



U.S. Fish and Wildlife Service
Assessment and Review of the San Juan River Basin Recovery Implementation
Program's Progress Toward Recovery

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Approval:

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INTRODUCTION

The Animas-La Plata Project biological opinion (BO) identified the development and implementation of the San Juan River Basin Recovery Implementation Program (SJRIP) as a reasonable and prudent alternative (RPA) to prevent jeopardizing the continued existence of Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*) (U.S. Fish and Wildlife Service [FWS] 2000). The SJRIP was established in 1992 through a cooperative agreement among federal, state, and tribal partners (SJRIP 2018a) with the goal to conserve and recover endangered Colorado pikeminnow and razorback sucker in the San Juan River basin (Figure 1) while providing Endangered Species Act (ESA) compliance for water development and management activities. We complete this assessment as part of the Department of Interior's responsibilities for the SJRIP to assess if the SJRIP's progress toward recovery is sufficient for the SJRIP to continue to provide ESA compliance for water development and management activities in San Juan River basin (SJRIP 2018a). In this "Sufficient Progress" report, we evaluate the status of the species and recovery activities conducted since the last "Sufficient Progress" report was completed (FWS 2021) and identify corrective actions necessary to ensure future ESA compliance in accordance with the "Principles for Conducting ESA Section 7 Consultations on Water Development and Water Management Activities Affecting San Juan River Basin Endangered Fish" (Principles; SJRIP 2022a).

The SJRIP implements activities identified in its Long Range Plan (LRP) to promote recovery of Colorado pikeminnow and razorback sucker in the San Juan River basin (SJRIP 2016). The LRP identifies management actions from recovery goals (FWS 2002a, FWS 2002b) thought necessary to minimize or remove threats and support wild self-sustaining populations of Colorado pikeminnow and razorback sucker. We anticipate that Colorado pikeminnow and razorback sucker will respond positively to the successful implementation of management actions and will ultimately result in their recovery in the San Juan River basin. Five recovery elements described in the SJRIP's Program Document (SJRIP 2022b) are listed below:

1. Protection of genetic integrity and management and augmentation of populations
2. Protection, management, and augmentation of habitat
3. Water quality protection and enhancement
4. Interactions between native and nonnative fish species
5. Monitoring and data management

We used the following sources of information for our assessment of the SJRIP's progress toward recovery: (1) the SJRIP's annual, research, integration, and evaluation reports; (2) SJRIP scopes of work (SOW); (3) relevant peer-reviewed scientific literature; (4) unpublished data collected as part of research or management activities conducted by the SJRIP or other entities; (5) BOs that rely on the SJRIP for ESA compliance; (6) the most recent "Sufficient Progress" report for the SJRIP signed in 2021 (FWS 2021); and (7) FWS Species Status Assessments (SSA) for Colorado pikeminnow (FWS 2022) and razorback sucker (FWS 2018a). These sources provided the best available science and summarized the SJRIP's management actions implemented to benefit recovery of Colorado pikeminnow and razorback sucker, in addition to detailing the monitoring and research activities that assessed the endangered fish responses to management actions and status of the species.

STATUS OF THE SPECIES IN THE SAN JUAN RIVER BASIN

Recovery goals provide objective, measurable recovery criteria in the upper Colorado River basin for Colorado pikeminnow (FWS 2002a) and in both the upper and lower Colorado River basins for razorback sucker (FWS 2002b). Our review of sufficient progress for Colorado pikeminnow and razorback sucker will focus on the San Juan River basin, one of the three subbasins of the upper Colorado River basin (also including the upper Colorado and Green River subbasins). The San Juan River basin includes the mainstem San Juan River, its tributaries, and the San Juan arm of Lake Powell to its historical confluence with the Colorado River. Recovery of these species in the San Juan River basin relies on the implementation of a variety of actions conducted by the SJRIP. We expect these actions to improve the status of both species and result in self-sustaining populations.

The SJRIP's monitoring activities provide information on the status of Colorado pikeminnow and razorback sucker summarized below. When the SJRIP was established, a small remnant population of Colorado pikeminnow existed in the San Juan River but razorback sucker was functionally extirpated. Due to a lack of wild-recruitment, both species' populations are supported by hatchery-reared augmentation programs. Without these stocking efforts and other SJRIP management actions, both species would be extirpated from the San Juan River basin.

Colorado pikeminnow

During the mid-1990s, 19 (17 adult and 2 juvenile) wild Colorado pikeminnow were collected in the San Juan River between river mile (RM) 142 (the former Cudei Diversion) and Four Corners at RM 119 (Ryden 2000, Ryden and Ahlm 1996). Population estimates in the 1990s suggested that there were fewer than 50 adult Colorado pikeminnow in the San Juan River (Ryden 2000). Since 2002 nearly 6 million hatchery-produced Colorado pikeminnow of various life stages have been stocked in the San Juan River (Furr 2020a). The low rate of recruitment of stocked fish to adulthood is probably due to a consistent and relatively low apparent survival of age 1-3 fish (0.19–0.25; Figure 2; Clark et al. 2018). This relatively low apparent survival and absence of an appreciable increase between ages 1-3 significantly slows accumulation of mature Colorado pikeminnow in the San Juan River and functions as a bottleneck to efficient and effective species recovery (SJRIP 2018a). Nonetheless, these stocking efforts have resulted in a slowly increasing adult population averaging 205 individuals annually over 2011-2021 from RM 147.9 to as far downstream to RM 52.9 (Figure 3; Saltzgeber and Mussmann 2022a, Schleicher et al. 2022). Additionally, a total of 365 Colorado pikeminnow individuals have been detected in Lake Powell and downstream of the Piute Farms waterfall since 2005 (<https://streamsystem.org>), suggesting limited use of those habitats but declining reservoir levels have expanded lotic habitat downstream of the waterfall. The adult Colorado pikeminnow population has successfully spawned in the San Juan River every year since 2013 (Farrington et al. 2022). However, recruitment of wild fish to the juvenile life stage has only occurred infrequently (Barkalow and Zeigler 2022).

Razorback sucker

Wild razorback sucker was functionally extirpated from the San Juan River by the 1990s and the current population was established through stocking of hatchery-reared fish (Holden 1999). Over 200,000 razorback sucker have been stocked into the San Juan River basin since 1994 although annual augmentation goals were not regularly reached until 2005 (Figure 4; <https://streamsystem.org>). Razorback sucker are typically stocked at sub-adult sizes (>300 millimeter [mm] total length [TL]; Furr 2022) and increased catch rates indicate survival of these stocked individuals to the adult life stage (≥ 400 mm TL; Schleicher 2018; Figure 5). The adult population appears to have stabilized around 3,000 individuals between RM 147.9 and RM 52.9 since 2011 (Saltzgeber and Mussmann 2022a, Schleicher et al. 2022; Figure 5). Since 2012

estimated abundance of razorback sucker in Lake Powell has ranged from 455-647 individuals annually with low precision because of limited recaptures (Francis et al. 2017, Pennock 2019) and at least 755 razorback sucker used the Piute Farms waterfall in 2017 (Cathcart et al. 2018) suggesting a total population size of less than 2,000 adults in the San Juan River – Lake Powell complex (Pennock 2019). Razorback sucker spawning has occurred consistently in the San Juan River since 1998 with generally increased density of larval fish captured and further upstream detection of spawning through time (Farrington et al. 2022). The percentage of adults participating in spawning in any given year is low but slowly increasing through time (Diver et al. 2021). Age at maturity in the San Juan River is unknown but the low proportion of individuals successfully contributing to annual spawning could be explained by older age at maturity and slow accumulation of reproductive adults (Diver et al. 2021). Densities of larval razorback sucker are similar to flannelmouth sucker (*Catostomus latipinnis*) and bluehead sucker (*Catostomus discobolus*) in the San Juan River but recruitment of razorback sucker to subsequent life-stages is rare in contrast to the two native sucker species (Figure 6). This apparent recruitment bottleneck could be explained by high emigration to Lake Powell, a lack of available rearing habitat, temperature suppression from Navajo Reservoir releases, environmental contaminants, or other biotic or abiotic factors. Research is ongoing in the San Juan River basin to address these hypotheses. Given the lack of wild recruitment, the San Juan River basin population of razorback sucker, like most other populations, remains reliant on hatchery augmentation for their persistence (FWS 2018a).

FWS REVIEW OF SJRIP ACCOMPLISHMENTS AND AREAS OF CONCERN

As part of our assessment of each recovery element, we identified accomplishments promoting recovery in the San Juan River basin and corrective actions to ensure future ESA compliance. While we detailed how the SJRIP's activities under the recovery elements satisfied or fell short of criteria outlined in the Principles (SJRIP 2022), the evaluation of whether the SJRIP is making sufficient progress toward recovery to provide ESA compliance for water development and management activities is based on the entirety of SJRIP's recovery management actions, species responses to those management actions, and improvement in population status of Colorado pikeminnow and razorback sucker within the San Juan River basin. We describe SJRIP

accomplishments and shortcomings by recovery element to provide context for our overall assessment of the SJRIP's progress toward recovery.

Significant SJRIP accomplishments by recovery element

Protection of genetic integrity and management and augmentation of populations

The SJRIP has consistently achieved goals outlined in its augmentation plans since 2005 (Ryden 1997, Ryden 2003a, Ryden 2003b, Furr and Davis 2009, Furr 2020b) to maintain and increase the size of adult Colorado pikeminnow and razorback sucker populations in the San Juan River. The SJRIP has increasingly recognized the need to evaluate and adaptively manage its augmentation efforts (Zeigler et al. 2020) and in 2021 transitioned from annually stocking 400,000 age-0 Colorado pikeminnow to stocking ~12,000 age-1 fish (Knight 2020). Stocking fish at age-1 rather than age-0 allows for individuals to be uniquely identified (by implanting a PIT tag prior to stocking). The primary benefits of stocking PIT tagged Colorado pikeminnow are to distinguish them from wild-spawned conspecifics and to allow for an experimental assessment of hatchery enrichment based on subsequent recaptures in the field. In early 2021, 3,803 juvenile razorback sucker were stocked in the San Juan arm of Lake Powell to determine if stocked juvenile fish would recruit in this habitat and future monitoring efforts will assess survival from this stocking effort. Of all the management actions to recover Colorado pikeminnow and razorback sucker in the San Juan River, stocking with hatchery-produced fish has led to the largest population responses because of its direct impact on increasing numbers of endangered fishes through time (Durst 2015, Franssen et al. 2016).

To increase the genetic diversity and abundance of Colorado pikeminnow broodstock at the Southwestern Native Aquatic Resources and Recovery Center (SNARRC; Diver et al. 2019), the SJRIP collaborated with the Upper Colorado River Endangered Fish Recovery Program to collect wild young-of-year fish from the Colorado and Green Rivers in 2020 and 2021 (Michaud 2020, Creighton et al. 2022).

Protection, management, and augmentation of habitat

The SJRIP continues to make significant progress addressing barriers to fish movement in the San Juan River. The SJRIP operates the Public Service Company of New Mexico (PNM) fish passage to allow Colorado pikeminnow, razorback sucker, and other native fish access to upstream

habitats. Since 2018, the PNM fish passage has been operated non-selectively during spring when few nonnative fish are locally present to improve passage efficiency for Colorado pikeminnow and razorback sucker (SJRIP unpublished data). Ongoing quantitative evaluation of the PNM fish passage is being used to improve its efficiency because it continues to be a substantial movement barrier (Kelly et al. in prep).

Additional fish passage work was conducted in 2020 and 2021 to determine if barriers to fish movement at the Piute Farms waterfall and PNM weir in the San Juan River are impeding reproductive output and natural recruitment of razorback sucker (Bogaard 2021, Saltzgiver and Mussmann 2021). Facilitated passage was provided upstream of these two barriers, transported fish were tracked to identify fish aggregations and potential spawning habitat, and the reproductive contribution of translocated razorback sucker was assessed via genetic analysis of subsequently collected larval fish. None of the translocated fish were identified as parents of larvae collected during larval monitoring but it is unlikely that no translocated fish spawned and their offspring were most likely not sampled (Saltzgiver and Mussmann 2022b). Nonetheless, razorback sucker spawning has been detected upstream of the Animas River confluence in the San Juan River (Farrington et al. 2021) and both Colorado pikeminnow and razorback sucker adults have been detected in the Animas River nearly 10 miles upstream from the San Juan River confluence (<https://streamsystem.org>) indicating at least seasonal use of upstream habitats made accessible by improving downstream fish passage.

The SJRIP has recently taken important steps to improve fish habitat in the San Juan River by minimizing the negative impacts of existing diversions and other passage barriers. In 2020 the SJRIP funded investigations to provide fish passage at the Arizona Public Service (APS) weir and selective fish passage at the Piute Farms waterfall. Fish passage at APS would improve access to the reach of the San Juan River upstream of the APS weir (RM 163.3). Selective fish passage at the Piute Farms waterfall would allow native fish access from Lake Powell to the mainstem San Juan River while excluding nonnative fish. On 8 June 2021 the SJRIP finalized “Prioritization of Diversions for Fish Passage and Entrainment Evaluation” to guide the evaluation, development, funding, and implementation of future projects on a three-year cycle to increase fish passage and reduce entrainment of endangered fishes at diversions and barriers identified in the San Juan and Animas Rivers (SJRIP 2021).

The SJRIP should renew attempts to improve fish habitat in the San Juan River by constructing floodplain wetlands and continue enhancing secondary channel complexity to aid the recovery of endangered fishes. Floodplain wetlands in the Green and Colorado Rivers have successfully entrained wild-spawned razorback sucker larvae and produced recruited juveniles that have rarely been documented elsewhere in the Colorado River basin. The SJRIP constructed a 8,500 square meter (m²) razorback sucker floodplain wetland at RM 107 in November 2020 to address the identified recruitment bottleneck between the larval and juvenile life-stages by providing a large, stable, predator-free, low-velocity habitat (known as Phase III). The wetland accomplished an initial goal by entraining wild-spawned razorback sucker in May 2021, but unstable substrates resulted in the wetland's concrete inlet and outlet structures failing during rising spring flows. Thus, the wetland's ultimate goal of producing wild juvenile razorback sucker was never realized. Given the success of floodplain wetlands producing wild razorback sucker juveniles in the upper Colorado River basin, the SJRIP should take its failed wetland as a "lessons learned" and build new wetlands in suitable locations with improved engineering design and construction to address the recruitment bottleneck between larval and juvenile razorback sucker in the San Juan River.

The SJRIP has conducted research to evaluate resource differences between backwater types and assess cost-effective methods for improving simplified in-stream habitats. While there were limited environmental difference between main channel and secondary channel backwaters both were of low habitat quality and degraded through time, stressing for the need for high spring discharge to maintain these habitats (Whitney and Hansen 2022). Preliminary results from recent experimental use of Russian olive (*Elaeagnus angustifolia*) to enhance in-stream habitat for native fish in the San Juan River suggest this could be a viable management action based on the more complex habitat and higher density of native fishes in treatment compared to control reaches (Pennock et al. 2022).

A small-scale effort to create and maintain low-velocity habitats and enhance secondary channel complexity to aid the recovery of endangered fishes by improving flow in secondary channels in the San Juan River was funded by the SJRIP in 2020 and 2021 (Bowman and Zeigler 2019). Previous large-scale projects (Phase I and Phase II habitat projects) demonstrated secondary channel habitats in the San Juan River could be modified to increase the persistence of flow and that juvenile native fishes would readily occupy these newly formed habitats (Lamarra et al. 2018).

The main intent of small-scale secondary channel modification was to allow the river to conduct the “heavy lifting” of sediment flushing following removal of flow impediments at several secondary channel sites. However, due to access restrictions caused by the COVID-19 pandemic and subsequent permitting issues, implementation of this project has been delayed. Given the need for habitat improvement in large reaches of the San Juan River, this small-scale approach needs to be conducted as soon as feasible to assess its potential as a cost effective, landscape level habitat improvement to benefit Colorado pikeminnow and razorback sucker recovery in the San Juan River.

Water quality protection and enhancement

Because some actions to protect and enhance water quality in the San Juan River basin are beyond the authority of the SJRIP to implement, we recognize the efforts of SJRIP partners in carrying out their commitments in various BOs that contribute to recovery of Colorado pikeminnow and razorback sucker. Results from a Colorado pikeminnow population viability analysis (Miller 2014) informed the Four Corners Power Plant and Navajo Mine Energy Project BO that stipulated conservation measures, reasonable and prudent measures (RPMs), and terms and conditions to promote recovery of Colorado pikeminnow and razorback sucker in the San Juan River related to water quality issues (FWS 2015). This included monitoring mercury and selenium concentrations in endangered fish in the San Juan River, funding a mercury effects study on Colorado pikeminnow, and conducting an experiment to assess the effect of temperature on larval razorback sucker growth and survival. These studies have been conducted in collaboration with SNARRC and results are forthcoming. Additionally, the Bureau of Indian Affairs (BIA) is finalizing a selenium effects study on razorback sucker. Finally, as part of the San Juan River Navajo Irrigation Rehabilitation and Improvement Project BO (FWS 2018b), BIA will conduct a study to quantify the selenium load returned to the San Juan River from the Hogback-Cudei and Fruitland-Cambridge irrigation systems once the project is complete to help determine if further remediation of these systems is necessary.

Interactions between native and nonnative fish species

In 2020 and 2021 the SJRIP conducted nonnative fish management targeted at channel catfish (*Ictalurus punctatus*) in the winter to determine if sampling during low flow and low

turbidity would improve efficiency (i.e., similar or better exploitation with reduced effort). However, these winter nonnative management efforts had lower removal rates over a shorter river reach compared to the average observed in 2011-2015, suggesting winter removal did not improve channel catfish electrofishing capture efficiency. The SJRIP assessed its nonnative fish management activities during a symposium in November-December 2021. In the symposium the SJRIP reviewed past research efforts to evaluate the effectiveness of nonnative removal, the response of native and nonnative species to nonnative removal efforts, and the predatory impact of channel catfish on native fish. Nonnative removal efforts directed at channel catfish decreased the population's size structure to more and smaller channel catfish, but exploitation rates were not sufficient to "crash" the population. Furthermore, the predatory impact of channel catfish on endangered fish could be mitigated by stocking age-1 Colorado pikeminnow and increasing the number or survival of stocked fish. The symposium concluded with the SJRIP deciding to take a 3-5 year "hiatus" from its nonnative fish management efforts to redirect resources toward identifying methods to increase exploitation rates and the efficiency of nonnative fish management and to increase the number and post-stocking survival of age-1 Colorado pikeminnow.

Monitoring and data management

The SJRIP's monitoring activities allow us to make an assessment on the status of the listed fishes in the San Juan River basin. Without monitoring to understand the status of the species, our ability to conduct this assessment would be compromised in addition to hindering our ability to determine where Colorado pikeminnow and razorback sucker sit on the continuum of recovery in the San Juan River basin. Monitoring activities also allow the SJRIP to assess the response of fish and habitat to management activities and are an essential step supporting efforts to adaptively manage recovery. Furthermore, the SJRIP's extensive monitoring activities also helped identify recruitment bottlenecks for Colorado pikeminnow and razorback sucker (SJRIP 2018a) and while research is ongoing, more experimental efforts will be necessary to identify appropriate management actions to alleviate impediments to recovery.

The SJRIP's ongoing efforts to plan post-2023 are essential for continued progress toward recovery and for the SJRIP to provide ESA compliance for ongoing and future water development and management activities in San Juan River basin. These efforts include securing future funding sources, renewing cooperative agreements, and managing reservoir operations in the face of

competing commitments for water and persistent drought. We foresee continued cooperation among SJRIP partners on these issues as critical to maintain progress and achieve recovery in the San Juan River basin.

FWS concerns and recommendations by SJRIP recovery element

Protection of genetic integrity and management and augmentation of populations

On 29 August 2022 all Colorado pikeminnow broodstock from the 1994 year class (79 individuals) and 2006 year class (50 individuals) at SNARRC were found dead. The FWS is working to determine the cause of this mortality and implement measure to protect remaining broodstock. SNARRC will be able to meet its SJRIP age-1 Colorado pikeminnow stocking commitments in fiscal years 2023 and 2024 but until further evaluation of the remaining broodstock occurs, future stocking commitments are uncertain. Given the Colorado pikeminnow's population reliance on hatchery augmentation in the San Juan River, the loss of these broodstock may hinder the SJRIP's recovery efforts. However, the full magnitude of this setback cannot be determined until the FWS determines the status of the remaining Colorado pikeminnow broodstock. We recommend the SJRIP conduct additional wild broodstock collection from the Colorado and Green Rivers to ensure SNARRC has sufficient broodstock with appropriate genetic diversity in captivity to produce and stock Colorado pikeminnow to sustain the San Juan River basin population until wild recruitment renders the augmentation program unnecessary.

Protection, management, and augmentation of habitat

Releases from Navajo Reservoir to mimic high spring peak flows are one of the SJRIP's primary management actions to develop and maintain habitat. However, the effects of the ongoing drought and consistent dry hydrology over the last 20 years has resulted in low runoff from the Animas River and low inflow to Navajo Reservoir with corresponding limited high spring peak flows in the San Juan River (Behery and Vandegrift 2022). The inability to reach high flow targets at the recommended frequency has contributed to a degraded habitat condition in the San Juan River (Lamarra and Lamarra 2016, SJRIP 2018b). Reaching high flow targets at the recommended frequency would likely result in reversing the long-term declines in important low velocity habitats used as nurseries for larval and juvenile Colorado pikeminnow and razorback sucker (Holden 1999, Lamarra and Lamarra 2020, SJRIP unpublished data). In general, attaining higher spring

flows creates and maintains important rearing habitats for Colorado pikeminnow and razorback sucker in the San Juan River (Lamarra and Lamarra 2020, SJRIP unpublished data). In particular, the inability to reach the 8,000 and 10,000 cfs flow targets at the recommended 33% and 20% annual frequency, respectively, is cause for concern. The lack of high magnitude flows at the frequency prescribed by the flow recommendations likely resulted in habitat degradation and impeded recruitment of wild-spawned individuals (Holden 1999, SJRIP 2018b). In the absence of appropriate flows to develop and maintain habitat necessary for recovery, the SJRIP and its partners have conducted secondary channel and low velocity habitat restoration and creation in the San Juan River. We recommend the SJRIP explore options to protect flows and potentially buy or lease water to augment flows necessary for habitat creation and maintenance. Additionally, we recommend the SJRIP conduct habitat construction and restoration projects at the appropriate spatial and temporal scale to complement flow management in the San Juan River as part of efforts to identify and ameliorate impediments to recovery.

Water quality protection and enhancement

We remain concerned with levels of mercury and selenium found in the tissues of Colorado pikeminnow and razorback sucker in the San Juan River basin because of potential reproductive impairment impeding progress toward recovery (FWS 2015). We recognize that remediation of these contaminants is beyond the scope and capabilities of the SJRIP and will require the assistance and actions by other federal and state agencies. However, we are supportive of the SJRIP's efforts to monitor and evaluate the effects of these contaminants in the endangered fish. We anticipate that conservation measures, RPMs, and terms and condition of previous and future BOs related to water quality issues within the San Juan River basin will continue to address specific management actions to minimize and further understand the effects of mercury and selenium on Colorado pikeminnow and razorback sucker.

Hypolimnetic (i.e., coldwater) release from Navajo Reservoir suppresses the temperature of the San Juan River in spring, summer, and fall; and potentially limits spawning habitat for endangered fishes in the San Juan River (Cutler 2005). Additionally, water temperature is a primary factor affecting growth, development, and survival of larval fish (Houde 1987, Harvey 1991). Larval growth rates of Colorado pikeminnow (Bestgen 1996) and razorback sucker (Bestgen 2008) declined at lower temperatures in laboratory studies. We are concerned about

potential negative effects of low temperature on Colorado pikeminnow and razorback sucker and depending on results of ongoing efforts to assess these effects, we may recommend future management action to ameliorate these impacts (e.g, a temperature control device for Navajo Reservoir).

Interactions between native and nonnative fish species

While the magnitude of the threat to endangered fish recovery posed by channel catfish has been a topic of substantial debate in the SJRIP, we remain concerned that potential future invasions of species like smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*) could occur in the San Juan River basin. These highly predatory species are a major impediment to recovery in the upper Colorado River and Green River basins because of their high abundance, habitat overlap with native fish, and ability to prey upon a wide variety of size classes (FWS 2018a, FWS 2022). We recommend that the SJRIP remain vigilant in preventing the establishment of predatory nonnative fish species and urge state and tribal partners to finalize their cooperative agreement on nonnative fish stocking procedures in the San Juan River basin to minimize the risk of harmful nonnative fish species escaping into the mainstem San Juan River.

Monitoring and data management

The SJRIP's research efforts are focused on identifying the source and alleviating apparent bottlenecks to recovery (SJRIP 2018a). For Colorado pikeminnow the low apparent survival of stocked juvenile fish slows the accumulation of adults resulting in a smaller adult population size and lower reproductive output (Clark et al. 2018). Unlike Colorado pikeminnow, adult razorback sucker is abundant in the San Juan River but relatively few contribute to successful spawning likely limiting the overall number of larvae produced (Diver et al. 2021). Additionally, razorback sucker consistently spawn in the San Juan River but larval fish rarely recruit to the juvenile life stage in contrast to native bluehead sucker and flannelmouth sucker (Farrington et al. 2017, Zeigler and Ruhl 2017). We recommend completion of ongoing research and prioritization of future research to determine the cause of these bottlenecks to identify and refine management activities to alleviate impediments and advance recovery of Colorado pikeminnow and razorback sucker in the San Juan River basin.

Recovery of Colorado pikeminnow and razorback sucker in the San Juan River basin will continue to require consistent and predictable funding sources. Continued implementation of successful recovery activities through sustained funding commitments factors heavily into our determination of sufficient progress. Consistent and predictable annual and capital funding sources are essential for sufficient progress to be maintained. Considering the expiration of the cooperative agreement in 2023, we encourage completion of discussions and negotiations to define the SJRIP's post-2023 future. We are concerned about the continued uncertainty regarding the future of the SJRIP and encourage all partners focus their efforts on reauthorizing the SJRIP as soon as possible.

FWS CONCLUSION ON SJRIP'S SUFFICIENT PROGRESS

We applaud the SJRIP's efforts in carrying out beneficial recovery actions for Colorado pikeminnow and razorback sucker in the San Juan River basin. The SJRIP has made substantial progress towards recovering Colorado pikeminnow and razorback sucker based on the improved status of these fish following the successful implementation of management actions detailed in the LRP. The SJRIP's ability to provide ESA compliance is based on the entirety of our evaluation of the SJRIP's cumulative activities, status of the endangered fishes, provision of adequate flows, and magnitude of water development projects. We consider the SJRIP's overall progress toward recovery of Colorado pikeminnow and razorback sucker within the San Juan River basin to be sufficient for the SJRIP to continue as the ESA compliance mechanism for water development, management, and operations within the San Juan River basin. However, achieving recovery in the shortest possible time frame requires additional efforts. If releases from Navajo Reservoir continue to be insufficient to meet high flow targets at the recommended frequency in the San Juan River due to more frequent poor runoff, the SJRIP needs to explore options to protect flows, potentially buy or lease water to augment flows, and develop non-flow alternatives to produce the same habitats created and maintained by high flows. Given the identified recruitment bottlenecks for Colorado pikeminnow and razorback sucker, we urge the SJRIP to prioritize research to determine and mitigate these impediments in the San Juan River basin. Additionally, we recommend the SJRIP continue its use of science-based management to guide and improve the efficiency of its activities to move towards recovery more expeditiously. Finally, with the cooperative agreement and funding authorization for the SJRIP set to expire in 2023 and the uncertain implementation of

future recovery management actions, we have concerns about continuing progress toward recovery in the future.

In the recent SSAs for Colorado pikeminnow and razorback sucker, future scenarios were considered where funding and implementation of recovery actions were reduced or eliminated, and these scenarios forecasted the eventual extirpation of both species from the San Juan River basin (FWS 2018a, FWS 2022). A sustained funding commitment to implement successful recovery activities and the status of each species (FWS 2018a, FWS 2022) has factored heavily into our determination of sufficient progress (FWS 2006, FWS 2010, FWS 2013, FWS 2021). The ESA compliance provided by the SJRIP for a variety of water management activities and projects in the San Juan River basin may be at risk if the SJRIP does not continue to make progress toward recovery. To maintain progress toward recovery and ESA compliance for existing projects, we urge SJRIP partners to renew their cooperative agreement and secure funding necessary to promote population recovery of Colorado pikeminnow and razorback sucker in the San Juan River basin. While recovery is taking longer than we and the SJRIP originally anticipated, we see continued cooperation among the SJRIP's partners as essential to achieve and then maintain recovery for Colorado pikeminnow and razorback sucker in the San Juan River basin.

FIGURES

Figure 1. Map of San Juan River basin highlighting major tributaries and river mile (RM) reference for select geographical locations or features. The San Juan River basin includes the mainstem San Juan River, its tributaries, and the San Juan arm of Lake Powell to its historical confluence with the Colorado River. Stars indicate select U.S. Geological Survey (USGS) gauging stations. Note that the San Juan River continues downstream of the Piute Farms waterfall at RM 0.0 to its inflow with the San Juan arm of Lake Powell. The location of the inflow depends on water elevation in Lake Powell but is currently approximately 30 river miles downstream of the waterfall.

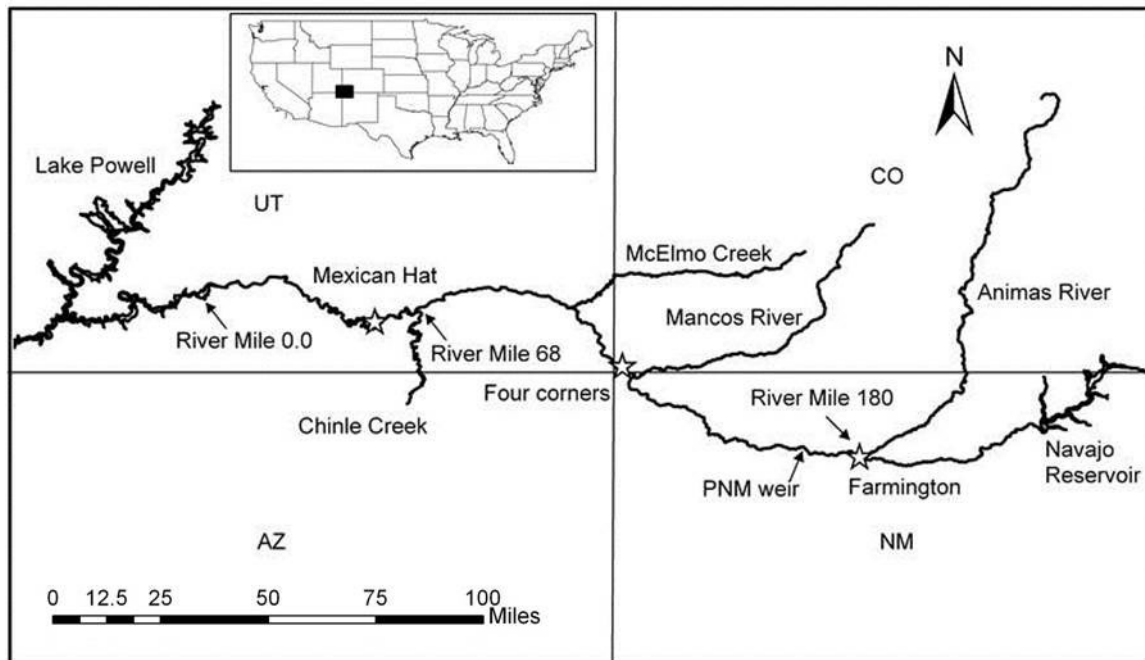


Figure 2. Age-specific apparent survival estimates for age 1-4 Colorado pikeminnow stocked into the San Juan River (Clark et al. 2018).

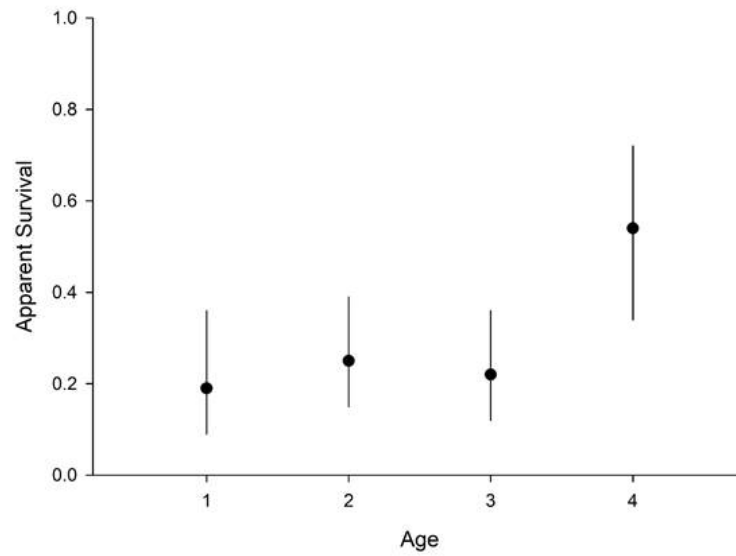


Figure 3. Annual abundance estimates of adult Colorado pikeminnow (and 95% CI) from a variety of mark-recapture data through time. Estimates were based on five passes from RM 147.9-52.9 from 2011-2017, three passes from RM 147.9-52.9 in 2018 (Saltzgiver and Mussmann 2022a), and three passes from RM 147.9-76.5 in 2019 and 2021 (Schleicher et al. 2020, Schleicher et al. 2022).

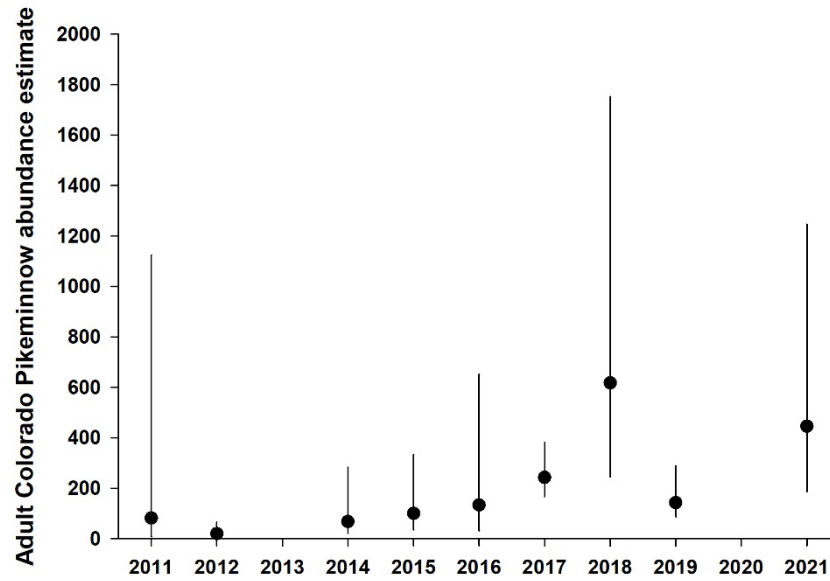


Figure 4. Cumulative number of razorback sucker stocked into the San Juan River basin, 1994-2021 (<https://streamsystem.org>).

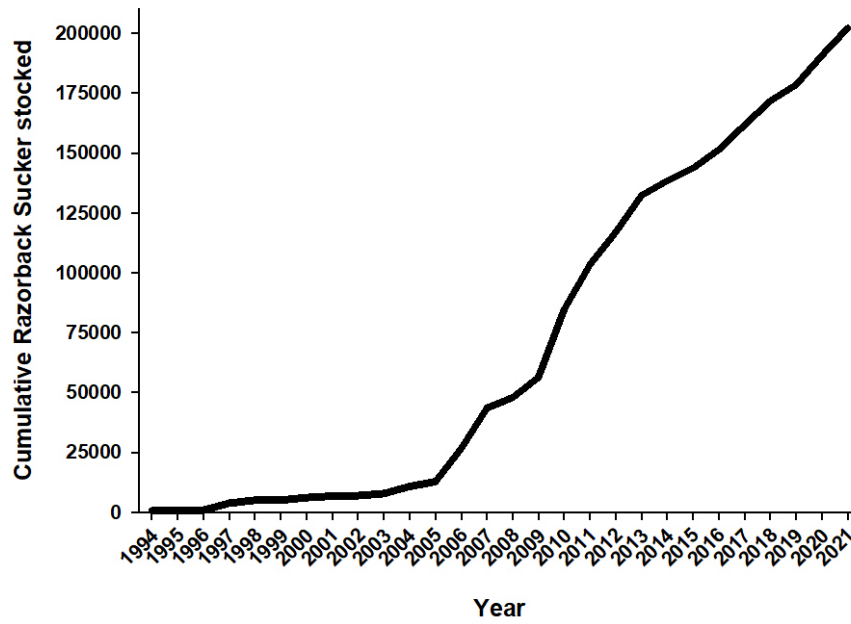


Figure 5. Adult razorback sucker abundance estimates from 2011-2016, 2019, 2021 based on mark-recapture models (black circle with 95% CI). Estimates were based on five passes from RM 147.9-52.9 from 2011-2016 (Saltzgiver and Mussmann 2022a) and three passes from RM 147.9-76.5 in 2019 and 2021 (Schleicher et al. 2020, Schleicher et al. 2022). Adult razorback sucker mean catch rates from 2008-2017 (CPUE, fish/hour) were based on standardized single pass monitoring from RM 180-76.5 (light gray bars; Schleicher et al. 2018).

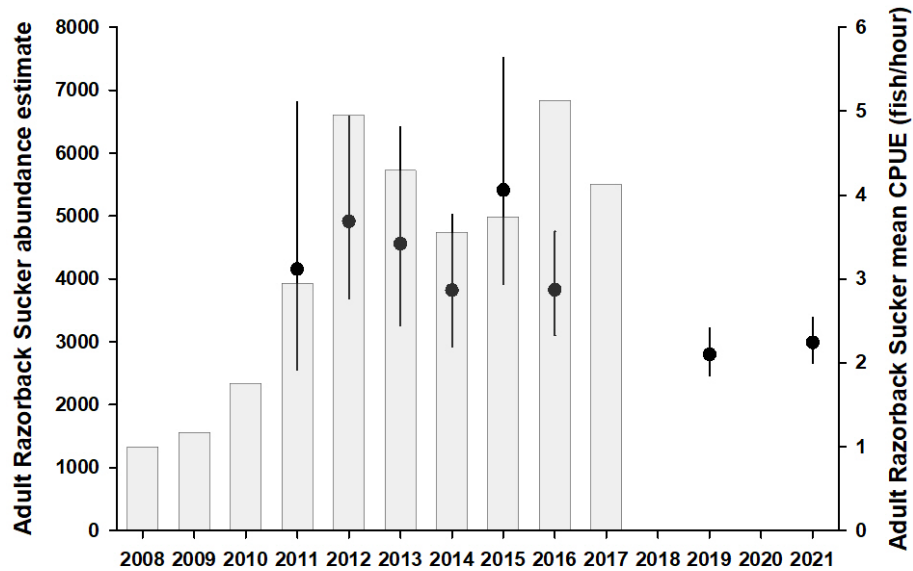
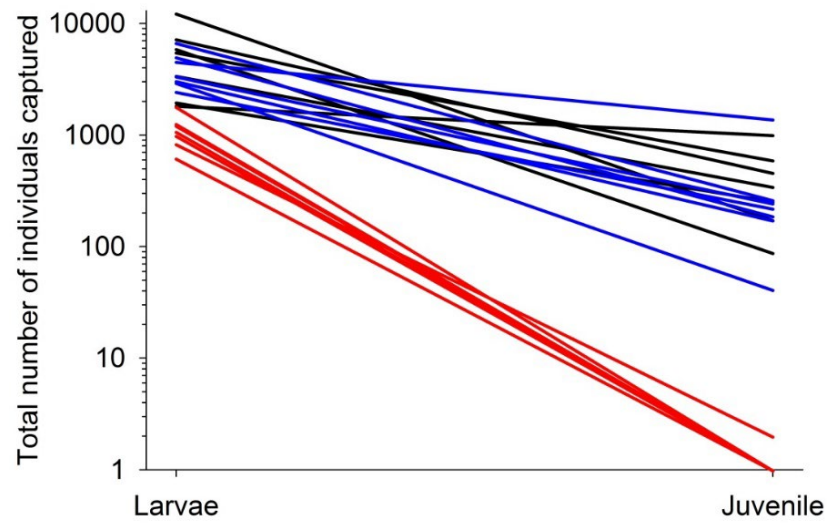


Figure 6. Annual number of larvae and juvenile sucker species captured in the San Juan River during larval (Farrington et al. 2017) and small-bodied fish monitoring (Zeigler and Ruhl 2017) 2010-2016. Each line represents a single year, flannelmouth sucker in black, bluehead sucker in blue, and razorback sucker in red. To facilitate plotting on a Log10 scale on y-axis, 1 was added to all values.



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