear: *(In kind contribution)*	$	0
Raft and rafting associated gear: *(In kind contribution)*	$	0
Fish Sampling and associated electronic recording gear: *(In kind contribution)*	$	0
Materials and Supplies: ..... Total	**$**	**0**

Travel and Per Diem

Field Data Collection

Animas River confluence to Hatch Brother's trading post (two trips) - RM 180.6 – 168.4

Travel - 4 x 4 pickup trucks (404 miles x $ 0.58/mile x 2 trips x 2 trucks).....	$	937
Per Diem - 2 hotel days per trip x 2 staff ($96/night GSA lodging rate) x 2 trips....	$	768
Per Diem - 3 field days per trip x 2 staff ($55/day GSA M&IE rate) x 2 trips	$	660
Travel and Per Diem (Field): .....Subtotal	**$**	**2,365**

SJRRIP Meetings (*Costs are covered under SOW 21)*

Travel (one vehicle at 430 miles r.t. x 3 trips x $ 0.58/mile):	$	0
Per Diem (2 GSA lodging + 2 M&IE per diem days/meeting x 3 meetings x 2 staff)	$	0
Travel and Per Diem (Meetings):.....Subtotal	**$**	**0**
Travel and Per Diem: ..... Total	**$**	**2,365**

2021 Project Totals

Personnel:	**Total**	**$**	**19,884**
Materials and Supplies:	**Total**	**$**	**0**
Travel and Per Diem:	**Total**	**$**	**2,365**
2021 Scope of Work:	**GRAND TOTAL**	**$**	**22,249**

Projected Out-year funding (Adjusted by 3% annually)

FY 2022	**$**	**22,916**
FY 2023	**$**	**23,604**
FY 2024	**$**	**24,312**

Response to reviewers' comments.

No comments received.

Museum of Southwestern Biology
Curation of Lower Colorado River Basin Larval Fish Collections and Digital Files

Fiscal Year 2021 Scope of Work

Submitted to

Bureau of Reclamation

From

The Museum of Southwestern Biology
Principle Investigators: Thomas F. Turner and Emily S. DeArmon
University of New Mexico MSC03-2020
Albuquerque, NM 87131
(505) 277-7541

Award R18AC00015
1 October 2020 to 30 September 2021

Description of SOW or Brief End-of-Fiscal Report: Specimens continue to be deposited in the Museum of Southwestern Biology to be curated and archived from the San Juan River Recovery Implementation Program. Curation activities include specimens from the Expanded Area survey, Paiute Farms Waterfall Area, Razorback Sucker, and Lake Powell larval fish surveys. The Data Integration and Synthesis Program was discontinued in FY2019 and outcomes and products were presented at the SJRRIP Biology Committee Meeting (December, 2018). To date, over 2 million specimens (>56,000 lots) collected from the SJRRIP have been deposited and curated in the MSB for SJRRIP research. These collections and records are digitized, electronically captured, and available to the Program via online portals such as https://fishnet2.net and ARCTOS http://arctos.database.museum/SpecimenSearch.cfm

Museum of Southwestern Biology
Curation of Lower Colorado River Basin Larval Fish Collections and Digital Files

Fiscal Year 2021 Scope of Work

Principle Investigators: Thomas F. Turner and Emily S. DeArmon
University of New Mexico MSC03-2020
Albuquerque, NM 87131

Contact (505) 277-7541 Thomas F. Turner
Award R18AC00015
1 October 2020 to 30 September 2021

Background

Collections Curation and Data Archives -- Since 1991, the MSB Division of Fishes has been the permanent repository for large numbers of voucher specimens and associated data collected by San Juan River Restoration Implementation Program (SJRRIP) researchers. The numbers of specimens and field notes processed each year have varied depending on the availability of specimen/field data after the field season, collecting techniques, and annual variability of sampling conditions.

Given the variability in number of fishes to process, the San Juan River Biology Committee has recommended that the annual budget for the San Juan River specimen curation and larval fish identification reflect an "average" year of sample processing. The SJRRIP Biology Committee recognizes that some years would require more effort from MSB staff than budgeted, while other years might not require the same high level of activity. A relatively stable budget would allow for uninterrupted processing of new collections and yet be sufficient to cover the ongoing work of processing backlogged SJRRIP collections due to circumstances previously discussed.

To date, over 56,000 lots (over 2,300,000 fish specimens) have been collected (1987-2019) by the San Juan River research group and these specimens have been processed, cataloged, and archived at the Museum of Southwestern Biology, Division of Fishes. A total of 20,991 San Juan River collection sites have been entered into the MSB database and georeferenced; all locality and habitat information has been captured using original field notes and data sheets. Over 25,000 pages of original San Juan River field notes and data sheets have been digitally captured, cleaned, and saved in both tiff and pdf formats for the MSB Division of Fishes electronic archives; the original field notes and data sheets are permanently stored in acid-free document boxes for long-term conservation.

Incoming specimen collections are removed from WhirlPaks®, cleaned of debris, placed in known concentrations of fixative (either 5% buffered formalin, 10 % buffered formalin, or 95% ethanol), and organized on the accession shelves by MSB staff. Collections are later sorted and identified by the principal SJRRIP investigators. Specimen collections are assigned an accession number (tracking number) and all associated documentation, like permits and field notes, are filed under that same number. Processing collections of fish specimens (adults and larvae) requires fluid transfers from

formalin fixative to ethanol preservative (typically), sending out specimens for species verification as required, counting the number of individuals in each collection, recording the standard lengths for the largest and smallest specimen in each collection, entering all locality and specimen data into an electronic catalog, digital capture of field notes and data sheets, and labeling and filing vials and jars of cataloged San Juan River specimens into the permanent MSB collections. The basic principles for accessioning specimens of fishes in the MSB are standard for most museums of natural history (e.g., Smithsonian Institution, Carnegie Museum, and University of Michigan Museum of Zoology). Species identifications and locality/collection data are verified as necessary prior to incorporation into the MSB catalog. This step is very important for the SJRRIP researchers so that any misleading information is not incorporated into subsequent reports on San Juan River fish species, particularly for the larval Colorado Pikeminnow (*Ptychocheilus lucius*) and Razorback Sucker (*Xyrauchen texanus*) studies. For purposes of permitting, the MSB provides the Program with field and species data in museum report format. This information includes species identification, catalog number (MSB number), number of specimens and size range per lot.

Study Area

The objective of this project is to process and organize specimens of fishes, collection data, and field notes taken under the San Juan River Recovery Implementation Program (San Juan River and Upper Colorado River Basin). Field data are captured in an electronic catalog and SJRRIP collections are organized in a phylogenetic system within the museum archives for easy access. All of these activities take place in the Division of Fishes, Museum of Southwestern Biology, on the University of New Mexico campus in Albuquerque, NM. Synthesis, analysis, and integration of relevant elements of this large database is done in collaboration with the USFWS SJRRIP Program Office in Albuquerque and continues to be presented at researchers' meetings held in the Four Corners area, Colorado or New Mexico.

The MSB Division of Fishes has three offices with a total of six computer workstations for data entry, data management, and data analysis; a fully equipped laboratory for preparation of fish specimens, and approximately 1,858 linear meters of compacted shelving for storage of cataloged collections. On average, four UNM student and one staff postions (three undergraduate, one graduate student, and Collections Manager) process and curate SJRRIP collections.

Curation and Collections Care Objectives

1. Provide a secure and organized repository for San Juan River fish collections, field notes, and associated data thereby facilitating access to these resources by SJRRIP researchers.
2. Insure that all SJRRIP species identifications and associated data are verified and correctly represented in the MSB electronic catalog; report discrepancies to SJRRIP principal investigators.
3. Georeference collection sites for SJRRIP collections; maintain license for ArcView and make collection data available to SJRRIP researchers in that format, as required.

Curation and Collections Care Methods

Tasks to be completed under this project are processing and curation of fish specimens and all data from the San Juan River Basin Recovery Implementation Program synthesized and integrated in the

form of reports to the Committee and peer review publications. Specimen collections are deposited with the MSB Division of Fishes by SJRRIP principal investigators.

Upon receipt of newly collected San Juan River specimens, MSB staff transfer these collections from formalin fixative into stages of 35%, 50%, and 70% concentrations of ethanol. Exceptions to this protocol are made per request of PI, as in the case of using 95% ethanol for genetic and/or otolith studies. Some tissue preservation includes a dry storage using Whatman filter paper. Tissues taken in the field are attached to the filter paper and allowed to dry. Once deposited, Whatman tissue samples are placed in plastic sleeves with the air removed and catalogued into the permanent collections. Preservation histories for all incoming SJRRIP collections are recorded on accession cover sheets and this information is stored in accession files. Fish specimens are removed from field containers and cleaned (debris removed) and placed into museum quality jars during the fluid transfers. SJRRIP principle investigators sort, identify, count and measure each lot (discrete collection) once the collections are transferred to ethanol. MSB staff catalog, label, and file the specimens once the principle investigators have completed their work. SJRRIP collections are organized in the permanent archives by drainage (San Juan River) and taxa. These archives are in a room that is controlled for temperature (18° Celsius) and light (complete darkness to low light levels). All data associated with the specimens are entered and organized in the electronic MSB Division of Fishes database (MS Access 2010) and georeferenced (GeoLocate Ver. 3). All original field notes and data sheets are digitally captured and archived in acid-free document boxes for permanent storage.

Products 2021

SJRRIP and Upper Colorado River Basin fishes and associated data will be curated in the Division of Fishes, Museum of Southwestern Biology (MSB), at the University of New Mexico (UNM). Collection sites will be georeferenced and continue to be available in Arctos (https://arctos.database.museum/). Original field notes will be digitized and archived by the MSB Division of Fishes and collection data electronically stored in a permanent MSB database program. San Juan River digital files (data and field notes) are backed up in three different media: two servers-one server in MSB Division of Fishes and the other server located in UNM Department of Biology; the Arctos database, which resides with The Texas Advanced Computing Center (TACC) in Austin, TX; and one external hard drive. Species verifications and corrections as well as digital copies (PDF) of field notes will be made available to SJRRIP principle investigators upon request. A draft report of the 2020 San Juan River and upper Colorado River Basin specimen curation, larval fish sampling and identification, and data integration activities will be prepared and distributed by 31 March 2020 to the San Juan River Biology Committee for review. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Biology Committee by 1 June 2020.

Manuscripts, suitable for peer reviewed publication, will be prepared in collaboration with appropriate Program personnel, the Biology Committee, and researchers for each commonly agreed upon investigation.

Budget Fiscal Year 2021 1 October 2020 to 30 September 2021

BUDGET ITEM DESCRIPTION	COMPUTATION		RECIPIENT FUNDING	OTHER FUNDING	RECLAMATION FUNDING	TOTAL COST
	$/Unit	Quantity				
SALARIES AND WAGES --Position title x hourly wage/salary x est. hours for assisted activity. Describe this information for each position.						
UNM Student Assistants(4)	$10.30/HR	3520			$36,256.00	$36,256.00
FRINGE BENEFITS – Explain the type of fringe benefits and how applied to various categories of personnel.						
Undergraduate student UNM rate	1% per salary	4			$362.56	$362.56
TRAVEL—dates; location of travel; method of travel x estimated cost; who will travel						
EQUIPMENT—Leased Equipment use rate + hourly wage/salary x est. hours for assisted activity—Describe equipment to be purchased, unit price, # of units for all equipment to be purchased or leased for assisted activity: Do not list contractor supplied equipment here.						
SUPPLIES/MATERIALS--Describe all major types of supplies/materials, unit price, # of units, etc., to be used on this assisted activity.						
Chemical Preservatives-EtOH 95%	$2.53/Liter	200			$506.00	$506.00
Labeling-paper and print film	$2.44/ea	100			$244.00	$244.00
Specimen containers-3 liter jars	$9.26/ea	30			$277.80	$277.80
Specimen containers-8oz jars	$1.02/ea	50			$51.00	$51.00
Specimen containers-8 dr vials	$1.15/ea	1200			$1,380.00	$1,380.00
Specimen containers-1 dr vials	$0.21/ea	300			$63.00	$63.00
Closures-cotton plugs	$0.01/ea	4000			$40.00	$40.00
Closures-gaskets	$3.30/ea	30			$99.00	$99.00
Closures-caps	$0.34/ea	45			$15.30	$15.30
CONTRACTUAL/ CONSTRUCTION—Explain any contracts or sub-Agreements that will be awarded, why needed. Explain contractor qualifications and how the contractor will be selected.						
OTHER –List any other cost elements necessary for your project; such as extra reporting, or contingencies in a construction contract.						
TOTAL DIRECT COSTS--					$39,294.66	$39,294.66
INDIRECT COSTS – **17.5%**						
					$6,876.57	$6,876.57

TOTAL PROJECT/ACTIVITY COSTS FY21				$46,171.23	**$46,171.23**

FY 2020 Budget Summary

2020 Grand Total
Curation of SJRRIP Specimen, Data, and Field Note Collections

$44,832.18

Indirect Costs Statement: A 17.5% (of Modified Total Direct Costs) Facilities and Administration Cost is applied to annual budgets in accordance with the Colorado Plateau Cooperative Ecosystem Study Unit (CPCESU). The US Bureau of Reclamation and the University of New Mexico are co-signatories on the agreement.

CESUs are cooperative networks that transcend political and institutional boundaries. Instead, their boundaries are based primarily on biogeographical considerations. The goal of the CESUs is create innovative opportunities for research, education, and technical assistance in support of the management and stewardship of natural and cultural resources on federal lands. More information on the CPCESU can be found at https://in.nau.edu/cpcesu/.

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Attachment A

Museum of Southwestern Biology
Curation of Specimens, Data, and Field Notes
San Juan River Restoration Implementation Program

FY 2021-2024

THE FOLLOWING BUDGETS ARE ESTIMATES ONLY (3% INCREASES) AND MAY NOT REPRESENT ACTUAL COSTS

Budget Fiscal Year 2021 1 October 2020 to 30 September 2021

BUDGET ITEM DESCRIPTION	COMPUTATION		RECIPIENT FUNDING	OTHER FUNDING	RECLAMATION FUNDING	TOTAL COST
	$/Unit	Quantity				
SALARIES AND WAGES --Position title x hourly wage/salary x est. hours for assisted activity. Describe this information for each position.						
UNM Student Assistants(4)	$10.30/HR	3520			$36,256.00	$36,256.00
FRINGE BENEFITS – Explain the type of fringe benefits and how applied to various categories of personnel.						
Undergraduate student UNM rate	1% per salary	4			$362.56	$362.56
TRAVEL—dates; location of travel; method of travel x estimated cost; who will travel						
EQUIPMENT—Leased Equipment use rate + hourly wage/salary x est. hours for assisted activity—Describe equipment to be purchased, unit price, # of units for all equipment to be purchased or leased for assisted activity: Do not list contractor supplied equipment here.						
SUPPLIES/MATERIALS--Describe all major types of supplies/materials, unit price, # of units, etc., to be used on this assisted activity.						
Chemical Preservatives-EtOH 95%	$2.53/Liter	200			$506.00	$506.00
Labeling-paper and print film	$2.44/ea	100			$244.00	$244.00
Specimen containers-3 liter jars	$9.26/ea	30			$277.80	$277.80
Specimen containers-8oz jars	$1.02/ea	50			$51.00	$51.00
Specimen containers-8 dr vials	$1.15/ea	1200			$1,380.00	$1,380.00
Specimen containers-1 dr vials	$0.21/ea	300			$63.00	$63.00
Closures-cotton plugs	$0.01/ea	4000			$40.00	$40.00
Closures-gaskets	$3.30/ea	30			$99.00	$99.00
Closures-caps	$0.34/ea	45			$15.30	$15.30
CONTRACTUAL/ CONSTRUCTION—Explain any contracts or sub-Agreements that will be awarded, why needed. Explain contractor qualifications and how the contractor will be selected.						
OTHER –List any other cost elements necessary for your project; such as extra reporting, or contingencies in a construction contract.						
TOTAL DIRECT COSTS--					$39,294.66	$39,294.66
INDIRECT COSTS – **17.5%**						
					$6,876.57	$6,876.57
TOTAL PROJECT/ACTIVITY COSTS FY21					$46,171.23	**$46,171.23**

Budget Fiscal Year 2022 1 October 2021 to 30 September 2022

BUDGET ITEM DESCRIPTION	COMPUTATION		RECIPIENT FUNDING	OTHER FUNDING	RECLAMATION FUNDING	TOTAL COST
	$/Unit	Quantity				
SALARIES AND WAGES --Position title x hourly wage/salary x est. hours for assisted activity. Describe this information for each position.						
UNM Student Assistants(4)	$10.60/HR	3520			$37,312.00	$37,312.00
FRINGE BENEFITS – Explain the type of fringe benefits and how applied to various categories of personnel.						
Undergraduate student UNM rate	1% per salary	4			$373.12	$373.12
TRAVEL—dates; location of travel; method of travel x estimated cost; who will travel						
EQUIPMENT—Leased Equipment use rate + hourly wage/salary x est. hours for assisted activity—Describe equipment to be purchased, unit price, # of units for all equipment to be purchased or leased for assisted activity: Do not list contractor supplied equipment here.						
SUPPLIES/MATERIALS--Describe all major types of supplies/materials, unit price, # of units, etc., to be used on this assisted activity.						
Chemical Preservatives-EtOH 95%	$2.61/Liter	200			$522.00	$522.00
Labeling-paper and print film	$2.51/ea	100			$251.00	$251.00
Specimen containers-3 liter jars	$9.54/ea	30			$286.20	$286.20
Specimen containers-8oz jars	$1.05/ea	50			$52.50	$52.50
Specimen containers-8 dr vials	$1.18/ea	1200			$1,416.00	$1,416.00
Specimen containers-1 dr vials	$0.22/ea	300			$66.00	$66.00
Closures-cotton plugs	$0.01/ea	4000			$40.00	$40.00
Closures-gaskets	$3.40/ea	30			$102.00	$102.00
Closures-caps	$0.35/ea	45			$15.75	$15.75
CONTRACTUAL/ CONSTRUCTION—Explain any contracts or sub-Agreements that will be awarded, why needed. Explain contractor qualifications and how the contractor will be selected.						
OTHER –List any other cost elements necessary for your project; such as extra reporting, or contingencies in a construction contract.						
TOTAL DIRECT COSTS--					$40,436.57	$40,436.57
INDIRECT COSTS – **17.5%**						
					$7,076.40	$7,076.40
TOTAL PROJECT/ACTIVITY COSTS FY22					$47,512.97	**$47,512.97**

Budget Fiscal Year 2023 1 October 2022 to 30 September 2023

BUDGET ITEM DESCRIPTION	COMPUTATION		RECIPIENT FUNDING	OTHER FUNDING	RECLAMATION FUNDING	TOTAL COST
	$/Unit	Quantity				
SALARIES AND WAGES --Position title x hourly wage/salary x est. hours for assisted activity. Describe this information for each position.						
UNM Student Assistants(4)	$10.90/HR	3520			$38,368.00	$38,368.00
FRINGE BENEFITS – Explain the type of fringe benefits and how applied to various categories of personnel.						
Undergraduate student UNM rate	1% per salary	4			$383.68	$383.68
TRAVEL—dates; location of travel; method of travel x estimated cost; who will travel						
EQUIPMENT—Leased Equipment use rate + hourly wage/salary x est. hours for assisted activity—Describe equipment to be purchased, unit price, # of units for all equipment to be purchased or leased for assisted activity: Do not list contractor supplied equipment here.						
SUPPLIES/MATERIALS--Describe all major types of supplies/materials, unit price, # of units, etc., to be used on this assisted activity.						
Chemical Preservatives-EtOH 95%	$2.69/Liter	200			$538.00	$538.00
Labeling-paper and print film	$2.58/ea	100			$258.00	$258.00
Specimen containers-3 liter jars	$9.82/ea	30			$294.60	$294.60
Specimen containers-8oz jars	$1.08/ea	50			$54.00	$54.00
Specimen containers-8 dr vials	$1.21/ea	1200			$1,452.00	$1,452.00
Specimen containers-1 dr vials	$0.23/ea	300			$69.00	$69.00
Closures-cotton plugs	$0.01/ea	4000			$40.00	$40.00
Closures-gaskets	$3.50/ea	30			$105.00	$105.00
Closures-caps	$0.36/ea	45			$16.20	$16.20
CONTRACTUAL/ CONSTRUCTION—Explain any contracts or sub-Agreements that will be awarded, why needed. Explain contractor qualifications and how the contractor will be selected.						
OTHER –List any other cost elements necessary for your project; such as extra reporting, or contingencies in a construction contract.						
TOTAL DIRECT COSTS--					$41,578.48	$41,578.48
INDIRECT COSTS – **17.5%**						
					$7,276.23	$7,276.23
TOTAL PROJECT/ACTIVITY COSTS FY23					$48,854.71	**$48,854.71**

Budget Fiscal Year 2024 1 October 2023 to 30 September 2024

BUDGET ITEM DESCRIPTION	COMPUTATION		RECIPIENT FUNDING	OTHER FUNDING	RECLAMATION FUNDING	TOTAL COST
	$/Unit	Quantity				
SALARIES AND WAGES --Position title x hourly wage/salary x est. hours for assisted activity. Describe this information for each position.						
UNM Student Assistants(4)	$11.22/HR	3520			$39,494.40	$39,494.40
FRINGE BENEFITS – Explain the type of fringe benefits and how applied to various categories of personnel.						
Undergraduate student UNM rate	1% per salary	4			$394.94	$394.94
TRAVEL—dates; location of travel; method of travel x estimated cost; who will travel						
EQUIPMENT—Leased Equipment use rate + hourly wage/salary x est. hours for assisted activity—Describe equipment to be purchased, unit price, # of units for all equipment to be purchased or leased for assisted activity: Do not list contractor supplied equipment here.						
SUPPLIES/MATERIALS--Describe all major types of supplies/materials, unit price, # of units, etc., to be used on this assisted activity.						
Chemical Preservatives-EtOH 95%	$2.77/Liter	200			$554.00	$554.00
Labeling-paper and print film	$2.65/ea	100			$265.00	$265.00
Specimen containers-3 liter jars	$10.11/ea	30			$303.30	$303.30
Specimen containers-8oz jars	$1.11/ea	50			$55.50	$55.50
Specimen containers-8 dr vials	$1.25/ea	1200			$1,500.00	$1,500.00
Specimen containers-1 dr vials	$0.24/ea	300			$72.00	$72.00
Closures-cotton plugs	$0.01/ea	4000			$40.00	$40.00
Closures-gaskets	$3.60/ea	30			$108.00	$108.00
Closures-caps	$0.37/ea	45			$16.65	$16.65
CONTRACTUAL/ CONSTRUCTION—Explain any contracts or sub-Agreements that will be awarded, why needed. Explain contractor qualifications and how the contractor will be selected.						
OTHER –List any other cost elements necessary for your project; such as extra reporting, or contingencies in a construction contract.						
TOTAL DIRECT COSTS--					$42,803.79	$42,803.79
INDIRECT COSTS – **17.5%**						
					$7,490.66	$7,490.66
TOTAL PROJECT/ACTIVITY COSTS FY24					$50,294.45	**$50,294.45**

San Juan River Annual Habitat Monitoring

Fiscal Year 2021 Scope of Work

Submitted to

Bureau of Reclamation

From

Ecosystems Research Institute

1023 West 800 North Suite 108

Logan Utah 84321

(435) 760-3071

1 October 2020 to 30 September 2021

Introduction

In 1998, flow recommendations were developed by the SJRIP for the San Juan River below the confluence with the Animas River (River Mile 180). The details of the flow recommendations were heavily based upon river channel and habitat response to flows determined from a 7-year research study of channel morphology and habitat. In 1999, long-term monitoring was established to monitor channel and habitat response to flows. The protocols were continuations of those established during the 7-year research period and continued through 2004. From 1992 to 2007, the river-wide habitat mapping was conducted by ERI staff.

During the data integration process of 2004–2005, it became evident that backwater habitat types during base flow periods (800-1500 cfs) had been reduced in number and surface area beginning in September, 1995. Backwater surface areas between River miles 2 to 180 had decreased from 140,000 m^2 in September 1995 to less than 20,000 m^2, river wide by October 2003. From 2005 to 2015, backwater surface areas have stabilized at approximately 30,000 to 40,000 m^2. However, during 2016, the area of backwaters increased to over 90,000 m^2. It was hypothesized that the characteristics of the 2016 San Juan River spring runoff (magnitude, duration, etc.) were instrumental in the increase in low velocity habitats. These habitats persisted in 2017 with another high spring flow. However, in 2018, there was no spring release from Navajo Reservoir and the San Juan River experienced significant periods with summer baseflows less than 500 cfs. These resultant low flows reduced backwater surface areas to levels near their lows in 2004. In 2019, two monitoring data points were collected because of additional available water from Navajo Reservoir. The first was at an elevated baseflow of 1,500 cfs and the second at a lower baseflow of 690 cfs. The antecedent conditions prior to data collections, were considered high spring runoff conditions. All high flow metrics were met by the spring runoff. The resultant low velocity habitat surface areas were the largest since the 1995 high measurements

The 2020-21 habitat monitoring will document the impacts of the 2020 hydrograph, which is anticipated to be a lower than average flow year. We are hypothesizing that the backwater habitat areas created in 2019 will be reduced.

Within the major goals of the SJRIP monitoring program, the results of this proposed project will in part meet goal number (2) “Track changes in abiotic parameters, including water quality, channel morphology, and habitat, important to the fish community in particular and the aquatic community in general”. Specifically, the major tasks to be undertaken are:

> Task 1) Arrange the acquisition of high- resolution digital imagery from Rm 180 to Rm -10, (confluence with Lake Powel) and prepare maps for field verifications. Areal imagery will be obtained from a consultant contracted by ERI. The ortho corrected photography will be acquired for the post run-off summer baseflows as soon as possible given the instability of flows due to the summer monsoonal season.
>
> Task 2) Field habitat mapping will be conducted to verify flowing secondary channel types, backwaters, embayments, islands and total wetted areas under summer baseflow conditions in critical complex areas of the San Juan River that are problematic in interpreting conditions on the aerial images (channels with minimal inflow through cobble at the inflow area)

Task 3) Post-process the planform geometry into ARC GIS and determine density and area for each habitat type.

Task 4) Analysis data and prepare a final report describing the effects of the 2019 high flow hydrograph on the habitats and secondary channel types found in 2018 and compare them to the habitats created in 2016 and 2017.

The scope of work time frame is from September 1, 2020 to September 31, 2021.

Project Justification

The SJRIP has, as one of its two primary goals, the conservation of populations of Colorado pikeminnow and razorback sucker in the San Juan River basin. To aid in the evaluation of achievement of these program goals, the following monitoring plan goals were developed (San Juan Draft Monitoring Protocols, 2010):

1) Track the status and trends of endangered and other fish populations in the San Juan River;
2) Track changes in abiotic parameters, including water quality, channel morphology, and habitat, important to the fish community in particular and the aquatic community in general;
3) Utilize data collected under Goals 1 and 2 to help assess progress towards recovery of endangered fish species; and,
4) Assess effectiveness of management actions, implemented flows, and intra- and inter-annual variability in flows on recovery of Colorado pikeminnow, razorback sucker and population status of other fish species.

Relative to this scope of work, SJRIP goal (2) and (4) above will be met in part. Specifically, achievement of this goal will occur through the tracking of species important low velocity habitats (numbers and areas), as well as channel complexity necessary for all life stages of the two rare fish in the San Juan River. Updating the existing database and comparing the current information will provide a status and trends.

Project Objectives

The specific objectives of this work-plan correspond to the overall objectives of the monitoring protocols (2012). Specifically the direct linkage of objectives between this study and protocol objectives (by number) that are in common include:

Objective 1) Annually, following spring runoff, document abundance and distribution of key habitats and geomorphic features (backwaters, embayments, islands and total wetted area) that indicate the response of the river channel and habitat to antecedent runoff conditions and specific management actions… (*Specifically, determine the impact of the 2020 water hydrograph conditions on habitat planform).*

Objective 8) Develop relationships between habitat availability and antecedent flow conditions. Use key habitats for this analysis. (*For example*, t*he hydrograph for 2019 produced more days above 10,000, 8,000 and 5,000 cfs since the high flows of 2008 and produced the most backwater area since 1995.Conversely, flows in 2018 were well below those in 2019 and backwater habitat was*

reduced to the second lowest level since 2004). The project will evaluate if the existing relationships between habitat densities and antecedent conditions are still valid for the habitat densities that will be found after the 2020 spring runoff).

Objective 9) Track long-term trends of habitat availability

Task 1. Develop high-resolution Digital Imagery for Rm -10 to Rm 180.

The San Juan River will be flown and digital images captured at a resolution of 10 centimeters. Images will be printed with a 20% overlap between images and placed in plastic overlays.

Task 2 Field Habitat Mapping

If necessary, field-verify selected problematic marginally flowing secondary channels during the summer base-flow period (2020) captured in the aerial images. This will be dependent upon flow at image capture. All secondary channels, main channel splits, island splits and cobble/sand bar splits will be noted on base-maps and compared to the newest images.

Task 3) Post-process the planform geometry into ARC GIS and determine density and area for each habitat type.

Once the digital frames have been registered, ArcGIS will be used to digitize the boundaries of the wetted secondary channels. In addition backwaters, embayments islands and in-stream sand/cobble bars will be mapped. The data will be processed and summarized by river-mile to match existing datasets.

Task 4) Prepare a final report describing the effects of the 2020 spring flow hydrograph on the habitats and secondary channel types compared to 2016 to 2019 habitat data

A final report will examine the relationships between hydrology (especially recent antecedent hydrology conditions prior to image capture and mapping) and habitat conditions (density and area) throughout the river. Trend analysis will be performed on all habitat types mapped to assess trend with time and flow at mapping. Trends with time will be analyzed with raw data (habitat count and area by river-mile with time) and with data normalized for flow at mapping where flow is a covariate. Antecedent conditions will be calculated and relationships to habitat abundance compared to previously developed relationships.

One of the following hypothesizes will be addressed for the 2020 data depending upon the hydrologic conditions prior to mapping.

H_{O1} : If the spring runoff is greater than the average runoff, TWA, Island Count and Backwater Type area will be equal to or greater than the areas from the 2019 habitat characteristics (density and area)

H_{O2} : If the spring runoff is equal to the average runoff, TWA, Island Count and Backwater Type area will remain the same compared to the 2019 habitat characteristics (density and area)

H_{O3} : If the spring runoff is less than the average runoff, TWA, Island Count and Backwater Type area will be less than the 2019 habitat characteristics (density and area)

As part of the habitat post processing analysis, backwater and embayments will be divided into several types. These types of backwaters include those associated with main channel point bars and point bars on islands. In addition, backwaters associated with dry secondary channels and dry island split channels will be defined and quantified by river mile (count and area). Recent analysis has resulted in all historical backwater data being reclassified into these categories.

Schedule

Base photography will be acquired in September, 2020 (flow permitting). Frame capture, rectification, and photo-interpretation will be completed by December 2020. Field mapping (verification) will occur as soon as possible following image capture and be completed by the end of September 2020. ARC GIS data transfer will be completed by December 31, 2020. The draft annual report will be completed by March 31, 2021 with the final report due June 1, 2021.

Deliverables

1) Aerial images of the San Juan channel at base flows (500 to 1000 cfs).
2) Polygon area, perimeter and geo-referenced location of backwaters, embayments, islands, and channel margins for each flight
3) Flow at mapping (flight date) for each USGS gage. Distribution and abundance (area and density) of backwaters, embayments and total wetted area in response to antecedent runoff condition and other management actions. Channel complexity (e.g. island count and total wetted area per river mile)
4) Date of mapping
5) Antecedent runoff hydrograph
6) Data summarized by river mile, geomorphic reach and full range
    - An annual draft report prepared and submitted by March 31, 2021
    - A final report submitted by June 1, 2021
    - Attendance at the annual report meeting (2021)

APPENDIX A
Qualifications of Investigators

The project team will be made up of staff from Ecosystems Research Institute, Inc (ERI) ERI has extensive experience on the San Juan River and its tributaries having annually mapping aquatic habitats since 1991. In addition, the principal (Dr. Vincent Lamarra, ERI) has a long-standing presence on the Biology Committee of the SJRIP. Mr. Daniel Lamarra of ERI will be responsible for the field and laboratory habitat portion of the work elements. Mr. Daniel Lamarra has mapped the habitats used by the SJRIP for the last five years, including the RERI Phase I and II channels. That same group of scientists at ERI will be used on this project. This will result in a consistent database between the current project and the historical information gathered by the program.

In addition, these scientists have written numerous reports dealing with habitat quality, habitat and fish interactions as well as the effect of physical factors (temperature) on fish distributions in the San Juan River.

For convenience, ERI will manage the Image acquisition contractor (Keystone Aerial Surveys, Inc)) as part of this project.

APPENDIX B
Budget Summary for 2021 Habitat Monitoring

Budget: 2021 (One Flight)

TASK	Labor	Direct Costs	Total by Task
Contractor Image Capture (Keystone Aeriel Survey)	0	$49,545	$49,545
Task 1 Map Preparation			
Image Clipping and Capture	$2,160	$1,275	$3,435
Task 2 Field Verification			
Habitat and Channel determination	$7,560	$1,184	$8,744
Task 3 Post Process			
Image rectification and overlay	$2,160		$2,160
Digitizing Waters Edge	$19,760		$19,760
Back Water/ Embayment Identification	$9,084		$9,084
Task 4 Final Report and Presentation			
Data Analysis	$25,642	$984	$26,626
Reporting	$18,184	$870	$19,054
Total Cost Estimate	$84,550	$53,858	$138,408

APPENDIX C
Keystone Aerial Surveys (Geomni) Bid Summary
2021 Habitat Monitoring

KEYSTONE
AERIAL SURVEYS, INC.
Northeast Philadelphia Airport • PO Box 21059 • Philadelphia, PA 19114
PHONE (215) 677-3119 • FAX (215) 464-2889

Quotation / Order form

All quotes are valid for 90 days.
Quotes after 90 days are subject to review and adjustments

TO: Daniel Lamarra
Ecosystems Research Institute
1023 W 800 N, Suite 108
Logan, UT 84321
V: 435-760-3071
F:

DATE: 3/11/20
QUOTED BY: John Schmitt
KAS REFERENCE #:

email: info@kasurveys.com or Web: www.kasurveys.com
Please Check here if you would like to receive a credit application

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
		Provide New Aerial Survey of client's area using		
		Vexcel UltraCam UCXp Digital Sensor		
	Location:	San Juan River, UT-CO-NM		
	Details:	60 Flight lines and 924 digital images		$ 35,890.00
	GSD:	10 cm		
	Processing:	Lvl.03		
	Bands:	RGBi		
	Bit depth:	8 bit		
	ABGPS:	Yes		
	IMU:	Yes		
		Delivery Items		
	1	Digital imagery sent on hard drive(s)		
	1	Orthorectied dataset (4-band)		$ 13,655.00
		UTM Zone 12, NAD83 meters		
		Accuracny of the final project will be +-6 meters		
		horizontally from the control imagery		
		Flight: 1st week in September		
		TOTAL:		$ 49,545.00

If Keystone's product/services has an end use for an engineering or architectural services trade or business, performed in the United States by the taxpayer in the ordinary course of such trade or business with respect to the construction of real property in the United States. (IRS Code Section 199).
The location/description of the construction is as follows: _____

SJRIP PIT ANTENNA MAINTENANCE IN THE SAN JUAN RIVER BASIN
2021 Project Proposal

Mark McKinstry, Ph.D. UC-735
Bureau of Reclamation
125 South State Street, Room 8100
Salt Lake City, UT 84138-1147
Phone 801-524-3835
FAX 801-524-5499
mmckinstry@uc.usbr.gov

BACKGROUND:

PIT tags are implanted in various fish species captured through various projects directly supported by the SJRIP or funded through other agencies and projects (CDP&W, BOR, BLM, NMG&FD, and UDWR). Stationary PIT Tag antennas have been installed at various locations in the San Juan River Basin to passively detect fish as they swim above, through, or underneath the antennas. This proposal is to conduct routine maintenance at each site as well as scout new sites for PIT tag antenna development in 2021.

1) Hogback Irrigation Canal and Fish Weir, ~ 20 miles upstream of Shiprock, NM
    a. Seven pass-through antennas are installed at various locations in the Hogback Fish Weir facility.
    b. Five antennas are served by a master controller and bank of batteries in a protected shed at the Hogback Irrigation Site that controls the various gates connected to the fish weir. The master controller is accessed using a Verizon cell data modem.
    c. Two antennas are located approximately 0.5 mi upstream of the fish weir near the canal headgate. These antennas are served by a master controller and bank of batteries (connected to 110 AC power source) located at the antennas. This site is accessed using a Verizon cell data modem.
    d. Six antennas are located in the Hogback Bypass and raft-launch channel that is south of the canal. These antennas are served by the same Master Controller and power source used to operate the antennas at the head of the headgates.

Antennas installed at Hogback Canal are being used in a "design" to give us information on how many, when, where, and how fish use the Hogback canal and fish weir. These antennas have been used under controlled experimental conditions and have given us some good information. If VFD pumps are replaced in the canal we can get good information on how the weir works under more normal operating conditions. Antennas were installed at the canal intake, in the canal downstream of the fish weir, and in the fish bypass that leads back to the river. Under this design, in theory, we can evaluate numbers of fish that enter the intake, numbers of fish that are entrained or bypassed back to the river, direction of fish movement, as well as date and timing of movements.

Antennas installed at Hogback Bypass were installed primarily due to proximity to existing infrastructure and antennas in the Canal portion of the project. These antennas

are not part of a design, but are giving us information on recaptures (i.e., survival), timing of fish movements, and potential information about use of the fish passage right next to it. There were two arrays of antennas installed at this site so, theoretically, movement direction as well as date and time can be evaluated at this bypass. Since this site is protected by a radial gate just upstream that regulates the amount of water than can go through this channel the antennas cannot be flushed out during high water.

2) TNC Restoration Site ~ 20 miles west of Shiprock
    a. Four pass-over antennas are installed in a secondary channel created by restoration activities conducted by TNC.
    b. The four antennas are served by a single master controller and solar energy supplied battery bank on an island created by the restoration activities. The site is accessed using a satellite data modem.

Antennas installed at TNC Restoration site were incorporated as a component of the evaluation of this habitat restoration and were installed in the secondary channel near the downstream mouth. Antennas were not installed as part of a "design" but can be used to provide information on movements of fish, timing, as well as simply increasing total number of detections river wide. There are two arrays of antennas at this site so, theoretically, movement direction can be evaluated. For fish that are detected here there is little more that can be said other than they were present at a certain date and time since there is no comparison being made to main channel sites, control sites, or other restoration sites.

3) McElmo Creek, ~ 25 miles upstream of Bluff, UT
    a. Five pass-over antennas were installed in McElmo Creek approximately 200m upstream of the confluence with the San Juan River.
    b. The antennas are served with a multiplexing antenna controller and the controller is accessed using a Verizon cell data modem.
    c. Four more antennas, along with a master controller and solar panel, were installed at the bridge crossing on McElmo Creek as part of a rehabilitation project for the bridge conducted by Utah Department of Transportation.

Antennas were initially installed in McElmo Creek near the mouth where it joins the San Juan. These antennas were installed as part of a "design" to look at fish movements (all fish) in and out of McElmo Creek. There are two arrays of antennas at this site so movement direction can theoretically be evaluated. These antennas are continuing to function even though they are past their planned lifespan, albeit at a reduced level of effectiveness due to burial by sediment and two of the 5 antennas being flushed away from floods.

McElmo Creek Bridge--These antennas were installed as part of a rework of the bridge abutment and, since the contractor had heavy equipment and was going to be using large rip rap to create a new channel, it was relatively easy and cheap to install a series of antennas. Antennas installed at the McElmo Creek Bridge were not installed as part of a "design", although there are two arrays of antennas, one upstream and the other downstream of the Bridge. Thus, movement direction and ability of fish to swim up the channel can be assessed. Additionally, when combined with antennas approximately 300 yards downstream at the mouth of McElmo, the antennas can be used to assess direction, timing, and movements of fish that come in and out of McElmo Creek.

4) Submersible antennas located near the waterfall on the San Juan River near Goulding, UT.
    a. Submersible antennas are installed at various locations including the Piute Farms Waterfall near Goulding, UT, and Colorado pikeminnow spawning bar near 4-Corners Bridge, CO, UT, AZ, NM.
    b. Additional submersible antennas and batteries are being purchased in 2016 to augment detections at additional sites.

    A single semi-permanent concrete antenna has been installed at the Piute Farms Waterfall downstream of the falls. This antenna was installed as part of a design to determine species, timing, and numbers of fish visiting the Piute Farms Waterfall and which are precluded further movement upstream.

5) Shiprock Bridge Secondary Channel--This site consists of a restored secondary channel that has a concrete inlet at the mouth. We installed a three-array system in October of 2018 as part of the concrete apron, which reduces risk of antennas being destroyed by flooding. Antennas installed here of a three-array system that provides information on species and timing of use, as well as direction of movement in and out of the secondary channel.

Proposed sites:

1) Four-Corners Bridge---The Four-Corners Bridge is being reworked due to erosion of rip rap on the bridge abutment on the upstream side of the north abutment. Antennas could be installed at this site as part of the repair work on the rip rap. River-wide antennas would be ideal but incorporating the antennas into the rip rap at the foot of the bridge is more likely. These antennas would not be part of a "design" but could provide more detections of fish in this portion of the river as well as information on a potential spawning bar for Colorado pikeminnow that may be located just upstream. Since this would not be a multiple-array system the data would only provide information on species, number, and timing of movements.

METHODS:

1) Stationary PIT tag antennas will be contacted periodically to check the settings, download the data, and perform diagnostics of the systems. Sometimes problems arise (batteries drain down due to lack of sun, antennas are washed away, wires are cut) that cannot be solved remotely. In these cases a site visit must be conducted by a technician to repair the system. The SOW and budget include the replacement of one antenna during the work period. If an antenna is not replaced the funding will be used to purchase additional PIT tags or submersible antennas to be used by other biologists.
2) Submersible antennas will be deployed at the waterfall for a continuous period from late February 2021 till August 2021, IF the cement semi-permanent antenna is not working, in an attempt to document fish movements and usage of the river immediately downstream of the waterfall.

TASKS – 2021

1. Maintain and operate stationary and portable PIT tag antennas

2. Replace one PIT tag antenna (location unknown, probably PNM)

FY 2021 BUDGET

O&M of Existing Antenna Systems, Replacement of one Antenna, and Data Management

A) Labor

Position	Salary total/hr	No. persons	Total Hours	Total cost
BOR Technical Representation for Contracts and Agreements	$80.00	1	40	$3,200.00
BioMark or USU Staff (contract)	$80.00	1-2	100	$6,400.00
Total				$9,600.00

B) Travel

Position	Destination	Purpose	Days	Lodging per day/total	Per diem per day/total	Other*
Reclamation Technical representative	Farmington, Shiprock	Project evaluation or field trips	2 trips @ 5 days/trip	$100/$500	$40/$400	$0
BioMark/USU representative	Boise, ID; Kennewick, WA; various	Field trips O&M Antennas	2 trips @ 5 days/trip	$100/$1000	$40/$400	$2500
Total				$1,500.00	$800.00	$2,500.00

*mileage of 5,000 mi at $0.55/mile

C) Equipment

Item	Unit Cost	Number	Total cost
Antenna system	$10,000	1	$10,000
Total			$10,000.00

Budget Summary
FY-2021

Category	**Total**
Labor	$9,600.00
Travel	$4,800.00
Equipment	$10,000.00
Total FY2021 Budget	**$24,400.00**

Projected funding:
FY-2022 $30,000.00
FY2023 40,000.00

Response to comments:

32	*SOW-32-SJRIP Antenna Installation at Hogback Fish Passage*	McKinstry; USBR

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

In the "potential sites" section, there are explanations of why several of the options would be good sites, but not for a couple of them. As the proponents say, these antennas aren't envisioned as part of a "design." We have never regretted having more tag detection data, so I'm all for deploying them, but it would be good to eventually have focused questions that they can help answer. For example, the antenna near the RERI site would provide a good comparison to the one in the secondary channel: what would we do with that info?

What is this SOW's contribution to recovery?

Monitoring—its value to recovery will depend on what use is made of the information produced.

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

Coordination with Ute Mountain Ute Tribe (UMUT) Water Quality Program Re: SOW 32 and 32b to for CWA 404 permitting and 401 certification for in-stream work and site reconnaissance work. Coordination with UMUT would facilitate proper site access to the UMUT Reservation as well as tribal environmental permitting for the projects. Please contact and coordinate activities planned in the San Juan River around the Four Corners Bridge area with Colin Larrick, Water Quality Program Manager clarrick@utemountain.org **Response: We will certainly do this if we are on UMUT lands.**

What is this SOW's contribution to recovery?

Contribute to efforts to track the status and trends of endangered and other fish

populations in the San Juan River and Assess effectiveness of management actions.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

The title is for installation of an antenna at Hogback and the body of the document describes the maintenance at all fixed and mobile antennas. The title should be changed. Please define "bi-weekly" or use a different term since it can mean both every two weeks or twice a week. The SOW seems to be missing some of the document. The current SOW ends at an incomplete sentence on page 137 of the PDF document. There are no deliverables and not reporting listed. A thorough editing, revision and re-submittal is needed for a complete technical evaluation. **Response: I went through and edited the proposal. The installation of antennas at Hogback was approved. The installation of Soft Starts was also approved but will not be completed due to confounding circumstances.**

What is this SOW's contribution to recovery?

Unknown until document is complete and resubmitted.

SJRIP PIT ANTENNA INSTALLATION—VARIOUS LOCATIONS
2021 Project Proposal

Principal Investigators:

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Bureau of Reclamation
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Salt Lake City, UT 84138-1147
Phone 801-524-3835
Cell 801-573-1161
mmckinstry@usbr.gov

BACKGROUND:

PIT tag antennas are used throughout the Colorado Basin to develop various vital rates for endangered fish, including survival, population size, movements and habitat use (Pennock et al. 2020, in press; Stout et al. 2020 a, b, Cathcart et al. 2018 a, b, 2019). Various fish species captured through various projects directly supported by the SJRIP or funded through other agencies and projects (CPW, BOR, BLM, NMGF, and UDWR) are PIT-tagged. Stationary PIT Tag antennae have been installed at various locations in the San Juan River Basin to passively detect fish as they swim above, through, or underneath the antennas (Table 1).

Table 1. Current PIT-tag antenna sites

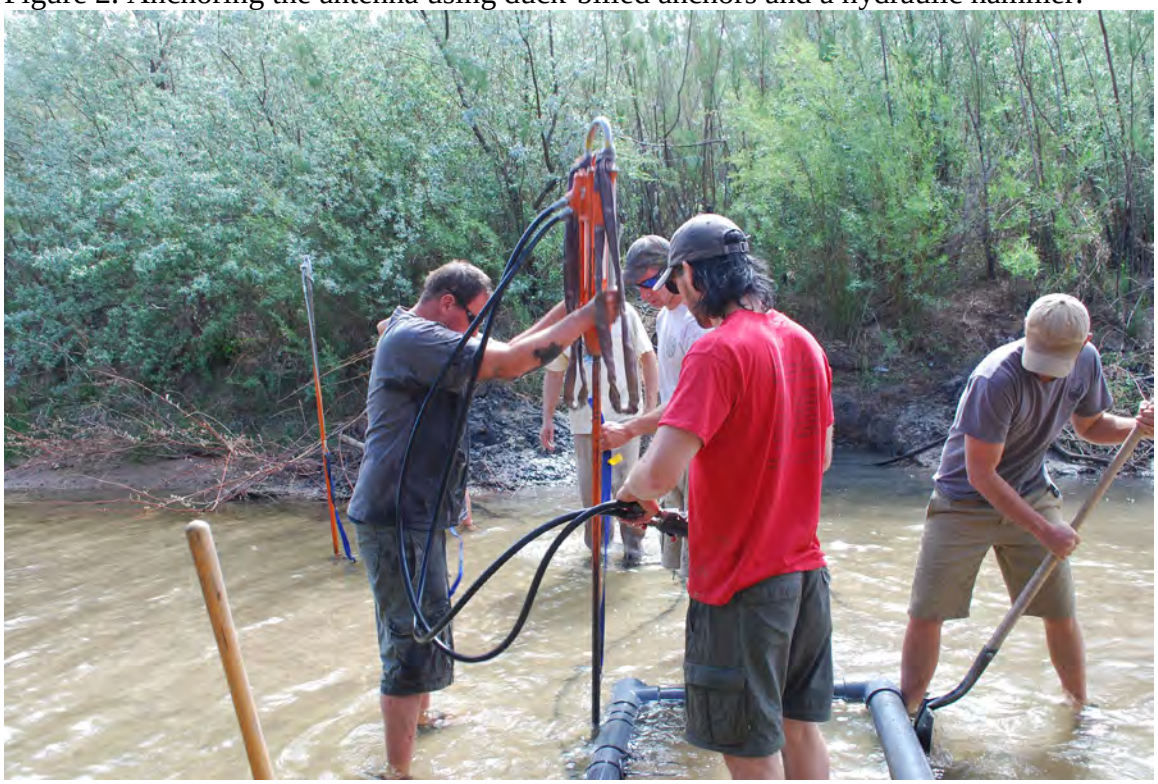
Site	Number of antennas	Number of arrays	River-wide
PNM Fish Passage and Weir	5	5	No, but detect most fish
Hogback Diversion and Fish Weir	6 in SJR 5 in Fish Weir	2 in SJR	No, but will be 9/2020
Shiprock Restored Channel	3	3	No, located on 2^0 channel
RERI/TNC Phase II	4	2	No, located on 2^0 channel
McElmo Creek	9	4	Yes, span McElmo in 4 places
Piute Farms Waterfall	1	1	No

OBJECTIVE:

This SOW proposes to install three more single, pass-over antennae at three additional sites in the San Juan River. Antennae would consist of a single 20-foot HDPE antenna (Figure 1) that would be anchored to the riverbed using duck-bill anchors and a hydraulic hammer (Figure 2). Antennae placement will occur near gravel beds that are stable and submerged at all flows. They will also be placed near bends in the river where most of the flow is typically on one side of the river.

Figure 1. Example of the proposed 20-foot antenna to be installed in San Juan River.

Figure 2. Anchoring the antenna using duck-billed anchors and a hydraulic hammer.



Electronics and power for the antennae would consist of:

- Solar panel with 4 X 115 AH batteries
- IS1001 reader with instream enclosure
- 200’ DOP cable

These antennae would not be part of a "design" but could provide more detections of fish in these sections of the river as well as information on a potential spawning bar for Colorado pikeminnow that may be located in the vicinity of the second antenna. Since this would not be a multiple-array system the data would only provide information on species, number, and timing of movements.

POTENTIAL ANTENNA SITES:

These proposed antenna sites will be evaluated during a river-long reconnaissance trip to evaluate suitability. Suggested antennas sites are:

1) Gravel bar near the RERI/TNC Restoration site. This antenna would serve as a good comparison to the antennae located in the secondary channel (Figure 3)
2) In gravel adjacent to the bank near the “Powerline takeout” (Figure 4) .

3) In large backwater or secondary channel, depending on flows approximately 1 km upstream of the 4-Corners Bridge (Figure 5). This location is near a potential Colorado pikeminnow spawning bar.
4) The bend just above Slickhorn Canyon (Figure 6). This is a potential Razorback Sucker spawning bar.
5) Somewhere between Montezuma Creek and Butler Wash (No site has been identified).

Figure 3. Potential PIT-tag antenna locations near RERI/TNC Restoration site.

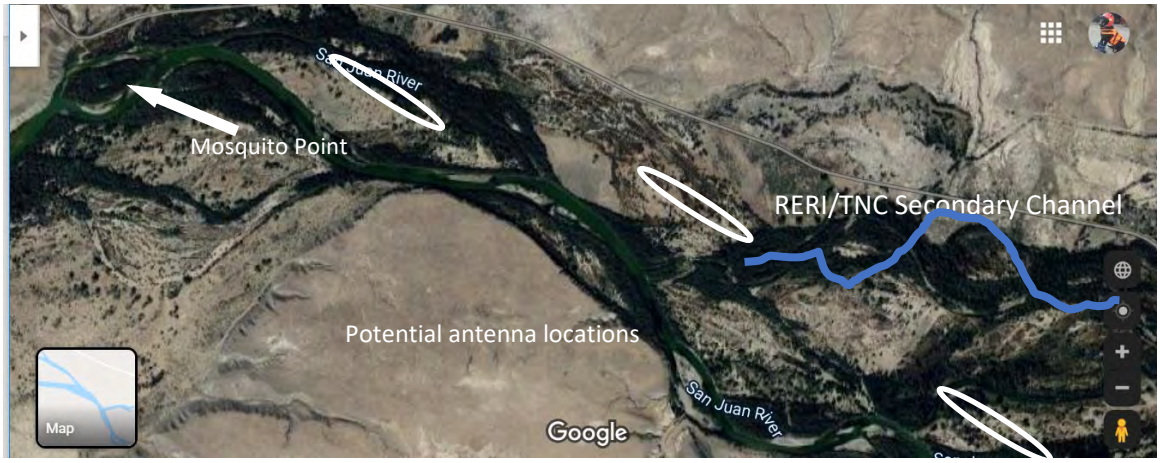
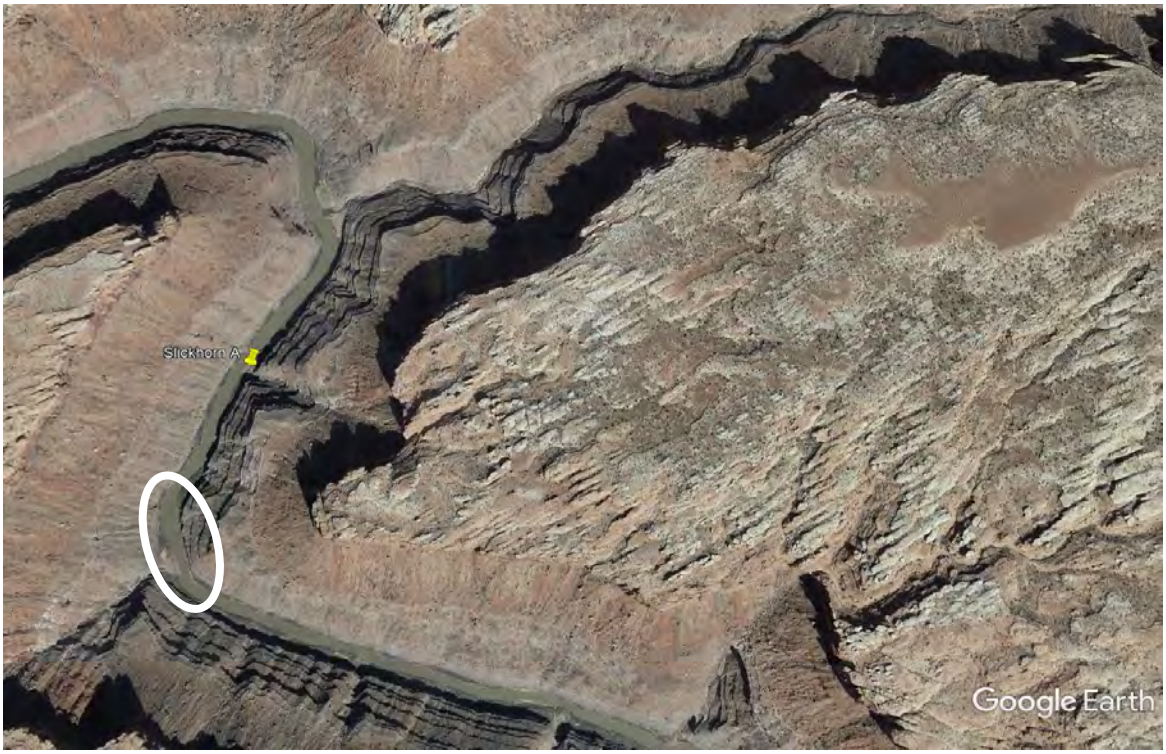


Figure 4. Potential PIT-tag antenna site near Powerline access point.

Figure 5. Potential PIT-tag antenna site near Four-Corners Bridge.

Figure 6. Potential PIT-tag antenna site above Slickhorn Camp A.



METHODS:

1) Antennas will be installed using hydraulic hammers and electronics will be placed in a small job box with a single solar panel and battery to power the system.
2) Antennae will be checked at least twice yearly and downloaded. Data will be uploaded to STReaMS database for use by other researchers.

Evaluation

The evaluation of the data that comes from these antennas is beyond the scope of this work. Pit tag detections are used in many projects and have been used to assess survival (Durst et al.), movements (Cathcart et al. 2018a, b, 2019, Pennock et al., 2020, in press) and population size (Stout et al. 2020). This data would be used in similar analyses and evaluations.

TASKS – 2021

1. Conduct reconnaissance trip to identify specific locations for antennae
2. Conduct 1-3 field trips to install antennas using vehicle or boat access.

FY 2021 BUDGET - $96,019.56

Budget is for UDWR employee. All other costs are contract costs for Biomark. See quote attached.

FY 2021 Draft Budget
San Juan River PIT Antenna Installation
Utah Division of Wildlife Resources

Submitted by Katie Creighton and Zach Ahrens
katherinecreighton@utah.gov, zachahrens@utah.gov
435.259.3780, 435.259.3783

2021 Costs for UDWR- Moab

San Juan River PIT Atnenna Installation

Task 1. Antenna Installation (2 trips x 7 days x 2 people (only one on first trip)

Labor: salary + benefits + applicable overtime

	Rate	Hours	Cost
Project Leader	$38.10	0	$0
Biologist	$33.91	200	$6,781
Technician	$17.08	100	$1,708
		subtotal	**$8,489**

Food and Transport

	Rate	Quantity	Cost
Monthly fleet rental (1 truck)	$199.37	1	$199
Mileage (1 truck x 500 miles x 2 trips)	$0.40	1000	$400
Food (5 days/trip)	$35.00	15	$525
Out-of-state Per Diem (2 days/trip)	$46.00	6	$276
Hotel (2 nights/trip)	$105.00	6	$630
Shuttle (Mexican-Clay Hills)	$180.00	2	$360
		subtotal	**$2,030**

Equipment

	Rate	Quantity	Cost
Camping gear repair/replacement:			$250
Sampling gear repair/replacement:			$0
Boating gear repair/replacement:			$750
		subtotal	**$1,000**

Task 1 Subtotal:	**$11,520**

Task 2. Site selection, project coordination, reporting

Labor: salary + benefits + applicable overtime

	Rate	Hours	Cost

Project Leader	$38.10	10	$381
Biologist	$33.91	40	$1,356
Technician	$17.08	0	$0
		subtotal	**$1,737**

Total Expenses	**$13,257**
Administrative Overhead (16% on all personnel services)	**$1,636.26**
UDWR-Moab Total	**$14,893**

Budget Summary

Biomark
SPECIALISTS IN IDENTIFICATION SOLUTIONS

705 S. 8th St.
Boise, ID 83702
PHONE: (208) 275-0011
FAX: (208) 275-0031

SUMMARY	Subtotal	Grand Total	Cumulative Total
Phase 1: Site Visit	$8,513	$8,513	$8,513
Phase 2: System Test	$43,864	$43,864	$52,376
Phase 3: Installation	$28,751	$28,751	$81,127
Phase 4: O&M	$0	$0	$81,127
TOTAL	**$81,126.56**		

SUMMARY (all Phases)

Labor		Hours	Rate	Subtotal
(1) Project Manager	00410	33.8625	$165.00	$5,587
(2) Chief Scientist		0	$141.00	$0
(3) Senior Scientist		0	$127.00	$0
(4) Scientist (Biology)		0	$91.00	$0
(5) Fisheries Specialist	00390	10.75	$99.00	$1,064
(6) Technician (Biology)		0	$64.00	$0
(7) Typist/Clerical		0	$64.00	$0
(8) Electronic Technician	00380	215	$113.00	$24,295
(9) Senior Electronic Eng.		0	$154.00	$0
Labor Total		259.6125		**$30,946.56**

Nonlabor		
Travel	00470	$6,500
Equipment		$43,680
Nonlabor Total		**$50,180.00**

Total	**$81,126.56**

Literature Cited

Cathcart, C.N., M.C. McKinstry, and P.D. MacKinnon. 2019. A tribute to tributaries: endangered fish distributions within critical habitat of the San Juan River, USA. North American Journal of Fisheries Management.

Cathcart, C.N., C.A. Pennock, C.A. Cheek, M.C. McKinstry, P.D. MacKinnon, M.M. Conner, and K.B. Gido. 2018a. Waterfall formation at a desert river-reservoir delta isolates endangered fishes. River Research and Applications 2018: 1-9.

Cathcart, C.N., K.B. Gido, M.C. McKinstry, and P.D. MacKinnon. 2018b. Patterns of fish movement at a desert river confluence. Ecology of Freshwater Fish 27:492-505.

Pennock, C.A. M.C. McKinstry, C.N. Cathcart, K.B. Gido, T.A. Francis, B.A. Hines, P.D. MacKinnon, S.C. Hedden, E.I. Gilbert, C.A. Cheek, D.W. Speas, K. Creighton, D. S. Elverud, and B. J. Schleicher. In Press. Movements of imperiled fish in novel ecosystems: River-reservoir exchanges by razorback sucker and experimental translocations to aid conservation. Aquatic Conservation

Stout, J.B., M. Conner, P. Budy, P. Mackinnon, and M. McKinstry. In Press. Keeping it classy: Differentiating between live fish and ghost tags detected with a mobile PIT tag interrogation system using an innovative analytical approach. Canadian Journal of Fisheries and Aquatic Sciences

Stout, J.B., M. Conner, P. Budy, P. Mackinnon, and M. McKinstry. (2019). We ain’t afraid of no ghosts: Tracking habitat interactions and movement dynamics of ghost tags under differing flow conditions in a sand bed river. North American Journal of Fisheries Management

Response to comments

Scope #	Project	PI(s)
32b	*SOW-32b-SRJIP Antenna Installation – Various Locations*	Hines; UDWR McKinstry; USBR

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

Specific details could be included on the types of statistical models to analyze the data this project will collect, and a description of the estimable parameters for the various model types (i.e. robust design models to estimate capture probability, annual survival and abundance; multi-state models to estimate annual survival and immigration, etc) **Response: Analysis by the Program Office and other PIs on other projects will use this data.**

What is this SOW's contribution to recovery?

This SOW provides a method to collect important data in a non-invasive and inexpensive manner. This work is especially important considering that it will allow the evaluation of recovery goals post 2023.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

I have been an advocate for this proposal for some time and I am supportive of this project. However, the logic for the placement of the smaller antenna needs to be clearly stated. Are we just interested in local comparisons (for example, in the main channel near the Phase II secondary array) or should we be looking at a river-wide comparison of data? I also feel that a data analysis component needs be added this proposal that rather than just placing the data in STREAMS. In addition, only twice a year downloads may not be enough. The site near RM 17 will be problematic, it maybe be safer below Slickhorn where current and gradient is lower. **Response: Analyses of data derived from these antennas will be analyzed under other SOWs. This is outside the scope of this SOW. Antenna locations were only suggestions. We may move some of them depending on logistics.**

What is this SOW's contribution to recovery?

No comment

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

Due to the nature of the installs I understand why a more specific study design is hard to pin down. Some contingency for equipment repair/replacement/maintenance/Data analysis is hopefully considered if these

systems are required to perform for any duration of time. **Response: O&M is covered under another SOW.**

What is this SOW's contribution to recovery?

It appears as the program moves toward 2023 and novel stocking/tagging techniques of Colorado Pikeminnow these arrays could provide useful information for *minimal* investment. I recall that we had fairly certain information that there were limited "missing fish" from analysis S. Durst and/or the PO has presented, so more arrays might not gain us as much as we hope?

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

The objective as stated is a more a description of the work than what is expected from the installations. There should be an hypothesis for the SOW. If the only objective is to put more antennas in the river it is lacking in contribution to the Program. There should be an associated data analysis with this project. There should be an objective that states why the antennas are being installed and how the data collected would be evaluated. Colorado Pikeminnow move locally during summer and fall post spawning to feed in or near riffles. A location that is near a riffle may provide additional data on both long range movement in combination with other antennas and local movement post-spawning. **Response: Data analyses is outside the scope of this SOW. Data will be analyzed under other projects just like antenna data from other locations are used. We would like to install an antenna near a suspected COPM spawning site by 4-Corners Bridge.**

What is this SOW's contribution to recovery?

The use of passive remote sensing could provide data on fish presence/numbers in place of some of the future active monitoring. This SOW could provide data to evaluate the use of this type of monitoring for a wider range of the river.

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

I like the idea of putting these semi-permanent antennas in. My concern is in location, with ease of shore access for PIs means ease of shore access for vandalism. Figure 4 is a great location however it is a high traffic area for locals and is also shifting sand and large rocks. Figure 5 is another great location where many RBS and CPM have been captured however the substrate is silt and at times over waste deep (personal experience). Site visits are planned in the SOW and that could alleviate my concerns with locations. Also, CDOT was going to add an antennas to the 4 Corners Bridge as part of their mitigation for fixing some erosion issues on the upstream river right bank, which is in close proximity of this proposed site. **Response: Antenna locations were only suggestions. We may move some of them depending on logistics.**

What is this SOW's contribution to recovery?

While I don't believe there is a direct contribution to recovery, and there is no specific question that is trying to be answered (as stated in the SOW) this information can be helpful with larger data synthesis reports, survival estimates, strategical timing of trips, etc…

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

This SOW would benefit by placing the need for three additional PIT antennae within the context of our existing antennae system and describing in additional detail what new information they will gather. Do the benefits of these three sites outweigh the need identified at recent Biology Committee meetings for several cross-channel arrays throughout the system? Also, what criteria will be used to select the three best of the possible five sites listed. Before adding more antennae, I think the Program would benefit from a bit of longer-term system-wide planning for determining the best direction for our PIT tag efforts.
Response: Antenna locations were only suggestions. We may move some of them depending on logistics. We agree a bigger look at antenna systems and data is good, but we proposed this in response to a request by the committee to install more antennas. Full river-wide antennas would be good, but they are expensive and difficult to install. This seems like a good compromise and could give us good information on fish survival and movements.

What is this SOW's contribution to recovery?

While almost all PIT tag information can be helpful for informing us regarding fish survival, movements and habitat use, I think some additional thought is needed here before we commit to additional antennae installation.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

This SOW I simple and technically sound.

Improvements can be made to inform the reader on the abilities of the proposed equipment (e.g. antennae read range, estimated upkeep costs, etc.), what has been accomplished with the antennae already in place, and what is the best-case scenario for the use of the data that will be collected.

Some additional site locations to consider include (1) within or at the mouth of an irrigation diversion that is most suspect of entraining endangered fishes, and (2) at the upstream mouth of the lower canyon near Mexican Hat. An antenna

located at an irrigation diversion could provide valuable information on a potentially significant source of mortality, especially considering what has been observed in the Upper Colorado River Basin. An antenna placed at the mouth of the lower canyon could provide valuable information on seasonal movements of Colorado Pikeminnow. These seems even more pertinent now that it appears that wild fish from the 2016 cohort appeared to remain in the lower canyon and move upstream in the summer. **Response: Antenna locations were only suggestions. We may move some of them depending on logistics.**

Given the five potential locations in the SOW and my two additional locations, I would suggest placing antennas at (1) Mexican Hat, (2) 4-Corners Bridge, and (3) RERI/TNC Restoration Site. **Response: Antenna locations were only suggestions. We may move some of them depending on logistics.**

What is this SOW's contribution to recovery?

PIT tag antennas installed at several limited locations in the San Juan River basin have provided an amazing amount of data. However, apart from assessing the efficacy of the PNM fish weir, I am unsure how all of this data is being used. Without a "design" or any idea of how the data will be used, it is difficult to assess how much benefit these additional antennas will be. I am in favor of installing these antennas, but the Program needs to begin assessing how all of this data can be used for the benefit of recovery. Until the Program demonstrates their worth, installation and O&M costs will always be in question.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

The SOW is to install three more single, pass-over antennas at three sites in the San Juan River to the array of PIT antennas in the system. The proponents state that "these antennae would not be part of a 'design' but could provide more detections of fish in these sections of the river as well as information on a potential spawning bar for Colorado pikeminnow that may be located in the vicinity of the second antenna." PIT tagging efforts in the SJR system lack of an overall experimental design. Definition of system-wide goals and objectives for PIT tagging work along with an overall experimental design and protocols for data storage and analyses are needed. PIT-tagging efforts and locations of antennas appear to be piece meal and without direction or project-wide organization. **Response: We agree a bigger look at antenna systems and design, as well as the data, is good, but we proposed this in response to a request by the committee to install more antennas. This seems like a good compromise and could give us good information on fish survival and movements.**

What is this SOW's contribution to recovery?

PIT data can provide valuable insights into movement patterns and demographics of the endangered species that may inform decision regarding the recovery of the species.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

I have no suggestions for improvement, and I hope this can get done.

Minor typos (highlighted text)

What is this SOW's contribution to recovery?

Detecting endangered fish (multiple hits over time) and monitoring local and long distance movements contribute to survival estimates and potential location of spawning location, both of which have allowed the Program important information about recovery. I strongly support the installation of these antennas. I wish we could go riverwide.

Program Office

How can the technical aspects of this SOW be improved?

- Provide a river-wide map of current and proposed locations.
- What are pros and cons of each site?
- What is the expected question that installing an antenna at each site would answer?
- What would be used to determine which 3 of these 5 sites would be chosen for installation?
- Wasn't the idea for another river-spanning system? Are any of these installations going to provide that?

Wasn't another idea to get more down-river detections and are any of these locations going to provide that? **Response: Antenna locations were only suggestions. We may move some of them depending on logistics. We will work with PO to determine answers to these questions.**

What is this SOW's contribution to recovery?

PIT tag antennas can help reduce the need to capture and handle individuals, which could directly reduce mortality rates. Antenna information could be used to increase population estimates and clarify seasonal movements that could inform identification of important spawning areas and causes of mortality (i.e., Colorado Pikeminnow movement over the waterfall).

FY 2021 Reclamation Program Management

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Relationship to SJRIP: Supports Program goals and management by supporting approved activities

Study Goals, Objectives, and End Product: Program Management funds support Reclamation staff involved in program management. Funds are used for the administration of funding agreements, including issuing requisitions for program supplies, and the preparation and oversight of work conducted under interagency agreements, cooperative agreements, contracts, and grants. The funds are also used for formation and participation of the technical and peer-review committees, implementation of committee assignments not specifically identified in a scope of work, reporting, and coordination of water operations. Management support for Capital fund projects, including technical oversight, budgeting, preparation of bids and funding agreements is covered in a separate scope of work. Participation in Hydrology and Biology Committee meetings and business is paid for separately by Reclamation with funds unrelated to the SJRIP.

Task Description and Schedule

Task 1: Manage and administer funding for Recovery Program projects related to the Biology Committee activities. Funding Recovery Program projects requires establishment or modification of approximately 20—30 Reclamation funding agreements or contracts each year. Each financial agreement requires multiple steps and activities, including: submission of requests for Federal assistance for Recovery Program-approved projects; working with Recovery Program's office on funding issues; reviewing and approving (if warranted) project budgets; writing SOWs for RFPs, requesting obligations to cover funding agreement or contract awards; awarding agreements or contract funding to recipients; maintaining agreement and contract filing system including agreement instruments, invoices, and accruals; reviewing and tracking budgets; participating in audits; reviewing and approving invoices; performing periodic site visits to monitor project performance and progress; filing advanced procurement reports; organizing and participating on TPECs; drafting requests for proposals (RFPs); evaluating proposals and awarding contracts; performing agreement closeouts; answering agreement inquiries from auditors, assistance recipients, and the Recovery Program; recording project performance and status of deliverables; and filing recipient performance reports.

Deliverables/Due Dates: Requests from the Recovery Program for funding are processed as

they are received. Other deadlines for committee activities are set by the Recovery Program participants during the development of the annual workplan.

Budget FY2021

Task 1: Biology Committee Annual Funding Administration

A) Labor

Position	Salary total/hr	No. persons	Total Hours	Total cost
Reclamation Contract Manager	$120.00	1	20	$2,400.00
Biology Committee Technical Representation for Contracts and Agreements*	$90.00	1	700	$63,000.00
Lead Contract Officer	$120.00	1	80	$9,600.00
Contract Specialist	$70.00	1	1000	$70,000.00
Contract and agreement Auditor	$120.00	1	100	$12,000.00
Agreement specialist	$55.00	2	1000	$55,000.00
Total				$212,000.00

** Funding for Reclamation to participate in the Biology Committee is funded by Reclamation and not the SJRIP.*

B) Travel

Position	Destination	Purpose	Days	Lodging per day/total	Per diem per day/total	Other*	Airfare total	Total
Reclamation Technical representative	Farmington, Durango, or Albuquerque	Contract support for CC meetings, program funding meetings	3 trips @ 2 days/trip	$100/$600	$50/$300	$400	$2,500	$3,800.00
Reclamation Technical representative	Farmington	Project evaluation or field trips	2 trips @ 6 days/trip	$100/600	$50/$300	$400	$2,000	$3,300.00
Reclamation Technical representative	Boise, ID; Kennewick, WA; various	Contract administration with suppliers	2 trips @ 3 days/trip	$100/$300	$50/$300	$400	$1,000	$2000.00
Lead agreement officer	Farmington, Durango	CC/BC mtg., or contract admin	1 trips @ 2 days	$100/$200	$50/$200	$100	$2,000	$1,500.00
Lead contract officer	Various locations	Contract Admin	1 trip @ 2 days	$125	$65/$130	$100	$300	$655.00
Total								$11,255.00

*Taxi $20; Parking $10; Rental car $100/trip

Budget Summary
FY-2021

Total labor	$212,000.00
Total travel	$11,255.00
Grand total	**$223,255.00**[1]

[1] **This total budget represents a 0% increase over the FY2020 Budget.**

Peer Review for 2021
Fiscal Year 2021 Project Proposal

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Background:

A Peer Review Panel was established in 1997 to assist the SJRIP with planning studies, analytical designs, data interpretation, and aiding the Program's use of science towards the process of recovery. The members of the Panel participated in meetings and reviewed pre-draft, draft, and final scopes of work, work plans, reports, integration analyses and reports, and other Program documents. However, the responsibilities of individual peer reviewers were generally unclear, leading to some unsatisfied individuals in the Program as well as peer reviewers themselves. This Scope of Work (SOW) aims to improve the Program's peer review process by refining and guiding the responsibilities of the Panel members to maximize the benefits to the Program while decreasing the ambiguity of peer reviewer expectations.

Goals:

The main goal of peer review in the SJRIP should be to use the professional expertise of panel members to improve the Program's scientific operations, particularly on technical and biological issues. Indeed, peer reviewers are invited to join the Program based on their reputations in their respective fields of study. Therefore, we developed this SOW to capitalize on the use of peer review to aid in guiding and defending management decisions made by the Program. Furthermore, we have incorporated new aspects of the peer review process that are aimed at encouraging candid reviews without the fear of personal/social reprisals as well as to increase transparency of contributions of individual peer reviewers to the Program Office (Program Office). The peer reviewers will contribute to three major components of the Program detailed below and we have noted expectations and responsibilities for each:

1) Review annual SOWs

Annual SOWs by Program PIs are due to the Program Office by 31 March of each year. After the Program Office receives SOWs, each peer reviewer will review a list of SOWs assigned by the Program Office (n=5-15). SOWs will be assigned such that each scope's topic aligns with each reviewer's expertise (as much as possible) and each SOW will receive at least two independent

reviews (as well as comments from the Program Office). Reviews will then be due back to the Program Office by 30 April. If reviewers don't want to remain anonymous, they will need to indicate that on individual reviews sent to the Program Office.

The Program Office would like to see reviews as succinct as possible (i.e., ≤ 1 page reviews will be acceptable) and do not necessarily want to read through track changes on word documents (blind track changes can be delivered to the PIs through the Program Office but will not be required for the review). Blind reviewer comments will then be compiled by the Program Office and disseminated to the BC and PIs. The PIs will then be required to respond to peer reviewer and Program Office comments and append those to their respective SOW before they will be considered in the annual work plan.

2) Attend the November/December meeting and review 2021 work

The November/December BC meeting consists largely of discussions of the previous year's activities conducted by the PIs and proposed future projects. This meeting is for the group to catch up on progress on individual projects in a relatively short period of time. As a result of the discussion of the previous year's work, the group then discusses potential changes in projects and potential projects and studies that could improve recovery actions and progress.

Each peer reviewer will evaluate the presentations and discussion and provide verbal comments on the individual recovery actions and send them to the Program Office by 31 December. These comments should focus on implications of the work toward recovery of the two fish species.

3**) Attend and review presentations during the February meeting**

The February BC meeting consists largely of presentations of the previous year's activities conducted by the PIs. This is a great opportunity for the group as a whole to catch up on progress on individual projects in a relatively short period of time. Moreover, these presentations should reflect comments supplied by peer reviewers in original SOWs and they are often rough drafts of how data will be analyzed and interpreted in the final reports.

Each peer reviewer will make blind comments on individual presentations (a list of presentations will be provided by the Program Office) and send them to the Program Office by 31 March. These comments should focus on data analysis, presentation, and interpretation but other general comments will be welcomed. The Program Office will then compile the reviewer comments and distribute them to the BC and individual PIs. These written comments to the Program Office will not preclude any questions or comments the peer reviewers want to make orally during the meeting.

An additional meeting (half day) will occur at the end of the February BC meeting among the Program Office, BOR staff and peer reviewers to discuss 'big picture' issues in the Program, progress toward recovery, and other concerns with individual projects or the peer review process. The peer reviewers will then draft a summary of their independent reviews of the Program's progress towards recovery as well as general suggestions for improvement and send them to the Program Office by 31 March.

3) Attend workshops/review special documents (upon invitation)

Workshops are occasionally held to address specific issues that arise during Program operations. These meetings usually occur over 2-3 day periods in Albuquerque, Farmington, or Durango. Some/all peer reviewers may be invited to attend workshops to provide professional and technical guidance. If a peer reviewer is invited, they will be required to provide a review of the workshop and their general opinion on discussions. The same review requirements as 1) and 2) above will apply to any special documents the Program Office asks to be reviewed. In FY 2021 one workshop is anticipated.

Rotating personnel:

The peer review process should benefit from the diverse experiences and expertise of individual reviewers. In this light, individual peer reviewers will be kept on the panel for 3-5 years and then required to take at least a 3-5 year hiatus to allow for new reviewers to join the panel. The exact timing of rotation of individuals from and onto the peer-review panel will be handled at the discretion of the Program Office and BOR.

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Budget FY-2021:

Payment for serving on the Peer Review Panel includes expenses for travel to and from the meeting, and an hourly rate for services. It is anticipated that Panel Members will spend approximately 15-20 days each in 2021 (includes travel, meetings, and document review).

The total budget is distributed among the four peer reviewers through individual Services Contracts with Reclamation.

Salaries:	$20,000
Travel:	$10,000
Total	**$30,000**

Future use of the Peer Review Panel is not known but they likely will be used each year to provide guidance to the Biology Committee.

San Juan River Recovery Implementation Program
Program Coordinator's Office
Fiscal Year 2021 Draft Proposal

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Cooperative Agreement #: R18PG0002
Period of Performance: 10/01/2020 to 9/30/2021

Background

The San Juan River Recovery Implementation Program (Program) is designed to simultaneously address endangered fish species recovery and development of water resources within the Basin. The Program includes representatives from not only Federal agencies, but also the States of Colorado and New Mexico, the Jicarilla Apache Nation, the Southern Ute Indian Tribe, the Ute Mountain Ute Tribe, the Navajo Nation, conservation interests, and water development interests, most of which have legally mandated responsibilities to the endangered fish and/or the water resources.

Region 2 of the U.S. Fish and Wildlife Service (Service) is responsible for directing and coordinating the Program. As stated in the Program Document, the Service will appoint a Program Coordinator who will be responsible for overall Program coordination and dissemination of information about Program activities. Element 5, *Program Coordination and Assessment of Progress toward Recovery*, of the Program's Long Range Plan (LRP) identifies Program coordination goals, actions, and tasks that the Program Office will undertake to administer the Program. Numerous additional Program Office tasks are included in the LRP under other Recovery Elements. The Service's Program Office is located in the New Mexico Ecological Services Office (NMESFO) in Albuquerque, NM. Program staff includes a Program Coordinator, Assistant Program Coordinator, Science Coordinator, Program Biologist, and a part-time Program Assistant.[1]

Program Coordination

The Service is responsible for coordinating the Program. To accomplish this responsibility, the Service will appoint a Program Coordinator for the Program. The Program Coordinator is responsible for overall Program coordination and the dissemination of information about Program activities. Specific Service responsibilities for Program coordination are described in the July 23, 2018 Program Document. An overview of these responsibilities includes:

- Coordinating all activities of the Program, its Coordination Committee and technical committees.
- Developing annual work plans consistent with Service-approved Recovery Plans and the Program's Long Range Plan.
- Conducting section 7 consultations and ensuring recovery actions identified in biological opinions are implemented to benefit Colorado Pikeminnow and Razorback Sucker.
- Maintaining the Program's data, providing technical assistance as requested and conducting analyses to inform science-based decision-making within the Program.
- Coordination with Upper Colorado River Endangered Fish Recovery Program on range-wide recovery issues.

It is recognized in the Program Document that some of these responsibilities will be carried out with the assistance from Program committees as more specifically defined in the Program Document sections entitled, "Biology

[1] The Program Office includes an additional Program Biologist who is funded through the Four Corners Power Plant and Navajo Mine Energy Project Mitigation Account although travel for that position is included herein (nathan_franssen@fws.gov; 505-761-4722).

Committee," "Long Range Plan Development and Annual Revision Process," and "Annual Work Plan Development Process" of the Program Document.

Fiscal Year 2021 Program Management Budget	USFWS Funding	Program Base Funding
Personnel/Labor Costs (Federal Salary + Benefits):		
Program Coordinator (GS-13) 520/1560 hours@ $61.41/hr	$34,039	$102,118
Asst. Program Coordinator (GS-12) 1560/520 hours@ $56.96/hr	$77,797	$25,932
Recovery Science Biologist (GS-12) 0/2080 @ $53.41/hr	$0	$120,203
Program Biologist (GS-9/11) 1560/520 hours @ 42.59/hr	$70,418	$23,473
Program Assistant (GS-7) 416/416 hours @ 26.01/hr	$11,041	$11,041
Personnel Sub-total	**$193,295**	**$282,767**
Travel/Lodging & Per Diem (based on published FY-2019 Federal Per Diem Rates):		
Hotel – 25 days in Farmington, NM @ $94/night		$2,350
Hotel – 40 days in Durango, CO @ $121/night		$4,840
Hotel – 16 days in Denver, CO @ $181/night		$2,896
Hotel - 3 days in St. George, UT @ $94/night		$282
Hotel – 8 days in Las Vegas, NV @ $108/night		$864
Per Diem – 25 days in Farmington, NM @ $55		$1,375
Per Diem – 40 days in Durango, CO @ $71		$2,840
Per Diem – 16 days in Denver, CO @ $76		$1,216
Per Diem - 3 days in St. George, UT @ $55		$165
Per Diem – 8 days in Las Vegas, NV @ $61		$488
Per Diem – 30 days camping @ $29 night		$870
Airfare to Denver, CO - $250 trip/9 trips		$2,250
Airfare to Las Vegas, NV - $300 trip/2 trips		$600
Airfare to St. George, UT - $800/1 trip		$800
Rental Car @ $60/day*12 days		$720
Travel/Lodging & Pier Diem Subtotal	**$0**	**$22,556**
Materials, Supplies, and Services:		
Registration Fee – UT Water Users Workshop, St. George, UT *1		$300
Registration Fee CRWUA, Las Vegas $250 *2		$500
Vehicle Fuel - Mileage to Farmington - 20 rd. trips@254 mi/trip; 18 mpg; $3.00/gal		$846
Vehicle Fuel - Mileage to Durango - 10 rd trips@418 mi/trip, 18 mpg; $3.00/gal		$687
Vehicle Fuel - Misc trips in the SJR Basin - 10 rd trips@500 mi/trip; 18 mpg; $3.00/gal		$833
Materials, Supplies, and Services Sub-Total	**$0**	**$3,166**
Equipment:		
Supplies		$1,761
Public Notices in Local Newspapers; $40-150/meeting@ 5 meetings		$750
Office Telephone support (1/4 of total office costs)		$4,000
Printing/Copier Support		$1,749

Computer Hardware/Software (e.g., upgrades, models, database mgt., license fees)		$2,000
Outreach Materials/Publication Costs		$2,500
Equipment and Supplies Sub-total	**$0**	**$12,760**
Facilities Rental Costs for Meetings:		
Farmington@ $100/5 days		$500
Durango @$300/15 days		$4,500
Facilities Rental Sub-Total	**$0**	**$5,000**
2021 Budget Subtotal	**$193,295**	**$326,249**
Administrative charge (3%)		**$9,787**
FY2021 Total	**$193,295**	**$336,037**

Remote Biologist for San Juan River Basin Recovery Implementation Program

Principal Investigators:
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and

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History

The San Juan River Basin Recovery Implementation Program's (SJRIP) mission is to recover the Colorado Pikeminnow and Razorback Sucker while allowing water development and management activities to continue in the San Juan River Basin. In pursuit of this mission, the SJRIP funds projects under six major program elements: management and augmentation of populations and protection of genetic integrity; protection, management, and augmentation of habitat; management and control of nonnative aquatic species; monitoring and evaluation of fish and habitat in support of recovery actions; program coordination and assessment of progress toward recovery; and, information and outreach. Principal investigators representing various federal and state agencies, tribal governments, and non-governmental organizations are contracted to perform tasks associated with the SJRIP's mission. Most of these entities reside outside of the basin and, as a consequence, extensive travel costs are incurred to complete this work.

Beginning in 2008, the U.S. Fish and Wildlife Service's (USFWS) New Mexico Fish and Wildlife Conservation Office (NMFWCO) filled a remote biologist position that was stationed in the Farmington, New Mexico area. This position focused primarily on endangered fish monitoring, nonnative fish control, and rare fish augmentation. Additionally, assistance was provided to the Navajo Nation Department of Fish and Wildlife (NNDFW) with daily operations at a selective fish passage near Fruitland, New Mexico, and with daily operation/maintenance at the Navajo Agricultural Products Industry (NAPI) Razorback Sucker grow-out ponds. Due to the proximity of the duty station to the Four Corners Area, the remote biologist was available to assist other SJRIP partners by shuttling support vehicles and providing reconnaissance prior to the initiation of sampling trips. In addition, the remote biologist provided urgent assistance to all SJPRIP partners in cases of emergency (i.e. equipment issues/loss, injury, Gold King mine spill, etc.). In January 2016 the individual filling this position retired, and the position remained vacant until August 2018.

Background

The following scope of work outlines the expected duties of the remote biologist for FY 2021. Proposed activities are similar to those described in the FY 2020 remote biologist scope of work. The remote

biologist will have responsibilities on the following Scopes of Work. Scopes of Work a, b, c, d and g will be considered full time in that these will require the biologist to assist with all parts of the project. Scopes of Work e and f will be part time in that they will require support by the biologist, but are not primary or full time work.

Scope of Work (a) Seasonal non-native channel catfish removal *(SOW 17)*. The remote biologist will work on all field trips and field trip preparation, as well as managing the data generated by the project.
Scope of Work (b) Secondary channel habitat maintenance project (SOW 42). The remote biologist will provide field support for this project.
Scope of Work (c) Native fish demographic monitoring and research led by USFWS Grand Junction Fish and Wildlife Conservation (GJFWCO), Utah Division of Wildlife Resources (UDWR), and NMFWCO (SOW 19-b). The remote biologist will work all demographic trips, if other personnel are available then the remote biologist can be freed to do other work.
Scope of Work (d) The remote biologist will assist NNDFW with daily operation/maintenance at NAPI rearing ponds, and provide support with operation and maintenance of permanent and portable PIT antennas throughout the San Juan Basin (SOW 11).
Scope of Work (e, and f) The remote biologist will assist as needed with coordinating annual endangered fish stocking events with other SJRIP participants at the Horsethief ponds, and at Southwest Native ARRC rearing (SOW 8, 9 and 10).
Scope of Work (g) Once completed, the remote biologist will provide support for operation and water quality monitoring of facilities and fish monitoring at the Phase III restoration site. The time commitment for this project is outlined in the Phase III SOW (NEW-3).

The remote biologist will have the flexibility to assist, as needed, with other projects as directed by the Program Office and with the supervisor's approval. We anticipate that the Remote Biologist will assist with larval and small-bodied fish assemblage monitoring, shuttling of vehicles and equipment, data analysis, etc, but the position may work other assignments. If other personnel are available to cover NMFWCO's responsibilities on projects then the remote biologist can be freed for other work and will not be required to provide support for every field trip.

The attached budget differs from past budgets. We are submitting a single budget that captures the complete cost of the Remote Biologist position to the Program. Included in the budget is the savings to the Program by individual scopes of work where the Remote Biologist provides labor. Nearly half of the cost of the Remote Biologist is covered by his/her labor on three current SOWs, and one new SOW.

Schedule:

Activity	Timeline	Duration
Nonnative removal	December 2020 to March 2021	50 days
Endangered fish augmentation	October 2020 to November 2020	12 days
Demographic monitoring	September 2020 to October 2020	38 days
Phase III maintenance and monitoring	March 2021 to May 2021	32 days
NAPI pond assistance	April 2020 to October 2020	18 days
Secondary channel habitat maintenance	April 2020 to August 2020	15 days
PIT antenna deployment and maintenance	Year-round	10 days

SJRIP meetings	May 2020, November 2020, February 2020, one workshop annually	9 days
Other program activities	Year-round	13 days
Training	Seasonally	10 days
Holiday	Seasonally	10 days
Sick leave	Seasonally	13 days
Paid time off	Seasonally	20 days

Budget Justification

For the 2021,the Remote Biologist proposed Scope of Work we are providing the full cost of a GS-09 Fish Biologist with benefits in our budget. This will account fully for the salary and benefits of this position. Cost savings for the other New Mexico FWCO projects where the Remote Biologist will provide assistance is provided. Nearly half of the requested funds for this project are accounted for in other Program funded projects.

Program Office

How can the technical aspects of this SOW be improved?

- Identify the need from each of the SOWs that this SOW supports (for example: provides 1 of the 2 NMFWCO personnel needed for each of the 5 day Demographic monitoring trips). Added additional information on how the remote biologist will support multiple SOWs. I indicated the SOW's where I believe the remote biologist will be used full time, and where they will be used part time. Keep in mind that even with that designation there will continue to be flexibility for this position to work on many projects.
- We understand the need to provide explicit details on how the Remote Biologist will participate with various SOWs to provide expectation and clarity in duties. However, the SOW should consider some flexibility, given that the original purpose was to have a person on the ground with the flexibility to conduct many different and often unplanned tasks when needed. Agree, added a sentence that allows for other personnel to fulfill our obligations, so that the remote biologist can have more flexibility. We should be able provide this flexibility most years.
- It is also hard to understand some of the totals under the schedule. How does Demographic monitoring require 48 days if there are 3 trips of 6 days each? I assume that some of the additional days are for field work preparation and clean up after the trip, and for data entry and management. We handle all the data entry for our trips. But even with that extra time I agree that 48 days for Demographic monitoring is high. Reduced to 36 days, but this is approximate.

What is this SOW's contribution to recovery?

Having personnel that can quickly respond to SJRIP needs increases overall efficiency and flexibility in implementing many other SOWs.

FY 2021						
SJRIP - Remote Biologist						
Labor Cost						
Position	**Grade/Step**	**Salary w/benefits**	**Hours/Day**	**Total Days**		**Sub-Total**
Fish Biologist (1 FTE)	GS 9/3-4	$82,215.45	N/A	N/A		$82,215.45
Supervisory Fish Biologist	GS 13/4	$71.12	8	5		$2,844.80
Adminstrative Officer	GS 9/8	$46.93	8	5		$1,877.20
					Total Labo	**$86,937.45**
Travel and Per Diem	**Days**	**Rate**				**Sub-total**
Hotel Costs (4 two-day meetings)	8	$102.00				$816.00
Per Diem (Travel Day)	4	$48.00				$192.00
Per Diem (Full Day)	4	$64.00				$256.00
Per Diem (Camping Rate)	6	$29.00				$174.00
Travel voucher fee	4	$14.75				$59.00
Hotel Tax	8	$12.00				$96.00
					Total Trav	**$1,593.00**
Equipment	**Miles/Qty**	**Total Miles**	**Rate**			**Sub-total**
Vehicle Fuel						
1 truck used throughout year	50	13,000	$0.54			$7,020.00
est. 50 miles/day 5 days/week						
52 weeks/year					**Equipmen**	**$7,020**
		Sub-total for Remote Biologist - NMFWCO only				**$95,550.45**
		Overhead 3%				$2,866.51
						$98,416.96
Remote Biologist Savings/SOW						
17	$16,688.00					
19a	$12,682.00					
8	$13,350.00					
Channel Maintanence (New)	$4,005.00					
Total Savings	$46,725.00					

San Juan River Recovery Implementation Program
Communication and Public Involvement Plan
Fiscal Year 2021 Draft Proposal

U.S. Fish and Wildlife Service
Melanie Fischer
P.O. Box 25486, DFC, Lakewood, CO 80225
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Period of Performance: 10/01/2021 to 9/30/2022

Background

The San Juan River Basin Recovery Implementation Program is working to recover the Colorado pikeminnow and razorback sucker in the San Juan River and its tributaries in Colorado, New Mexico, and Utah, also while water development proceeds. The San Juan Program was established in 1992 with the signing of a cooperative agreement by the Governors of Colorado and New Mexico; the Secretary of the Interior; the Southern Ute Indian Tribe; the Ute Mountain Ute Tribe; and the Jicarilla Apache Nation. The Navajo Nation joined the program in 1996. The parties extended the cooperative agreement through September 30, 2023.

The Upper Colorado River Endangered Fish Recovery Program and the San Juan River Basin Recovery Implementation Program each have a multi-stakeholder structure in which federal and state agencies work with public and private entities to recover endangered fish species in a manner that is consistent with federal, state, and tribal water laws. Although their structure and goals are similar, these recovery programs operate independently, working with their own program partners and governing committees to fulfill requirements detailed in their respective cooperative agreements. Nevertheless, the similarities in these programs provide for effective communication and public outreach under a coordinated effort. The funding for capital construction and ongoing operation and maintenance (O&M) for the Upper Colorado River and San Juan River Basin Recovery Programs is also tied together in Federal legislation (Public Laws 106-392, 107- 375, 109-183, 111-11 and 112-270).

Using a shared approach, the two recovery programs coordinate their outreach efforts and work with other organizations throughout the Colorado River Basin to ensure common audiences receive consistent, current, and accurate information about the endangered fishes and efforts to recover them. These audiences include the general public, elected officials, Indian Tribes, landowners, anglers, river rafters and guides, environmental organizations, water and power developers, teachers, students, and Program participants. Although the geographic coverage of these recovery programs differs within the Upper Colorado River Basin, the majority of affected parties are interested in the recovery efforts taking place for both programs.

Funding for capital construction projects and ongoing operation and maintenance is authorized in Federal legislation through enactment of public laws. Non-Federal Recovery Program partners meet annually with members of Congress and their staffs and key Department of Interior leaders to update them about the recovery programs' progress. The recovery programs' success depends, in part, to their ability to work cost-effectively and efficiently and to document and report measurable outcomes. The recovery programs coordinate efforts in many ways such as sharing research findings and technical expertise in common pursuits including: nonnative fish management, endangered fish propagation and stocking, habitat restoration, and population monitoring.

Communication and outreach are also coordinated. Using a shared approach helps ensure that common audiences receive accurate, consistent information about the endangered fishes and efforts to recover them.

The Information and Education (I&E) Committee developed and approved general key messages in 2009 and is currently discussing updating those messages. The Information and Education (I&E) Coordinator in the Upper Colorado Recovery Program Director's office staffs the I&E Committee, which has representatives from most of the Recovery Program partners and the San Juan Recovery Program.

Relationship to Long Range Plan:

Goal 6.1 Increase Public Awareness and Support for the Endangered Fishes and the Recovery Programs

Mission

- To support the Recovery Program's success in recovering the endangered fishes by assuring that the public understands what is being done and why, and has confidence that the process is honest, open, sensitive, clear, and understandable.

Objective

- Develop public involvement strategies at the beginning of any and all projects.
- Educate target audiences about endangered fish, the threats to their survival, and Recovery Program efforts to recover them.
- Promote Recovery Program accomplishments.
- Improve communication within the Recovery Program and its partner organizations.

Target Audiences

- News Media
- General Public
- Elected Officials at All Levels
- Land and pond owners
- Anglers
- River rafters and guides
- Educators
- Recovery Program Partners

Strategies/Dates

This communication plan addresses Recovery Program strategies in general for the overall program. Separate communication plans are prepared for specific projects as appropriate. The intent of this plan is to revise it as needed to seize opportunities to partner with others to achieve the stated goals.

1. **NEWS MEDIA.** Actively work to identify issues that would generate the interest of the news media. Prepare and distribute advance and follow-up news releases to media, members of Congress and Recovery Program partners. Identify and seek support of partner and other organizations to issue news releases and/or provide supportive statements. Invite reporters to accompany biologists as they conduct their work.
   RESPONSIBILITY: I&E Coordinator/I&E Committee
   COMPLETION DATE: Ongoing

2. **PUBLICATIONS AND OTHER EDUCATIONAL MATERIALS.** Produce and distribute publications and other educational materials to provide current information to target audiences,

ensuring consistent identity and content (such as brochures, newsletter, Program Highlights document, fact sheets, magnets, rulers, etc.)
RESPONSIBILITY: I&E Coordinator/I&E Committee
COMPLETION DATE: Varies depending upon the publication and target audience

3. **SPECIAL EVENTS AND PUBLIC MEETINGS.** Strategically identify opportunities to reach target audiences through participation in special events and public meetings.
RESPONSIBILITY: I&E Coordinator/I&E Committee/Recovery Program partners
COMPLETION DATE: Ongoing

4. **INTERPRETIVE EXHIBITS/SIGNAGE.** Interpretive signs and exhibits at museums and visitor centers are key tools used to educate the general public. Coordinate production and installation of interpretive signs/exhibits at public facilities with high visitation in target communities. Place program exhibit in highly visible public locations.
RESPONSIBILITY: I&E Coordinator/I&E Committee/Recovery Program partners
COMPLETION DATE: Ongoing

5. **SOCIAL MEDIA and WEBSITE.** Maintain and promote updated Facebook page and public website (ColoradoRiverRecovery.org)
RESPONSIBILITY: I&E Coordinator/Recovery Program staff
COMPLETION DATE: Ongoing

6. **AGENCY PUBLICATIONS/WEBSITES.** Publish articles in Recovery Program partners' publications and websites.
RESPONSIBILITY: I&E Coordinator/I&E Committee
COMPLETION DATE: Ongoing

7. **INTEGRATE CERTAIN OUTREACH PROJECTS WITH THE SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM.** These include the newsletter, Program Highlights document, brochure, exhibit, educational materials such as a ruler, and other items as appropriate.
RESPONSIBILITY: I&E Coordinator/I&E Committee/Program Directors
COMPLETION DATE: Ongoing

8. **COORDINATE MESSAGES WITH ALL AGENCIES INVOLVED WITH RECOVERY OF THE ENDANGERED FISHES.** Coordinate I&E efforts among agencies outside of the Recovery Program to assure consistent and clear messages to target audiences.
RESPONSIBILITY: I&E Coordinator/I&E Committee
COMPLETION DATE: Ongoing

Evaluation

- Document print and broadcast news media placements.
- Document the number of special events/public meetings held and presentations made, including attendance numbers.
- Track visitation numbers at sites where interpretive exhibits are in place where feasible.
- Document the number of articles published in agency/partner publications.
- Prepare an annual report to Recovery Program committees.

- **Budget**

PROJECT	**UNIT COST**	**FY 20 CRRP**	**FY 20 SJRRIP**	**FY 21 CRRP**	**FY 21 SJRRIP**
Congressional Briefing Document (*Program Highlights*)	Printing: 24 pp 8.5 x 11, saddle-stitched into 9 x 12 pocket folder QTY: 1,500 = **$12,052.46(**printed through GPO and costs based on previous years); Design/layout = **$0** (in house);Shipping costs for bulk quantities**; $300** **TOTAL: $12,352.46**	$6,176[1]	$6,176[1]	$6,300[1]	$6,300[1]
Field Report (*Swimming Upstream*)	GPO Printing: 16 pp Self CVR. 4/4 8.5 x 11 Saddle-Stitched; QTY: 4,500 = **$2,907** Design/layout = **$0** (in house); Mailing Services: 2,420@.0843 each = **$204** Postage: 2,420 = **$1,042** Shipping for bulk quantities: **$300** TOTAL: **$4,453**	$2,363[1]	$2,363[1]	$2,411[1]	$2,411[1]
Aquarium Supplies UCREFRP Aquarium Supplies SJRRIP	50/50 cost share with CPW to support classroom program (Aquarium costs determined based on previous years' costs.) Aquarium supplies to start RBS in the Classroom	$2,971	$2,971	$3,060	$3,060
Exhibit Fees	Vendor fee plus noted expenses: CO Water Congress, Denver - **$1,600** CO Water Workshop, Gunnison - **$500** CO River Water Users, Las Vegas - **$3,350** (includes electricity/shipping) UT Water Users, St.George - **$2,500** (includes electricity & shipping) WY Water Assoc., Casper - **$150** CO Rocky Mountain Coal Institute Annual Meeting **-$300** Animas River Festival $**300** Navajo Nation Fair **$500** **TOTAL: $9,200.00**	$4,600[1]	$4,600[1]	$4,738[1]	$4,738[1]

[1] *50/50 cost-share for these integrated projects. The San Juan Program has its own budget for outreach expenses incurred only for that program.

Repairs/replacement	Cost varies depending on need. Estimate based on replacing banner stands and repairs/replacements to exhibit.	$2,653[1]	$2,653[1]	$2,706[1]	$2,706[1]
Ute Water Festival-UCREFRP, 2 days each May, Grand Junction, CO. Children's Water Festival, Durango, CO SJRRIP	2 people @ 45 hrs x $41/hr = $3,690 3 people @ 16 hrs x $46/hr = $2,208 Miscellaneous supplies = $242 **TOTAL: $6,140**	$6,140	$3,070	$6,263	$3,210
Miscellaneous Supplies/Equipment	Specialty paper (for photos and briefing book inserts) and other design materials.	$2,100	-0-	$2,163	-0-
Educational Materials FY 18 New or replacement item (TBD) FY 19 New or replacement item (TBD)	**Endangered Fish Tattoos**: 23,000 = $3,496 **Lil Suckers**: 1,000 = $2225 **Endangered Fish Charms with half circle-used for key rings, zipper pulls and glass charms**: Colorado pikeminnow (Shared) QTY:1050 = $1,628; Razorback sucker (Shared) 1050 = $1,628; Humpback chub 525 = $866; Bonytail 525 = $866 **Endangered Fish Lapel Pins**: Colorado pikeminnow (Shared) QTY:1050 = $1,628; Razorback sucker (Shared) 1050 = $1,628; Humpback chub 525 = $866; Bonytail 525 = $866 **Paper Stickers:** 5000 each set-2.5x4", 500 per roll 4-color = $2,444 **Magnets:** 4 versions; 3 ½ x 2", 4-color, QTY of 6,000 ea. = $3,495 **Rulers:** 12" 4/4 inches/metric 10,500 = $3,485 **Can Koosies:** 500 ea of 4 / 2000 = $3,100 **Vinyl Fish Stickers:** 2750 ea of 4 = $3,479 **Trading Cards:** 2.5x3.5 4/1 12pt C1S 25,000 ea of 4 = $2,486 **TOTAL:$34,186**	$34,186	$4,806	$35,211	$4,950
Signs/Exhibits/ Interpretive Signs	**Design/Produce/Install**: signs/exhibits/interpretive signs at locations with high visitation in target communities.	$5,000		$5,150	
TOTAL		**$66,189**	**$26,639**	**$68,002**	**$27,375**

- **IF ADDITIONAL FUNDS BECOME AVAILABLE:**

Reprint Historic Doc	60 pp 1/1 8.5 x 11 Perfect Bind QTY: 5000	$12,000		TBD	
Print/Direct Mail 6 x 11 postcard Western Slope	25 Adult Age To: 40 Income $0 - $49,999 Gender Male 3431 pieces: mailing list, printing, address and sort, postage and deliver to USPS Mail quarterly	$8,960		$9,139	
Billboards	Billboard message in Craig CO Junior Bulletin 6’ x 12’ $630.00 per month plus setup of $150.00 (3 months)	$2,040		$2,081	
Radio Spots	Series of radio spots targeting Western Slope	$2,800		$2,856	
Movie	5-10 min, featuring both programs; produced in-house, place on website, distribute through Facebook and other outlets.	$2,000		$2,040	
TOTAL		**$98,989**	**$26,639**	**$84,118**	**$27,375**

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

Proposed Scope of Work for FY 2020 and 2021

March 27, 2020

Principle Investigators
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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

Submitted by Katie Creighton and Brian Hines

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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

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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Eliminating flow impediments at the interface of main and secondary channels in the San Juan River: enhancing channel complexity and low-velocity habitats for endangered fishes

Proposed Scope of Work for FY 2020 and 2021

Submitted for Final Year (2 of 2)

June 24, 2020

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Bureau of Reclamation Agreements
R17AP00303 (NNDFW) | R19AC00022 (NMDGF) | R17PG00083 (NMFWCO)

Background

Dam construction and invasive species have irreversibly transformed the aquatic ecosystem of the Colorado River Basin. Impoundments altered the natural flow regime that simultaneously shaped environmental conditions of stream systems as well as the life history traits of native fishes that interacted with them (Olden et al. 2006). Specific to stream flow magnitude, the reduction of high spring flows have likely reduced the ability of streams to demonstrate channel migration and facilitated the encroachment of nonnative vegetation, further reducing channel heterogeneity through bank armoring (Tickner et al. 2001). Understanding and ameliorating the combined deleterious effects of altered flows and nonnative vegetation will be a continued challenge for managers charged with endangered fish recovery in these 'novel' ecosystems (*sensu* Hobbs et al. 2006).

Since 1962, the geomorphology of the San Juan River has been severely affected by the construction of Navajo Dam and the subsequent proliferation of nonnative riparian vegetation has resulted in channel simplification and loss of aquatic habitat. The San Juan River's stream channel is longitudinally and laterally heterogeneous between Navajo Dam and Lake Powell (Bliesner & Lamarra, 2000) and most large-scale stream heterogeneity stems from anastomosing channels that form relatively spatially stable stream braids (or secondary channels; Franssen et al. 2015). In 1998, the San Juan River Basin Recovery Implementation Program (SJRIP) developed flow recommendations for Navajo Dam operations to mimic a more natural hydrograph aimed at improving spawning and rearing conditions for the endangered Colorado Pikeminnow *Ptychocheilus lucius* and Razorback Sucker *Xyrauchen texanus* (Holden et al. 1999). However, since these flow recommendations were enacted, Navajo Dam operations have failed to meet the highest discharge flow targets at the recommended frequency and duration (largely due to the extended drought experienced in the basin during this time) (SJRIP 2018). These high flow targets were aimed at creating and maintaining important low-velocity stream habitats. Accordingly, the scarcity of high spring flows over the last two decades also coincided with a reduction in the number of flowing secondary channels and backwater habitats in the system, presumably due to the river's reduced ability to move and rework channel substrates (Lamarra and Lamarra 2016). The reduced availability of these low-velocity habitats could be a key component limiting the recruitment wild-spawned Razorback Sucker and stocked Colorado Pikeminnow in the San Juan River.

To date, the SJRIP has devoted minimal efforts into creation and maintenance of habitats presumed to be important for larval fish growth and recruitment, likely due to the presumption these habitats would be made available through successful implementation of the 1999 flow recommendations (SJRIP 2018). Nonetheless, since 2011, non-SJRIP funds provided for increased flow persistence in seven degraded secondary channel systems (i.e., Phase I and II) by removing sediment that hindered inflow from the primary channel as well as removal of riparian nonnative vegetation along the secondary channel corridors (Keller-Bliesner Engineering, 2012; Lamarra et al. 2018). These relatively large-scale projects demonstrated secondary channel habitats in the San Juan River could be modified to increase the persistence of flow and that juvenile native fishes would readily occupy these newly formed habitats (Lamarra et al. 2018).

Overall, these two phases of habitat restoration have provided much needed insight into the likelihood endangered fishes will use these types of restored habitats as well as the potential life- span of these relatively large-scale efforts.

Here, we propose a second year of relatively small-scale efforts to create and maintain low-velocity habitats through removal of impediments to flow at the upstream interface of secondary and main channels in the San Juan River. For fiscal year 2021 we intend to identify new sites (n=11–15) and revisit and readdress any side channels that were deemed failures in 2020 or have accumulated new blockages. Primarily, our efforts will focus on removal of woody debris in the inflow area of secondary channels prior to spring run-off. This debris traps sediment and reduces the amount of flow entering these impeded channels during elevated discharges. Figures 8 and 12 (a-c) illustrate the type of small-scale effort that would be needed to alleviate flow impediments through the removal of dead and downed woody debris. The main intent from this activity will be to allow the river to conduct the 'heavy lifting' of sediment removal in the secondary channels during the run-off period. Secondly, high volume gas-powered water pumps will be used to open those secondary channels that have been bermed off by sediment following spring run-off (Figure 12c). Additionally, further effort to remove debris will occur at secondary channels where flow impediments occur in preparation for the following spring run-off. We think an approach of spreading our efforts among several secondary channel sites rather than focusing on one or two channels mitigates the risk of the project and provides more immediate responses of habitat enhancement in perpetually degrading secondary channel inflow areas. Moreover, because all work will be accessed by raft, the number of channels that can potentially be maintained will not be limited by road access. The overarching goal of the project will be maintaining flow (or wetted backwater or embayment habitats) in each of 11-15 secondary channels after spring runoff for the duration of the fish growing season each year.

Task 1: Reconnaissance of secondary channels for treatment prior to spring run-off (trip 1)

Methods

Similar to 2020, 11–15 secondary channels between Shiprock and Montezuma Creek (river miles 148–93?) which appear to have woody debris impeding flow at their upstream entrance will be identified using a remote sensing GIS analysis. Previous efforts identified 11 channels (Figures 1-11) that persisted in recent times at variable base flows (Table 1). Our intent is to repeat this effort and identify a similar number of sites (11–15) and "ground-truth" the GIS analysis and determine the type of work required to treat each of the newly identified secondary channels. A reconnaissance trip will be conducted prior to spring run-off to obtain information on each identified channel. An extensive visual record of both the upstream and downstream portions of each secondary channel will be made through standardized photography. Similarly, flow characteristics will be observed and documented (i.e., entire channel flowing, backwater or embayment present, or no flow). Secondary channels that received channel maintenance in 2020 will also be reassessed to determine if any additional small-scale removal of woody debris is necessary to increase secondary channel flow.

Personnel, equipment, and timeline

This trip would require 2-3 people with personnel from agencies representing the principal investigators participating. Equipment would include water vessels (either a single raft, cataraft, or kayaks) and take 4-5 days.

Task 2: Remove woody debris impeding secondary channel flow prior to spring run-off (trip 2)

Methods

The purpose of this trip will be to remove woody debris at the inlet of the newly identified and/or

the previously visited (2020) secondary channels to increase the volume of flow going into each channel during spring runoff. Our prediction is that removal of flow impediments will increase the likelihood that the secondary channel will be wetted at base flows and will help clean the channel's outlet, which in turn increase the likelihood of a backwater forming at base flow. Before work is conducted, the site will be extensively photographed to document levels of change. All woody material that is removed will be placed on the river's bank high enough to keep it from reentering the river during high water. High pressure water pumps mounted on rafts will be used to excavate any buried woody material to aid its removal.

Personnel, equipment, and timeline

This trip would require 4-5 people with personnel from agencies representing the principal investigators will participate in this trip. At a minimum, two 16' rafts, two high pressure pumps and hoses, shovels, and Pulaskis would be used. Depending on the type and extent of woody debris identified during the reconnaissance trip, winches and pruning equipment such as limb saws, battery operated reciprocating saws, tree pruner, chainsaws, etc. will be required. We estimate a day of work at each secondary channel and expect trip 2 to take 10-15 days, dependent on the identification of additional channels during trip 1.

Task 3: Ensure secondary channels are wetted post spring run-off (trip 3)

Methods

This trip will be conducted after spring run-off during base flows (hopefully July). The purpose of the trip will be to ensure secondary channels provide fish habitat by being wetted and connected to the main channel. Each channel would be assessed as flowing, containing a backwater or embayment, or not flowing and extensive photographic record will be taken. If the channel is not flowing, then the impediment will be identified and potentially eliminated. It is most likely that the impediment would be woody debris or the deposition of a sediment berm (see Figure 12c for an example). High pressure water pumps will be used to create at least a 0.3 x 1.0 m cross sectional channel between the main stem river in hopes of withstanding up to a ~0.25 m drop in stage.

Personnel, equipment, and timeline

This trip will require a similar number of personnel and equipment as trip 2. We estimate roughly a day of work at each secondary channel but expect the trip to take less time, approximately 7-10 days.

Task 4: Evaluation and reporting

Methods

After spring runoff, we will assess whether each channel is wetted and note the discharge of the river at the time of visit. We will use the photography from trip 3 and obtain data from the larval/small-bodied fish and habitat monitoring efforts to assess our effectiveness at providing fish habitat. The goal of this project is to have 100% of the channels flowing or contain

backwaters or embayments at base flows. The percent of channels with flow will be compared to a historical benchmark to assess whether removal of impediments to flow at rehabilitated secondary channels was successful (described below).

We obtained fall habitat monitoring data (2011-2016 and 2018) for each of the 11 secondary channels identified through the GIS analysis (Table 1). For each channel, we identified whether it was flowing, which was defined as either fully wetted or containing a backwater or embayment. The median discharge at habitat monitoring mapping was 750 cfs. At this flow, for these 11 secondary channels, the highest percentage of flowing channels was in 2016 at 82%. Therefore, we would consider this project successful if >82% of the 11+secondary channels are wetted at base flow during the summer months. A similar table and success metrics will be developed and utilized for sites (new) identified for 2021 channel maintenance.

Long-term (5 months to 1 year) success of opening these channels will be assessed using coordinated monitoring by the larval and small-bodied fishes crews. These fish monitoring efforts often stop at all secondary channels and low-to-zero velocity habitats to sample. The location of all channels opened during this project will be provided to fish monitoring crews. These sites will be visited during routine monitoring efforts to determine if they are flowing or have an embayment or backwater. The small-bodied fishes crew will take photographs of each channel site in September. The presence/absence of native and native fishes will be determined from these monitoring efforts and help to assess their use when flowing.

Timeline and deliverables

This project was proposed as a two-year effort in fiscal year 2020. We will submit an annual report for work conducted in 2020 and a final report following the completion of the project in 2021. Reports will follow San Juan River Basin Recovery Implementation Program guidelines.

Permitting

Permitting is still in process, efforts to obtain a Pre-Construction Notification permit from Army Corp of Engineers have been made and a permit is anticipated in prior to scheduled 2020 work activities. Navajo Nation Office personal at NNEPA and Historical Preservation have extra documentation needed and we are awaiting response from both departments.

Budget Justification

A source of significant cost increase for FY 2021 is the addition of USFWS NMFWCO as principal investigators to the project. This addition was necessary to efficiently accomplish aspects of the work that were overlooked in the FY2020 proposal. The increase in funds associated with NMFWCO are necessary to accomplish the goals outlined. Further, our goal is to make this project as efficient as possible. A significant cost during the first year was associated with initial equipment purchases. In 2021, we are only seeking funds to repair and replace lost or broken items (see Table 2). The remainder of the budget is comprised of salaries and per diem. Most labor will be provided in the form of summer technicians from Navajo Nation.

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Table 1. Summary of wetted states of 11 secondary channels between 2011 and 2018 and the river's discharge at each mapping evaluation. The states of each channel were categorized as "Flow" as freely flowing, "None" with no part of the channel wetted, "BW" for a backwater at the downstream end, and "Emb" for an embayment on the upstream end. The percent of channels that were wetted (i.e., Flow, BW, or Emb) was quantified for each year and the percent of years each channel was wetted was also quantified.

			Discharge at mapping (cfs)							
			950	750	1500	750	750	750	500	
			Annual Channel State							
RM	River Side	~Length (m)	2011	2012	2013	2014	2015	2016	2018	Percent Years Wetted
127.2	Right	1200	None	Flow	Flow	Flow	Flow	Flow	None	71%
124.0	Left	1500	Flow	Flow	Flow	Flow	Flow	BW	None	86%
122.8	Left	1700	Flow	Emb	Flow	None	None	None	None	43%
114.2	Left	1000	BW	None	Flow	BW	None	None	None	43%
113.6	Left	650	None	None	Flow	None	None	BW	None	29%
105.9	Left	600	None	None	BW	None	None	BW	None	29%
103.3	Left	900	None	None	Flow	None	None	Flow	None	29%
99.0	Left	650	Flow	BW	Flow	None	BW	BW&Emb	None	71%
97.2	Left	400	None	None	BW	None	None	BW	None	29%
92.1	Right	800	Flow	BW	Flow	None	BW	BW&Emb	None	71%
78.4	Right	850	Flow	Emb	Flow	None	BW	Flow	None	71%
		Percent Channels Wetted	55%	55%	100%	27%	45%	82%	0%	

Table 2. Proposed equipment list needed to eliminate woody debris and sediment from the inflow areas of secondary channels.

Part	QTY	Cost	Distributor
3" Trash pump and Hose kit from Home Depot	1	$897.09	Home Depot
Floating Home Fire Fighting Pump System	1	$2,395.00	www.jjsfiresupply.com
Pulaski w/sheaths	3	$332.40	Forestry Suppliers
Shovel	3	$204.75	Forestry Suppliers
Tree Limb Saw	3	$637.38	Forestry Suppliers
Limb Saw Blades	3	$229.47	Forestry Suppliers
Honda EU2200i Portable Inverter Generator — 2200 Surge Watts, 1800 Rated Watts, CARB-Compliant, Model# EU2200iTA	1	$1,009.00	www.northerntool.com
Dewalt radio/charging station	1	$219.00	www.toolnut.com
Reciprocating Saw Dewalt	2	$344.00	Home Depot
Reciprocating Blades pk10	2	$79.97	Home Depot
Dewalt Battery extra	6	$539.91	Home Depot
HD limb loppers	3	$74.25	Forestry Suppliers
Z-drag Kit	1	$299.95	nrs.com
Camera with tripod	1	$800.00	
Chainsaw Powered Winch	1	$899.00	https://www.westechrigging.com/capstan-cs.html
MS-311 Chainsaw	2	$979.90	Noel's Inc.
Performance zip chaps - 6 layer	2	$219.98	Noel's Inc.
2020 Equipment Purchase	Total	17,440.95	
2021 Service and Replacement @ 10% of Equipment Cost	Total	1,744.10	

Figures

Figure 1. River mile 127.2 on river right. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 2. River mile 124.0 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 3. River mile 122.8 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 4. River mile 114.2 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 5. River mile 113.6 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris and Russian olives impeding flow.

Figure 6. River mile 105.9 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 7. River mile 103.3 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 8. River mile 99.9 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow, with the right indicating the amount of woody debris that would be the focus of removal.

Figure 9. River mile 97.2 on river left. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 10. River mile 92.1 on river right. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 11. River mile 78.4 on river right. The top panel shows the entire secondary channel, the bottom shows a closer view of woody debris impeding flow.

Figure 12. Examples of expected treatment types. Panels a-c provide examples of woody debris that would be removed prior to spring run-off and panel d shows an example of a berm that would be removed during the post spring run-off trip.

NMDGF FY2021 Budget

New Mexico Department of Game and Fish (NMDGF) FY2021 budget for the "Eliminating flow impediments at the interface of main and secondary channels in the San Juan River: enhancing channel complexity and low-velocity habitats for endangered fishes" scope of work.

Task 2 - Pre-runoff Trip

Tasks - Assist with opening inlets of secondary channels on the San Juan River between Shiprock, NM and Sand Island, UT prior to spring-runoff; 2 days trip preparation (8 hrs day), 15 field days (12 hrs day), 2 days post-trip clean-up (8 hrs day) = 212 hrs (152 hours regular, 60 hours overtime).

Personnel		
Project Leader (1)		
72 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))		$ 3,437
28 hrs overtime @ $71.60/hr ($47.73/hr * 1.5 (time-and-a-half)		$ 2,005
Project Biologist (1)		
80 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))		$ 3,059
32 hrs overtime @ $57.36/hr ($37.13/hr * 1.5 (time-and-a-half))		$ 1,836
	Sub-total	**$ 10,337**
Per Diem		
5 days @ $85/day (standard NM in-state rate)		$ 425
10 days @ 115/day (standard NM out-of-state rate)		$ 1,150
	Sub-total	**$ 1,575**
Equipment and Supplies		
Chainsaw and supplies		$ 800
Camera with tripod		$ 800
Z-drag Kit		$ 300
	Sub-total	**$ 1,900**
Vehicles		
Round-trip to Sand Island, UT – 650 miles @ $0.55/mile		$ 358
	Sub-total	**$ 358**
	Task 2 Sub-total	**$ 14,170**

Task 3 - Post-runoff Trip

Tasks - Assist with post-runoff re-visiting and re-opening any secondary channels that were opened in the pre-runoff Task 2 trip on the San Juan River between Shiprock, NM and Sand Island, UT ; 2 days trip preparation (8 hrs day), 10 field days (12 hrs day), 2 days post-trip clean-up (8 hrs day) = 152 hrs (112 hours regular, 40 hours overtime).

Personnel	
Project Leader (1)	
56 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$ 2,673
20 hrs overtime @ $71.60/hr ($47.73/hr * 1.5 (time-and-a-half)	$ 1,432

Project Biologist (1)			
56 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))		$	2,141
20 hrs overtime @ $57.36/hr ($37.13/hr * 1.5 (time-and-a-half))		$	1,147
	Sub-total	**$**	**7,394**
Per Diem			
3 days @ $85/day (standard NM in-state rate)		$	255
7 days @ 115/day (standard NM out-of-state rate)		$	805
	Sub-total	**$**	**1,060**
Vehicles			
Round-trip to Sand Island, UT – 650 miles @ $0.55/mile		$	358
	Sub-total	**$**	**358**
	Task 3 Sub-total	**$**	**8,811**

Administration, Data Management/Analysis, and Report Preparation

Personnel

Tasks – Managing grant, Data management and QA/QC, data analysis and synthesis, table and graph preparation, report drafting and revision; Project Leader (40 hrs) and one Project Biologist (120 hrs).

Project Leader (1)			
60 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))		$	2,864
Project Biologist (1)			
180 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))		$	6,883
	Data Management/Analysis & Report Preparation Sub-total	**$**	**9,747**

FY 2021 Total

Task 2 - Pre-runoff Trip Sub-total		$	14,169
Task 3 - Post-runoff Trip Sub-total			8,811
Data Management/Analysis & Report Preparation Sub-total		$	9,747
	Project Total	$	32,727
	IDC @ 23.77%	$	7,779
	NMDGF Total	**$**	**40,506**

Navajo Nation Budget

Fiscal Year - 2021 Smallscale channel maintenance along the San Juan from Shiprock, NM to Sand Island, Ut

Personnel/Labor Costs (salary + benefits)

Task 1 - Reconnaissance of potential secondary channels to conduct work	
1 FTE NNDFW - Fisheries Biologist @ $21.50/Hr for 72Hrs	$1,548.00
Fringe Benefits $1,548.00 X 47.88%	$741.18
1 Wildlife Technician @ $11.89/Hr for 72Hrs	$856.08
Fringe Benefits Temp. $856.08 X 9.68%	$82.87
Personnel Subtotal	**$3,228.13**
Travel	
1 GSA Vehicle Round-trip to Sand Island, UT - 242 miles @ $.31/mile	$75.02
Per Diem Lodging for Biologist for 5-days	$480.00
Per Diem Lodging for Technician for 5-days	$480.00
Per Diem Meals for Biologist for 5-days	$275.00
Per Diem Meals for Technician for 5-days	$275.00
Travel Subtotal	**$1,585.02**
Task 2 - Pre-runoff Trip	
1 FTE NNDFW - Fisheries Biologist @ $21.50/Hr for 128Hrs	$2,752.00
Fringe Benefits $2,752.00 X 47.88%	$1,317.66
1 Wildlife Technician @ $11.89/Hr for 128Hrs	$1,521.92
Fringe Benefits Temp. $856.08 X 9.68%	$147.32
Personnel Subtotal	**$5,738.90**
Travel	
1 GSA Vehicle Round-trip to Sand Island, UT - 242 miles @ $.31/mile	$75.02
Per Diem Lodging for Biologist for 12-days	$1,152.00
Per Diem Lodging for Technician for 12-days	$1,152.00
Per Diem Meals for Biologist for 12-days	$660.00
Per Diem Meals for Technician for 12-days	$660.00
Travel Subtotal	**$3,699.02**
Task 3 - Post-runoff Trip	
1 FTE NNDFW - Fisheries Biologist @ $21.50/Hr for 112Hrs	$2,408.00
Fringe Benefits $1,548.00 X 47.88%	$1,152.95
1 Wildlife Technician @ $11.89/Hr for 112Hrs	$1,331.68
Fringe Benefits Temp. $856.08 X 9.68%	$128.91

Personnel Subtotal	**$5,021.54**
Travel	
1 GSA Vehicle Round-trip to Sand Island, UT - 242 miles @ $.31/mile	$75.02
Per Diem Lodging for Biologist for 10-days	$960.00
Per Diem Lodging for Technician for 10-days	$960.00
Per Diem Meals for Biologist for 10-days	$550.00
Per Diem Meals for Technician for 10-days	$550.00
Travel Subtotal	**$3,095.02**
Navajo Nation Fish & Wildlife Total	**$22,367.63**
NNDFW Administrative charge (18.7% @ $22,367.63/1.1870 x.1870) =	**$3,523.80**
NN Total	**$25,891.43**

FY 2021 USFWS New Mexico Fisheries Conservation Office

Small Scale Channel Maintence- 3 trips, Shiprock Bridge, NM to Montezuma Creek, UT. NMFWCO supplying 1 person per trip

Labor Cost - Field Work (3 trips x 5-15 days/trip)

Position	Grade/Step	Hourly Rate	Fringe	Salary w/benefits	Hours/Day	Total Days	Sub-Total
Fish Biologist	GS 9/7	$31.46	27.46%	$51.53	8	30	$12,367.20
Overtime Hours (weekend or >8 hour work days)							
Fish Biologist	GS 9/7	$31.46	27.46%	$63.41	4	30	$7,609.20
Administrative, Reporting, Planning	GS 9/7	$31.46	27.46%	$51.53	8	5	$2,061.20
Fish Biologist	GS 13/4	$48.39	30.02%	$69.98	8	1	$559.84
Supervisory Fish Biologist	GS 9/9	$33.16	27.22%	$45.46	8	1	$363.68
Adminstrative Officer							
						Total FY21 Labor	**$22,961.12**

	Days	Rate	
Travel and Per Diem	3	$96.00	$288.00
Hotel Costs	3	$15.00	$45.00
Hotel tax	9	$41.25	$371.25
Per Diem (Travel Day)	50	$29.00	$1,450.00
Per Diem (Full Day)	7	$14.75	$103.25
Concur Fee			
		Total Travel/Per Dien	**$2,257.50**

Equipment	Miles/Qty	Total Miles	Rate	
Vehicle Fuel				
1 trucks X 3 trips - ABQ to Montezuma Creek, UT 532 mi R 532*3		1,596	$0.58	$925.68
				$1,000.00
Maintenance, repair, replace (i.e. gloves, hard hats, ppe, etc.)				
			Equipment Total	**$1,925.68**

Sub-total for 3 trips - NMFWCO	**$27,144.30**
USFWS Administrative Overhead	**$839.51**
Total for 3 trips - NMFWCO	**$27,983.81**

FY 2021 BUDGET SUMMARY

New Mexico Department of Game and Fish	40,506.00
Navajo Nation Fish and Wildlife	25,891.43
Equipment Costs (see Table 2)	1,744.10
USFWS New Mexico Fisheries Conservation Office	27,983.81
Total	**96,125.34**

Response to Comments

Mark McKinstry

How can the technical aspects of this SOW be improved?

I notice that most of the work for this project is 2020 is scheduled for the Spring. With Covid-19 can we put this project off till 2021?

Response — Indeed COVID-19 has certainly impeded the proposed work for 2020. Our intentions during the fast-changing scenario in the spring of 2020 were to wait and see if it became feasible to complete the proposed work later in the year. If we are unable to complete the 2020 work, it will be completed in 2021, and the proposed work within the 2021 SOW will be completed the following year (2022).

1) Another idea is to possibly do the recon and actual work trips in the fall or later summer when water levels are consistently low and water is warmer. That way you don't have to deal with cold water and possibly getting wet with waders. You would then evaluate the work after the next high flows when you do a recon trip the next year. You would be combining the recon and evaluation trips.

   Response — Mark this is a great idea and we will likely be investigating many options just like this one to potentially get some the work in 2020 accomplished during the COVID-19 pandemic.

What is this SOW's contribution to recovery?

If habitat can be improved relatively cheaply it would be a good contribution towards recovery.

Stocking Razorback Sucker in Lake Powell

Fiscal Year 2021 Scope of Work

Submitted to
Bureau of Reclamation

From

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Contract or Agreement number:
R17PG00084 for USFWS – Grand Junction, CO

1 October 2020 to 30 September 2021

Razorback sucker (Xyrauchen texanus) were historically found in the San Juan River but virtually disappeared in the San Juan River Basin by 1995 (USFWS 1991; (Buntjer et al. 1993, 1994, Lashmett 1993, 1994, Ryden and Pfeifer 1993, 1994b, Gido and Propst 1994)). Extremely small numbers of wild razorback sucker and the long-term lack of recruitment led to this species being listed as endangered under the Endangered Species Act on 22 November 1991 (USFWS 1991). Critical Habitat in the San Juan River was designated in 1993 (Maddux et al. 1993) as the area from the Hogback irrigation diversion in New Mexico downstream to Neskahi Canyon in Lake Powell (USFWS 1994), which is currently approximately 10 miles from the San Juan River inflow area.

The San Juan River Basin Recovery Implementation Program (SJRIP) undertook a propagation and stocking program for razorback suckers in the late 1990's and they have been stocked in the San Juan River in varying numbers since 1994, but only since 2005 have numbers > 5,000 been stocked (Ryden and Pfeifer 1994a). Current stocking goals include stocking 10,000+ razorback suckers each year that are > 300mm in length (Furr 2012). Stocking the larger size class is hypothesized to improve initial survival by stocking fish that have nutrient reserves that can carry them through winter and spring, and also larger fish will not be as susceptible to predation.

While the obvious intention of stocking razorback sucker into the San Juan River is to have these fish retain, survive, recruit and reproduce in the riverine portion of the San Juan River, it has long been known that some unknown number of stocked razorback sucker have been moving downstream out of the San Juan River and into the San Juan River arm of Lake Powell. Cathcart et al. (2018) estimated a population of 750 fish using the area just downstream of the Piute Farms Waterfall during a two-week period in 2017. However, Pennock et al. (in press) also identified a sizeable proportion of the population (~50%) that likely never leaves the reservoir and also estimated the population in the Lake Powell at approximately 750 fish. Critical Habitat for razorback sucker in the San Juan River basin extends downstream into Lake Powell as far as Neskahi Canyon. Therefore, any razorback sucker occupying this section of the San Juan River arm of Lake Powell are part of the San Juan River razorback sucker population and contribute towards the demographic recovery criteria. Furthermore, fish stocked in the River or the Lake contribute toward the recovery criteria when and if natural recruitment occurs.

Captures of fish in the San Juan Arm have varied since the first sampling event in 2011, but in some years it has been considerable (Francis et al. 2013; Table 1). Additionally, larval fish have been captured in most years. A large proportion (10-40%) of fish captured each year at the Piute Farms Waterfall and in Lake Powell have been untagged fish. These untagged fish could be explained by accumulated tag loss from fish that travel past the waterfall and are not available for capture in the river, or through recruitment of larvae in the River or Lake and their inability to travel upstream past the waterfall. Although the number of untagged fish declines every year with tagging we hypothesize that a certain level of recruitment is occurring in the River and Lake downstream of the waterfall. Efforts to capture younger age-class fish in the River and Lake have not been successful, although Albrecht et al. (2010, 2018) have also had difficulty capturing juvenile fish in areas where natural recruitment is occurring. The lack of captures could be due to timing of sampling, number of larvae and juveniles present, sampling techniques, differential habitat use, or other unknown factors.

Table 1. Total number of unique adult razorback suckers detected or captured in 2011-2012, and 2017-2019.

Year	Total Captured	Total Detected	Captured & Detected	Total Unique
2011	75			75
2012	72			72
2017	149	179	22	306
2018	57	30	6	81
2019	31			31

The SJRIP has identified a "recruitment bottleneck" as the most likely factor limiting recruitment of larvae to adult life stages. Many ideas have been suggested for this bottleneck including predation of smaller fish and larvae, drift and passage past the waterfall, unsuitable or lack of habitat, reduced water temperatures, contaminants, or other factors. We propose stocking a smaller size class (i.e., 200mm) of PIT-tagged razorback sucker at the inflow of Lake Powell and using existing and ongoing sampling/detection methods to determine if fish of that size class are able to recruit into adult size class fish in the lake or section of river below the waterfall.

Study Area:
The study area for the Lake Powell razorback sucker survey in 2021-2024 would be in the San Juan River arm of Lake Powell downstream to confluence of the San Juan and Colorado River arms upstream to the waterfall. Our ability to actually sample (or deploy remote PIT tag readers in) any given area in Lake Powell (in either arm) will depend upon lake levels and inflow. The PIT tag antenna being used to detect eventual survival is located approximately 20 miles upstream of the inflow area is at the Piute Farms Waterfall.

Goal
The goal of this project is to test survivability of stocked Razorback Sucker of approximately 200mm in Lake Powell. By stocking fish ~200mm size fish we can test for potential recruitment in Lake Powell and possibly answer questions about a hypothesized recruitment bottleneck. For example, if fish from this stocking event do survive in appreciable numbers we could possibly stock 100mm fish to test survival of that size class in the future.

Objectives:
In FY 2021 and 2022:

1) Stock excess fish from Ouray Nation Fish Hatchery Grand Valley Unit (ONFH-GVU) approximately 4,000 (or whatever is available) that are less than 300mm (ideally 200mm or less) PIT-tagged Razorback Sucker at the San Juan River inflow area of Lake Powell. Note: This is the only portion of the work that the SJRIP would be responsible for funding.
2) Link 2022-2024 sampling funded by BOR for Lake Powell Razorback Sucker work with this stocking effort to determine success, survival, growth and

habitat use of fish stocked during 2021 and 2022. The sampling goals and objectives for the monitoring are provide further down in this proposal and are separated from the actual stocking SOW.

Methods

Fish will be reared at the ONFH-GVU rearing facility and transported to Bullfrog Bay Boat Ramp on Lake Powell after they have attained a suitable size. Fish will be PIT tagged at the hatchery approximately 1-2 months prior to transport and will be checked for PIT tags prior to being transported to the Lake. At the boat ramp fish will be kept in a hatchery truck until they are transferred to a large boat for the 75 mi trip to the inflow area on the San Juan Arm. Fish will be hauled in groups of 1,000 to 2,000 fish depending on size of stocking tank and crowding. Once at the stocking location, fish will be tempered using lake water and any mortalities will be removed and documented prior to stocking.

Evaluation

The success of this stocking event will be evaluated using two different methods. The first method is to use PIT Tag detections at the Piute Farms Waterfall antenna. Past research by Cathcart et al. (2018) demonstrated that detection probabilities at this location are ~ 90%, which provides a high likelihood that any fish that recruit to an adult size and move upstream to this location will be detected. Further, Pennock et al. (in press) showed that between 40 and 60 percent of razorback suckers in Lake Powell moved upstream during the year and eventually contacted the PIT antenna at Piute Farms Waterfall, suggesting that if fish survive to an adult size class that they may travel upstream and contact that antenna. If these fish recruited to larger size classes, and behaved similarly to other fish, there is a high likelihood that we would detect their survival at this antenna. The second opportunity to detect recruitment will come in spring of 2023 when a project being conducted in Lake Powell to find spawning adult razorback suckers will move from the Colorado Arm of Lake Powell back over to the San Juan Arm. In the past, this project has successfully captured and detected hundreds of fish at the inflow area (Table 1) and if these smaller stocked fish did recruit to an adult size there is a chance that they would be detected by portable PIT antennas or captured with trammel nets and electrofishing.

Successful recruitment of this smaller size class of fish could yield important information on recruitment bottlenecks and answer questions about the suitability of the lake and inflow for recruitment of razorback suckers. Success of these fish could be used to suggest stocking even smaller fish (100mm) in this area to provide further information on recruitment limitations.

Budget for USFWS—Grand Junction

Fiscal Year 2021 Estimated Budget

Personnel/Labor Costs (Projected Federal Salary + Benefits)

(Salaries based on projected FY-2020 amounts.)

Salaries

Biologist GS-11/7	Rate/Hr	People	Total
Transport: Hatchery to lake boat launch	$53.84	2	$2,745.84
Transport: lake boat launch to lake stocking site	$53.84	2	$2,745.84
PIT-tagging fish prior to transport	$53.84	4	$1,722.88
		Personel total	**$7,214.56**

Travel and Per Diem

Lodging	Rate	People	Total
Defiance House Lodge	$96.00	2	$384.00
Meals & Incidentals	**Rate**	**People**	
Hotel	$55.00	2	$330.00
Hatchery	$55.00	2	$330.00
		Travel Total	**$1,044.00**

Equipment and Supples

Vehicle Maintenance and Gas			
Vehicle Mileage	Mileage	Mileage Rate	Total
Lake Crew	550	$0.43	$473.00
Hatchery Crew	550	$0.43	$709.50
Vehicle Lease	**Days**	**Lease/day**	
Lake Crew	3	$12.35	$74.10
Hatchery Crew	3	$12.35	$37.05
Gasoline	**$$/Gal**	**Trips**	
Boat	$4.25	2	$1,105.00
Lake Crew	$2.50	1	$250.00
Hatchery Crew	$2.50	3	$412.50
Misc supplies		**Price per unit**	
300 gallon fiberglass tank		$3,000.00	$6,000.00

Oxygen bottles (3 per trip X 3 trips)	120 Ft^3 Bottle		$25.50	$229.50
		Equip. and Sup. Total		**$9,290.65**
		Sub Total		**$17,549.21**
		Region overhead (3%)		**$526.48**
		Grand Total		**$18,075.69**

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Response to comments:

Scope #	Project	PI(s)
NEW-1	NEW-1-Stocking Razorback Sucker in Lake Powell	Schleicher and Francis; GJFWCO Creighton and Hines; UDWR McKinstry; USBR

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

I don't really see hypotheses in this. The goal of testing survival of stocked RZB <300mm is clear, but I am not grasping how this stocking would help "test ideas on the potential for recruitment in Powell" or "possibly answer questions about a hypothesized recruitment bottleneck." Is the idea of the latter that there's a recruitment bottleneck in the river because recruits are all drifting to Powell? You could explore that and whether recruitment is happening in Powell more directly just by sampling for smaller fish, independent of stocking. I'm not at all opposed to the project however, just think the scope could use clarification.

Response: We have significantly changed this SOW. The "hypothesis" is basically: Will fish stocked at ~200mm recruit to an adult size in appreciable numbers? Lake Mead is the only place where we have natural recruitment and they survey for smaller fish at all of their sampling sites, but rarely capture anything smaller than 350mm. Looking for juvenile fish is very difficult, which is why we want to stock 200mm fish to see if they will recruit.

What is this SOW's contribution to recovery?

If stocked fish recruit and reproduce, they should all count toward recovery.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

This SOW was a little long and many sections were not necessary to describe proposed work (historical background and already funded work). The amount of explanation for why we need to release 4000 RBS into the reservoir is very short, most of this SOW is from a project that is already funded, but there is very little information about why we need to augment RBS in Lake Powell, or how this will benefit recovery. I think this SOW would be improved by developing a better

study design specific to the augmentation of RBS into Lake Powell. The goal of the SOW is to test survivability of 4000 stocked RBS < 300 mm into Lake Powell in 2021. Does Ouray hatchery have the resources/space to raise out these extra fish to this length? Will increasing the RBS production impact proposed Colorado Pikeminnow broodstock production at Ouray? The SOW does not mention the very large population of non-native piscivores (Striped Bass) in Lake Powell.

Response: We have significantly changed this SOW and shortened it considerably. We have tried to address the issues related to clarity and add specific questions.

What is this SOW's contribution to recovery?

This SOW's contribution to recovery could be significant if the stocked and resident RBS in this highly altered river section could contribute, through successful reproduction, recruitment and dispersal, to the population in the San Juan River upstream of the waterfall. I am no sure this will happen any time soon, except by moving the desired fish with crews below the waterfall. The proposal needs to do more to tell us how adding more RBS to the existing reservoir population is necessary- this population is already augmented by upstream reproduction. Is the proposed work needed to enhance the data collection identified in the SOW? Or is it an actual recovery action?

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

The proposal is straight forward but I am not sure if it warrants funding. The logic that newly stocked fish (200 mm) will remain within that location is suspect. Quoting the authors "A population estimate done on razorback sucker captured in 2012 had a point estimate of 527 fish with 95% confidence intervals of 239-1312 (T. Francis and B. Gerig unpublished data). However, this population estimate takes into account roughly 24 miles of the San Juan River arm of Lake Powell. There is roughly 1960 miles of shoreline in all of Lake Powell. Thus the actual number of razorback sucker inhabiting the lake as a whole could be very large (line 198). Also given the fact that the program has stocked over 171,000 RBS into the San Juan River since 1994, and only a fraction remain in the river (pop estimate is approximately 3,300 fish in 2019) where have they gone. Because we have not seen a large number of dead, newly stocked fish, one must assume that the majorities have migrated into Lake Powell. My point being is that we are already indirectly stocking the Lake.

From a technical standpoint, I was under the assumption that the program had decided not to stock RBS under 300 mm?

Response: We have significantly changed this SOW. With the antennas and sampling we are doing at the Piute Farms Waterfall and in the lake we feel that we have an excellent chance to detect the tagged fish if they recruit to the adult size. Pennock et al. found that 40-60% of fish in the San

Juan Arm of Lake Powell eventually travel to the waterfall and are detected. Stocking of fish ~200mm will give us information on recruitment of that smaller size class.

What is this SOW's contribution to recovery?

Given the proposals stated goal and the concerns expressed above, I don't think the project will contribute to recovery of RBS.
Response: We disagree. If the smaller fish recruit then we will know more about potential recruitment bottlenecks and the ability of smaller fish to recruit in Lake Powell. Furthermore, if these fish recruit they would count toward recovery goals similar to fish in the river.

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

The technical aspects of this SOW are researched thoroughly and appear to be sufficient to accomplish the objectives of the project.

What is this SOW's contribution to recovery?

Contribute to efforts of recovery for endangered fish by augmenting the population of RBS.

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

No Comment

What is this SOW's contribution to recovery?

This SOW has great potential to increase our understanding of the Razorback population in the San Juan Arm/Lake Powell. Of course, as indicated by NEW-2 there appears to be a lack of suitable spawning bars in the SJ Arm. The Program needs recruited wild fish to advance recovery. If there is some density dependent limitation with spawning in the SJ Arm and not just a lack of habitat then stocking efforts could quite well be the most prudent measure to bolster the population to a point where spawning occurs at a high enough rate to be detected by monitoring and contribute to the recovery goals. In recent years the Program has put a large effort to the waterfall/SJ Arm inflow area of Lake Powell, and this project seems like a logical next step in gathering information on the Razorback population (as well as other non-target species of concern) to further our understanding of, and guide future recovery efforts.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

The number proposed for stocking seems to be very low compared with the area to be sampled. Do the fish stocked in this project reduce the number available for stocking in the San Juan River? **Response: We are using 4,000 fish because that is what we feel that we can get. And it is a decent number that if they recruit they will likely be detected at the waterfall antenna.**
Does this project overlap or interfere with any other project being conducted in the San Juan Arm of Lake Powell, in particular the translocation study and the current study by Kansas State? **Response: The project by KSU will not be affected by this. In fact that project may be able to detect some of these fish if/when they move to the waterfall**
Will fish be stocked in multiple years or will this be a one time event?
The schedule is confusing. The objective is to determine potential for recruitment by smaller razorback sucker. The sampling schedule seems to have a delay of several months after stocking and the sampling is schedule to coincide with the expected spawning season. Do the PIs expect that the stocked subadult Razorbacks will congregate with the spawning adults? The proposal seems to be an add-on to another project looking for spawning Razorback Suckers. More detail is needed to specifically address how these smaller fish will be tracked or collected. **Response: We have significantly changed this SOW. The stocking will take place when the fish reach the 200mm size and can be stocked safely. We expect that if these fish survive and recruit that they will integrate with fish already in the Lake and will eventually be captured with the other project and/or detected at the waterfall. Stocking would be done for two years, 2021-2022 Assessment of recruitment will occur in 2023 and 2024.**

What is this SOW's contribution to recovery?

It is unclear from the SOW how this will contribute beyond what is being achieved from the current stocking of larger fish in the river.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

If I understand this correctly, the SJRIP contribution to this project will only be to provide up to 4000 200mm PIT-tagged razorback sucker per year in 2021 and 2022 for stocking in the San Juan Arm of Lake Powell. As part of the larger, BOR funded study, the investigators will then attempt to study the survival, growth and habitat use of these fish beginning in 2022 to hopefully provide insight regarding recruitment potential. One question that should be answered in the SOW is the likelihood we have sufficient hatchery capability to provide this number of fish at the times needed without affecting our other stocking obligations. Other questions would be, what would be a measure of success that these fish are successfully recruiting in Lake Powell (e.g. 1%?, 10%?....) and what would be the management implications for recovery if we do find some level of survival? The proposal could be strengthened by providing a bit more detail regarding goals, objectives and potential benefits of the project.

Response: We have been told that 4,000 200mm fish should be available for stocking. We do not have a predicted survival rate. When/if we recapture and/or detect these fish we can debate if the numbers are significant enough to warrant further work.

What is this SOW's contribution to recovery?

While I think this effort has a fairly high risk of producing only limited or no results, I think from the standpoint of recovery there is a modest chance we could gain some valuable information regarding the role of Lake Powell to our overall recovery effort.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

This SOW needs to be edited to improve clarity. There are many grammatical and consistency errors throughout that makes it difficult to read. The Introduction also appears to be cobbled together from several sources and needs significant revision. **Response: We have significantly changed this SOW.**

Lines 178-181 "Scales collected from untagged Razorback Sucker will be examined"……..this seems leftover from an old proposal and will only lead to confusion because results from scale analysis were found to be unreliable and inconclusive. Remove this from the SOW. **Response: We have removed this.**

Line 252: At the end of the Introduction, it is stated that "this study is designed to help determine the extent to which Razorback Sucker occupying Lake Powell are interacting with and supplementing populations in various Upper Basin rivers". However, the goal of the project is stated as "to test survivability of stocked Razorback Sucker < 300 mm in Lake Powell". Those are two different things. **Response: We have changed this, although the goal of the project would be to look at survival and eventually determine where these fish move to and what they do over time.**

Line 263: Why do we need to test whether stocked RBS < 300 mm would survive in Lake Powell? **Response: As stated in the proposal, there is a hypothesized recruitment bottleneck. This project could help answer the question of whether 200mm fish can survive in an area where there are obviously adults surviving. If 200mm fish survive you could then try 100mm fish to see if they survive.**

Line 264-266: How will stocking Razorback Sucker < 300 mm test the potential for recruitment in Lake Powell? How will these be assessed? There is nothing included in the Methods for testing the potential for recruitment. This is also the first time in the SOW that a recruitment bottleneck is mentioned. What recruitment bottleneck is being tested? Recruitment of small stocked Razorback Sucker to adults? **Response: We have significantly changed this SOW. We**

added a section on evaluation which includes using antennas and active capture through another project to assess survival and recruitment. The recruitment bottleneck is the hypothesis, I don't think any of us know what the mechanism is.

Line 270: Why 4,000 Razorback Sucker? Given the probability of very high initial post-stocking mortality, its highly unlikely that most of these fish will ever be captured again. This is also the first mention of stocked Razorback Sucker being < 200 mm. Previously it was stated that stocked fish would be < 300 mm. How many years is it anticipated for Razorback Sucker to grow large enough to be effectively sampled by the gear being used? At what age will these fish be stocked? **Response: 4,00 fish is what we can likely get and get them stocked. Fish would be stocked in fall of 2020 and 2021. Evaluation would occur in 2023 once fish reach an adult size. Evaluation includes active captures and detections in the Lake under another project, but more importantly, the Piute Farms Antenna will be used to assess fish that move from the Lake to the waterfall.**

Lines 281-283: When will these fish be stocked? Consideration of time of stocking may increase or decrease survival given a number of different variables (e.g. water temperature, air temperatures, increased presence of predatory fishes, etc.). **Response: Stocking will be in Fall of 2020 and 2021.**

Line 285: What is the total time to complete one round trip to stock fish? The amount of time some fish remain in a stocking truck may have an effect on survival. **Response: We predict 8 hours round trip.**

Lines 286 -287: It is stated that "Fish will be hauled in groups of 1,000 to 2,000 fish depending on stocking tank and crowding", does this mean that all of the fish will not be released on the same day as a result of transport restrictions or is this just stating the intended fish transport methods? What are the methods for fish release? Will fish be held in pens to acclimatize? Will water pumps be used to temper the holding tank with water from the lake? Please clarify the stocking protocol. **Response: Fish will be stocked in groups that can be hauled in the tank. Fish will be tempered by pumping water into tanks as they are hauled. This will occur over 3-4 hour trip through the lake.**

Line 294-296: Will the current methods to sample large adult Razorback Sucker in Lake Powell be suitable to sample smaller subadults? Will these fish even occupy similar habitats? **Response: We will use sampling for adult fish to evaluate this. Not sure how to answer this question with more work.**

Line 307: This should state "Collect fin rays" not scales. As stated above, isotopic analysis from scales was found to be unreliable and inconclusive.

Line 337: Will Razorback Sucker stocked in 2021 and 2022 at less than 200 mm even be sexually mature by the end of the monitoring project in 2024? If they are not sexually mature, and thus not congregating at spawning locations, how will this affect the results? Will additional sampling be conducted to try and detect these fish if they are not located at spawning aggregations? **Response: This may be true, but we will assess for 2 years, 2023-2024. The fish should reach a size during that time that they will be captured or detected. The Piute Farms Antenna should continue to provide data over time.**

Line 487: There is no clear link between this project's data analysis and stated objectives. There is not even a mention of how survival of stocked RBS will be assessed. **Response: Survival will be assessed with captures and detections over time using STReaMS database..**

Reports from Albrecht et al. are dated. Including more recent work from Lake Mead seems important given that the data currently referenced within much of this SOW is a decade or older. Lake Mead work continues and annual reports as recent as 2019 are available. **Response: We updated the lit cited to include more contemporary work, but that earlier work is important.**

Will genetic material be collected from fish prior to being stocked? Collecting genetic material prior to release would likely benefit current and future work being conducted with the San Juan River. **Response: Good idea, we will investigate.**

What is this SOW's contribution to recovery?

Increasing the abundance of Razorback Suckers in Lake Powell would be beneficial for the recovery of the species in both basins. However, I do not think that this project will provide a significant positive effect on the population in Lake Powell. As stated in this SOW, the Program is already inadvertently stocking Lake Powell due to down stream movement of Razorback Suckers stocked into the river. The survival and persistence of stocked Razorback Suckers in Lake Powell can already be assessed by monitoring the fish that are currently there. I am not sure how stocking 4,000 < 200 mm Razorback Suckers, which will probably have significant post stocking mortality, will provide any meaningful information or contribute much to recovery of the species. I also think its unnecessary to divert resources to study an unknown and undefined recruitment bottleneck in Lake Powell when there are still many unanswered questions about recruitment in the San Juan River. A project specifically assessing current levels of spawning and recruitment of the population already established in Lake Powell would provide more meaningful information. **Response: We disagree that the project would not be important. If we could get fish to recruit in Lake Powell this would be an important finding and might suggest that the population could be expanded in Lake Powell.**

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

The SOW provides an informative history of Razorback Sucker in the San Juan Arm of Lake Powell. There is evidence that Razorback Sucker have been present in the San Juan Arm for at least four decades and possibly since impoundment of Lake Powell. That provides logic for extending efforts to recover Razorback Sucker to the Sand Juan Arm.

It is clearly stated that the stocking of Razorback Sucker in the San Juan Arm of Lake Powell is to support another research project that is not funded by the SJRRIP. The design, goals, and objectives of that study are not clear in this SOW. The SOW states, "This study is designed to help determine the extent to which the Razorback Sucker occupying Lake Powell are interacting with and supplementing populations in various Upper Basin rivers." The stated goal in the SOW is to test survivability of stocked Razorback Sucker < 300 mm in Lake Powell." The proponents of the project go on to state, "By stocking fish smaller than 300 mm we can test ideas on the potential for recruitment in Lake Powell and possibly answer questions about the hypothesized recruitment bottleneck." Hypotheses to be tested or questions to be answered are not explained in the SOW. **Response: We have significantly changed this SOW.**

A variety of field sampling methods are described in a fair amount of detail, but there is no linkage of the data to be obtained to the testing of hypotheses or answering of questions. There is no mention of planned statistical analyses which may have provided some insight into hypotheses to be tested. The description of the research project being supported by the stocking effort is not sufficient to enable judgement of the technical merit of NEW-1. **Response: Once fish are eventually captured or detected this information will be entered into STReaMS database and eventually used in survival and population extimates.**

What is this SOW's contribution to recovery?

The stocking of Razorback Sucker < 200 mm into the San Juan Arm of Lake Powell may yield insight into survival of stocked fish, how they contribute to and interact within the fish community, and the extent to which they may move within and out of the upper portion of the San Juan Arm. It is a contribution to overall efforts to recover the species.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

66-"that never leave the reservoir" is unclear to me. How could they leave? Do you mean they stay in San Juan arm of Powell?

160-"did not correspond with any year-class of fish"…This is not clear. Do you mean no razorbacks were stocked in that year?

270- how did you come up with 4000? Is it based on recap probability or just that's how many you can get? If you can stock more, I suggest you do so to increase recap probability. **Response: 4,000 is the number we have been told we can get. More would be better since the lake is basically unlimited habitat, but that is what we can get from hatcheries.**

397-"will be set at 2-4 hour intervals in" Not clear will they checked at 2-4 h intervals or set sequentially?

Minor typos
Line (see highlights in SOW)
45
65
79
286
428

What is this SOW's contribution to recovery?

I fully support this effort. The information it might provide could be a game changer for the razorback sucker in the system.

Program Office

How can the technical aspects of this SOW be improved?

- It would be helpful if the SOW stated whether or how the ~4,000 fish stocked as part of this SOW would impact the 2,000-4,000 Razorback Sucker > 300 TL produced as part of SOW-7 (Horsethief Razorback rearing SOW). **Response: We have been told that these are excess fish that would normally be euthanized or not stocked.**
- Why stock only 4,000? Wouldn't more fish increase the chances of survival and potential recapture? **Response: 4,000 is the number we have been told we can get. More would be better since the lake is basically unlimited habitat, but that is what we can get from hatcheries.**
- The SOW indicates that Lake Powell is stocked indirectly via stocking the San Juan River. It would be useful to clarify what is expected to be gained from stocking Lake Powell directly (i.e., what is the test/question/goal of this stocking effort). We assume your hypothesis is that smaller, stocked Razorbacks will survive better in the inflow area compared to the river proper because that habitat is more conducive to recruitment (i.e. low velocity turbid habitats)?
- It would be useful to revise the sampling section to specifically indicate how those efforts would inform those tests/questions/goals. Otherwise, the sampling section seems to confuse the goals of the SOW and could be removed or placed in an appendix. **Response: The SOW was revised to clarify this.**
- Survival estimates require at least three years to estimate, is it expected that monitoring would provide those three years of data? What would these new

survival estimates be compared to? **Response: Comparison would be made to existing survival estimates.**

- It appears much of the sampling is related to spawning (i.e., larval fish collection) so it would be helpful to explain how ~200 mm TL fish would be sampled by that methodology or how that methodology provides information for these smaller sized fish. **Response: Most evaluation is relying on detection of fish on remote antennas in the lake and at the waterfall.**
- Are we going to be able to identified hatchery fish that lose their tags versus wild recruits? The SJRIP shifted to stocking fish > 300 mm TL in an effort to reduce this ambiguity but it appears this stocking effort will confound distinguishing wild versus hatchery origin fish. If this stocking occurs, and several untagged Razorbacks are subsequently detected in the inflow area, how do we interpret these captures? **Response: Fish that lose their tags will likely not be distinguished. However, by tagging fish several weeks prior to stocking and then checking just before stocking we will reduce tag loss to ~1% based on previous work.**

Some specific editorial suggestions:
Line 148 “metalarvae” is misspelled.
Line 172 and 209 Durst and Francis 2016 for these citations.
Line 281 “Ouray” is misspelled.
Lines 281-287 where exactly will these fish be stocked?

What is this SOW’s contribution to recovery?

If stocking Razorback Suckers <200 mm TL in the inflow area resulted in substantial survival of those individuals compared to fish stocked in the river, it would greatly increase our understanding of the recruitment bottleneck in the San Juan River proper. This could be a great test of turbid low velocity habitats as being critical for overcoming the lack of recruitment in the river. In addition, increasing the number of fish in San Juan River population(s) could increase the potential for production and subsequent recruitment.

Physical and Biological Monitoring and Evaluation of Phase III Habitat Restoration: A Constructed Floodplain Wetland Refugium

Can wild-spawned San Juan River Razorback Sucker larvae recruit to juvenile life-stages in a relatively large, stable, zero-velocity habitat?

Fiscal Year 2021 Scope of Work

Submitted to the U.S. Bureau of Reclamation

From

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Purpose

The San Juan River Basin Recovery Implementation Program (SJRIP) approved a construction scope of work for a Razorback Sucker floodplain wetland refugium (Appendix I) with construction expected to occur in winter 2020/2021. That scope of work outlined an operations, monitoring, and evaluation plan for the wetland while this scope of work details the logistics, identifies each entity's responsibilities, and provides a budget for that plan. As described in the construction scope of work, should the wetland not function as intended, a contingency plan to stock wild-produced larvae would be implemented. Should the Biology and Coordination committees decide the contingency plan needs to be implemented, a different operations, monitoring, and evaluation scope of work would need to be developed and submitted for approval.

Background

In the San Juan River, collection of larval Razorback Sucker has occurred every year for the past 18 years. However, juvenile Razorback Sucker have been rarely detected in fall sampling, indicating a potential recruitment bottleneck between the larval and juvenile life-stage. Within the last seven years, the number of larval Razorback Sucker captured annually was approximately 30% that of Bluehead Sucker or Flannelmouth Sucker, two common species that are consistently collected as juvenile age-0 fishes (Figure 1). The apparent lack of recruitment to the juvenile life-stage is unlikely a function of the fewer number of larval Razorback Sucker collected compared to the other two native suckers. Additionally, the limited collection of metalarval Razorback Sucker, the most mature phase of larvae, and limited collections of this larval phase as early as July (Farrington et al. 2017) and subsequent lack of collection in the fall suggests relatively high apparent mortality rate between the larval and juvenile life-stages. The source of this apparent recruitment bottleneck in the San Juan River is presently unknown. However, stable, low-velocity habitat was identified by the SJRIP Biology Committee as the habitat most likely critical for age-0 Razorback Sucker recruitment (SJRIP December 2019 Habitat Workshop) and is a habitat that can be relatively scarce in the San Juan River (Lamarra and Lamarra 2017).

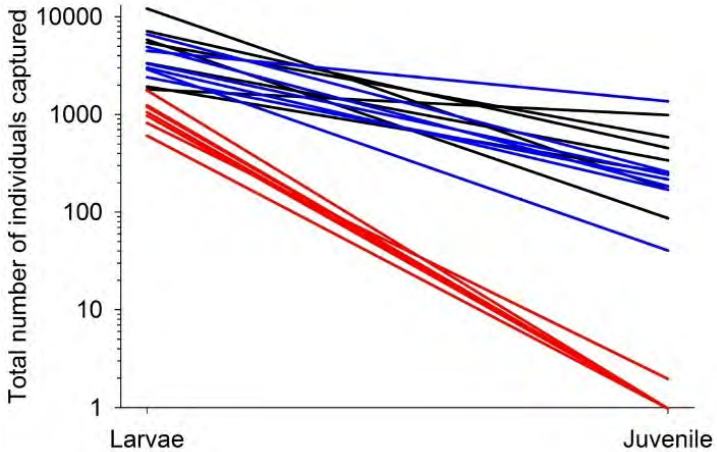

Figure 1. Total number of larval fish captures between 2011 and 2018 from larval and small-bodied fish sampling. Razorback Sucker (red) show lower recruitment rates between spring/summer larval samples and fall age-0 juvenile collections compared to Bluehead Sucker (blue) and Flannelmouth Sucker (black) as indicated by the steeper slopes. Every line represents one year and 1 was added to each value to facilitate plotting on a log scale. Figure developed for the SJRIP's February 2018 Recruitment Bottleneck Workshop with data from Farrington et al. (2017) and Zeigler and Ruhl (2017).

Methods

Site and general operations

The Phase III habitat restoration project was designed to mimic a floodplain wetland (Appendix I). The 8,500 m^2 wetland will be located at river mile 107 and filled from an upstream secondary channel (Figure 2). After larval fish are entrained and reared during spring through fall, fish will be harvested and released from the wetland's downstream outlet.

Figure 2. Aerial photograph and Keller-Bliesner's wetland design concept at San Juan River mile 107 (Appendix I). The red arrow depicts direction of river flow. The large blue polygon is the wetland and the smaller one is the stilling basin at the inlet from the secondary channel. The other red lines represent channels for water transfer into and out of the wetland.

Task 1: Operations and water quality monitoring (NMFWCO)

Staff gauges and electronic sensors to monitor water depth and quality will be installed prior to filling the wetland and entraining larval fish. Staff gauges will allow water depth to be measured visually and electronic water level (pressure)-temperature sensor and loggers (HOBO U20L-001) will be installed to collect hourly water levels and temperatures. Three water quality sensors will be placed at the deepest points along the length of the wetland (Figure 3). A fourth staff gauge will be installed at the confluence of the wetland outlet and San Juan River to establish a relationship with wetland depth and river level (Figure 3). A relationship between staff gauge and pressure sensor measurements will be established to provide a continuous record of wetland water levels. The sensors will be installed in an L-shaped stilling basin with the bottom of the "L" underwater and data from loggers downloaded during each visit to the site. Standard operating procedures for field calibration, cleaning, and maintenance of the electronic sensors will be implemented at each visit.

Filling of the wetland and entrainment of larval fish will begin in May when larval Razorback Sucker are expected to be present and at their highest densities (Appendix I). The inlet gate will be opened the first week of May and remain open for four weeks. While the wetland is entraining larval fish, gate(s) will be checked twice a week to ensure they are operating properly and to remove debris from the trash rack/screen.

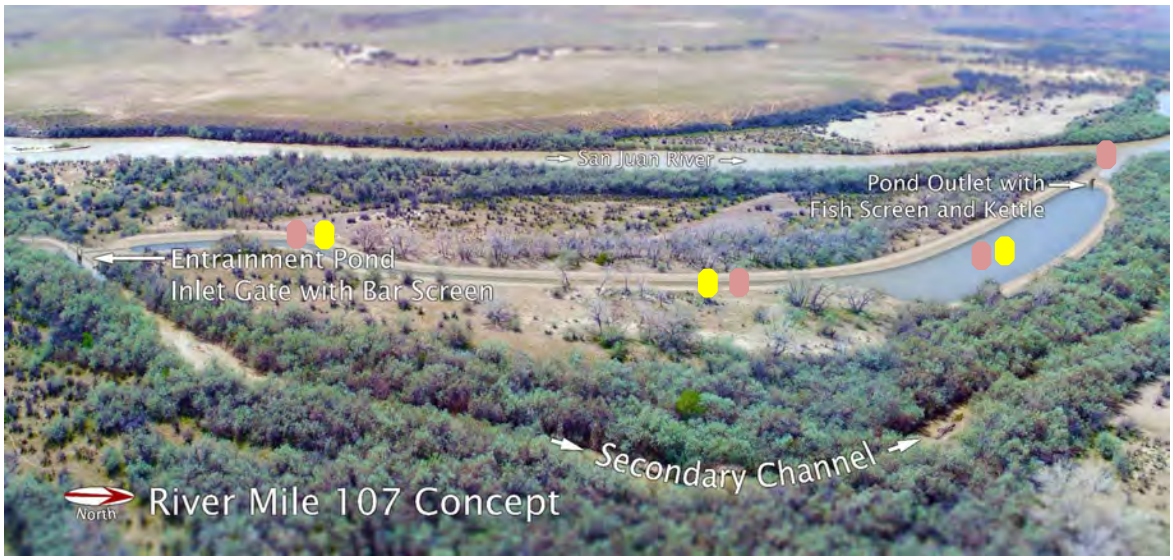

Figure 3. Potential location of water quality monitoring sites for the Phase III constructed wetland (image from Keller-Bliesner's design concepts Appendix I). Yellow polygons indicate potential locations for water quality monitoring sensors and red polygons indicate water depth monitoring sites.

Water quality monitoring will occur weekly once the wetland gates are closed. Measurements will include water depth and dissolved oxygen concentrations from the staff gauges and electronic water quality sensors, respectively. If pond depth is < 1 m in the deepest portion of the pond or dissolved oxygen concentrations are 4-5 mg/L and trending downward, the inlet gate will be opened to increase water to depths > 1 m or to add additional oxygenated water. This monitoring and management will continue until the pond is drained in mid-October (Table 1).

Table 1. Activities, timetable and agency participation for wetland operations.

	Install water monitoring equipment	Twice weekly, check trash rack/screen	Once weekly, water quality monitoring and pond operations
NMFWCO	Spring (between March and April)	Month of May (4 weeks)	June to October (~ 20 weeks)

Task 2: Assessing larval Razorback Sucker entrainment and monitoring survival

As outlined in the construction scope of work (Appendix I), four fish sampling trips (three larval, one small-bodied) will be conducted (Table 2). Prior to the four fish sampling efforts, locations of each individual seine haul will be pre-selected and geographic coordinates determined and recorded with a hand-held GPS unit. These coordinates will be used to place numbered bamboo stakes (2 m) at the beginning and end of each haul to ensure subsequent sampling efforts occur in the same locations and that sampling effort remains consistent across trips. Sampling will be designed to target approximately 1% of the overall surface area of the wetland. This equates to 10 discrete seine hauls, each about 10 m long, that will be evenly distributed between shoreline and open water habitats. Both shoreline and open water habitats will be sampled in the inflow canal and wetland. Larval fish sampling will employ small mesh seines (ca. 1.0 m x 1.0 m x 0.8 mm mesh) and larger seines (ca. 3.0 m x 1.8 m x 3.0 mm mesh) will be used for small-bodied fish sampling. Aquatic habitat designations (either shoreline or open water) will be recorded by seine haul and contents of

each seine haul preserved independently. Retained specimens will be placed in Whirl-paks containing 95% ethanol (EtOH) and a tag inscribed with unique alphanumeric code that will also be recorded on a field data sheet and placed into the sample bag. Capture densities of fish from seine samples will be reported as the number of fish per 100 m^2. Native species large enough to be positively identified will be measured and released. All nonnative fish species identified in the field will be enumerated and removed.

The first two sampling efforts (pre-closure and post-closure) will be conducted by a two-person crew who will travel (during morning) to the wetland and sample the site upon arrival (late afternoon). For both trips, the sampling crew will camp overnight at the wetland site and again sample the same 10 locations in the wetland the following morning. Samples will be returned to the University of New Mexico, Museum of Southwestern Biology for processing.

The third sampling effort will coincide with a scheduled long-term larval fish monitoring trip. For the third effort, sampling crews will be floating the San Juan River (July) between Shiprock, NM and Sand Island, UT. Upon arrival at the Habitat Restoration Phase III site, personnel will sample each of the 10 seining locations using the same techniques as described above and then continue downstream to complete the monthly long-term larval fish sampling trip.

Collection and preservation of specimens, gathering of physical data, field work safety, laboratory work, fish identifications, quality assurance and control, and data analysis will follow the methodology outlined for the San Juan River larval Razorback Sucker and Colorado Pikeminnow monitoring program (i.e., SOW 21).

Trip 1:
The purpose of the first trip is to determine whether larval fish were entrained during the filling process. The initial filling of the site is likely to be completed in < 24 hours but the 1.2 m-wide inlet gate will remain fully open for about four weeks. Therefore, the first larval fish sampling effort will likely occur prior to closure of the inlet gates (ca. end of May). This will allow for determination of Razorback Sucker larvae entrained (number of fish per 100 m^2) prior to closing the inlet gates.

Trip 2:
This trip will occur in early June and the purpose of the second trip is to confirm short-term survival of entrained larval Razorback Sucker. Data obtained from this sample will also be used to calculate growth rates of larval fish and compare those to growth rates to other larval San Juan River suckers (Clark-Barkalow et al. 2019). In future years, if overall entrainment of Razorback Sucker is deemed low by the Biology and Coordination Committees, the results of the first two monitoring efforts would be used to trigger the contingency plan for the wetland, which consisted of stocking wild larval suckers into the wetland as described in the construction scope of work (Appendix I).

Trip 3:
The purpose of the third sampling trip is to determine long-term survival of larval fish and assess larval fish development. This trip will occur during mid-July and be conducted in conjunction with the long-term larval fish monitoring efforts. Based on previous larval fish samples, it is anticipated that most Razorback Sucker collected from the wetland during July would have progressed into the early juvenile stage. Therefore, most fish collected should be identifiable in the field and released into the wetland. Fish that are too small for field

identification will be retained for laboratory identification. All Razorback Sucker collected will be measured (standard and total length) and those data combined with previous samples to determine average wetland-specific Razorback Sucker growth rates.

Trip 4:
The fourth and final monitoring trip will occur in early to mid-September to verify that Razorback Sucker survived the recruitment bottleneck and transitioned to the juvenile stage. Because fish at this time will likely be juveniles, a larger seine will be used, and the same sites sampled for larval fish will be sampled. Razorback Sucker will be measured (standard and total length) and released back into the wetland. All other native and nonnative fishes will be counted and returned to the wetland. Any unidentifiable fishes will be retained as described above for laboratory identification. Sampling of the inlet canal will not occur during this trip.

Laboratory work:
Based on the densities of larvae typically found in the San Juan River from May through July, it is anticipated that processing and identification of all retained samples will require approximately seven days. This sample processing estimate assumes that nonnative species (particularly nonnative small-bodied cyprinids) would mostly be absent from wetland collections. If nonnative species establish and reproduce within the wetland, processing and identification of the constructed wetland larval fish samples could take considerably longer.

Table 2. Activities, timetable, and agency participation for assessing entrainment and monitoring survival of larval Razorback Sucker in the constructed wetland.

	Quantify entrainment	Assess initial survival	Asses survival and growth	Assess larval recruitment to juvenile
ASIR	End of May, larval sampling	Early June, larval sampling	Mid-July, larval sampling	
PO				Early September, juvenile sampling

Task 3: Wetland draining and evaluation
Draining the wetland with the capture and enumeration of fish will occur in mid-October (Appendix I and Table 3). Based on experience draining and enumerating fish at Navajo Agricultural Products Industry (NAPI) ponds, the wetland is likely to take approximately three days to drain. During this time, the aeration system from NAPI Razorback Sucker grow out ponds will be utilized at the wetland and operated continuously. Once fish are concentrated, they will be collected and held in an aerated foldable holding tank. Processing of all native suckers prior to release will include species identification, total length measurement, and implantation of a passive integrated transponder tag into Razorback Sucker if appropriately sized (i.e., > 120 mm). All native fishes will be released into the San Juan River while nonnative fishes will be enumerated and euthanized.

Table 3. Timetable and agency participation for draining the wetland and evaluating its success.

	Drain pond over a 3-day period	Capture and process fish
NNDFW	Between October 18th and the 30th	
PO	Between October 18th and the 30th	

Evaluation

As described in the construction scope of work (Appendix I), the objective of this habitat project is to assess whether providing large, stable, low-velocity habitat can increase the number of Razorback Sucker that recruit to and beyond the juvenile stage in the San Juan River. In 2018, the greatest number (n = 6) of wild age-0 Razorback Sucker were collected across primary and secondary channel and backwater habitats during a spatially truncated small-bodied monitoring effort (Zeigler and Wick 2019). Extrapolating the estimated catch per unit effort of wild age-0 Razorback Sucker in 2018 (0.011 fish/10 m^2; Zeigler and Wick 2019) to the size of the Phase III wetland (8,500 m^2) would result in approximately nine fish being present at those densities. The proposed Phase III wetland represents almost 2/3 of the mean area of backwater habitat associated with secondary channels (13,684 m^2, SD = 7,719 m^2; Lamarra and Lamarra 2017). Based on these calculations, the ultimate measure of success for this wetland would be production of 1-9 wild juvenile Razorback Sucker in the fall. This would demonstrate that large, stable, low-velocity habitat can increase Razorback Sucker larvae survival through the spring and summer to the juvenile life-stage in the fall. Ultimately, success of the Phase III project would indicate larger and more stable backwater habitats may increase the recruitment success of wild-spawned Razorback Sucker in the San Juan River.

As described in the construction scope of work (Appendix I), a proximate objective for the first few years of the wetland's operation will be to ensure that mechanisms to entrain native larval suckers are working. Since Razorback Sucker are relatively rare, the evaluation of this objective will be based on assessing densities of the two common native suckers. Larval Bluehead and Flannelmouth sucker densities in the wetland should be similar to those captured in low-velocity habitats in the adjacent mainstem San Juan River if the facility is adequately entraining larval fish. To make this assessment, larval fish captures from the first sampling effort (May, post filling) will be compared to larvae fish captures 10 river miles upstream of the wetland and downstream to the San Juan River-McElmo Creek confluence (in total: river miles 117.0-100.5). The downstream section will end at the McElmo Creek confluence because spawning by suckers is known to occur within McElmo Creek. A simple independent samples t-test will be used to test for differences in mean larval sucker densities in the wetland versus low-velocity habitats in the river proper, using individual seine hauls as the unit of replication. A lack of significant differences would indicate the facility is entraining larval at a rate similar to other backwater or low velocity habitats in the river.

Deliverables
A draft annual report will be compiled by the PO by 31 March 2022 and a revision that includes responses to BC member comments submitted by 30 June 2022. An oral report will be given at the winter SJRIP Biology Committee (BC) meeting.

Acknowledgements
Vince Lamarra (Ecosystems Research Institute) first suggested the idea of a restored floodplain wetland. Ron Bliesner and Brian Westfall (Keller-Bliesner Engineering, LLC) further developed the concept by evaluating potential sites and developing the design concepts and initial construction budgets. David Gori (The Nature Conservancy) led the development of the construction scope of work.

Budgets
ASIR – Task 2

Travel, Per Diem, Material/Supplies, and Personnel	
Travel - 4 x 4 pickup trucks (530 miles x $ 0.575/mile x 2 trips x 1 truck)	$615
Per Diem - 2 field days per trip x 2 staff ($55/day GSA M&IE rate) x 2 trips	$440
SJRRIP Meetings (Costs are covered under SOW 21)	0
Travel and Per Diem Total	$1,055
Personnel	$9,982
Materials and Supplies	0
Total	$11,036

NMFWCO – Task 1

Equipment	
Measuring water level (staff gauge, board, pvc): 4 units at $200 each	$800
HOBO MX2001 data logger (pressure sensor): 4 units at $599 each	$2,396
HOBO MX2001 read water level logger cable 30 m cable: 4 units at $190 each	$760
HOBO U26-001 data logger (dissolved oxygen and temperature): 3 units at $1,250 each	$3,750
HOBO U26-001 shuttle/base station/software	$373
Shipping/handling and taxes at ~6%	$400
Total	$8,479

NNDFW – Task 4
No request for funds

PO – Tasks 3 and 4
No request for funds

TOTAL REQUESTED
$19,516

References

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Zeigler, M. P. and M. E. Ruhl. 2017. Small-bodied fish monitoring in the San Juan River: 2016. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM.

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Appendix I
Phase III construction scope of work

Can be accessed at
https://www.fws.gov/southwest/sjrip/pdf/2019workplan.pdf

Response to Comments (in blue font*)* from BC Members

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

Seems well-thought-out overall. Why was the target capture density set at 10% of that in the adjacent river? Seems like a very modest goal.

The Scope has some missing words and such; recommend a good edit before finalizing.

We struggled with identifying a metric that we thought would signal successful entrainment and agree a 10% of densities observed in the river was a modest goal. We have changed this section to actually test if densities are different between the main stem river (only low-velocity habitats) and the wetland using a simple t-test. We think starting with the null hypothesis that densities should not be different in the wetland compared to other zero-velocity habitats is a good starting point to assess the function of the structure. We have tried to clean up the typos as well.

What is this SOW's contribution to recovery?

If the wetland refugium concept works it could be a game-changer. I don't see why we would build the constructed wetland and then not do this evaluation.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

A contingency plan could be included that states how many years the phase iii will be operated as planned if no Razorback Sucker are captured in the first year, and also outlines the process of stocking larval Razorback in the wetland if no Razorback are entrained in flows during the first few years.

When to implement the contingency plan was not determined during development of the construction scope of work and will need to be determined by the Biology and Coordination Committee. Earlier drafts of the Phase III construction scope of work detailed how wild larval fish collection and stocking process would occur but was withdrawn from the approved version. In the draft version the proposal was:

> "Since the species of larval fish cannot be identified during collection and stocking, area seined will be used as a surrogate and calculated as the quantity necessary to increase the wetland density to the desired density (i.e., $0.111/m^2$). Therefore, we would use the following calculations to estimate the amount of backwater habitat that would need to be sampled in order to supplement numbers of larval Razorback Sucker in the wetland:
>
> 1) The constructed wetland is $8{,}500m^2$. Therefore, the total number of larvae at the desired density of $0.111/m^2$ is 944 individuals.
> 2) The total number of individuals present in the wetland if their density is $0.025/m^2$ is 213.
> 3) Density in the month of May in San Juan River backwaters near the wetland is $0.111/m^2$
> 4) Thus, to approximate capture of 731 larvae (944-213), $6{,}579m^2$ would be sampled from San Juan River backwaters ($731/0.111/m^2$).

5) Efficiency of collection may be increased if larval Razorback Sucker is present at inlet embayment in prior week(s) and larvae from this habitat could be continually seined."

What is this SOW's contribution to recovery?

This SOW could identify whether a lack of low velocity habitat is limiting Razorback Sucker recruitment to a juvenile life stage.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

How can the technical aspects of this SOW be improved? I think that this is a strong proposal with appropriate metrics that determine success. I would add that the WQ and physical monitoring of the constructed pond be expanded to include water elevations of the river or secondary channel. I think that the water elevations in the pond will vary as river stage changes. In addition, the water quality in the pond will not be the same as in the well points. Moving forward, if larvae are not detected, rather than seed the pond with larvae at a future date, it may be better to put spawning adults in the pond as an alternative.

To relate river and wetland stage, a staff gauge was added to the protocol and would be placed at the confluence of the outlet and river. Two additional oxygen sensor locations were added to the protocol. These will be located at the deepest points along the length of the wetland which is now shown in Figure 3. The contingency plan agreed upon in the construction scope of work indicated seeding the pond with wild larvae. If the Biology and Coordination committees decide they would prefer a different contingency plan then this scope of work will be revised to reflect the implementation, monitoring, and evaluation of that plan.

What is this SOW's contribution to recovery?

No comment

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

SOPs for field calibration, cleaning and maintenance and drift correction for the Dissolved Oxygen sensor should be developed (if not in place already) and implemented. The resource characterization synergy with SOW 1 is good.

The scope of work was revised to state that standard operating procedures (SOPs) would be followed.

What is this SOW's contribution to recovery?

Improve survival rates and augment the population of RBS to support recovery efforts and assess the effectiveness of management actions (creation of low velocity wetland habitat).

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

No comment

What is this SOW's contribution to recovery?

Not sure, but this scope is a contribution to our understanding of managed flood plain refugium and it allows measurable outcomes of our Phase III Project. A large amount of time, effort, and funds have gone toward Phase III and without a well thought out monitoring protocol we will not gain the information required to analyze success and or limitations, or the knowledge required to identify possible recruitment bottlenecks in the population. The purpose of Phase III was to advance recovery goals, this scope is a requirement to do so properly.

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

I like this SOW and I think we need to pursue this work. We need to have monitoring of this site!) My one major comment stems from a statement made on lines 62-67.

"*Additionally, the limited collection of metalarval Razorback Sucker, the most mature phase of larvae, and the reduction in collection of this larval phase as early as July (Farrington et al. 2017) suggests relatively high mortality rates within the larval phases and is likely a factor contributing to the lack of recruitment to the juvenile life-stage over the spring-summer months. The source of this apparent recruitment bottleneck in the San Juan River is presently unknown."*

I find it interesting that because we don't have metalarvae that we assume that it is because of high mortality. If mortality between the three species were the same, then we assume that we would just have 1/3rd the number of RBS than we have of BHS (+/-). Why do we not consider/hypothesize that RBS have a VERY DIFFERENT drift ecology? What about if BHS and FMS were "stickier" with respect to getting caught up in channel margins and slack/back waters? What if RBS just aren't that sticky and drift downstream. Maybe their ecology was to take advantage of a very warm and productive lower river which historically was Glen Canyon? It might be possible that RBS actually have HIGHER survival because they are in the main channel and are not entrained or stuck in back and slack waters where they could be predated or trapped due to receding water levels.

The section was edited to use the phrase "apparent" mortality to provide for the possibility that drift out of the system was causing the lack of detecting recruitment in the river. Given the monitoring protocol it may be possible to inform these hypotheses.

2) I think you may want more than one DO sensor in the wetland. Do can vary greatly across even a small body of water and one sensor might not accurately measure DO across the wetland. The stilling basin might be exceptionally low and not really give an

accurate reading. I think at least 2-4 would be better. One at the stilling basin in mid water column, one along the shore, and one located in vegetation that develops.
We agree. Please see response to Lamarra above.

3) Why can't all four sampling trips be combined with larval sampling in the River like you are planning for the 3rd sampling trip? In your proposal you do not mention what you will do for trip # 4. It just seems excessive to drive that far to collect 10 seine hauls of 10 meters each. A lot of travel for minimal sampling. For the first trip why not close the inlet gate then collect a sample, or collect sample and then close the gate? No need to return after you collect samples to close the inlet.
The fourth trip is planned to occur after larval sampling has ceased for the year. The fourth trip was included in the construction scope of work to verify that larvae transitioned to juveniles. This purpose was clarified in the current draft scope of work. Since these are the life-stage where the recruitment bottleneck has been identified and what the project is attempting to alleviate, it is important to have enough data resolution to determine with degree of confidence that the wetland was successful. Waiting until October (a 2.5 month period between sampling events) would leave open the possibility that fish did transition to juveniles but that the juveniles then died. This option does not increase costs for this scope of work and once the wetland is shown to function as intended monitoring trips can be thinned. Trip 1 is proposing to collect the sample and then close the gate to verify larvae were actually entrained. Trip 2 would occur a few weeks later to assess whether entrained larvae survived. Hopefully the purposes of these trips were clarified in this draft.

4) I see you have a contingency plan or stocking the wetland if numbers of larvae are "low." I really like this idea and support it 1,000% percent. A couple of questions about this contingency plan:

A) What number/metric/density are you using to determine "low?"
Please see response to Davenport.

B) Do you have an agreement with SNARRC to have them hold back some larval RBS for stocking into the wetland?
At the current time, the contingency plan in the construction scope of work is to stock wild caught larvae not hatchery fish. We think the SJRIP should be open to other options but the BC will likely need to make those decisions before a final contingency plan can be developed.

C) What is the number of larvae you want in the pond, i.e., density?
Again, these details will likely need developed by the BC before a SOW can be written.

5) Line 217 needs to be rewritten—it doesn't make sense as it is now. I think you want it to read "compar**ed to** capture**s**". Check lines 219-220 as well.
The sentence was revised.

6) The criteria for success is 1-9 RBS at the end of the growing season. I understand where this number is derived (extrapolated from densities of wild RBS YOY's captured in 2018). But, this seems like an awfully small number of fish to develop success criteria. If only one or two RBS were to die just prior to release to the river then the project would

not be "successful." I have always been an advocate of stocking this wetland just to have a larger number of fish for a sample size. I think we should consider stocking the wetland and collecting genetic samples from fish released from the wetland for comparison to known parental units at the hatchery. This would give us more fish to work with in the wetland and allow us to separate wild larval fish from stocked larval fish when they are released to the river in the fall. The nice thing about doing this is the ability to put a known number of fish in the wetland and be able to calculate survival.
We are open to developing a SOW for other contingency options, if the Biology and/or Coordination committees decide to manage this wetland in a different fashion, this scope of work can be rewritten to implement that.

What is this SOW's contribution to recovery?
Knowing the success and productivity of this wetland is important for knowing whether the money spent on this habitat was worthwhile and whether we should construct more of these in the future. Evaluating the success of this wetland should be considered a high priority.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?
Appendix I is missing from the proposal and a full review could not be completed. The SOW needs to have all documents for a thorough review. The SOW should include a figure that shows the physical layout of the wetland and proposed location for the monitoring equipment. The narrative states the locations for equipment placement, however, it is not descriptive enough to fully visualize the placement for this review. The SOW states the inlet gate will be open for four weeks starting the first week of May. There should be a table that shows the wetland volume and fill rate based on the gate opening. Will the gate remain fully open and if so how long will it take to fill? Task 2 states that fill will take less than 24 hours. Will there be flow through the wetland or will the downstream closure of the wetland preclude any further flow into the wetland? Measurements of the inflow velocity during the fill and the times the gate is open would provide data to evaluate the ability to entrain larval fish. The SOW states that water level will be increased if DO levels are trending downward. Does the secondary channel that provides water to the inlet flow all summer discharges?
A figure is needed to show example locations for the seining in Task 2. Trip 4 is scheduled for early to mid-September. Is this trip needed since the wetland would be drained in October and any fish remaining could be captured at the outlet?
The live link to Appendix I was broken when the annual work plan document was compiled. The web link to the annual work plan where the SOW is published has been added as appendix I. Figures 2 and 3 were added from the construction scope of work and a hypothetical layout of proposed water quality monitoring sites was added to Figure 3. The construction scope of work stated the wetland would be expected to be filled within 24 hours and would be filled with the outlet gate closed to limit intake of sediment. The construction scope of work indicated the location of the wetland was chosen because the adjacent secondary channel was historically stable/flowing at 500 cfs. Please see response to McKinstry #3 in regards to trip 4.

What is this SOW's contribution to recovery?

It would document whether larval Razorback Suckers could be retained in grow in an artificial off-channel habitat.

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

What is this SOW's contribution to recovery?

It is essential to document any success that the Phase III site would have. This SOW provides data while the wetland is operational and at the end of the season as well. With the exception of 2018, YOY Razorback Suckers have been hard to come by in sampling, hopefully this will show success in the wetland.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

Overall, I found the SOW to be well-written and comprehensive. On page 227 there does appear to be some duplication in the write-up of the fish sampling that could be eliminated. Also, to reduce the potential sacrifice of larval razorback sucker, is Trip 2 really needed? Why not just combine it with Trip 1.

Please see response to McKinstry #3.

What is this SOW's contribution to recovery?

As the Program has identified this management action as potentially critical to improving recruitment of razorback sucker, thorough monitoring is a high priority to determine if this type of habitat creation can contribute substantially to recovery.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

Line 51-52: Adding stationary wildlife cameras to the site would likely benefit the project goal of identifying "when mortality events may have occurred". Avian predation is a known source of significant mortality in constructed aquatic habitats. Wildlife cameras may be able to document sources of mortality that would otherwise go unnoticed. Secondly, relatively inexpensive wildlife cameras are capable of transmitting images and video via cellular connections and this option would allow personnel to monitor water levels more often than once or twice weekly. Lastly, wildlife cameras would be capable of documenting potential vandalism if any occurred.

It was determined that vandalism would likely be an issue with the cameras themselves and there is no cellular service at the site.

Line 99: Will a weekly check of the DO be frequent enough to catch sudden decreases? Is it possible to get a DO meter than can transmit readings?

Given NMFWCO's remote biologist's capacity, the maximum frequency of checking on DO was once a week. If there are sudden decreases that cause fish kills this may indicate additional staffing capacity is necessary and/or there are larger issues with the wetland. There is no cellular service at the site.

Line 117-122: Given the depth of the pond (> 3 ft), how effective will sampling larval and small-bodied fishes be using seines? Sampling for larval fish will obviously be more effective, but small-bodied sampling will probably be very difficult, especially when sampling open water pond sections.
We agree sampling efficiency may vary across different water depths. However, because we will sample ALL juvenile fish that survive the entire rearing period, we will be able to assess variation in efficiency. For example, if very few fish are collected on the fourth trip but lots of fish are present when the pond drains, then we will know we were not very efficient and change monitoring accordingly.

Line 159: What contingency plan is in place to stock wild larval suckers into the wetland? Please provide information on what triggers this contingency plan and what its methods are.
The contingency plan was stated under Trip 2's description in the first draft and has been reiterated in the Purpose to be more explicit. Please see response to Davenport.

Line 173: Why is trip 4 needed? Draining the pond in October will provide information on whether or not Razorback Sucker recruited past the larval stage and survived. This was discussed in length at the February 2020 BC meeting. I thought that it was determined that this sampling was not needed.
It was determined at the BC meeting that NMDGF did not want to conduct this effort. Please see response to McKinstry #3.

Line 179: All native suckers should also be measured. This would allow for the assessment of differences in growth between any entrained sucker species.
This section was clarified to include all native suckers.

There are a number of omissions, typos, and awkwardly constructed sentences within the SOW (see examples below). Editing these would greatly improve the readability of the SOW
Typos identified below were corrected.

Line 120-122: "Sampling efforts will employ small mesh seines (ca. 1.0 m x 1.0 m x 0.8 mm mesh) fish larval fish sampling and larger seines (ca. 3.0 m x 1.8 m x 3.0 mm mesh) for small-bodied fish sampling".
Line 130-131: "The first two sampling efforts will consists of two person crews who will travel to the wetland and sample the site upon arrival (late afternoon).
Line 148-150: "The initial filling of the site is likely to be complete in <24 hours but that the 4-ft wide inlet gate would remain fully open for ca. four weeks."
Line 155-156: "This effort conducted to verify the continued presence/survival of larval Razorback Sucker in the wetland."

Line 202-204: Change "pit-tag" to passive integrated transponder tag
Line 242-245: "This would objectively and quantifiably demonstrating that large, stable, low-velocity habitat increases Razorback Sucker larvae survival through the spring and summer to the juvenile life-stage in the fall."
Line 245-248: "The lower end of the range of success represents more wild juvenile Razorback Sucker than have been documented across all sampled habitats in all but two year of small-bodied monitoring and the upper end assumes the estimated CPUE of wild YOY Razorback Sucker documented in across all habitats in 2018 could be replicated in the constructed wetland."

What is this SOW's contribution to recovery?

Phase III provides a unique opportunity to assess the hypothesized recruitment bottleneck of Razorback Sucker within a mostly controlled system. Monitoring water quality and quantity, as well as fish will be important for assessing how well the wetland entrains larval fish and if Razorback Suckers recruit into post-larval juvenile fish. The Phase III project has the potential to provide a significant contribution to recovery if it increases knowledge on the recruitment of Razorback Sucker. Success or failure of the project will only be determined with this monitoring.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

It is good that a reasonable scale of monitoring and evaluation is planned for Phase III. This illustrates a sound attempt of a test of concept (i.e., artificial wetlands may enhance Razorback Sucker survival in the San Juan River). The project is being developed and assessed within an adaptive management framework, not as a formal research project with specified hypotheses. That is reasonable. However, the proponents should consider a wider array of quantifiable objectives to enable a stronger evaluation of the project, as well as more specific objectives for Razorback Sucker.
This scope of work details the objectives that were agreed to in the construction scope of work. If the Biology or Coordination committees determine other objectives are warranted, this scope can be amended to include and evaluate them.

The first "goal" (actually a quantifiable objective) to be used in the evaluation process is not clear to this reviewer. The biological goal pertinent to larval density is "common sucker capture density in the wetland to be at least 10% of that in the adjacent mainstem San Juan River." Data and an example computation are provided, but the goal for larval fish density remains unclear.
Please see response to Crockett.

A second goal (objective) is to find 1-9 juvenile Razorback Sucker in the wetland upon its draining. That is an easily understood quantifiable objective, but what additional objectives may be applied to the fish community structure upon draining? For example, what is a reasonable density of nonnative predators and competitors?
This is a good question and we agree other objectives could be asked from this monitoring. However, at this point, those are likely secondary questions and we are

primarily focused on native Razorback Sucker. Nonetheless, we will be able to investigate those types of questions, but to keep the SOW focused to meet most people's concerns we have not included them here.

Beyond the focus on Razorback Sucker, there are several additional quantitative objectives that could be developed to facilitate evaluation of success or failure of Phase III, and to provide insight into biological and physical processes occurring in the wetland. Water levels and dissolved oxygen will be monitored, but what are the quantifiable objectives for water levels and water quality in the wetland? There are additional physical and biological factors that may affect survival of Razorback Sucker and other fish species in the wetland that could be identified with associated objectives. Consider formal sampling/observations and objectives for water temperature, phytoplankton blooms (particularly cyanobacteria), turbidity/water clarity, filamentous algae and aquatic macrophytes, fine sediment deposition, vertebrate activity (beaver, muskrats), etc.
Please see responses above.

The sampling design for larval and small-bodied fishes is not clear. It is stated that 10 fixed sampling sites will be established. Sampling will be stratified between shoreline and open water, and between the inflow canal and the wetland. It is not clear how many sampling sites will be established in each strata. This reviewer suggests 5 shoreline and 5 open water sampling sites for larval fish, with additional sampling in the inflow canal, during Trips 1-3. When sampling small-bodied fish with a larger seine during Trip 4 the inefficiency of sampling in open water must be addressed. This reviewer recommends sampling at 10 shoreline locations during this trip. Sampling of the inflow canal is probably not necessary during Trip 4.
The scope of work was revised to state sampling would be split between habitat types. It is agreed that there would be inefficiencies but the objective is to determine whether larval fish have transitioned to juveniles rather than make a quantification. Trip 4 was revised to indicate the inflow canal would not be sampled.

It is stated that during Trip 4 when sampling with a larger seine nonnative fishes that are collected will be removed from the wetland. This may seem to be a wise management activity, but how will that bias the outcome upon draining of the wetland? Control on nonnative fishes is not a management activity that takes place among artificial wetlands. This reviewer suggests that nonnative fishes collected during Trip 4 be returned to the pond to provide a better understanding of the processes (i.e., competition, predation) that may be occurring in the wetland.
This is a good point, while we doubt we would have a substantial impact to over-all abundances of nonnative fishes, we have altered the text to state nonnative fish will be returned to the wetland to limit potential 'hidden treatments'.

SOW 1 describes sampling for chlorophyll a and macroinvertebrates in the "Phase III artificial pond." In is not clear within either this SOW or SOW 1 what is planned for the monitoring and evaluation of the Phase III relative to primary production or benthic invertebrates. The nature of the collaboration needs to be described in detail. What is the experimental design for assessment of Phase III? What are the metrics to be assessed?

How are the data to be analyzed? More detailed criticisms of the sampling methods are provided in the review of SOW 1.
In the future there may be interest from the committees to ask and answer these questions but currently the metrics are the number of juvenile Razorback Sucker that result from draining the wetland and the density of larval fish compared to the river.

What is this SOW's contribution to recovery?
Phase III is another test of concept project that has potential for determining if artificial wetlands have application to recovery of Razorback Sucker in the San Juan River.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?
The PIs have covered the bases. The estimate of production is disappointing but maybe it's wrong.

Minor typos (highlighted text)
84
157
246
247
The typos were corrected

What is this SOW's contribution to recovery?
If the "wetland" is built then the Program has to know how well or poorly it worked. If it produces juvenile razorbacks in good numbers over time then we will know this is a viable management for that purpose. Hopefully one more key to overcoming the juvenile bottleneck.

Program Office

How can the technical aspects of this SOW be improved?
Provide a rational for the 10% metric in line 215.
Please see response to Crocket.

The math in Table 4 needs to be checked for Speckled Dace and Fathead Minnow.
The values were corrected.

May want to consider adding several areas in the wetland to measure 0_2 given the multiple factors that could impact these concentrations at different depths and other local conditions (e.g., river influenced versus ground water influenced).
Please see response to Lamarra

Editorial comments:
Line 217 are there some words missing from this sentence?
The sentence was revised.

Lines 223-224 clarify whether these are wetland larval densities
The sentences were revised for clarification.

Line 243 tense of “demonstrating.”
The tense was corrected.

What is this SOW’s contribution to recovery?
This work will be the only assessment of the constructed Phase III wetland.

COLORADO PIKEMINNOW BROODSTOCK COLLECTION FROM THE GREEN AND COLORADO RIVERS, UTAH

FISCAL YEAR 2021 SCOPE OF WORK

SUBMITTED TO THE U.S. BUREAU OF RECLAMATION

SUBMITTED BY

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COLORADO PIKEMINNOW BROODSTOCK COLLECTION FROM THE GREEN AND COLORADO RIVERS, UTAH
FISCAL YEAR 2021 PROJECT PROPOSAL

Background

Colorado Pikeminnow *Ptychocheilus lucius* and Razorback Sucker *Xyrauchen texanus*, once common throughout the Colorado River basin, have declined from historic levels. Various factors have contributed to the decline of the species including alteration of natural stream flows and temperature regimes, loss of habitat and habitat fragmentation as a result of water development and the introduction of nonnative fish species. If an effort to halt the decline and recover these two species, recovery programs were established in the upper Colorado River basin and San Juan River basin. A cornerstone, among the myriad of tasks being undertaken to save these species from extinction, is the propagation and augmentation of wild populations with hatchery produced fish. Southwestern Native Aquatic Resource and Recovery Center (Southwest ARRC) has developed production guides for both species and produces large numbers of each for distribution throughout the upper and lower Colorado River Basin.

Southwestern ARRC has been the leader in propagating and culturing Colorado Pikeminnow since 1981. The facility maintains several captive stocks as genetic reserves and has successfully produced fish for the Upper and Lower Colorado River Basin programs and the San Juan River basin Recovery Implementation Program (SJRRIP). A primary emphasis of Colorado Pikeminnow study at Southwestern ARRC has been examining the reproductive biology of the species, broodstock development, and culturing age-0, age-1, and adult fish. Southwestern ARRC currently produces 400,000 age-0 fingerlings (50 mm TL) annually for reintroduction in the San Juan River. Broodstock consists of 200 (F1) and 450 (F2) adults. These fish are 1999, 2004 and 2006 year-class progeny from wild adults collected from the Yampa, Green and Colorado Rivers, respectively. In 2006 Southwestern ARRC staff began culturing a second broodstock of 500 (F2) individuals for future use. This stock is referred to as the 06CRDX lot, derived from the 1991broodstock.

Recent investigations of the genetics of the Colorado Pikeminnow broodstock at Southwestern ARRC suggest the need to initiate the process of developing a new, and hopefully more genetically robust Colorado Pikeminnow broodstock using wild specimens from the Green and Colorado rivers. Early life-stage Colorado Pikeminnow monitoring is an ongoing effort in the Green and Colorado River basins to evaluate spawning success and monitoring of juvenile Colorado Pikeminnow occurs in conjunction with adult population estimates in the Green and Colorado rivers. Maintaining a healthy and robust Colorado Pikeminnow broodstock has been identified as a priority in both the San Juan and upper Colorado River basins, and may be necessary given recent declines in this species in the Green River basin. Southwestern Native Aquatic Resource and Recovery Center (Southwest ARRC) has requested, after discussions with the San Juan River basin recovery upper Colorado River basin programs, 1,000 individual YOY Colorado Pikeminnow for broodstock augmentation purposes from the Green and Colorado Rivers. Ideally, equal numbers of Colorado Pikeminnow can be collected from each of the three nursery habitat reaches (middle and lower Green River and lower Colorado River), over the next several years to improve the genetic diversity of the captive Colorado Pikeminnow population.

Objectives

The objective of this effort is identified below. This objective is related to the goals and tasks listed below in the 2016 Long Range Plan as reported by the San Juan River Basin Recovery Implementation Program (SJRRIP).

1) Collect young-of-year Colorado Pikeminnow from three nursery habitat reaches (two in the Green River, one in the Colorado River) and transport them to Southwestern ARRC for broodstock augmentation.

Goal 1.1 - Establish a Genetically and Demographically Viable, Self-Sustaining Colorado Pikeminnow and Razorback Sucker Populations.

Action 1.1.2 Produce, rear, and stock sufficient numbers of Colorado Pikeminnow to meet stocking goals of augmentation plan.

Task 1.1.2.2 Stock at least 400,000 age-0 (50–55 mm TL) Colorado Pikeminnow annually into the San Juan River.

Task 1.1.2.3 Opportunistically stock available Colorado Pikeminnow in excess of those described above.

Goal 1.2 - Identify and Implement Strategies for Improving the Colorado Pikeminnow and Razorback Sucker Augmentation Program and Genetic Integrity.

Action 1.2.1 Implement methods to evaluate status and success of stocked Razorback Sucker and Colorado Pikeminnow.

Task 1.2.1.2 Identify, describe, and implement strategies for improving survival and retention of stocked razorback sucker and Colorado Pikeminnow, including acclimation prior to stocking, size of fish stocked, time and location of stocking, physiological conditioning, and predator avoidance.

Goal 1.3 - Support Operations and Maintenance of Facilities to Support Colorado Pikeminnow and Razorback Sucker Stocking Programs.

Action 1.3.1. Support production and grow-out facilities.

Task 1.3.1.1 Support operation and maintenance of hatchery facilities at Southwestern ARRC for Colorado Pikeminnow and Razorback Sucker production.

Study Area

The study area for this project is Colorado Pikeminnow nursery habitat areas in the Green and Colorado rivers in Utah (Valdez et al. 1982; Archer et al. 1985; Tyus and Haines 1991). The three localities identified for sampling for YOY Colorado Pikeminnow in 2021 are:

- *Middle Green River* Split Mountain to Sand Wash (RM 319–RM 215)
- *Lower Green River* Green River State Park Colorado River confluence (RM 120–RM 0)
- *Colorado River* Cisco, Utah to its confluence with the Green River (RM 111–RM 0).

Methods:

Four week-long sampling trips will occur soon (one week) after conclusion of annual UDWR fall monitoring for young-of-year (YOY) Colorado Pikeminnow and small-bodied native fishes (usually conducted mid-September). Colorado Pikeminnow broodstock sampling teams will be comprised of staff from the Utah Division of Wildlife Resources (UDWR) and American Southwest Ichthyological Researchers (ASIR). UDWR personnel will provide the sampling vessels (two boats) and associated gear as well as two boat operators and supplemental sampling and holding gear. ASIR will provide sampling gear, live tanks to hold and transport captured specimens and two staff (with extensive Colorado Pikeminnow identification experience) for each boat. The two teams of three people will head to different reaches of the river(s) to conduct sampling for YOY Colorado Pikeminnow.

Access to the river sampling sites will be with 16’ to 18’ shallow water, high floatation, aluminum jon boats with float pods and tunnel hulls. The maximum beam (width) of these vessels are between 5’ and 6’ which adds to its extreme stability. The boats are powered by high horsepower (70–115 hp) outboard motors (jet-boots or propellers) and are able to safely navigate the waters in the study area of the Green and Colorado rivers.

Habitats will be sampled using a 1.2 m x 4 m seine with 3 mm mesh. Multiple seine hauls will be made in each habitat sampled but no attempt will be made to record the effort expended at a site as this work does not require determination of catch-per-unit-effort. Two people will seine and a third individual will assist in the sorting and identification of specimens collected.

At the end of each seining run, particular attention will be paid to ensure that captured fish remain in the water at all times and that processing of fish occurs as rapidly as possible (while ensuring accurate of identifications). Upon location of a captured YOY Colorado Pikeminnow, the specimen will be transferred, using a fine mesh aquarium net, from the seine to an Engel 19 quart live bait cooler (with a battery powered pump and air stone) that is filled with approximately 3 gallons of water taken from the habitat in which the specimen was captured. These coolers have latching clasps and a rubber gasket between the lid and base and will not spill if knocked over. Water temperature of the live bait cooler will be compared with water temperature of the habitat to ensure they are within 1°C. In addition, salt will be added to the water in the live bait cooler so that the solution is a 0.05% concentration of salt. The site of capture will be recorded with a GPS unit and water quality (water temperature, pH, conductivity, salinity, and Secchi depth) at the site will be recorded. At the completion of the sampling effort at that site, the specimen(s) will be returned to the boat where they will ultimately (upon equilibration of water temperatures) be transferred to a 30 quart Engel live bait cooler (with battery powered pump) that is being held inside a high density insulation ice chest. All Engle live bait coolers are lined with aquarium net material that is the same dimension of the inner box so fish never need to be handled and can be easily transferred between coolers. No more than 1 Colorado Pikeminnow will be held per gallon of water in the live bait coolers. At present, we have four 30 quart live bait coolers available for each boat.

Staff from Southwestern Native Aquatic Resources and Recovery Center (Southwestern ARRC) will provide a hatchery truck with a large reservoir live well (600 gallons) and will be responsible for all aspects of holding and transfer (back to Dexter, NM) of Colorado Pikeminnow that are collected as part of this effort. The simplistic plan for the daily sampling runs is to hold the YOY Colorado Pikeminnow on the sampling boats throughout the day and pass them onto Southwestern ARRC late that afternoon upon return to the launch site. However,

field crews will have to decide if they need to return, before the end of a sampling day, to the transfer their catch to the hatchery truck. This decision will be based on the number, size, and condition of YOY Colorado Pikeminnow collected, climatic conditions (air and water temperature, water conditions) and time of day. Field crews and hatchery personnel will discuss these matters each morning prior to departing for the day's sampling and proceed based upon the recommendation of Southwestern ARRC staff.

Once collected YOY Colorado Pikeminnow have been transferred to Southwestern ARRC personnel and the hatchery vehicle, those specimens become the responsibility of Southwestern ARRC. UDWR and ASIR will be available to assist Southwestern ARRC staff, but the latter organization is the ultimate authority on maintaining the health of those fish and the field sampling crews will always defer to their expertise.

We have scheduled for four consecutive weeks (five days/week) of sampling in late September and October. The template for the weekly sampling effort for ASIR follows:

- Day 1 Fieldwork preparation, travel from Albuquerque to Moab, UT (hotel).
- Day 2 Sample YOY Colorado Pikeminnow/camp on river
- Day 3 Sample YOY Colorado Pikeminnow/camp on river
- Day 4 Sample YOY Colorado Pikeminnow/hotel, Moab
- Day 5 Return to Albuquerque.

The sampling schedule for UDWR will differ in that they do not have to travel during days 1 and 5. Conversely, travel time for Southwestern ARRC is considerably longer than ASIR as they are 200 miles further away from Moab than ASIR, and they can not travel at a high rate of speed due to the size of their vehicle and volume of water they will be transporting upon return.

Laboratory Work

<u>Biosecurity-Wild Fish Transport and Holding Protocol</u> (Southwestern ARRC, Dexter, NM)

Fish transport and handling*:* All fish will be handled with the best animal husbandry practices available. Transport of all fish will follow guidelines described in the USFWS Protocols for Biological Investigations developed by Dr. Gary Carmichael, retired U.S. Fish and Wildlife Service employee. The protocol is as follows:

(1) When any life stage of fish collected from the wild are handled they will be placed in a 0.5% salt bath to help in osmoregulation and reduce the effects of handling stress.
(2) Temperature should be approximately 2-5 degrees Fahrenheit lower in the hauling truck than in the river.
(3) Drivers must be informed of and follow a specified route.
(4) Transport water will contain 0.5 percent NaCl (18.9 grams per gallon) and 15 mg/L Furacin (nitrofurazone).
(5) Oxygen levels will be greater than 6.0 mg/L as determined with an oxygen meter.
(6) Nets must be functional. Aeration equipment must be in place and must be used. A fish holding container will be a minimum of 5 gallons in size and fish densities will not exceed 1 lb of fish per gallon of water. Small, soft mesh nets will be present to transfer

the fish from one container to another, although it is preferred to have water to water transfer. Oxygenation/aeration equipment will be in place and working.

(7) Prior to transfer and after the fish are concentrated, they should be quickly placed in the transport tank. When using nets to place fish in transfer buckets or tanks, nets should not be overloaded. The fish on the bottom will be crushed. Using a wet transfer with buckets is preferable. When emptying the nets and buckets, care will be taken to avoid adding algae and mud to the transport tank. Before loading, dissolved oxygen levels should be at saturation.

(8) Immediately after loading, all equipment on the transport vehicle should be re-checked and the vehicle should depart. Oxygen concentrations and temperatures should be monitored at a minimum of every hour.

(9) During unloading tempering water should be present and functional, and thermometers should be used to match water temperatures. Hauling water temperatures should be equal to receiving water temperature.

***Acclimatizing the fish to the receiving water temperature will be conducted in increments of 2 degrees towards equalizing per 30 minutes time. Due to the high alkalinity and TDS of Southwestern ARRC water, staff will temper and acclimate the transported fish to the receiving water quality for a minimum of 1 hour prior to release. This process will allow sufficient time for the fish to osmoregulate to the receiving water quality. Tempering can be accomplished in the shipping tank by adding receiving water to the tank at given intervals.**

Fish Isolation /Quarantine Protocols

***Southwestern ARRC - Quarantine and disease treatment*:**

Southwestern ARRC houses a fully equipped isolation/quarantine building and lab. All aquatic species brought in from the wild or other facilities are housed in this area approximately 45 days or until diseases testing and prophylactic treatments are completed on the arriving fish. A fish health inspection will be conducted to examine fish for bacterial, viral and parasitic infections. Normally 60 fish per lot are sacrificed for an adequate sample. However, in the case of endangered or rare fish of genetic importance, numbers sampled will be less and will depend on availability. The Center also employs a full time certified veterinarian to prescribe and help administer treatments and associated animal drugs. Prophylactic treatments for the control and management of internal and external bacteria, parasites and aquatic invasive species are conducted on each wild fish lot received at Southwestern ARRC. Center staff will provide on-site monitoring for the species. Fish can be held in 10, 20 and 40 gallon aquaria, 3 and 4(ft.) diameter fiber glass tanks. No more than a 50 grams of fish/ per gallon will be held in each tank. All fish will undergo standard prophylactic bacterial and parasite treatments upon arrival and the hatchery staff will follow strict protocols for water treatments and exchanges. Hatchery staff will be advised of critical nature of this action and procedures to eliminate the possibility of contamination with other hatchery stocks will be followed. Fish condition will be monitored daily and mortality will be recorded. Fish will be fed a combination of live, frozen and prepared diets daily. If chronic mortality occurs fish health assessments will be completed by the Southwestern ARRC Fish Health Unit.

Upon arrival, fish will be slowly acclimated to water conditions within the holding tanks. Fish in the hauling tank will be exposed to water changes of 1/5 volume/hour, and observed carefully for signs of stress. If stress is noted (e.g., darkening or discoloration of color appearing on dorsal surface, gasping at surface, partial loss of equilibrium), the water change rate will be reduced to 1/10 volume/hour. The hauling tank will be aerated/oxygenated at all times during this procedure. Once acclimated, fish will be inventoried and placed into the quarantine tanks. Nylon tank covers will be placed on all tanks to stop fish from jumping out; aeration or oxygen will be supplied to the tank to ensure that dissolved oxygen levels are maintained at ≥ 6 mg/L. The lead Fish Culture biologist will administer and provide oversight during chemical treatments for the control and removal of internal and external bacteria, parasites and aquatic invasive species.

Treatment schedules:

The first week to ten days of maintaining the salvaged fish are the most critical. If the species has never been held on station or physiological response to the treatment chemicals is unknown, staff will conduct bioassays using 1 or 2 fish, and dosages adjusted prior to treating the entire lot. All static bath treatments require the addition of supplemental oxygen and concentrations are to be maintained at ≥ 6 mg/L during the duration of the treatment. Staff will monitor fish behavior during the treatment and no treatment will be left unattended. If fish begin to stress from the treatment, the chemical will be flushed from the system with fresh water. Starting dosages and frequency for chemical treatment of fish at Southwestern ARRC are as follows:

Bacterial prevention: Daily upon receipt for 3 consecutive days, 4-8 hours static bath. (0.5% NaCl is used in conjunction with one theriputant only)

- 0.5 % NaCl
- Oxytetracycline 343 @ 15-20 mg/L -Or
- Nitrofurazone @ 15 mg/L
- Chloramine T - Can also be used to combat external bacterial and parasite infections when applied at 8-10ppm, 1 hour static bath.

Internal & External parasite control: Fish will undergo chemical treatments for external parasites that consist of static bath treatments with formalin at 25 -125 mg/L depending on bioassay results. The initial treatment is administered on day 2 in the AM for a 1-hour static bath, flushed for 1 hour and fish prepped for the daily scheduled anti-bacterial treatment. The formalin treatment is repeated on day 4 and a final treatment at day-11 post receipt of the fish.

If the fish are diagnosed with cestodes they are treated with Praziquantel at 2 mg/L for 24 hours (static bath) at day-7 post receipt of the fish. As a precaution, the fish will be treated twice for cestodes, with the second treatment administered at approximately 21 days post the initial treatment.

-3’ circular tanks= 2 grams Praziquantel mixed (dissolved) then added into tank.
-4’ circular tanks= 4 grams Praziquantel mixed (dissolved) then added into tank.

If diagnosed with lernaea (anchor worm) the fish are treated with Dimilin at 0.25 mg/L for 24 hours (static bath) at day-9 post receipt of the fish. The treatment is repeated 7 days later to ensure complete removal of parasite.

If parasite loads on the fish are heavy, treatment procedures will continue for several weeks depending on the life cycle of the parasites being treated. A daily log recording water quality, temperature, treatments and comments on fish health will be maintained.

Permitting

Fish will be collected under a U.S. Fish and Wildlife Endangered and Threatened Permit and reported annually.

Deliverables

Meetings

The number of Colorado Pikeminnow collected annually as part of this project will be reported at annual SJRRIP by ASIR in collaboration with UDWR, and Southwestern ARRC.

Products

A short (ca. 5 pages) draft report of the 2021 Colorado Pikeminnow Broodstock Collection from the Green and Colorado Rivers, Utah will be prepared by ASIR in collaboration with UDWR, and Southwestern ARRC and distributed to the San Juan River Basin Biology Committee for review by 31 March 2022. Upon receipt of written comments, that report will be finalized and disseminated to members of the San Juan River Basin Biology Committee by 30 June 2022 to meet Objective 5 of this proposal.

Literature Cited

Archer, D.L., L.R. Kaeding, B.D. Burdick, and C.W. McAda. 1985. A study of the endangered fishes of the upper Colorado River. Final Report. U.S. Fish and Wildlife Service, Colorado River Fishery Project. Grand Junction, Colorado.

Tyus, H.M. and G.B. Haines. 1991. Distribution, habitat use, and growth of age-0 Colorado squawfish in the Green River basin, Colorado and Utah. Transactions of the American Fisheries Society 120:79-89.

Valdez, R., P. Mangan, R. Smith, and B. Nilson. 1982. Upper Colorado River investigation (Rifle, Colorado to Lake Powell, Utah). Pages 101-279 in W.H. Miller et al., editors. Colorado River Fishery Project Final Report; Part Two, Field Studies. U.S. Fish and Wildlife Service and Bureau of Reclamation. Salt Lake City, Utah.

ASIR 2021 BUDGET: COLORADO PIKEMINNOW BROODSTOCK COLLECTION FROM THE GREEN AND COLORADO RIVERS, UTAH

Personnel

Field Sampling Efforts

Green and Colorado Rivers

Fisheries Biologist I (1 staff x 4 trips x 5 days x 8 hr/day at $63.89/hr)	$	10,222
Fisheries Technician (3 staff x 4 trips x 5 days x 8 hr/day at $39.31/hr).....	$	18,869
Personnel..... Subtotal	**$**	**29,091**
Personnel..... GSA General and Administrative Fee (IFF)	**$**	**218**
Personnel..... Total	**$**	**29,309**

Materials and Supplies

Safety dedicated first aid gear: *(Value added contribution)*	$	0
Fish Sampling and associated electronic recording gear: *(Value added contribution)*	$	0
Materials and Supplies: ..... Total	**$**	**0**

Travel and Per Diem

Field Sampling Effort

Albuquerque to Moab, Utah (four trips)

Travel - (800 miles round trip x $ 0.58/mile x 4 trips)	$	1,856
Hotel Per Diem - 2 days/trip x 2 rooms ($96/night GSA rate) x 4 trips	$	1,536
Hotel Per Diem - 2 days/trip x 4 staff ($55/day GSA rate) x 4 trips	$	1,760
Camping Per Diem - 2 field days/trip x 4 staff ($25/day) x 4 trips	$	800
Travel and Per Diem: ..... Total	**$**	**5,952**

2021 Project Totals

Personnel:..... Total	**$**	**29,309**
Materials and Supplies: ..... Total	**$**	**0**
Travel and Per Diem: ..... Total	**$**	**5,952**
2021 Scope of Work: .....GRAND TOTAL	**$**	**35,261**

2021 Costs for UDWR- Moab

Colorado Pikeminnow Broodstock Collection

Task 1. Pikeminnow collection (3 trips x 3 days x 2 people; note: 4th week funded by UCREFRP)

Labor: salary + benefits + applicable overtime

	Rate	Hours	Cost
Project Leader	$38.10	50	$1,905
Biologist	$33.91	150	$5,086
Technician	$17.08	100	$1,708
		subtotal	**$8,699**

Food and Transport

	Rate	Quantity	Cost
Monthly fleet rental (2 trucks)	$199.37	2	$399
Mileage (2 trucks x 250 miles x 3 trips)	$0.40	1500	$600
Food (3 days/trip)	$35.00	18	$630
Fuel for motors (60 gallons/trip)	$4.00	180	$720
		subtotal	**$2,349**

Equipment

	Rate	Quantity	Cost
Camping gear repair/replacement:			$300
Sampling gear repair/replacement:			$600
Boating gear repair/replacement:			$1,500
		subtotal	**$2,400**
		Task 1 Subtotal:	**$13,448**

Task 2. Project coordination, reporting

Labor: salary + benefits + applicable overtime

	Rate	Hours	Cost
Project Leader	$38.10	20	$762
Biologist	$33.91	40	$1,356
Technician	$17.08	0	$0
		Task 2 Subtotal:	**$2,118**

Total Expenses	**$15,566**
Administrative Overhead (16% on all personnel services)	**$1,731**
UDWR-Moab Total	**$17,297**

TOTAL 2021 BUDGET: COLORADO PIKEMINNOW BROODSTOCK COLLECTION FROM THE GREEN AND COLORADO RIVERS, UTAH - $52,558