

Stocking Razorback Sucker in Lake Powell

Fiscal Year 2021 Scope of Work

Submitted to
Bureau of Reclamation

From

Principal Investigators:

Ben Schleicher, Travis Francis, & Dale Ryden

U. S. Fish and Wildlife Service

Colorado River Fishery Project

445 West Gunnison Avenue, Suite 140

Grand Junction, Colorado 81501

(970) 245-9319

benjamin_schleicher@fws.gov; travis_francis@fws.gov; dale_ryden@fws.gov

Katie Creighton & Brian Hines

Utah Division of Wildlife Resources, Moab Field Station

1165 S. Hwy. 191 – Suite 4

Moab, Utah 84532

(435) 259-3782

katherinecreighton@utah.gov; bhines@utah.gov

Mark McKinstry 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

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

	Rate/Hr	People	Total
Biologist GS-11/7			
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

<u>Lodging</u>	Rate	People	Total
Defiance House Lodge	\$96.00	2	\$384.00
<u>Meals & Incidentals</u>	Rate	People	Total
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	Total
Lake Crew	3	\$12.35	\$74.10
Hatchery Crew	3	\$12.35	\$37.05

Gasoline

	\$\$/Gal	Trips	Total
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	Total
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

Literature Cited:

- Albrecht, B. A., P. B. Holden, R. Kegerries, and M. E. Golden. 2010. Razorback sucker recruitment in Lake Mead, Nevada—Arizona, why here? *Lake and Reservoir Management* 26:336-344.
- Albrecht, B. A., H. E. Mohn, R. Kegerries, M. C. McKinstry, R. Rogers, T. Francis, B. Hines, J. Stolberg, D. Ryden, D. Elverud, B. Schleicher, K. Creighton, B. Healy, and B. Senger. 2018. Use of inflow areas in two Colorado River Basin reservoirs by the endangered razorback sucker (*Xyrauchen texanus*). *Western North American Naturalist* 77:500-515.
- Buntjer, M.J., T. Chart, and L. Lentsch. 1993. Early life history investigations. Utah Division of Wildlife Resources, Salt Lake City, UT.
- Buntjer, M.J., T. Chart, and L. Lentsch. 1994. Early life history fishery survey of the San Juan River, New Mexico and Utah. Utah Division of Wildlife Resources, Salt Lake City, UT.
- Cathcart, C.N., C.A. Pennock, C.A. Cheek, M.C. McKinstry, P.D. MacKinnon, M.M. Conner, and K.B. Gido. 2018. Waterfall formation at a desert river-reservoir delta isolates endangered fishes. *River Research and Applications* 2018: 1-9
- Francis, T.A.¹, D.S. Elverud², D.W. Ryden¹ and B.J. Schleicher¹. 2013. San Juan River arm of Lake Powell razorback sucker (*Xyrauchen texanus*) survey: 2011. Final Annual Report. ¹U.S. Fish and Wildlife Service, Grand Junction, CO. ²Utah Division of Wildlife Resources, Moab, UT.
- Furr, D.W. 2012. San Juan River Razorback Sucker (*Xyrauchen texanus*) Population Augmentation: 2011. Final Annual Report. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Gido, K.B., and D.L. Propst. 1994. San Juan River secondary channel community studies permanent study sites: 1993 Annual Report (Final). New Mexico Department of Game and Fish, Santa Fe, NM.
- Lashmett, K. 1993. Fishery survey of the lower San Juan River and the upper Arm of Lake Powell (RM 4.0-[]11.0) 1991/1992. Bureau of Reclamation, Durango, CO.
- Lashmett, K. 1994. Fishery survey of the lower San Juan River and the upper Arm of Lake Powell (RM 4.0-[]0.8) 1993. Bureau of Reclamation, Durango, CO.
- Maddux, R.H., L.A. Fitzpatrick, and W.A. Noonan. 1993. Colorado River endangered fishes Critical Habitat: Draft Biological Support Document and appendices. U.S. Fish and Wildlife Service, Salt Lake City, UT.
- 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. 2020. Movements of imperiled fish in novel ecosystems: River-reservoir exchanges by razorback sucker and experimental translocations to aid conservation. *Aquatic Conservation*
- Pennock, C.A., M.C. McKinstry, and K.B. Gido. (2020) Razorback Sucker exhibit multiple movement strategies across a river-reservoir habitat complex. *Transactions of the American Fisheries Society*.
- Pennock, C.A. M.C. McKinstry, K.B. Gido, T.A. Francis, B.A. Hines, D. S. Elverud, and B. J. Schleicher. 2020. Reservoir fish assemblage structure across an aquatic ecotone: Can river-reservoir interfaces provide conservation and management opportunities? *Fisheries Management and Ecology*
- Ryden, D.W., and F.K. Pfeifer. 1993. Adult fish collections on the San Juan River (1991-1992): Annual Progress Report. U.S. Fish and Wildlife Service, Grand Junction, CO.
- Ryden, D.W., and F.K. Pfeifer. 1994a. An experimental stocking plan for razorback sucker in the San Juan River. U.S. Fish and Wildlife Service, Grand Junction, CO.
- Ryden, D.W., and F.K. Pfeifer. 1994b. Adult fish community monitoring on the San Juan River: 1993 Annual Progress Report. U.S. Fish and Wildlife Service, Grand Junction, CO.
- San Juan River Basin Recovery Implementation Program. 2012. 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. 1991. Endangered and threatened wildlife and plants: the razorback sucker (*Xyrauchen texanus*) determined to be an endangered species. Dept. of the Interior, U.S. Fish and Wildlife Service, Federal Register, 23 October 1991, 56:54957-54967.

U.S. Fish and Wildlife Service. 1994. Determination of critical habitat for the Colorado River endangered fishes; razorback sucker, Colorado pikeminnow, humpback chub, and bonytail chub. Dept. of the Interior, U.S. Fish and Wildlife Service, Federal Register, 21 March 1994, 59:13374-13400.

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 not 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)^[SEP]. 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 estimates.**

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.