SMALL-BODIED FISHES MONITORING IN THE SAN JUAN RIVER

FY 2021 SCOPE OF WORK

TO

BUREAU OF RECLAMATION

FROM

New Mexico Department of Game and Fish
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27 March, 2020

FOR

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

REPORTING DATES:

10/01/2020 through 9/30/2021

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

NEED

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

GOAL

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

MONITORING OBJECTIVES

The specific objectives for SBF monitoring include:

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

STUDY AREA

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

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

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

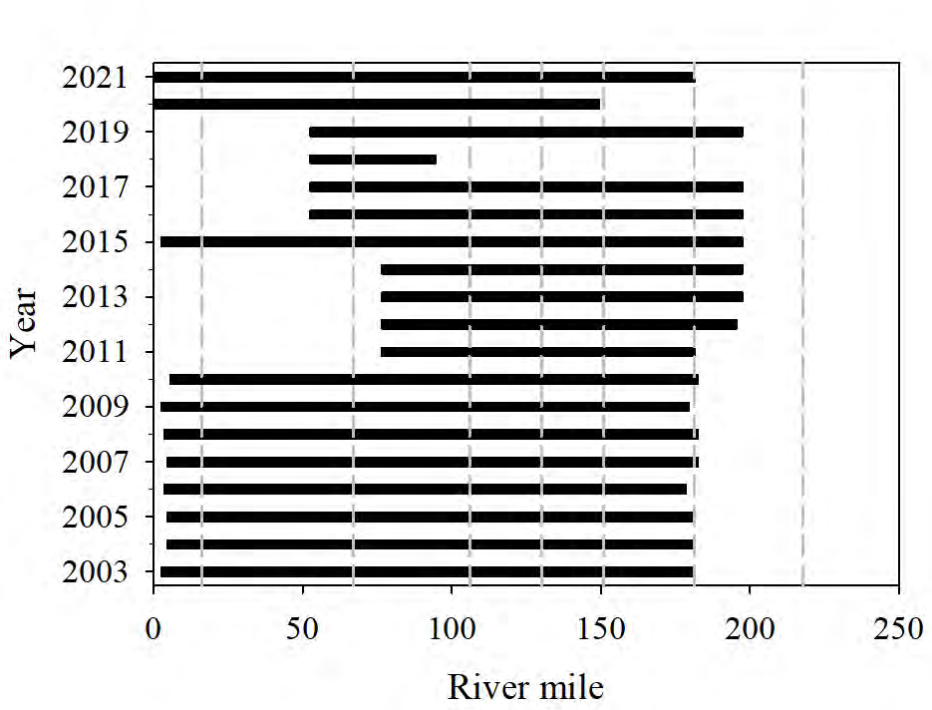

Figure 1. Spatial extent of sampling during small-bodied fishes monitoring on the San Juan River since 2003. The spatial extents of sampling in 2020 and 2021 are proposed. Note that river miles begin at the inflow of Lake Powel in Utah (River Mile 0) and end at Navajo Dam in New Mexico (River Mile 224).

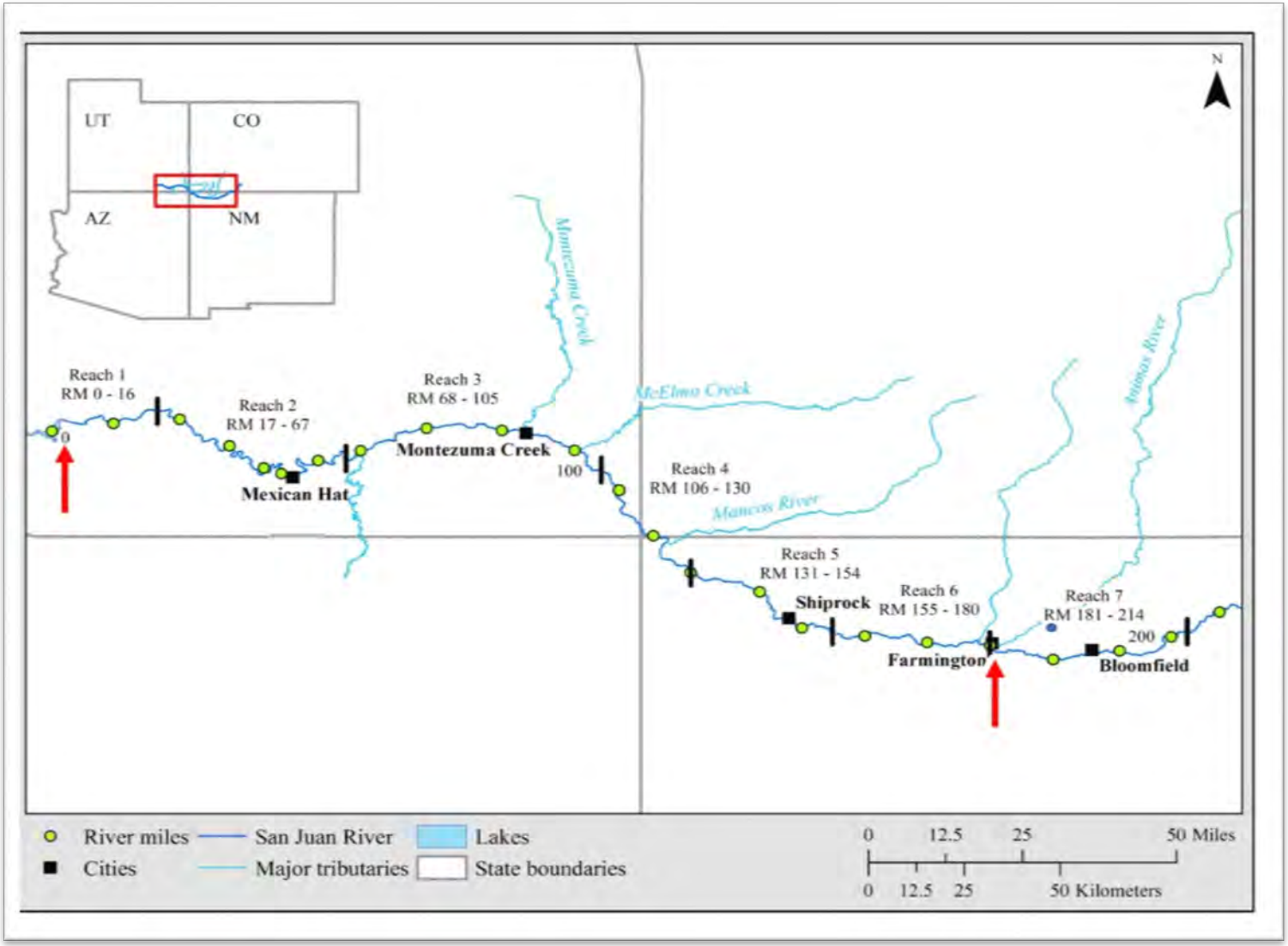

Figure 2. The San Juan River in New Mexico, Colorado, and Utah with river miles and geomorphic reaches indicated. The section between the red arrows will be sampled during 2021 small-bodied fishes monitoring (Animas River confluence downstream to Clay Hills Crossing, UT). Inset indicates location of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

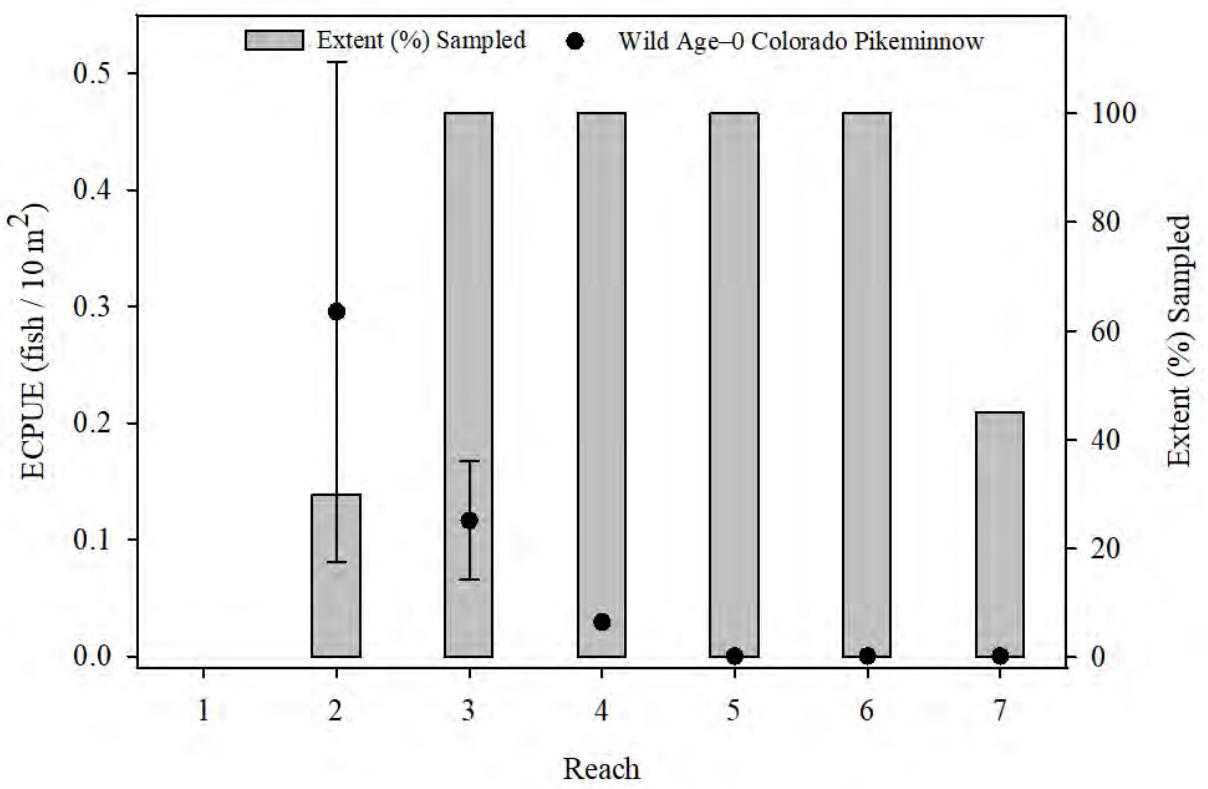

Figure 3. The expected catch-per-unit-effort (ECPUE, fish/10 m^2) of wild age-0 Colorado Pikeminnow in Reaches 1 – 7 in 2016, 2017, and 2019 overlaid on the extent in percent of total Reach length sampled in the same years. Note that Reach 1 was not sampled. Circles represent mean ECPUE estimates and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

METHODS

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

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

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

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

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

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

DATA ANALYSIS AND REPORTING

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

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

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

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

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

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

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

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

Budget Justification

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

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FY 2021 Budget

Sampling - Animas River to Shiprock, NM

Personnel

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

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

Per Diem

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

Vehicles

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

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

Sampling - Shiprock, NM to Clay Hills Crossing, UT

Personnel

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

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

Per Diem		
3 days @ $85/day (standard NM in-state rate) * 4 biologists	$	1,020
12 days @ $115/day (stanadard NM out-of-state rate) * 4 biologists		5,520
Sub-total	**$**	**6,540**
Vehicles		
Round-trip (2 vehicles) to Clay Hill Crossing, UT – 1,500 miles @ $0.55/mile	$	825
Sub-total	**$**	**825**
Shiprock to Clay Hills Crossing Sampling Sub-total	**$**	**45,379**
Field Equipment & Supplies		
Water quality instrument maintence 2 @ $400	$	800
Life Jackets 5 @ $60	$	300
Raft maintenance	$	500
Whirlpacks (500) @ $50.00/per 500	$	50
Formalin (6 gal) @ $25/gal	$	150
Raft (16'), Frame, and Oars (funds not requested)	$	0
Sub-total	**$**	**1,800**
Sampling Sub-total	**$**	**59,210**

Specimen Management

Personnel

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

Project Biologist (1)		
96 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))	$	3,671
Specimen Management Sub-total	**$**	**3,671**

Data Management/Analysis and Report Preparation

Personnel

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

Project Leader (1)		
120 hrs regular @ $47.73/hr ($34.84/hr (base salary) + $12.89/hr (benefits))	$	5,728
Project Biologist (1)		
200 hrs regular @ $38.24/hr ($27.91/hr (base salary) + $10.33 (benefits))	$	7,648
Data Management/Analysis & Report Preparation Sub-total	**$**	**13,376**

FY 2021 Total

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

RESPONSE TO COMMENTS

Harry Crockett, Colorado DNR, BC member

How can the technical aspects of this SOW be improved?

No recommendations. It seems well-conceived to me.

RESPONSE—Thank you, Harry.

What is this SOW's contribution to recovery?

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

Steve Davenport, USFWS Region 2, BC member

How can the technical aspects of this SOW be improved?

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

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

What is this SOW's contribution to recovery?

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

Vince Lamarra, Navajo Nation, BC member

How can the technical aspects of this SOW be improved?

Agree with the spatial change

RESPONSE—Thanks Vince.

What is this SOW's contribution to recovery?

No comment

Colin Larrick, Ute Mountain Ute Tribe, BC member

How can the technical aspects of this SOW be improved?

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

RESPONSE—Thanks Colin.

What is this SOW's contribution to recovery?

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

Jacob Mazzone, Jicarilla Apache Nation, BC member

How can the technical aspects of this SOW be improved?

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

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

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

What is this SOW's contribution to recovery?

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

Mark McKinstry, BOR, BC member

How can the technical aspects of this SOW be improved?

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

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

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

RESPONSE—Thanks Mark.

What is this SOW's contribution to recovery?

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

Bill Miller, Southern Ute Indian Tribe, BC member

How can the technical aspects of this SOW be improved?

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

RESPONSE—Thanks Bill.

What is this SOW's contribution to recovery?

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

Ben Schleicher, USFWS R6, BC member

How can the technical aspects of this SOW be improved?

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

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

Will the Phase III site be sampled during this project?

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

What is this SOW's contribution to recovery?

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

Tom Wesche, Water Development Interests, BC member

How can the technical aspects of this SOW be improved?

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

RESPONSE—Thanks Tom.

What is this SOW's contribution to recovery?

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

Matt Zeigler, NMDGF, BC member

How can the technical aspects of this SOW be improved?

No Comment.

What is this SOW's contribution to recovery?

No Comment.

Wayne Hubert, Peer Reviewer

How can the technical aspects of this SOW be improved?

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

RESPONSE—Thanks Wayne.

What is this SOW's contribution to recovery?

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

Mel Warren, Peer Reviewer

How can the technical aspects of this SOW be improved?

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

RESPONSE—Thanks Mel.

What is this SOW's contribution to recovery?

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

Program Office

How can the technical aspects of this SOW be improved?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

What is this SOW’s contribution to recovery?

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