Physical and Biological Monitoring and Evaluation of
Phase III Habitat Restoration: A Constructed Floodplain Wetland Refugium

Can wild-spawned San Juan River Razorback Sucker larvae recruit to juvenile life-stages in a relatively large, stable, zero-velocity habitat?

Fiscal Year 2021 Scope of Work

Submitted to the U.S. Bureau of Reclamation

From

Principle Investigators (alphabetically ordered by agency acronym)
American Southwest Ichthyological Researchers, LLC (ASIR) Contract # GS-10F-0249X
Michael Farrington michael_farrington@asirllc.com

Navajo Nation Department of Fish and Wildlife (NNDFW)
Jerrod Bowman jbowman@nndfw.org
Kim Yazzie kyazzie@nndfw.org

U.S. Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office (NMFWCO)
Stephen Davenport stephen_davenport@fws.gov
Daniel Kaus Daniel_kaus@fws.gov

San Juan River Basin Recovery Implementation Program Office (PO)
Scott Durst scott_durst@fws.gov
Nathan Franssen nathan_franssen@fws.gov
Eliza Gilbert eliza_gilbert@fws.gov

Purpose

The San Juan River Basin Recovery Implementation Program (SJRIP) approved a construction scope of work for a Razorback Sucker floodplain wetland refugium (Appendix I) with construction expected to occur in winter 2020/2021. That scope of work outlined an operations, monitoring, and evaluation plan for the wetland while this scope of work details the logistics, identifies each entity's responsibilities, and provides a budget for that plan. As described in the construction scope of work, should the wetland not function as intended, a contingency plan to stock wild-produced larvae would be implemented. Should the Biology and Coordination committees decide the contingency plan needs to be implemented, a different operations, monitoring, and evaluation scope of work would need to be developed and submitted for approval.

Background

In the San Juan River, collection of larval Razorback Sucker has occurred every year for the past 18 years. However, juvenile Razorback Sucker have been rarely detected in fall sampling, indicating a potential recruitment bottleneck between the larval and juvenile life-stage. Within the last seven years, the number of larval Razorback Sucker captured annually was approximately 30% that of Bluehead Sucker or Flannelmouth Sucker, two common species that are consistently collected as juvenile age-0 fishes (Figure 1). The apparent lack of recruitment to the juvenile life-stage is unlikely a function of the fewer number of larval Razorback Sucker collected compared to the other two native suckers. Additionally, the limited collection of metalarval Razorback Sucker, the most mature phase of larvae, and limited collections of this larval phase as early as July (Farrington et al. 2017) and subsequent lack of collection in the fall suggests relatively high apparent mortality rate between the larval and juvenile life-stages. The source of this apparent recruitment bottleneck in the San Juan River is presently unknown. However, stable, low-velocity habitat was identified by the SJRIP Biology Committee as the habitat most likely critical for age-0 Razorback Sucker recruitment (SJRIP December 2019 Habitat Workshop) and is a habitat that can be relatively scarce in the San Juan River (Lamarra and Lamarra 2017).

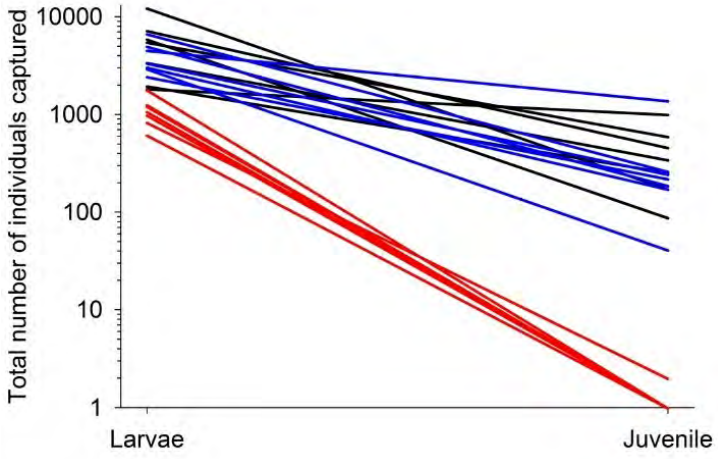

Figure 1. Total number of larval fish captures between 2011 and 2018 from larval and small-bodied fish sampling. Razorback Sucker (red) show lower recruitment rates between spring/summer larval samples and fall age-0 juvenile collections compared to Bluehead Sucker (blue) and Flannelmouth Sucker (black) as indicated by the steeper slopes. Every line represents one year and 1 was added to each value to facilitate plotting on a log scale. Figure developed for the SJRIP's February 2018 Recruitment Bottleneck Workshop with data from Farrington et al. (2017) and Zeigler and Ruhl (2017).

Methods

Site and general operations

The Phase III habitat restoration project was designed to mimic a floodplain wetland (Appendix I). The 8,500 m^2 wetland will be located at river mile 107 and filled from an upstream secondary channel (Figure 2). After larval fish are entrained and reared during spring through fall, fish will be harvested and released from the wetland's downstream outlet.

Figure 2. Aerial photograph and Keller-Bliesner's wetland design concept at San Juan River mile 107 (Appendix I). The red arrow depicts direction of river flow. The large blue polygon is the wetland and the smaller one is the stilling basin at the inlet from the secondary channel. The other red lines represent channels for water transfer into and out of the wetland.

Task 1: Operations and water quality monitoring (NMFWCO)

Staff gauges and electronic sensors to monitor water depth and quality will be installed prior to filling the wetland and entraining larval fish. Staff gauges will allow water depth to be measured visually and electronic water level (pressure)-temperature sensor and loggers (HOBO U20L-001) will be installed to collect hourly water levels and temperatures. Three water quality sensors will be placed at the deepest points along the length of the wetland (Figure 3). A fourth staff gauge will be installed at the confluence of the wetland outlet and San Juan River to establish a relationship with wetland depth and river level (Figure 3). A relationship between staff gauge and pressure sensor measurements will be established to provide a continuous record of wetland water levels. The sensors will be installed in an L-shaped stilling basin with the bottom of the "L" underwater and data from loggers downloaded during each visit to the site. Standard operating procedures for field calibration, cleaning, and maintenance of the electronic sensors will be implemented at each visit.

Filling of the wetland and entrainment of larval fish will begin in May when larval Razorback Sucker are expected to be present and at their highest densities (Appendix I). The inlet gate will be opened the first week of May and remain open for four weeks. While the wetland is entraining larval fish, gate(s) will be checked twice a week to ensure they are operating properly and to remove debris from the trash rack/screen.

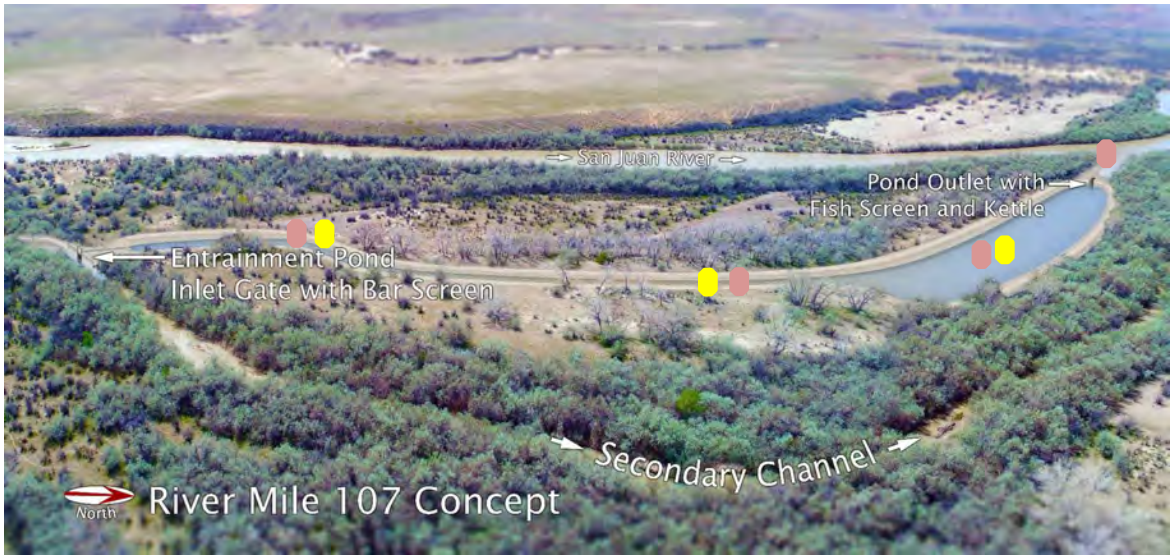

Figure 3. Potential location of water quality monitoring sites for the Phase III constructed wetland (image from Keller-Bliesner's design concepts Appendix I). Yellow polygons indicate potential locations for water quality monitoring sensors and red polygons indicate water depth monitoring sites.

Water quality monitoring will occur weekly once the wetland gates are closed. Measurements will include water depth and dissolved oxygen concentrations from the staff gauges and electronic water quality sensors, respectively. If pond depth is < 1 m in the deepest portion of the pond or dissolved oxygen concentrations are 4-5 mg/L and trending downward, the inlet gate will be opened to increase water to depths > 1 m or to add additional oxygenated water. This monitoring and management will continue until the pond is drained in mid-October (Table 1).

Table 1. Activities, timetable and agency participation for wetland operations.

	Install water monitoring equipment	Twice weekly, check trash rack/screen	Once weekly, water quality monitoring and pond operations
NMFWCO	Spring (between March and April)	Month of May (4 weeks)	June to October (~ 20 weeks)

Task 2: Assessing larval Razorback Sucker entrainment and monitoring survival

As outlined in the construction scope of work (Appendix I), four fish sampling trips (three larval, one small-bodied) will be conducted (Table 2). Prior to the four fish sampling efforts, locations of each individual seine haul will be pre-selected and geographic coordinates determined and recorded with a hand-held GPS unit. These coordinates will be used to place numbered bamboo stakes (2 m) at the beginning and end of each haul to ensure subsequent sampling efforts occur in the same locations and that sampling effort remains consistent across trips. Sampling will be designed to target approximately 1% of the overall surface area of the wetland. This equates to 10 discrete seine hauls, each about 10 m long, that will be evenly distributed between shoreline and open water habitats. Both shoreline and open water habitats will be sampled in the inflow canal and wetland. Larval fish sampling will employ small mesh seines (ca. 1.0 m x 1.0 m x 0.8 mm mesh) and larger seines (ca. 3.0 m x 1.8 m x 3.0 mm mesh) will be used for small-bodied fish sampling. Aquatic habitat designations (either shoreline or open water) will be recorded by seine haul and contents of

each seine haul preserved independently. Retained specimens will be placed in Whirl-paks containing 95% ethanol (EtOH) and a tag inscribed with unique alphanumeric code that will also be recorded on a field data sheet and placed into the sample bag. Capture densities of fish from seine samples will be reported as the number of fish per 100 m^2. Native species large enough to be positively identified will be measured and released. All nonnative fish species identified in the field will be enumerated and removed.

The first two sampling efforts (pre-closure and post-closure) will be conducted by a two-person crew who will travel (during morning) to the wetland and sample the site upon arrival (late afternoon). For both trips, the sampling crew will camp overnight at the wetland site and again sample the same 10 locations in the wetland the following morning. Samples will be returned to the University of New Mexico, Museum of Southwestern Biology for processing.

The third sampling effort will coincide with a scheduled long-term larval fish monitoring trip. For the third effort, sampling crews will be floating the San Juan River (July) between Shiprock, NM and Sand Island, UT. Upon arrival at the Habitat Restoration Phase III site, personnel will sample each of the 10 seining locations using the same techniques as described above and then continue downstream to complete the monthly long-term larval fish sampling trip.

Collection and preservation of specimens, gathering of physical data, field work safety, laboratory work, fish identifications, quality assurance and control, and data analysis will follow the methodology outlined for the San Juan River larval Razorback Sucker and Colorado Pikeminnow monitoring program (i.e., SOW 21).

Trip 1:
The purpose of the first trip is to determine whether larval fish were entrained during the filling process. The initial filling of the site is likely to be completed in < 24 hours but the 1.2 m-wide inlet gate will remain fully open for about four weeks. Therefore, the first larval fish sampling effort will likely occur prior to closure of the inlet gates (ca. end of May). This will allow for determination of Razorback Sucker larvae entrained (number of fish per 100 m^2) prior to closing the inlet gates.

Trip 2:
This trip will occur in early June and the purpose of the second trip is to confirm short-term survival of entrained larval Razorback Sucker. Data obtained from this sample will also be used to calculate growth rates of larval fish and compare those to growth rates to other larval San Juan River suckers (Clark-Barkalow et al. 2019). In future years, if overall entrainment of Razorback Sucker is deemed low by the Biology and Coordination Committees, the results of the first two monitoring efforts would be used to trigger the contingency plan for the wetland, which consisted of stocking wild larval suckers into the wetland as described in the construction scope of work (Appendix I).

Trip 3:
The purpose of the third sampling trip is to determine long-term survival of larval fish and assess larval fish development. This trip will occur during mid-July and be conducted in conjunction with the long-term larval fish monitoring efforts. Based on previous larval fish samples, it is anticipated that most Razorback Sucker collected from the wetland during July would have progressed into the early juvenile stage. Therefore, most fish collected should be identifiable in the field and released into the wetland. Fish that are too small for field

identification will be retained for laboratory identification. All Razorback Sucker collected will be measured (standard and total length) and those data combined with previous samples to determine average wetland-specific Razorback Sucker growth rates.

Trip 4:
The fourth and final monitoring trip will occur in early to mid-September to verify that Razorback Sucker survived the recruitment bottleneck and transitioned to the juvenile stage. Because fish at this time will likely be juveniles, a larger seine will be used, and the same sites sampled for larval fish will be sampled. Razorback Sucker will be measured (standard and total length) and released back into the wetland. All other native and nonnative fishes will be counted and returned to the wetland. Any unidentifiable fishes will be retained as described above for laboratory identification. Sampling of the inlet canal will not occur during this trip.

Laboratory work:
Based on the densities of larvae typically found in the San Juan River from May through July, it is anticipated that processing and identification of all retained samples will require approximately seven days. This sample processing estimate assumes that nonnative species (particularly nonnative small-bodied cyprinids) would mostly be absent from wetland collections. If nonnative species establish and reproduce within the wetland, processing and identification of the constructed wetland larval fish samples could take considerably longer.

Table 2. Activities, timetable, and agency participation for assessing entrainment and monitoring survival of larval Razorback Sucker in the constructed wetland.

	Quantify entrainment	Assess initial survival	Asses survival and growth	Assess larval recruitment to juvenile
ASIR	End of May, larval sampling	Early June, larval sampling	Mid-July, larval sampling	
PO				Early September, juvenile sampling

Task 3: Wetland draining and evaluation
Draining the wetland with the capture and enumeration of fish will occur in mid-October (Appendix I and Table 3). Based on experience draining and enumerating fish at Navajo Agricultural Products Industry (NAPI) ponds, the wetland is likely to take approximately three days to drain. During this time, the aeration system from NAPI Razorback Sucker grow out ponds will be utilized at the wetland and operated continuously. Once fish are concentrated, they will be collected and held in an aerated foldable holding tank. Processing of all native suckers prior to release will include species identification, total length measurement, and implantation of a passive integrated transponder tag into Razorback Sucker if appropriately sized (i.e., > 120 mm). All native fishes will be released into the San Juan River while nonnative fishes will be enumerated and euthanized.

Table 3. Timetable and agency participation for draining the wetland and evaluating its success.

	Drain pond over a 3-day period	Capture and process fish
NNDFW		Between October 18th and the 30th
PO		Between October 18th and the 30th

Evaluation

As described in the construction scope of work (Appendix I), the objective of this habitat project is to assess whether providing large, stable, low-velocity habitat can increase the number of Razorback Sucker that recruit to and beyond the juvenile stage in the San Juan River. In 2018, the greatest number (n = 6) of wild age-0 Razorback Sucker were collected across primary and secondary channel and backwater habitats during a spatially truncated small-bodied monitoring effort (Zeigler and Wick 2019). Extrapolating the estimated catch per unit effort of wild age-0 Razorback Sucker in 2018 (0.011 fish/10 m^2; Zeigler and Wick 2019) to the size of the Phase III wetland (8,500 m^2) would result in approximately nine fish being present at those densities. The proposed Phase III wetland represents almost 2/3 of the mean area of backwater habitat associated with secondary channels (13,684 m^2, SD = 7,719 m^2; Lamarra and Lamarra 2017). Based on these calculations, the ultimate measure of success for this wetland would be production of 1-9 wild juvenile Razorback Sucker in the fall. This would demonstrate that large, stable, low-velocity habitat can increase Razorback Sucker larvae survival through the spring and summer to the juvenile life-stage in the fall. Ultimately, success of the Phase III project would indicate larger and more stable backwater habitats may increase the recruitment success of wild-spawned Razorback Sucker in the San Juan River.

As described in the construction scope of work (Appendix I), a proximate objective for the first few years of the wetland's operation will be to ensure that mechanisms to entrain native larval suckers are working. Since Razorback Sucker are relatively rare, the evaluation of this objective will be based on assessing densities of the two common native suckers. Larval Bluehead and Flannelmouth sucker densities in the wetland should be similar to those captured in low-velocity habitats in the adjacent mainstem San Juan River if the facility is adequately entraining larval fish. To make this assessment, larval fish captures from the first sampling effort (May, post filling) will be compared to larvae fish captures 10 river miles upstream of the wetland and downstream to the San Juan River-McElmo Creek confluence (in total: river miles 117.0-100.5). The downstream section will end at the McElmo Creek confluence because spawning by suckers is known to occur within McElmo Creek. A simple independent samples t-test will be used to test for differences in mean larval sucker densities in the wetland versus low-velocity habitats in the river proper, using individual seine hauls as the unit of replication. A lack of significant differences would indicate the facility is entraining larval at a rate similar to other backwater or low velocity habitats in the river.

Deliverables
A draft annual report will be compiled by the PO by 31 March 2022 and a revision that includes responses to BC member comments submitted by 30 June 2022. An oral report will be given at the winter SJRIP Biology Committee (BC) meeting.

Acknowledgements
Vince Lamarra (Ecosystems Research Institute) first suggested the idea of a restored floodplain wetland. Ron Bliesner and Brian Westfall (Keller-Bliesner Engineering, LLC) further developed the concept by evaluating potential sites and developing the design concepts and initial construction budgets. David Gori (The Nature Conservancy) led the development of the construction scope of work.

Budgets
ASIR – Task 2

Travel, Per Diem, Material/Supplies, and Personnel	
Travel - 4 x 4 pickup trucks (530 miles x $ 0.575/mile x 2 trips x 1 truck)	$615
Per Diem - 2 field days per trip x 2 staff ($55/day GSA M&IE rate) x 2 trips	$440
SJRRIP Meetings (Costs are covered under SOW 21)	0
Travel and Per Diem Total	$1,055
Personnel	$9,982
Materials and Supplies	0
Total	$11,036

NMFWCO – Task 1

Equipment	
Measuring water level (staff gauge, board, pvc): 4 units at $200 each	$800
HOBO MX2001 data logger (pressure sensor): 4 units at $599 each	$2,396
HOBO MX2001 read water level logger cable 30 m cable: 4 units at $190 each	$760
HOBO U26-001 data logger (dissolved oxygen and temperature): 3 units at $1,250 each	$3,750
HOBO U26-001 shuttle/base station/software	$373
Shipping/handling and taxes at ~6%	$400
Total	$8,479

NNDFW – Task 4
No request for funds

PO – Tasks 3 and 4
No request for funds

TOTAL REQUESTED
$19,516

References

Clark-Barkalow, S. L., M. J. Chavez, and S. P. Platania. 2019. San Juan River-specific growth functions for larval Colorado Pikeminnows and Razorback Suckers from otolith microstructure and somatic size. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM.

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

Keller-Bliesner Engineering. 2017. San Juan River Larval Razorback Sucker Refugia Enhancement Conceptual Design, 2nd Draft. Prepared for The Nature Conservancy, 212 East Marcy St., Suite 200. Santa Fe, NM 87501.

Lamarra, D., and V. Lamarra. 2017. San Juan River annual habitat monitoring 2016. San Juan River Recovery Implementation Program, Albuquerque, NM.

Zeigler, M. P. and M. E. Ruhl. 2017. Small-bodied fish monitoring in the San Juan River: 2016. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM.

Zeigler, M. P. and J. M. Wick. 2019. Small-bodied fish monitoring in the San Juan River: 2018. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM.

Appendix I
Phase III construction scope of work

Can be accessed at
https://www.fws.gov/southwest/sjrip/pdf/2019workplan.pdf

Response to Comments (in blue font*)* from BC Members

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

Seems well-thought-out overall. Why was the target capture density set at 10% of that in the adjacent river? Seems like a very modest goal.

The Scope has some missing words and such; recommend a good edit before finalizing.

We struggled with identifying a metric that we thought would signal successful entrainment and agree a 10% of densities observed in the river was a modest goal. We have changed this section to actually test if densities are different between the main stem river (only low-velocity habitats) and the wetland using a simple t-test. We think starting with the null hypothesis that densities should not be different in the wetland compared to other zero-velocity habitats is a good starting point to assess the function of the structure. We have tried to clean up the typos as well.

What is this SOW's contribution to recovery?

If the wetland refugium concept works it could be a game-changer. I don't see why we would build the constructed wetland and then not do this evaluation.

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

A contingency plan could be included that states how many years the phase iii will be operated as planned if no Razorback Sucker are captured in the first year, and also outlines the process of stocking larval Razorback in the wetland if no Razorback are entrained in flows during the first few years.

When to implement the contingency plan was not determined during development of the construction scope of work and will need to be determined by the Biology and Coordination Committee. Earlier drafts of the Phase III construction scope of work detailed how wild larval fish collection and stocking process would occur but was withdrawn from the approved version. In the draft version the proposal was:

> "Since the species of larval fish cannot be identified during collection and stocking, area seined will be used as a surrogate and calculated as the quantity necessary to increase the wetland density to the desired density (i.e., 0.111/m^2). Therefore, we would use the following calculations to estimate the amount of backwater habitat that would need to be sampled in order to supplement numbers of larval Razorback Sucker in the wetland:
>
> 1) The constructed wetland is 8,500m^2. Therefore, the total number of larvae at the desired density of 0.111/m^2 is 944 individuals.
> 2) The total number of individuals present in the wetland if their density is 0.025/m^2 is 213.
> 3) Density in the month of May in San Juan River backwaters near the wetland is 0.111/m^2
> 4) Thus, to approximate capture of 731 larvae (944-213), 6,579m^2 would be sampled from San Juan River backwaters (731/0.111/m^2).

5) Efficiency of collection may be increased if larval Razorback Sucker is present at inlet embayment in prior week(s) and larvae from this habitat could be continually seined."

What is this SOW's contribution to recovery?

This SOW could identify whether a lack of low velocity habitat is limiting Razorback Sucker recruitment to a juvenile life stage.

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

How can the technical aspects of this SOW be improved? I think that this is a strong proposal with appropriate metrics that determine success. I would add that the WQ and physical monitoring of the constructed pond be expanded to include water elevations of the river or secondary channel. I think that the water elevations in the pond will vary as river stage changes. In addition, the water quality in the pond will not be the same as in the well points. Moving forward, if larvae are not detected, rather than seed the pond with larvae at a future date, it may be better to put spawning adults in the pond as an alternative.

To relate river and wetland stage, a staff gauge was added to the protocol and would be placed at the confluence of the outlet and river. Two additional oxygen sensor locations were added to the protocol. These will be located at the deepest points along the length of the wetland which is now shown in Figure 3. The contingency plan agreed upon in the construction scope of work indicated seeding the pond with wild larvae. If the Biology and Coordination committees decide they would prefer a different contingency plan then this scope of work will be revised to reflect the implementation, monitoring, and evaluation of that plan.

What is this SOW's contribution to recovery?

No comment

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

SOPs for field calibration, cleaning and maintenance and drift correction for the Dissolved Oxygen sensor should be developed (if not in place already) and implemented. The resource characterization synergy with SOW 1 is good.

The scope of work was revised to state that standard operating procedures (SOPs) would be followed.

What is this SOW's contribution to recovery?

Improve survival rates and augment the population of RBS to support recovery efforts and assess the effectiveness of management actions (creation of low velocity wetland habitat).

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

No comment

What is this SOW's contribution to recovery?

Not sure, but this scope is a contribution to our understanding of managed flood plain refugium and it allows measurable outcomes of our Phase III Project. A large amount of time, effort, and funds have gone toward Phase III and without a well thought out monitoring protocol we will not gain the information required to analyze success and or limitations, or the knowledge required to identify possible recruitment bottlenecks in the population. The purpose of Phase III was to advance recovery goals, this scope is a requirement to do so properly.

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

I like this SOW and I think we need to pursue this work. We need to have monitoring of this site!) My one major comment stems from a statement made on lines 62-67.

"*Additionally, the limited collection of metalarval Razorback Sucker, the most mature phase of larvae, and the reduction in collection of this larval phase as early as July (Farrington et al. 2017) suggests relatively high mortality rates within the larval phases and is likely a factor contributing to the lack of recruitment to the juvenile life-stage over the spring-summer months. The source of this apparent recruitment bottleneck in the San Juan River is presently unknown."*

I find it interesting that because we don't have metalarvae that we assume that it is because of high mortality. If mortality between the three species were the same, then we assume that we would just have 1/3rd the number of RBS than we have of BHS (+/-). Why do we not consider/hypothesize that RBS have a VERY DIFFERENT drift ecology? What about if BHS and FMS were "stickier" with respect to getting caught up in channel margins and slack/back waters? What if RBS just aren't that sticky and drift downstream. Maybe their ecology was to take advantage of a very warm and productive lower river which historically was Glen Canyon? It might be possible that RBS actually have HIGHER survival because they are in the main channel and are not entrained or stuck in back and slack waters where they could be predated or trapped due to receding water levels.

The section was edited to use the phrase "apparent" mortality to provide for the possibility that drift out of the system was causing the lack of detecting recruitment in the river. Given the monitoring protocol it may be possible to inform these hypotheses.

2) I think you may want more than one DO sensor in the wetland. Do can vary greatly across even a small body of water and one sensor might not accurately measure DO across the wetland. The stilling basin might be exceptionally low and not really give an

accurate reading. I think at least 2-4 would be better. One at the stilling basin in mid water column, one along the shore, and one located in vegetation that develops.
We agree. Please see response to Lamarra above.

3) Why can't all four sampling trips be combined with larval sampling in the River like you are planning for the 3rd sampling trip? In your proposal you do not mention what you will do for trip # 4. It just seems excessive to drive that far to collect 10 seine hauls of 10 meters each. A lot of travel for minimal sampling. For the first trip why not close the inlet gate then collect a sample, or collect sample and then close the gate? No need to return after you collect samples to close the inlet.
The fourth trip is planned to occur after larval sampling has ceased for the year. The fourth trip was included in the construction scope of work to verify that larvae transitioned to juveniles. This purpose was clarified in the current draft scope of work. Since these are the life-stage where the recruitment bottleneck has been identified and what the project is attempting to alleviate, it is important to have enough data resolution to determine with degree of confidence that the wetland was successful. Waiting until October (a 2.5 month period between sampling events) would leave open the possibility that fish did transition to juveniles but that the juveniles then died. This option does not increase costs for this scope of work and once the wetland is shown to function as intended monitoring trips can be thinned. Trip 1 is proposing to collect the sample and then close the gate to verify larvae were actually entrained. Trip 2 would occur a few weeks later to assess whether entrained larvae survived. Hopefully the purposes of these trips were clarified in this draft.

4) I see you have a contingency plan or stocking the wetland if numbers of larvae are "low." I really like this idea and support it 1,000% percent. A couple of questions about this contingency plan:
A) What number/metric/density are you using to determine "low?"
Please see response to Davenport.
B) Do you have an agreement with SNARRC to have them hold back some larval RBS for stocking into the wetland?
At the current time, the contingency plan in the construction scope of work is to stock wild caught larvae not hatchery fish. We think the SJRIP should be open to other options but the BC will likely need to make those decisions before a final contingency plan can be developed.
C) What is the number of larvae you want in the pond, i.e., density?
Again, these details will likely need developed by the BC before a SOW can be written.

5) Line 217 needs to be rewritten—it doesn't make sense as it is now. I think you want it to read "compar**ed to** capture**s**". Check lines 219-220 as well.
The sentence was revised.

6) The criteria for success is 1-9 RBS at the end of the growing season. I understand where this number is derived (extrapolated from densities of wild RBS YOY's captured in 2018). But, this seems like an awfully small number of fish to develop success criteria. If only one or two RBS were to die just prior to release to the river then the project would

not be "successful." I have always been an advocate of stocking this wetland just to have a larger number of fish for a sample size. I think we should consider stocking the wetland and collecting genetic samples from fish released from the wetland for comparison to known parental units at the hatchery. This would give us more fish to work with in the wetland and allow us to separate wild larval fish from stocked larval fish when they are released to the river in the fall. The nice thing about doing this is the ability to put a known number of fish in the wetland and be able to calculate survival.
We are open to developing a SOW for other contingency options, if the Biology and/or Coordination committees decide to manage this wetland in a different fashion, this scope of work can be rewritten to implement that.

What is this SOW's contribution to recovery?

Knowing the success and productivity of this wetland is important for knowing whether the money spent on this habitat was worthwhile and whether we should construct more of these in the future. Evaluating the success of this wetland should be considered a high priority.

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

Appendix I is missing from the proposal and a full review could not be completed. The SOW needs to have all documents for a thorough review. The SOW should include a figure that shows the physical layout of the wetland and proposed location for the monitoring equipment. The narrative states the locations for equipment placement, however, it is not descriptive enough to fully visualize the placement for this review. The SOW states the inlet gate will be open for four weeks starting the first week of May. There should be a table that shows the wetland volume and fill rate based on the gate opening. Will the gate remain fully open and if so how long will it take to fill? Task 2 states that fill will take less than 24 hours. Will there be flow through the wetland or will the downstream closure of the wetland preclude any further flow into the wetland? Measurements of the inflow velocity during the fill and the times the gate is open would provide data to evaluate the ability to entrain larval fish. The SOW states that water level will be increased if DO levels are trending downward. Does the secondary channel that provides water to the inlet flow all summer discharges?
A figure is needed to show example locations for the seining in Task 2. Trip 4 is scheduled for early to mid-September. Is this trip needed since the wetland would be drained in October and any fish remaining could be captured at the outlet?
The live link to Appendix I was broken when the annual work plan document was compiled. The web link to the annual work plan where the SOW is published has been added as appendix I. Figures 2 and 3 were added from the construction scope of work and a hypothetical layout of proposed water quality monitoring sites was added to Figure 3. The construction scope of work stated the wetland would be expected to be filled within 24 hours and would be filled with the outlet gate closed to limit intake of sediment. The construction scope of work indicated the location of the wetland was chosen because the adjacent secondary channel was historically stable/flowing at 500 cfs. Please see response to McKinstry #3 in regards to trip 4.

What is this SOW's contribution to recovery?

It would document whether larval Razorback Suckers could be retained in grow in an artificial off-channel habitat.

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

What is this SOW's contribution to recovery?

It is essential to document any success that the Phase III site would have. This SOW provides data while the wetland is operational and at the end of the season as well. With the exception of 2018, YOY Razorback Suckers have been hard to come by in sampling, hopefully this will show success in the wetland.

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

Overall, I found the SOW to be well-written and comprehensive. On page 227 there does appear to be some duplication in the write-up of the fish sampling that could be eliminated. Also, to reduce the potential sacrifice of larval razorback sucker, is Trip 2 really needed? Why not just combine it with Trip 1.

Please see response to McKinstry #3.

What is this SOW's contribution to recovery?

As the Program has identified this management action as potentially critical to improving recruitment of razorback sucker, thorough monitoring is a high priority to determine if this type of habitat creation can contribute substantially to recovery.

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

Line 51-52: Adding stationary wildlife cameras to the site would likely benefit the project goal of identifying "when mortality events may have occurred". Avian predation is a known source of significant mortality in constructed aquatic habitats. Wildlife cameras may be able to document sources of mortality that would otherwise go unnoticed. Secondly, relatively inexpensive wildlife cameras are capable of transmitting images and video via cellular connections and this option would allow personnel to monitor water levels more often than once or twice weekly. Lastly, wildlife cameras would be capable of documenting potential vandalism if any occurred.

It was determined that vandalism would likely be an issue with the cameras themselves and there is no cellular service at the site.

Line 99: Will a weekly check of the DO be frequent enough to catch sudden decreases? Is it possible to get a DO meter than can transmit readings?

Given NMFWCO's remote biologist's capacity, the maximum frequency of checking on DO was once a week. If there are sudden decreases that cause fish kills this may indicate additional staffing capacity is necessary and/or there are larger issues with the wetland. There is no cellular service at the site.

Line 117-122: Given the depth of the pond (> 3 ft), how effective will sampling larval and small-bodied fishes be using seines? Sampling for larval fish will obviously be more effective, but small-bodied sampling will probably be very difficult, especially when sampling open water pond sections.
We agree sampling efficiency may vary across different water depths. However, because we will sample ALL juvenile fish that survive the entire rearing period, we will be able to assess variation in efficiency. For example, if very few fish are collected on the fourth trip but lots of fish are present when the pond drains, then we will know we were not very efficient and change monitoring accordingly.

Line 159: What contingency plan is in place to stock wild larval suckers into the wetland? Please provide information on what triggers this contingency plan and what its methods are.
The contingency plan was stated under Trip 2's description in the first draft and has been reiterated in the Purpose to be more explicit. Please see response to Davenport.

Line 173: Why is trip 4 needed? Draining the pond in October will provide information on whether or not Razorback Sucker recruited past the larval stage and survived. This was discussed in length at the February 2020 BC meeting. I thought that it was determined that this sampling was not needed.
It was determined at the BC meeting that NMDGF did not want to conduct this effort. Please see response to McKinstry #3.

Line 179: All native suckers should also be measured. This would allow for the assessment of differences in growth between any entrained sucker species.
This section was clarified to include all native suckers.

There are a number of omissions, typos, and awkwardly constructed sentences within the SOW (see examples below). Editing these would greatly improve the readability of the SOW
Typos identified below were corrected.

Line 120-122: "Sampling efforts will employ small mesh seines (ca. 1.0 m x 1.0 m x 0.8 mm mesh) fish larval fish sampling and larger seines (ca. 3.0 m x 1.8 m x 3.0 mm mesh) for small-bodied fish sampling".
Line 130-131: "The first two sampling efforts will consists of two person crews who will travel to the wetland and sample the site upon arrival (late afternoon).
Line 148-150: "The initial filling of the site is likely to be complete in <24 hours but that the 4-ft wide inlet gate would remain fully open for ca. four weeks."
Line 155-156: "This effort conducted to verify the continued presence/survival of larval Razorback Sucker in the wetland."

Line 202-204: Change “pit-tag” to passive integrated transponder tag
Line 242-245: “This would objectively and quantifiably demonstrating that large, stable, low-velocity habitat increases Razorback Sucker larvae survival through the spring and summer to the juvenile life-stage in the fall.”
Line 245-248: “The lower end of the range of success represents more wild juvenile Razorback Sucker than have been documented across all sampled habitats in all but two year of small-bodied monitoring and the upper end assumes the estimated CPUE of wild YOY Razorback Sucker documented in across all habitats in 2018 could be replicated in the constructed wetland.”

What is this SOW’s contribution to recovery?

Phase III provides a unique opportunity to assess the hypothesized recruitment bottleneck of Razorback Sucker within a mostly controlled system. Monitoring water quality and quantity, as well as fish will be important for assessing how well the wetland entrains larval fish and if Razorback Suckers recruit into post-larval juvenile fish. The Phase III project has the potential to provide a significant contribution to recovery if it increases knowledge on the recruitment of Razorback Sucker. Success or failure of the project will only be determined with this monitoring.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

It is good that a reasonable scale of monitoring and evaluation is planned for Phase III. This illustrates a sound attempt of a test of concept (i.e., artificial wetlands may enhance Razorback Sucker survival in the San Juan River). The project is being developed and assessed within an adaptive management framework, not as a formal research project with specified hypotheses. That is reasonable. However, the proponents should consider a wider array of quantifiable objectives to enable a stronger evaluation of the project, as well as more specific objectives for Razorback Sucker.
This scope of work details the objectives that were agreed to in the construction scope of work. If the Biology or Coordination committees determine other objectives are warranted, this scope can be amended to include and evaluate them.

The first “goal” (actually a quantifiable objective) to be used in the evaluation process is not clear to this reviewer. The biological goal pertinent to larval density is “common sucker capture density in the wetland to be at least 10% of that in the adjacent mainstem San Juan River.” Data and an example computation are provided, but the goal for larval fish density remains unclear.
Please see response to Crockett.

A second goal (objective) is to find 1-9 juvenile Razorback Sucker in the wetland upon its draining. That is an easily understood quantifiable objective, but what additional objectives may be applied to the fish community structure upon draining? For example, what is a reasonable density of nonnative predators and competitors?
This is a good question and we agree other objectives could be asked from this monitoring. However, at this point, those are likely secondary questions and we are

primarily focused on native Razorback Sucker. Nonetheless, we will be able to investigate those types of questions, but to keep the SOW focused to meet most people's concerns we have not included them here.

Beyond the focus on Razorback Sucker, there are several additional quantitative objectives that could be developed to facilitate evaluation of success or failure of Phase III, and to provide insight into biological and physical processes occurring in the wetland. Water levels and dissolved oxygen will be monitored, but what are the quantifiable objectives for water levels and water quality in the wetland? There are additional physical and biological factors that may affect survival of Razorback Sucker and other fish species in the wetland that could be identified with associated objectives. Consider formal sampling/observations and objectives for water temperature, phytoplankton blooms (particularly cyanobacteria), turbidity/water clarity, filamentous algae and aquatic macrophytes, fine sediment deposition, vertebrate activity (beaver, muskrats), etc.
Please see responses above.

The sampling design for larval and small-bodied fishes is not clear. It is stated that 10 fixed sampling sites will be established. Sampling will be stratified between shoreline and open water, and between the inflow canal and the wetland. It is not clear how many sampling sites will be established in each strata. This reviewer suggests 5 shoreline and 5 open water sampling sites for larval fish, with additional sampling in the inflow canal, during Trips 1-3. When sampling small-bodied fish with a larger seine during Trip 4 the inefficiency of sampling in open water must be addressed. This reviewer recommends sampling at 10 shoreline locations during this trip. Sampling of the inflow canal is probably not necessary during Trip 4.
The scope of work was revised to state sampling would be split between habitat types. It is agreed that there would be inefficiencies but the objective is to determine whether larval fish have transitioned to juveniles rather than make a quantification. Trip 4 was revised to indicate the inflow canal would not be sampled.

It is stated that during Trip 4 when sampling with a larger seine nonnative fishes that are collected will be removed from the wetland. This may seem to be a wise management activity, but how will that bias the outcome upon draining of the wetland? Control on nonnative fishes is not a management activity that takes place among artificial wetlands. This reviewer suggests that nonnative fishes collected during Trip 4 be returned to the pond to provide a better understanding of the processes (i.e., competition, predation) that may be occurring in the wetland.
This is a good point, while we doubt we would have a substantial impact to over-all abundances of nonnative fishes, we have altered the text to state nonnative fish will be returned to the wetland to limit potential 'hidden treatments'.

SOW 1 describes sampling for chlorophyll a and macroinvertebrates in the "Phase III artificial pond." In is not clear within either this SOW or SOW 1 what is planned for the monitoring and evaluation of the Phase III relative to primary production or benthic invertebrates. The nature of the collaboration needs to be described in detail. What is the experimental design for assessment of Phase III? What are the metrics to be assessed?

How are the data to be analyzed? More detailed criticisms of the sampling methods are provided in the review of SOW 1.
In the future there may be interest from the committees to ask and answer these questions but currently the metrics are the number of juvenile Razorback Sucker that result from draining the wetland and the density of larval fish compared to the river.

What is this SOW's contribution to recovery?
Phase III is another test of concept project that has potential for determining if artificial wetlands have application to recovery of Razorback Sucker in the San Juan River.

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?
The PIs have covered the bases. The estimate of production is disappointing but maybe it's wrong.

Minor typos (highlighted text)
84
157
246
247
The typos were corrected

What is this SOW's contribution to recovery?
If the "wetland" is built then the Program has to know how well or poorly it worked. If it produces juvenile razorbacks in good numbers over time then we will know this is a viable management for that purpose. Hopefully one more key to overcoming the juvenile bottleneck.

Program Office

How can the technical aspects of this SOW be improved?
Provide a rational for the 10% metric in line 215.
Please see response to Crocket.

The math in Table 4 needs to be checked for Speckled Dace and Fathead Minnow.
The values were corrected.

May want to consider adding several areas in the wetland to measure 0_2 given the multiple factors that could impact these concentrations at different depths and other local conditions (e.g., river influenced versus ground water influenced).
Please see response to Lamarra

Editorial comments:
Line 217 are there some words missing from this sentence?
The sentence was revised.

Lines 223-224 clarify whether these are wetland larval densities
The sentences were revised for clarification.

Line 243 tense of “demonstrating.”
The tense was corrected.

What is this SOW’s contribution to recovery?
This work will be the only assessment of the constructed Phase III wetland.