ENDANGERED LARVAL FISH MONITORING DOWNSTREAM OF THE SAN JUAN RIVER WATERFALL.

FISCAL YEAR 2019 SCOPE OF WORK

SUBMITTED TO THE U.S. BUREAU OF RECLAMATION

FROM

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ENDANGERED LARVAL FISH MONITORING DOWNSTREAM OF THE SAN JUAN RIVER WATERFALL. FISCAL YEAR 2019 PROJECT PROPOSAL

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Project Justification:

Throughout the tenure of the larval fish surveys conducted on the San Juan River, increasing upstream distribution of both larval Colorado Pikeminnow and Razorback Sucker has necessitated expansion of the study area. The most recent expansion occurred in 2017 when the study area was extended nearly 33 river miles upstream to include the area between Shiprock NM and the Animas River confluence in Farmington NM. Sampling of this newly added section of the San Juan River during 2017 documented the presence of both larval Colorado Pikeminnow and Razorback Sucker.

To date, no corresponding downstream extension of the larval fish survey study area has occurred. Currently, the larval fish study area extends downstream to Clay Hills crossing Utah. A waterfall located approximately 4 river miles downstream of Clay Hills crossing is one of the reasons that the larval fish surveys have not continued beyond Clay Hills crossing.

Recent collaborative work being conducted (for the San Juan River Recovery Implementation Program, SJRBRIP) by the U.S. Fish and Wildlife Service (USFWS) and Utah Division of Wildlife Resources (UDWR) below the waterfall and within the San Juan arm of Lake Powell have documented a substantial number of adult Razorback Sucker, and the presence of adult Colorado Pikeminnow (Francis et al., 2017). This same study has also documented larval Razorback Sucker in both 2011 (n = 1) and 2017 (n = 6, W.H. Brandenburg, pers. comm.). To date, no larval Colorado Pikeminnow has been collected.

While the data produced by the Francis et al. study has been of extreme value to the SJRBRIP, its primary focus has been the collection of adult fish. Furthermore, this study has (necessarily) sampled a mixture of lentic reservoir and lotic riverine habitat types. Within these habitats, limited sampling efforts for larval fish have been conducted using passive sampling techniques (light-traps). Light-traps are most effective in clear, zero or near zero velocity habitats. However, both larval Colorado Pikeminnow and Razorback Sucker have been repeatedly documented within the San Juan River in habitats with a wide range of turbidity and velocity characteristics (Farrington et al., 2014 and 2017).

The purpose of this proposed study is to conduct a systematic survey of larval fishes below the waterfall within the San Juan River arm of Lake Powell. To avoid duplication of work currently being conducted by the USFWS and UDWR, this study will strictly focus on riverine habitat types, and will employ the use of active (i.e. larval seines) sampling techniques for larval fish. The goal of this study is to:

- Assess the presence and abundance of larval fishes below the waterfall.
- If possible, determine if larvae collected were the result of spawning activities above or below the waterfall.

It is not the goal of this study to document spawning within Lake Powell, or identify potential spawning aggregations within the reservoir. Those questions are currently being addressed by the USFWS/UDWR work reference above.

Study Area:

The proposed study area will be from immediately below the San Juan River waterfall downstream to the mouth of Nokia Canyon. This ten-mile reach of habitat is located above Zahn Bay within the San Juan Arm of Lake Powell. It is similar in length to the 14 miles of geomorphic Reach 1 within the San Juan River that is currently being sampled for the larval fish monitoring program. Reach 1 of the San Juan River is immediately upstream of waterfall, and a comparative analysis between Reach 1 and the new study area below the waterfall will be part of this proposed study.

Methods:

Field Work:

Sampling for larval fishes would be done during the presumed peaks in spawning activity for Razorback Sucker and Colorado Pikeminnow (May through July). A total of three sampling trips will be conducted. It is anticipated that these three trips will occur monthly from May through July. However, abiotic factors such as discharge and temperature, as well as capture data obtained from the concurrent San Juan River larval fish monitoring will be used to inform the exact sampling dates for this study. This "adaptive sampling" approach to the scheduling of sampling trips is the same approach that has been successfully used to schedule sampling trips in the newly expanded upstream study area (Shiprock to Farmington NM).

Access to the river will be gained through the use of motorized boats equipped with all of the necessary equipment to successfully sample nursery habitats. Sampling crews will consist of two people operating out of a fixed base camp established near the waterfall on the San Juan River. A proposed schedule for each sampling trip is as follows:

- Day 1 Travel from Albuquerque NM to the waterfall (near Goulding's Trading Post UT). Set up base camp and ready boat for sampling and launch the following day.
- Day 2 Run motorized boat to the bottom of the study area (Nokai Canyon). Begin sampling nursery habitats while traveling upstream. Return to base camp at the end of the day.
- Day 3 Complete sampling of nursery habitats not visited during the previous days sampling. Return to base camp at the end of the day.
- Day 4 Break down base camp, load boat and return to Albuquerque NM. Deposit specimens at the UNM Museum of Southwestern Biology.

The collection and preservation of specimens, gathering of physical data, and field work safety, will follow the methodology outlined for the San Juan River larval Razorback Sucker and Colorado Pikeminnow Monitoring program (see *SOW 19 21*). Importantly, specimen preservation (95% EtOH) and the same habitat classifications being used for the current larval fish monitoring will be used for this study. Again, this protocol dictates that only riverine type habitats are sampled. It is recognized that the elevation of Lake Powell will dictate the availability of riverine habitat. It is hoped that the location of the study area above Zahn Bay, coupled with the fact that Lake Powell is currently at less than 60% of storage capacity, will allow for the persistence or riverine habitat types within the study area.

Data analysis:

The same type of data analysis that is currently being done for the San Juan River larval fish monitoring will also be done for this study (see *SOW 19 21*). Data from this study would be integrated into the long-term San Juan River larval fish monitoring data set. A comparative analysis between data gathered for this study, and that taken from Reach 1 of the concurrent larval fish monitoring will also be done. This analysis will include but not be limited to:

- Differences in species composition and relative abundance.
- Differences in species density (fish/100m^2) as a whole and by habitat type.
- Temporal differences in species composition, abundance, and density.
- Spatial differences in species composition, abundance, and density.
- Differences in the density of specific ontogenetic stages for larval Colorado Pikeminnow and Razorback Sucker.

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.

$1H_0$) Densities of larval fishes will not 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.

$3H_0$) Elevated spring discharge has no effect on the 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.

$4H_0$) Elevated spring discharge has no effect on the 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.

Finally, while this study would take place outside of the San Juan River proper, the data gathered as a result of this project relates to the following tasks outlined in the 2016 SJRBRIP Long Range Plan.

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.

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)

Literature cited:

Farrington, M.A., R. K. Dudley, W. H. Brandenburg and S. P. Platania 2014. Colorado Pikeminnow and Razorback Sucker larval fish survey in the San Juan River during 2013. Annual Report. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM. 61 pp.

Farrington, M.A., R. K. Dudley, J. L. Kennedy, S. P. Platania and G. C. White. 2017. Colorado Pikeminnow and Razorback Sucker larval fish survey in the San Juan River during 2016. Annual Report. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM. 75 pp.

Francis T. A., D. S. Elverud, B. J. Schleicher, D. W. Ryden and B. Gerig. 2017. San Juan River Arm of Lake Powell Razorback Sucker (*Xyrauchen texanus*) Survey: 2012. Interim Progress Report. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM. 71 pp.

San Juan River Basin Recovery Implementation Program. 2016. Long-range plan. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 70 pp.

San Juan River Basin Recovery Implementation Program. 2012. Monitoring Plan and Protocols. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 53 pp.

Appendix A. Response to comments.

	New-4	**(New-4) Larval Fish Monitoring Downstream of San Juan River Waterfall**
PO	**How can the technical aspects of this SOW be improved?** *Will fishes be preserved in ethanol and be available for genetic analyses?* Response: Fish will be preserved in ethanol. This has been clarified within the methods section. Thank you for reviewing the document. **What is this SOW's contribution to recovery?** *This will be the second year of assessment of this life-stage below the waterfall and this work could help quantify densities of larval fishes above and below the waterfall. We suggest all larval endangered fishes collected be made available for genetic N_b analyses. If this is not an issue, we recommend including this SOW in the FY19 Annual Work Plan.*	
Schleicher (BC)	**How can the technical aspects of this SOW be improved?** *Lines 156 and 157 are duplicates* *I understand the amount of work picking samples would take but would a larval drift net be best suited to answer this question of loss to the lake?* Response: Lines 156 and 157 have been corrected. A larval drift survey would provide a more definitive answer to larval fish loss to the lake. This study was designed as the most cost effective means to try and gauge larval fish loss to the lake. Thank you for taking time to review the document. **What is this SOW's contribution to recovery?** *Currently there appears to be a bottleneck at the larval stage for RZ and CS, this would give insight as to what the rate of loss to the system due to the waterfall occurs on a given year.*	
Wesche (BC)	**How can the technical aspects of this SOW be improved?** *The SOW is well-written and represents an important new contribution to our overall monitoring efforts and our knowledge of the San Juan River-Lake Powell complex below the waterfall. Two things are unclear to me regarding the planned study. First, how does this work interrelate with the KSU study ongoing below the waterfall? Are we duplicating efforts or do the two studies compliment one another? And second, will this study be able to document the "loss" of endangered larvae from the river above the waterfall? If not, should such an effort be included in this project?* Response: We are coordinating our efforts with Casey Pennock (KSU) to ensure that there is not duplication of efforts. It is my understanding that the larval fish material needed to complete the KSU study has been obtained from the UNM, Museum of Southwestern Biology and that KSU will not be collecting larval specimens below the waterfall. As far as the ability to document the loss of endangered fish larvae from the river	

	above, I would suggest the answer is both yes and no. Larvae collected will be available for genetic N_b analysis. The project leader, Tracy Diver (USFWS), has successfully documented substantial differential drift in cohorts of both larval Colorado Pikeminnow and Razorback Sucker within the river. This same technique could be used to identify cohorts of larvae captured above and below the waterfall. Other data gathered such as ontogenetic stage and the age (in days) of larvae collected can be used to formulate a most probable scenario for some larvae. For example, a 50 day-old juvenile Razorback Sucker collected directly below the waterfall likely was hatched in the river above the falls. The alternative explanation, while not impossible, is that the individual was hatched below the waterfall and experienced little to no drift prior to capture. Through the examination of multiple types of data, such as genetic N_b analysis, aging of larvae, location of capture, discharge rates during the study period, and a comparative analysis of larvae capture in the river reach upstream of the waterfall, this study should provide the recovery program with an estimation of the number of larvae being transported over the waterfall. **What is this SOW's contribution to recovery?** *The potential contribution of the San Juan River-Lake Powell complex below the waterfall to our recovery efforts is becoming clearer each year. This SOW addresses an important component of the fish population dynamics in this section of critical habitat for the endangered fishes and should provide key information for helping us make progress toward recovery.*
Mazzone (BC)	**How can the technical aspects of this SOW be improved?** *No Comment*. Response: Thank you for taking time to review the document. **What is this SOW's contribution to recovery?** *The collection of long term standardized monitoring data is a hallmark of sound fisheries management. The extension of larval sampling below the waterfall seems a natural progression. The expansion of standardized larval fish sampling in the lower SJR Basin should be of great interest to the Program, especially in light of the increased Program presence and expenditure below the falls.*
Lamarra (BC)	**How can the technical aspects of this SOW be improved?** *I think this study is important and should be conducted. I would suggest that one backwater/low velocity habitat be sampled above the waterfall but below Clay Hills. This would address the potential error of sampling lake -spawned fish. The comparison of timing and larval stage may help in this analysis. Using Reach 1 as a control is problematic in that it is either sand bedded or side washes. These low velocity habitats are unlikely to be the same structural form as the LVH below the waterfall.* Response: The potential to collect larvae that were the result of fish spawning below the waterfall is a concern. Sampling a habitat above the waterfall is a possibility, however it would need to be in close proximity (i.e. hiking distance) to the waterfall. It is possible that the structural form of the habitats is substantially different than

	those of Reach 1, which would confound comparisons between nursery habitats located above and below the waterfall. However, one benefit of using Reach 1 as a control is the assumption that larvae present are the result of substantial drift. It seems unlikely that the sand bedded nature of Reach 1 would be suitable spawning habitat for either Razorback Sucker or Colorado Pikeminnow. The question then becomes, "Is Reach 1 of a sufficiently low gradient with enough suitable habitat to retain larvae, or do the majority simply continue to drift over the waterfall?" It is this question, among others, that we hope to address with this study. Thank you for reviewing the document. **What is this SOW's contribution to recovery?** *No Comment*
Davis (BC)	**How can the technical aspects of this SOW be improved?** *Lines 91-94: Will you be able to differentiate whether collected larvae were spawned in the San Juan River and drifted downstream of the waterfall or if they were spawned immediately below the waterfall? If so, how?* Response: Thank you for reviewing the document. Please see the response to a similar comment by Dr. Tom Wesche above. **What is this SOW's contribution to recovery?** *A significant amount of work has occurred in the San Juan arm of Lake Powell, primarily with large-bodied life stages, and more intensive larval surveys will further advance our knowledge of the system below the waterfall.*
Warren (PR)	**How can the technical aspects of this SOW be improved?** *I have no suggestions for improvement of technical aspects*. Response: Thank you for reviewing the document. **What is this SOW's contribution to recovery?** *Larval sampling below the waterfall should provide insight into spawning of focal species below the waterfall or drift of larvae over the waterfall. If larvae of either focal species is abundant, this should trigger a more intensive effort to understand the importance of the area for reproduction in both species. The understanding of the San Juan arm has necessarily been a piece by piece process and at each step it becomes more intriguing concerning the role it might play in recovery. I think this is another important piece*.
Hubert (PR)	**How can the technical aspects of this SOW be improved?** *Sampling methods will be the same as those applied to the San Juan River and have been shown to be effective over time. However, it is questionable if the frequency and intensity of sampling planned for the 10-mile-long reach downstream from the waterfall is sufficient to achieve the stated goals (p. 3, l. 91-93). Is sampling for 2 days once a month from May to July sufficient to detect and estimate relative abundance (temporally and spatially) of both Colorado Pikeminnow and Razorback Sucker within the study area?* Response: The intensity of sampling will follow the established protocols for the long-term larval fish monitoring program. Specifically, we will try to match or exceed the effort that is typical of monthly Reach 1 sampling. Because of the size and frequency of

	large backwater habitats often found within Reach 1, the monthly effort that is expended in this reach is similar to that of the upstream reaches, despite the fact that Reach 1 is the shortest geomorphic reach within the San Juan River. *Within the Study Area section (p. 3, l. 106), it is stated that the results of sampling downstream from the falls will be compared to a 14-mile-long reach upstream from the waterfall. What metrics and statistical methods will be applied to test for differences between the two reaches?* Response: metrics used to compare the reach below the waterfall and Reach 1 above the waterfall will include differences in species composition and relative abundance, differences in species density (fish/100m^2) as a whole and by habitat type, temporal and spatial differences in species composition, abundance, and density and differences in the density of specific ontogenetic stages for larval Colorado Pikeminnow and Razorback Sucker. All statistical tests used for this project will be those outlined within the methods section of SOW 19 21 (i.e. mixture model density estimates by reach, habitat type, and habitat location) as well as those outlined in the 2012 SJRRIP Monitoring Plan and Protocol (e.g. testing for differences in densities of ontogenetic stages will likely be done using a one-way ANOVA). *Within the list of hypotheses to be tested, the first hypothesis (p. 4, l. 164) states that "Densities of larval fishes will be influenced by specific mesohabitat types." Substantial explanation is needed as to how testing of this hypothesis will be approached. First, a clear statement of the null hypothesis should be made. If it is rejected, what are the alternative hypotheses? What is the definition of density (i.e., the metric to be used as the response variable) and how is it computed for a specific habitat unit? What are the definitions of the mesohabitat types? How will specific mesohabitat types be identified among habitat units that are sampled?* Response: The null hypothesis for this, and all hypotheses that can be tested is now included in the document. The definition of density has been clarified to indicate that it will be fish/100m^2 of habitat sampled. All habitat types will follow programmatic definitions as defined by Bliesner et al. 2009. *Within the list of hypotheses to be tested, the second hypothesis (p. 4, l. 166) is that relative abundance will be highest in mesohabitats that contain cover, inundated vegetation, and submerged debris. Again, a clear statement of the null hypothesis is needed. What are the alternative hypotheses? How will cover types be defined and measured within individual habitat units that are sampled for larval fish? What statistical methods will be applied to test this hypothesis?* Response: This hypothesis, was taken from the 2012 SJRRIP Monitoring Plan and Protocol. In SOW 19 21, the ability to test this hypothesis has been rejected. Rather than reference SOW 19 21, I have listed the reasoning for not testing this hypothesis within this document. Thank you for taking time to review the document.

	What is this SOW's contribution to recovery? *The value of this SOW is that it is likely to identify further the connectivity of the endangered fishes populations in the San Juan River-Upper Colorado River-Lake Powell system and guide recovery efforts into the future. It is needed research.*
Ross (PR)	**How can the technical aspects of this SOW be improved?** *Lines 85-89. The technical aspects are appropriate for this study. It is important that sampling with the small-mesh "larval" seine will be used in larval collections in the San Juan River both above and below the Piute Farms waterfall and in the areas in Lake Powell.* Response: Thank you for taking time to review the document. **What is this SOW's contribution to recovery?** *This study will contribute to recovery by providing much needed information on larvae of the listed fishes downstream of the waterfall but within the approximately 10 miles of lotic habitat. It will also dovetail with work being done in the impounded area of the San Juan arm of Lake Powell.*
Zeigler	**How can the technical aspects of this SOW be improved?** *The goal of this study implies some ability to assess differences in origin of larval fish below the waterfall. I suggest editing the goal of this project to simply state that you are assessing the presence/abundance of larval endangered fishes below the waterfall. However, coupling larval collections with the recent genetics work by Tracey Diver may be used to elucidate some information about where larval fish captured below the waterfall were spawned. I know that this is outside of the immediate goals of this SOW, but I think some information it is eventual use to address this question would strengthen the SOW, in particular its contribution to recovery.* Response: Changes to the stated goal of the study were made. As noted in a response to a similar comment by Dr. Tom Wesche, the incorporation of multiple types of data, including that being generated by Tracy Diver, should give us the ability to differentiate the source of some proportion of larvae collected below the waterfall. *Other Comments:* - *Line 118: Change "adaptive management" to "adaptive sampling".* Response: Changes made. Thank you for reviewing the document. **What is this SOW's contribution to recovery?** *This project was funded to occur in FY2018 as well, and past providing empirical evidence of larval endangered fish below the waterfall I struggle to determine its contribution to recovery. If data collected under this SOW would be beneficial for future analyses to determine reproductive contribution of endangered fish below the waterfall or to understand how many larval fish we are losing from the system (i.e., over the waterfall) then I could see its benefit. However, potential use of this data to answer these questions is missing from the SOW.*