

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

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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 moisture, 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 Suckers 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 F₁ or F₂ 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
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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 are in 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 an 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, dedicated 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 identify 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.