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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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 and razorback sucker (U.S. Fish and Wildlife Service [FWS] 2000). The SJRIP was established in 1992 through a cooperative agreement between Federal, State, and Tribal partners (SJRIP 2018a) with the goal to conserve and recover endangered Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*) in the San Juan River Basin (Figure 1) while providing Endangered Species Act (ESA) compliance for water development and management activities. We complete this FWS assessment as part of the Department of Interior's responsibilities for the SJRIP covering 2018-2020 (SJRIP 2018a) 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. In this "Sufficient Progress" report, we evaluated ongoing recovery activities and identified 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 2001). We used the four factors identified in the Principles to evaluate if 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. These factors are:

1. Actions that will result in a measurable positive population response, a measurable fish habitat improvement, legal protection for flows required for recovery, or a reduced immediate extinction threat
2. Fish population status
3. Flow adequacy
4. Magnitude of the activities' impact, including, but not limited to, contaminant and fish migration impacts

In this report we describe how the implementation of recovery management actions from each species' Recovery Goals satisfies the four factors of the Principles. These recovery

management actions are activities thought necessary to minimize or remove threats and support wild self-sustaining populations of Colorado pikeminnow and razorback sucker (FWS 2002a, FWS 2002b). We anticipate that Colorado pikeminnow and razorback sucker will respond positively to the successful implementation of these management actions and will ultimately result in their recovery in the San Juan River Basin. The recovery actions identified in the Recovery Goals that are relevant to the San Juan River Basin (FWS 2002a, FWS 2002b) are:

1. Provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations.
2. Provide passage over barriers within occupied habitat to allow adequate movement and, potentially, range expansion.
3. Minimize entrainment of subadults and adults in diversion canals/out-take structures.
4. Ensure adequate protection from diseases and parasites.
5. Regulate nonnative fish releases and escapement into the San Juan River, floodplain, and tributaries.
6. Control problematic nonnative fishes as needed.
7. Minimize the risk of hazardous-materials spills in critical habitat.
8. Remediate water quality problems.
9. Reestablish populations with hatchery-produced fish.
10. Minimize the threat of hybridization with white sucker (*Catostomus commersonii*) [only applicable to razorback sucker].
11. Provide for the long-term management conservation plans to protect populations and their habitats beyond delisting [efforts to develop long-term species conservation plans are not a priority until the SJRIP is closer to meeting delisting objectives].

We also used demographic criteria for downlisting and delisting from the Recovery Goals as unambiguous, objective, and measurable age-specific population targets to assess progress toward recovery (FWS 2002a, FWS 2002b). Incremental improvements in the population status of Colorado pikeminnow and razorback sucker prior to attaining downlisting and delisting criteria would indicate progress toward recovery. Proposed downlisting and delisting of Colorado

pikeminnow and razorback sucker would indicate progress toward recovery by definition. However, the demographic criteria in particular, and the Recovery Goals in general, only provide guidance for downlisting and delisting decisions. Downlisting or delisting may occur at any time when species no longer meet the definition of threatened or endangered species under ESA. Until the Recovery Goals are revised, the demographic criteria represent the best available science regarding the size and structure of the populations needed for persistence in the San Juan River Basin. Previously, we used Positive Population Response Criteria (U.S. Bureau of Reclamation [Reclamation] 2001) to evaluate positive population response to management actions and incremental improvement in reaching recovery demographic criteria (FWS 2010, FWS 2013, FWS 2019). However, we view these interim targets as out of date due to the improved status of Colorado pikeminnow and razorback sucker in the San Juan River Basin and have not used them in the current report.

ASSESSMENT AND REVIEW OF PROGRESS TOWARD RECOVERY

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 2019 (FWS 2019); and (7) FWS Species Status Assessments (SSAs) completed for Colorado pikeminnow (FWS 2020a) 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.

As part of our assessment, we identified corrective actions for each recovery management action and benchmark toward recovery to ensure future ESA compliance. While we detailed how the SJRIP's recovery management actions and recovery benchmarks satisfied or fell short of criteria outlined in the Principles (SJRIP 2001), 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 recovery management actions implemented,

species responses to those management actions, and the incremental improvement in population statuses of Colorado pikeminnow and razorback sucker within the San Juan River Basin.

IMPLEMENTATION OF RECOVERY MANAGEMENT ACTIONS

Recovery Action 1. Provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations.

We evaluated Recovery Action 1 based on the ability of the SJRIP to meet downstream flow targets based on releases from Navajo Reservoir; the development, implementation, and evaluation of habitat creation or restoration projects in the San Juan River Basin; and efforts to assess how cold water releases from Navajo Reservoir may impede species recovery.

FLOW REGIME

Per the Animas-La Plata Project BO (FWS 2000), Reclamation committed to operate Navajo Reservoir to benefit endangered fishes as a conservation measure. Thus, the SJRIP developed flow recommendations for the operation of Navajo Reservoir that were intended to mimic a more natural flow regime characterized by variability in flow, spring peak flow, and low base flows by releasing water to meet specific flow targets thought necessary to develop and maintain the habitat and hydrologic conditions needed for all native fishes in the San Juan River (Holden 1999). Since 1998, the recommended frequency criteria for higher flow targets have not been achieved and in some cases the maximum frequency criteria have been exceeded (Table 1). In 2018, the SJRIP revised the decision tree for operating Navajo Reservoir in an effort to meet the high targets more regularly by increasing the frequency of long duration releases and minimizing short duration releases (SJRIP 2018b). When sufficient water is available, longer duration releases from Navajo Reservoir are more likely to match the Animas River peak, typically a requirement to meet the magnitude, duration, and frequency of high flow targets (i.e., 8,000 and 10,000 cubic feet per second [cfs]). Because of hydrologic variability, it will take several years of operating Navajo Reservoir under this revised decision tree to determine if it is more effective in meeting flow recommendation targets.

The inability to meet the minimum and maximum frequency criteria for 8,000 and 10,000 cfs flow recommendation targets (Table 1) may be a significant modification of the conservation

measure affecting Colorado pikeminnow, razorback sucker, and their designated critical habitat, possibly requiring reinitiation of section 7 consultation (FWS 2000). High flows are one of the SJRIP's primary management actions to develop and maintain habitat and 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). More regularly reaching high flow targets 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 (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 (Figure 2; Lamarra and Lamarra 2020, SJRIP unpublished data). Higher baseflows appeared to be associated with larger size of off-channel backwaters and increased frequency of flowing secondary channels (Figure 2). However, in 2019 when low velocity habitat was measured at two different baseflows, there was twice as much low velocity habitat at 685 cfs compared to 1,431 cfs (Lamarra and Larmarra 2020), suggesting additional research is needed to understand the effects of how other managed releases could be used to sustain habitat in the absence of higher spring flows. However, we are optimistic that the revised operating procedures for Navajo Reservoir will result in more frequently meeting the 8,000 cfs and 10,000 cfs high flow targets.

HABITAT CREATION

Because the highest flow targets were not met at the desired frequency due to the combined effects of operational constraints (including the previous operating decision tree) and prolonged drought, additional means to create and maintain habitats were needed to promote recovery. Various projects were conducted to clear secondary channels and remove nonnative vegetation to provide habitat for the native fish community. In 2011, The Nature Conservancy (TNC), in partnership with the SJRIP, mechanically restored low velocity habitats to six sites in the San Juan River between Shiprock, New Mexico (river mile [RM] 148) and Four Corners (RM 119) by removing nonnative vegetation, clearing existing channel inlets, and excavating new secondary channels as a first phase of habitat creation and restoration (Keller-Bliesner 2012). In 2014, TNC worked with the SJRIP again to conduct a second phase of channel and floodplain restoration along the San Juan River downstream of Shiprock, New Mexico at RM 137.1-134.5. In the winter of

2020-2021, the SJRIP will construct a third phase of this work as a ~2 acre floodplain wetland at RM 107 with the goal of entraining wild-spawned larval razorback sucker in the spring and releasing them to the San Juan River as juveniles each fall (Gori et al. 2018). The wetland is designed to provide larval razorback suckers with a large stable low velocity habitat absent large-bodied predators that would increase their survival to the juvenile life-stage to help alleviate an identified recruitment bottleneck in the San Juan River (SJRIP 2020). In 2020 the SJRIP planned small-scale mechanical efforts to create and maintain low velocity habitats by removing flow impediments at the upstream end of secondary channels and the mainstem San Juan River (Bowman and Zeigler 2019). However, due to the COVID-19 pandemic, implementation of this SOW is delayed until 2021.

The importance of low velocity habitats to Colorado pikeminnnow and razorback sucker early life-stage recruitment is unequivocal (Barkalow et al. 2020, Farrington et al. 2020a), but the recovery benefit of any individual constructed habitat is unknown. Nonetheless, monitoring of constructed habitats is critical to evaluate the effect of this management action. Small-bodied fish monitoring at the first phase habitat restoration indicated that restored sites had similar densities of total, native, and nonnative fish compared to reference locations (Franssen et al. 2015); however, not all restored sites were wetted at low flow (Farrington et al. 2014, Gilbert 2014). The SJRIP deemed the second phase of restoration effort successful based on the secondary channel continuously flowing at discharges as low as 400 cfs in the main channel and documentation of native fish, particularly Colorado pikeminnow, using the restored channel (Lamarra et al. 2018). The SJRIP will monitor the third phase off-channel wetland to evaluate if wild razorback sucker larvae are entrained, determine if larvae survive and grow in the wetland, and will quantify the number of wild-reared juvenile released to the San Juan River when the wetland is drained each fall (Farrington et al. 2020b). The success of the small-scale habitat creation and maintenance project will be assessed by the proportion of manipulated secondary channels that are flowing during summer baseflow conditions when the project is implemented in 2021 (Bowman and Zeigler 2019).

TEMPERATURE

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. While no relationship between water temperature and native fish density has been demonstrated in the San Juan River (Miller and Swaim 2016), we are concerned about potential negative effects of low temperature on Colorado pikeminnow and razorback sucker. There has been a general upstream trend in detection of larval Colorado pikeminnow and razorback sucker (at RM 162.5 and RM 155.9 in 2017 for Colorado pikeminnow and razorback sucker, respectively; Farrington et al. 2018), thus spawning further upstream in cooler reaches of the San Juan River. In collaboration with the Southwestern Native Aquatic Resources and Recovery Center (SNARRC), the SJRIP is developing an experiment to assess the effect of temperature on larval razorback sucker growth and survival per the Four Corners Power Plant and Navajo Mine Energy Project BO (FWS 2015).

RECOVERY ACTION 1: SUMMARY AND RECOMMENDATIONS

We are optimistic that the SJRIP's efforts to implement a revised strategy for releases from Navajo Reservoir will result in attaining the duration and frequency targets for 8,000 and 10,000 cfs flows identified in the flow recommendations. However, the inability to reach the 8,000 and 10,000 cfs flow targets at the recommended frequency is cause for serious concern. The lack of high magnitude flows at the frequency prescribed by the flow recommendations (Holden 1999) likely resulted in habitat degradation and impeded recruitment of wild-spawned individuals. 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 to create and maintain habitat in the San Juan River. We recommend the SJRIP explore options to protect and potentially acquire flows necessary for recovery and continue habitat restoration at the appropriate spatial and temporal scale as part of efforts to identify and ameliorate impediments to recovery in the San Juan River. While spring peak releases from Navajo Reservoir are clearly linked to the creation of low-velocity habitats (Lamarra and Lamarra 2018), the effects of concomitant cooler temperatures are less understood. The SJRIP's efforts to identify the contribution of cooler temperatures to recruitment bottlenecks in the San Juan River will inform future management actions to alleviate this potential threat.

Recovery Action 2. Provide passage over barriers within occupied habitat to allow adequate movement, and potentially, range expansion.

Holden (2000) identified five diversion structures between RM 180-140 as potential barriers to fish movement, particularly upstream movement: Fruitland Diversion (RM 178.5); Public Service Company of New Mexico Weir (PNM Weir; also known as San Juan Generating Station Weir; RM 166.6); Arizona Public Service Company Weir (APS Weir; also known as Four Corners Generating Station Weir; RM 163.3); Hogback Diversion (RM 158.6); and Cudei Diversion (RM 142.0) (Ryden 2000, Davis and Coleman 2004, Stamp et al. 2005). Additionally, in the lower San Juan River near Piute Farms, a waterfall (RM 0.0) that has persisted almost continuously since 2002 is an upstream passage barrier except during a brief period when it was inundated in July-August 2011 (Durst and Francis 2016). In the San Juan River's major tributary, the Animas River (confluence at RM 180), Animas Pump Station #2 (also known as Penny Lane) and Farmers Ditch Diversion (located 9.2 and 21.9 river miles upstream of the San Juan River confluence, respectively) were identified as locations that were at least partial barriers to upstream movement for native flannelmouth sucker (*Catostomus latipinnis*) and bluehead sucker (*Catostomus discobolus*) (Francis 2007).

The SJRIP and other entities have attempted to ameliorate the impacts of many of these movement barriers. In 2002, the SJRIP constructed a nonselective fish passage at Hogback Diversion and replaced Cudei Diversion with a subsurface siphon that does not impact fish movement, restoring access to 36 miles of critical habitat (Davis and Coleman 2004). In 2003, the SJRIP constructed a selective fish passage around the PNM Weir operated by Navajo Nation Department of Fish and Wildlife to allow native fish access to upstream habitat while removing nonnative fish from the San Juan River. Since 2018, PNM fish passage has been operated non-selectively during spring to improve passage efficiency when there are few nonnatives so more Colorado pikeminnow and razorback sucker can access upstream habitats (SJRIP unpublished data). Additionally, modifications to improve fish passage at the APS Weir and Fruitland Diversion Weir were included in recent BOs (FWS 2015, FWS 2018b). The SJRIP conducted experimental translocation of razorback sucker from downstream of the Piute Farms Waterfall upstream to the San Juan River in 2016-2018 (Pennock et al. 2020; https://streamsystem.org). While most razorback sucker translocated upstream of the waterfall subsequently returned downstream of the waterfall, allowing fish even temporary access to the San Juan River provides

an opportunity to spawn and potentially contribute to successful recruitment (Pennock et al. 2020). The SJRIP is continuing research to assess the contribution of translocated fish to successful spawning in the San Juan River in a facilitated passage study (Gido et al. 2020) that was planned to start in 2020 but was delayed due to the COVID-19 pandemic. Finally, the City of Farmington modified the Penny Lane diversion in the winter of 2017-2018 to improve boat passage, with the added benefit that this modification may also increase fish passage in the Animas River. To date there have been 7 Colorado pikeminnow and 14 razorback sucker individuals remotely detected from June to September in 2018 and 2019 at this structure (https://streamsystem.org), indicating at least seasonal use and access to this portion of the Animas River. Additional endangered fish monitoring upstream of Penny Lane in the Animas River will be provided to the SJRIP as part of the Ranchmans – Terrell Ditch Improvement Project that will include installation of a passive integrated transponder (PIT) tag antenna approximately 1.3 river miles upstream of the Penny Lane Diversion (FWS 2020b).

Given the SJRIP's reliance on these constructed passages to allow Colorado pikeminnow and razorback sucker unimpeded access to all suitable habitats they could occupy, there is a need for a thorough evaluation of the effectiveness of these passages. The nonselective passage at Hogback has not been quantitatively evaluated, although it was dry as recently as 19 February to 9 April 2018 (SJRIP unpublished data) and has been anecdotally reported as dry during other periods since 2002. It appears the operations of the Hogback Diversion and the design of the passage itself may be related to these periods of dewatering at the nonselective fish passage. Additionally, variable frequency drive (VFD) pumps that operate during irrigation season (March-October) interfere with PIT tag antennas that would allow for an evaluation of fish movement through the Hogback non-selective fish passage. Although it is unclear when the fish passage modifications at APS Weir and Fruitland Diversion Weir will be completed, the SJRIP needs to ensure these passages perform as intended.

RECOVERY ACTION 2: SUMMARY AND RECOMMENDATIONS

We recommend the SJRIP continue to evaluate the need to provide passage at the Piute Farms Waterfall and upstream locations in both the San Juan and Animas Rivers. At sites where access to habitats is needed for fish to complete their life-cycle, the SJRIP must implement management actions to improve passage for Colorado pikeminnow and razorback sucker.

Additionally, the SJRIP needs to conduct evaluation of passage efficiency at the Hogback, APS, and Fruitland Diversions to ensure these capital investments are functioning as anticipated.

Recovery Action 3. Minimize entrainment of subadults and adults in diversion canals/out-take structures.

In addition to blocking upstream movement of adult fish, diversion dams may also affect recruitment by entraining fish. The SJRIP constructed an experimental fish weir instead of a fish screen in the Hogback Canal in 2013 in response to the entrainment of numerous native fishes, including Colorado pikeminnow (Renfro et al. 2006). A similar structure will be built in the Fruitland Irrigation Canal to minimize entrainment at that diversion (FWS 2018b). While a variety of controlled tests were conducted to assess entrainment at the Hogback Fish Weir (M. McKinstry 2016 personal communication), ongoing issues with the VFD pumps (described in the previous section) interfere with operation of the PIT tag antennas, so the number of Colorado pikeminnow and razorback sucker lost to the irrigation canal cannot be quantified. Because we anticipated only larval fish would be entrained in the Hogback Irrigation Canal after the construction of the Hogback Fish Weir, continued entrainment of larger life stages of endangered fish would result in unauthorized "take" at this facility (FWS 2011). A total of four and nine diversion sites have been identified within occupied habitat in the San Juan and Animas rivers, respectively (Lyons et al. 2016), that pose some level of entrainment risk to Colorado pikeminnow and razorback sucker (Schleicher 2018). However, the recovery threat posed by entrainment remains unknown at this point. Since the Renfro et al. (2006) study was completed, Colorado pikeminnow and razorback sucker are more abundant in upstream reaches (Schleicher 2018), they spawn further upstream (Farrington et al. 2018), and stocking of age-0 Colorado pikeminnow has occurred upstream of some diversions (Furr 2020a), suggesting this risk has increased through time.

RECOVERY ACTION 3: SUMMARY AND RECOMMENDATIONS

The SJRIP constructed a fish weir at Hogback and will construct another at Fruitland to minimize entrainment. However, to ensure these structures minimize entrainment as anticipated, the SJRIP must conduct monitoring at these sites. To date, the SJRIP has not been able to evaluate entrainment into the Hogback Irrigation Canal because of the ongoing interference issues with the VFD pumps, resulting in an unknown level of potentially unauthorized take at the site (50 C.F.R.

§402.14(i)(4)). In addition, all diversion structures in the San Juan and Animas rivers have been inventoried (Lyons et al. 2016), but the SJRIP has yet to prioritize investigation or management actions to minimize entrainment at those posing the greatest risk. Given the length of time since the Renfro et al. (2006) study, and increases in the upstream distribution of endangered fish in the San Juan River, quantitatively assessing entrainment at high priority sites is long overdue. We recommend the SJRIP assess entrainment and screen or modify those diversions that pose the greatest entrainment risk and thus a greater impediment towards recovery in the San Juan River Basin. Furthermore, in the Hogback Fish Barrier on the San Juan River BO, the reasonable and prudent measures (RPM) directed Reclamation and Bureau of Indian Affairs (BIA) to survey remaining diversions on the San Juan River and design structures to minimize or avoid entrainment of Colorado pikeminnow and razorback sucker (FWS 2011). To date, this survey and design has yet to be conducted.

Recovery Action 4. Ensure adequate protection from diseases and parasites.

Investigations of lesions and other abnormalities in surrogate flannelmouth sucker and bluehead sucker (Landye et al. 1999) indicate that fish health is not a limiting factor for Colorado pikeminnow and razorback sucker in the San Juan River (Holden 2000). Opercle deformities in native larval suckers (including razorback sfuckers) were found in 2011 (Brandenburg et al. 2012) and were more prevalent in museum-archived razorback suckers compared to the other native suckers but the source of the deformities and their effect on recruitment and recovery was unknown (Barkstedt et al. 2014). Microbiota associated with external lesions found in multiple species in the San Juan River have been examined, but the cause of disease and fish response remain unknown (T. Diver 2016 personal communication). Visual inspections of general fish health and condition occur during routine fish handling and capture activities on the San Juan River. Any increase in abnormalities will trigger an investigation to determine the threat of disease and parasites.

RECOVERY ACTION 4: SUMMARY AND RECOMMENDATIONS

We consider the recovery threat posed by disease and parasites to be minimal and recommend no further management actions to ensure endangered fishes have adequate protection from disease and parasites. Visual inspections of endangered fishes continue as part of routine

monitoring activities. Any indication of poor health of endangered fishes will continue to be logged and reported. If the SJRIP finds that indicators of poor health are a concern or an impediment to recovery, the SJRIP should identify the causes and recommend corrective actions.

Recovery Action 5. Regulate nonnative fish releases and escapement into the San Juan River, floodplain, and tributaries.

The State of New Mexico's Department of Game and Fish took the lead for a cooperative agreement for nonnative fish stocking procedures in the San Juan River Basin. The agreement will be finalized once signatures are obtained from all participating entities: Jicarilla Apache Nation, Navajo Nation, Southern Ute Indian Tribe, Ute Mountain Ute, Colorado, New Mexico, Utah, and FWS Legacy Regions 2 and 6. Additionally, Reclamation constructed a sleeve-valve as part of the outlet works at Lake Nighthorse in 2011 to prevent escapement of any nonnative fish life stages to Basin Creek, a tributary to the Animas River (Bark et al. 2013). Reclamation also has a monitoring plan to determine if nonnative fish are escaping from the reservoir and will develop a management plan to address potential escapement or the establishment of problematic nonnative fish species in Lake Nighthorse. Four Corners Power Plant constructed a wedgewire screen at the outlet of Morgan Lake to minimize escapement of nonnative fish to the San Juan River and developed public education materials about the threat of nonnative species introduction to Morgan Lake and the San Juan River (FWS 2015; H. Day 2018 personal communication).

RECOVERY ACTION 5: SUMMARY AND RECOMMENDATIONS

Efforts to finalize a cooperative agreement for stocking nonnative fish species in the San Juan River Basin and construction of escapement barriers for Lake Nighthorse and Morgan Lake are positive steps to regulate nonnative fish releases and escapement into the San Juan River Basin. While other sources of nonnative fish escapement likely exist within the San Juan River Basin, we have no further recommendations to address nonnative fish release and escapement.

Recovery Action 6. Control problematic nonnative fishes as needed.

The two most abundant large-bodied nonnative fishes in the San Juan River are channel catfish (*Ictalurus punctatus*) and common carp (*Cyprinus carpio*) (Schleicher 2018). The SJRIP has conducted some degree of mechanical removal of nonnative fishes from the San Juan River

since its inception and intensive removal via raft electrofishing began in 2001. The response of native fishes from nonnative removal has been equivocal and evaluating the efficacy of mechanical removal has been difficult (Franssen et al. 2014). Nonetheless, dramatic declines in the densities of common carp were primarily attributed to the effect of the nonnative removal program (Franssen et al. 2016). Modelled removal rates were not sufficient to "crash" the channel catfish population because electrofishing was only effective removing relatively large fish (Pennock et al. 2018). However, the observed decline in channel catfish total length and mass through time was consistent with the substantial reduction in the modeled biomass of the channel catfish population compared to an unmanaged population (i.e., without removal), suggesting observed levels of removal have had a population-level effect on channel catfish (Pennock et al. 2018).

Most recently, the SJRIP made efforts to quantify the threat posed by channel catfish predation on endangered fish. The probability of native fishes consumption by channel catfish in the San Juan River increased with size of channel catfish, water temperature, and turbidity (Hedden et al. 2020). Additionally, channel catfish consumed 1.8-6.1 kg/ha/yr of fish in the San Juan River (lowest and highest 95% confidence interval (CI) across 2018 and 2019), with 54% being native fish (Hedden et al. 2020). Combining the results of multiple studies (Pennock et al. 2018; Hedden et al. 2020) and an abundance estimate of 42,056 adult channel catfish in 2018 (Duran et al. 2020), we estimated 1,021-1,570 age-1 Colorado pikeminnow would be consumed under a scenario with the observed channel catfish size structure (i.e., with nonnative removal via electrofishing) but 2,236-3,413 could be consumed with a channel catfish size structure increased to reflect no removal (FWS, February 2020 Biology Committee presentation). However, annual age-1 Colorado pikeminnow mortality attributable to channel catfish predation varies widely (from < 10% to ~85%) based on the number of age-1 fish available prior to when predation occurs (i.e., summer; FWS, February 2020 Biology Committee presentation). Because work to estimate age-specific endangered fish abundance does not occur until the late summer and early fall (Schleicher et al. 2020), the number of age-1 Colorado pikeminnow present at the start of the year is unknown. Until the SJRIP makes an assessment of the level on nonnative fish management that needs to occur in the San Juan River, removal efforts were scaled back to a "maintenance level" during the winter 2020, when sampling efficiency and removal rates are presumed to be high (Duran 2019).

RECOVERY ACTION 6: SUMMARY AND RECOMMENDATIONS

The SJRIP's recent work to experimentally evaluate the effects of nonnative removal on channel catfish, Colorado pikeminnow, and razorback sucker (Duran et al. 2018), modeling to assess the effect of removal on channel catfish (Pennock et al. 2018), and quantifying the incidence of endangered fish preyed on by channel catfish (Hedden et al. 2020) has greatly increased our understanding of the threat posed by nonnative fish and the effect of mechanical removal efforts. Clearly, the SJRIP management efforts have reduced the predation threat by removing the largest and most predatory channel catfish from the San Juan River. However, the SJRIP needs to assess the level of nonnative removal needed in the future to maintain this reduced size structure of the channel catfish population as modelling indicated it cannot be "crashed" at observed levels of removal. We also urge experimental work to identify methods, seasons, flows, or river reaches to further improve the efficiency of nonnative removal efforts.

Recovery Action 7. Minimize the risk of hazardous-materials spills in critical habitat.

We previously identified tasks to address the risk of hazardous spills within critical habitat that included: (1) review and recommend modifications to state and federal hazardous-materials spills emergency-response plans to ensure adequate protection for Colorado pikeminnow and razorback sucker populations from hazardous-materials spills, including prevention and quick response to hazardous-materials spills; (2) implement state and federal emergency-response plans that contain the necessary preventive measures for hazardous-materials spills; (3) identify the locations of all petroleum-product pipelines within the 100-year floodplain of critical habitat; and, (4) assess the need and install emergency shut-off valves on problematic petroleum-product pipelines within the 100-year floodplain of critical habitat to minimize the potential for spills (FWS 2002a, FWS 2002b, FWS 2006, FWS 2010, FWS 2013, FWS 2019). The SJRIP has taken steps to identify the locations of hazardous materials threats that included, among other factors, identifying oil and gas wells within the floodplain and an analysis of pipeline and highway spill risk based on their proximity to San Juan River drainages or floodplains (Wood 2013). Additionally, a spill contingency plan was developed to address a potential ash pond failure as a conservation measure for the Four Corners Power Plant and Navajo Mine Energy Project BO (FWS 2015).

RECOVERY ACTION 7: SUMMARY AND RECOMMENDATIONS

We recognize that some tasks to minimize the threat of hazardous-materials spills in critical habitat are beyond the authority of the SJRIP to implement. However, a detailed plan using the information from Wood (2013) could have established specific actions to respond to an event like the Gold King Mine spill that occurred on 5 August 2015. We recommend the SJRIP develop a plan to provide a response to potential future hazardous material spills. Importantly, Arizona Public Service (2017) developed a spill contingency plan to address potential ash pond failures. This plan includes periodic table-top exercises and provides emergency response in the event of a potential ash pond failure as a conservation measure for the Four Corners Power Plant and Navajo Mine Energy Project BO (FWS 2015).

Recovery Action 8. Remediate water quality problems.

Results from a Colorado pikeminnow population viability analysis (Miller 2014) informed the Four Corners Power Plant and Navajo Mine Energy Project BO and the BO stipulated conservation 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 funding to study mercury effects on Colorado pikeminnow and monitoring mercury and selenium concentrations in endangered fish in the San Juan River. In addition, the 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.

RECOVERY ACTION 8: SUMMARY AND RECOMMENDATIONS

We are concerned with levels of mercury and selenium found in the tissues of Colorado pikeminnow and razorback sucker across the entire Upper Colorado River Basin (including the San Juan River Basin) because of potential reproductive impairment (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. Additionally, coordination with local groups like the San Juan Watershed Group and Animas Watershed Partnership could improve efforts to identify and remediate water quality issues. The conservation measures, RPMs, and terms and condition of previous and future BOs related to water quality issues within the San Juan River Basin will also address specific management actions to minimize and further understand the effects of mercury and selenium on Colorado pikeminnow and razorback sucker.

Recovery Action 9. Reestablish populations with hatchery-produced fish.

The SJRIP has implemented a series of augmentation plans to guide the stocking of Colorado pikeminnow and razorback sucker in the San Juan River (Ryden 1997, Ryden 2003a, Ryden 2003b, Furr and Davis 2009, Furr 2020b). While the SJRIP has largely achieved the goals of these augmentation plans (Table 2, Table 3; Furr 2020a), they are yet to result in the establishment of adult populations that produce sufficient wild-offspring for these populations to be self-sustaining (Schleicher 2019, Barkalow et al. 2020). Increasingly, the SJRIP has recognized the need to evaluate and adaptively manage its augmentation efforts (Zeigler et al. 2020). To increase the genetic diversity of Colorado pikeminnow broodstock at SNARRC (Diver et al. 2019), the SJRIP recently began collecting wild young-of-year fish from the Colorado and Green Rivers that will continue through 2021 (Creighton et al. 2020).

The SJRIP is in the process of transitioning from annually stocking 400,000 age-0 Colorado pikeminnow to stocking ~12,000 age-1 fish (Knight 2020). Although past survival rates suggest these stockings will result in similar numbers of age 2+ fish persisting post-stocking (SJRIP unpublished data), stocking fish at age-1 rather than age-0 will allow 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. Results of limited stocking of prey-trained age-1 Colorado pikeminnow to date have been equivocal, but hatchery enrichment of Colorado pikeminnow needs to be systematically explored. The latest razorback sucker augmentation plan recommends annually stocking at least 4,800 fish ≥ 300 millimeter (mm) total length in the San Juan River (Furr 2020). However, based on preliminary results showing flow-trained fish have twice the first-overwinter survival of control

fish (0.28 versus 0.14), efforts to scale up experimental hatchery enrichment efforts are crucial to increase the efficiency of this management activity (Franssen et al. in press).

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 (Durst 2015). However, because both species are long-lived, it may take many years to determine if the SJRIP's stocking activities will ultimately be successful in establishing self-sustaining populations. Nevertheless, populations of hatchery-reared Colorado pikeminnow and razorback sucker have increased in the San Juan River through time because of stocking efforts (Franssen et al. 2016). To establish self-sustaining populations based on hatchery-reared fish, the fish must retain, persist, spawn, and recruit in the San Juan River following stocking. Annual monitoring of larval fish indicates that both Colorado pikeminnow and razorback sucker are reproducing (Farrington et al. 2020a) and recently, wild-produced fish have survived to juvenile life-stages (Zeigler and Ruhl 2017, Schleicher 2020). However, all wild razorback sucker juveniles identified in the field in 2019 and 2020 were determined to be razorback – flannelmouth sucker hybrids upon genetic evaluation (SJRIP Biology Committee presentation February 2021). Furthermore, there has been no evidence of endangered fishes recruiting into the adult population for either species in the San Juan River Basin.

RECOVERY ACTION 9: SUMMARY AND RECOMMENDATIONS

The SJRIP is meeting annual and longer-term stocking goals for Colorado pikeminnow and razorback sucker. We view the SJRIP's efforts to improve the efficiency of augmentation as important steps to maximize the recovery benefit of this management action. When moving forward with augmentation plans for Colorado pikeminnow and razorback sucker, we recommend a more meaningful metric to evaluate the success of the SJRIP's augmentation efforts based on the numbers of stocked fish that persist, spawn, and ultimately produce wild-offspring that recruit to adulthood. Basing the success of augmentation efforts simply on the number of fish stocked on a yearly basis or over some defined time may be misleading if those stocked individuals do not contribute to the establishment of a wild-populations of Colorado pikeminnow and razorback sucker in the San Juan River Basin.

Recovery Action 10. Minimize the threat of hybridization with White Sucker.

The SJRIP evaluated the degree of razorback sucker hybridization using DNA-based genetic markers on larval fish (Turner et al. 2002). Of 61 total fish screened, only two flannelmouth – bluehead sucker crosses were detected (Turner et al. 2002). Screening eight razorback sucker indicated no evidence of white – razorback sucker hybridization (Turner et al. 2002). Morphological hybrids were rarely observed during routine monitoring (Schleicher 2018) but the SJRIP proposed assessing razorback – flannelmouth sucker hybridization in spring monitoring efforts in 2020 to quantify putative hybrids and provide a check on hybrids identified in the field (Schleicher 2019). Unfortunately, this work was postponed until 2021 due to the COVID-19 pandemic. However, wild razorback sucker juveniles identified in the field during other monitoring efforts in 2019 and 2020 were determined to be razorback – flannelmouth sucker hybrids upon genetic evaluation indicating potentially higher rates of hybridization than previously thought (SJRIP Biology Committee presentation February 2021). White suckers and their hybrids are rare in the San Juan River (FWS 2019) but are removed during monitoring, nonnative fish control, and other SJRIP activities.

RECOVERY ACTION 10: SUMMARY AND RECOMMENDATIONS

Given the rarity of white sucker and their hybrids in the San Juan River, we do not consider the current threat level of this species to be substantial enough to warrant further management. However, the proposed genetic assessment of razorback – flannelmouth sucker hybridization will provide some insight into the degree of hybridization that is occurring with native suckers and an assessment of the accuracy of identifying these hybrids in the field.

DOWNLISTING AND DELISTING RECOVERY DEMOGRAPHIC CRITERIA

We used the demographic criteria for downlisting and delisting in the Recovery Goals as measurable and objective benchmarks to assess the SJRIP's progress toward recovery. For Colorado pikeminnow in the San Juan River Basin, downlisting criterion call for 1,000 age-5+ Colorado pikeminnow established through augmentation or natural reproduction and the delisting criterion is a population of 800 self-sustaining adults (FWS 2002a). The razorback sucker Recovery Goals target a population of 5,800 self-sustaining adults in the San Juan River for five

years to meet the downlisting criterion and an additional three years beyond downlisting for the delisting criterion (FWS 2002b).

In 2019, the SJRIP conducted its first of three years of dedicated monitoring to estimate age-specific survival, detection probability, and abundance for Colorado pikeminnow and razorback sucker in the San Juan River (Schleicher et al. 2020). We did not consider previous SJRIP abundance estimates for endangered fishes in this assessment because those efforts were conducted with management or monitoring work that did not have estimating demographic parameters as their primary goal (FWS 2019). In 2019 from RM 147.9-77, the SJRIP estimated 142 (95% CI: 86-288) age-4+ and 1,053 (727-1,595) age-3 Colorado pikeminnow (Schleicher et al. 2020). In the same reach of the San Juan River, the SJRIP estimated 2,796 (2,461-3,210) adult and 991 (740-1,377) juvenile razorback sucker in 2019 (Schleicher et al. 2020). This dedicated monitoring effort in the San Juan River from Shiprock, New Mexico to Sand Island, Utah only covered ~40% of the known occupied habitat for both species in the San Juan River (Schleicher 2016). Additionally, large numbers of razorback sucker are present downstream of the Piute Farms Waterfall and in the San Juan River arm of Lake Powell (Cathcart et al. 2018). Thus, the estimates presented here are minimum abundances for Colorado pikeminnow and razorback sucker in the San Juan River Basin, but they appear to be lower than the benchmarks called for in the downlisting and delisting criteria.

An important component in the delisting criteria is that populations of Colorado pikeminnow and razorback sucker be self-sustaining. For these populations to be self-sustaining, impediments to recovery must be abated. Adult Colorado pikeminnow and razorback sucker must have sufficient wild-spawn to produce larvae, juvenile, and subsequent life stages that survive to replace adults lost to mortality. The SJRIP's current demographic monitoring effort will provide age-specific annual survival estimates after completing its third year of sampling (2019 was the first year). That effort, like previous work for Colorado pikeminnow (Clark et al. 2018), will likely provide annual survival for only hatchery-origin fish until more wild-spawned fish are detected in the San Juan River Basin. The number of wild recruits necessary to achieve self-sustaining adult populations at abundances described in the recovery goals (i.e., 800 Colorado pikeminnow and 5,800 razorback sucker) is currently unknown because the survival rates of wild adults and sub-adults in the San Juan River cannot be calculated in the absence of those fish from the system. Although there have been recent encouraging signs of larval fish surviving to age-0 juvenile and

age-1 life stages (Zeigler et al. 2018, Schleicher 2020), recruitment of wild-spawned fish to adulthood has been extremely limited (FWS 2018a, FWS 2020a). Thus, the population of Colorado pikeminnow and razorback sucker in the San Juan River Basin remains reliant on hatchery augmentation (FWS 2018a, FWS 2020a). However, augmentation, by its very nature, bypasses many stages of mortality faced by a fish population in an ecosystem; making augmented individuals and populations relatively less fit compared to wild counterparts (Clarke et al. 2016).

Despite the lack of long-term dedicated abundance estimate data in the San Juan River Basin, there is clear indication of substantial increases in the catch rates of adult Colorado pikeminnow and razorback sucker, indicating improved status of their population through time (Figure 3; Schleicher 2018). Thus, while age-specific targets in the recovery demographic criteria have not been met, Colorado pikeminnow and razorback sucker have responded positively to the SJRIP's management actions (primarily hatchery augmentation of the populations). When the SJRIP began, Colorado pikeminnow and razorback sucker were extirpated or nearly extirpated from the San Juan River. We recognize the substantial improvement in their population status based on the SJRIP's management activities (FWS 2018a, FWS 2020a). Both populations have increased in size through time, successfully spawn on a regular basis, and have recently exhibited survival of wild-spawned fish through early life stages (Schleicher 2018, Zeigler et al. 2018, Schleicher 2020, Farrington et al. 2020). However, a level of spawning and recruitment needed to attain and maintain self-sustaining populations is currently not evident and the overarching goal of the SJRIP is to restore self-sustaining populations of Colorado pikeminnow and razorback sucker in the San Juan River Basin. Thus, we recommend that the SJRIP continue to prioritize the identification and amelioration of impediments to wild recruitment to attain self-sustaining populations. Given the current size of adult populations in the San Juan River, successful wild recruitment from larval to juvenile life stages for Colorado pikeminnow appears to occur in years when the 5,000 cfs flow target was met (2016, 2017, and 2019) and for razorback sucker in low flow years that were preceded by high flow years (2018 and 2020). Over the next several years, we anticipate that the SJRIP will be able to track these wild cohorts to the adult life stage and provide demographic parameters for wild-spawned fish, shedding light on what is required for these populations to be self-sustaining in the San Juan River Basin.

CONCLUSION AND RECOMMENDATIONS

Below is a summary of how we assessed the recovery management actions and progress in reaching specific benchmarks toward recovery demographic criteria according to each of the four factors from the Principles.

1. Actions that will result in a measurable positive population response, a measurable fish habitat improvement, legal protection for flows required for recovery, or a reduced immediate extinction threat.
    a. Provide and legally protect habitat necessary to provide habitat and sufficient range for all life stages to support recovered populations (Recovery Management Action #1).
        i. The SJRIP has identified the benefit of high flow releases from Navajo Reservoir in conjunction with spring peak flow from the Animas River to create and maintain low velocity habitat and channel complexity in the San Juan River to benefit Colorado pikeminnow and razorback sucker early life stage recruitment.
        ii. The SJRIP and its partners have conducted secondary channel and low velocity habitat restoration along the San Juan River.
        iii. In collaboration with SNARRC and through the Four Corners Power Plant and Navajo Mine Energy Project BO, the SJRIP is developing an experiment to assess the effect of temperature on larval razorback sucker growth and survival.
    b. Control problematic nonnative fishes as needed (Recovery Management Action #6).
        i. The SJRIP's work to evaluate the effects of nonnative removal on channel catfish, Colorado pikeminnow, and razorback sucker, modeling to assess the effect of removal on channel catfish, and quantifying the incidence of endangered fish preyed on by channel catfish has greatly increased our understanding of the threat posed by nonnative fish and the effect of mechanical removal efforts. We recognize that SJRIP

management efforts have reduced the predation threat by removing the largest and most predatory channel catfish from the San Juan River.

ii. We recommend that the SJRIP assess the level of nonnative removal needed to maintain this reduced size structure of the channel catfish population. Additionally, we recommend experimental work to identify methods, seasons, flows, or river reaches to increase removal rates to improve the efficiency of nonnative removal efforts.

2. Fish population status.
    a. Reestablish populations with hatchery-produced fish (Recovery Management Action #9).
        i. The SJRIP is meeting annual and longer-term stocking goals for Colorado pikeminnow and razorback sucker. We view the SJRIP's efforts to improve the efficiency of augmentation as important steps to maximize the recovery benefit of this management action.
        ii. Because of the hatchery-augmentation program, populations of Colorado pikeminnow and razorback sucker have increased in size through time, successfully spawn on a regular basis, and have recently exhibited survival of wild-spawned fish through early life stages.
        iii. In moving forward with augmentation plans for Colorado pikeminnow and razorback sucker, we recommend development of biologically meaningful metrics to evaluate the success of the SJRIP's augmentation efforts based on the numbers of stocked fish that persist, spawn, and ultimately produce wild-offspring that recruit to adulthood.
    b. Progress toward reaching downlisting and delisting recovery demographic criteria (Recovery Goal Criteria).
        i. Despite the lack of long-term dedicated abundance estimate data in the San Juan River Basin, there is clear indication of substantial increases in the catch rates of Colorado pikeminnow and razorback sucker indicating improved status of their populations through time. Thus, despite not meeting the age-specific targets in the recovery demographic

criteria, Colorado pikeminnow and razorback sucker have responded positively to the SJRIP's management actions.

ii. Despite recent encouraging signs of survival of larval fish to age-0 juvenile and age-1 life stages, recruitment of wild-spawned fish to adulthood has been extremely limited. Thus, the population of Colorado pikeminnow and razorback sucker in the San Juan River Basin remains reliant on hatchery augmentation.

iii. We recommend the SJRIP continue to prioritize the identification and amelioration of impediments to wild recruitment to attain self-sustaining populations in the San Juan River Basin.

3. Flow adequacy.
    a. Provide and legally protect habitat necessary to provide habitat and sufficient range for all life stages to support recovered populations (Recovery Management Action #1).
        i. The inability to meet the 8,000 and 10,000 cfs targets at the recommended frequency outlined in the Flow Recommendations, is cause for serious concern. Over the 23 years of record (1998-2020), the 8,000 and 10,000 cfs targets have only been met 2 and 3 times, respectively (9% and 13% observed frequency compared to 33% and 20% recommended frequency).
        ii. We recommend the SJRIP explore options to protect and potentially acquire flows necessary for recovery. In the absence of adequate flows to create and maintain habitat, the SJRIP will need to develop non-flow alternatives to provide those same habitats at the appropriate spatial and temporal scale.
4. Magnitude of the activities' impact, including, but not limited to, contaminant and fish migration impacts.
    a. Provide passage over barriers within occupied habitat to allow adequate movement, and potentially, range expansion (Recovery Management Action #2).

i. The SJRIP has provided passage at sites in the mainstem San Juan River (Hogback and PNM) and is working to address others (Fruitland, Piute Farm Waterfall, APS).

ii. We recommend the SJRIP continue to evaluate the need to provide passage at the Piute Farms Waterfall and upstream locations in both the San Juan and Animas Rivers.

iii. The SJRIP needs to conduct an evaluation of passage efficiency at the Hogback, APS, and Fruitland Diversions to ensure these capital investments are functioning as anticipated.

b. Minimize entrainment of subadults and adults in diversion canals/out-take structures (Recovery Management Action #3).

i. The SJRIP constructed a fish weir at Hogback and will construct another at Fruitland to minimize entrainment. However, to ensure fish weirs minimize entrainment as anticipated the SJRIP must evaluate the efficacy of these structures to reduce entrainment as anticipated. VFD pumps at Hogback continue to interfere with PIT tag antennas and prevent an assessment of endangered fish entrainment into this irrigation facility. We recommend the SJRIP address this ongoing issue to allow for an evaluation of the fish weir's ability to minimize entrainment.

ii. We recommend the SJRIP prioritize investigation at structures identified in Lyons et al. (2016) and screen or modify those diversions that pose the greatest entrainment risk, and thus the greatest impediment towards recovery in the San Juan River Basin.

c. Ensure adequate protection from disease and parasites (Recovery Management Action #4).

i. We consider the current recovery threat posed by disease and parasites to be minimal. We recommend no further management actions to ensure endangered fishes have adequate protection from disease and parasites.

d. Regulate nonnative fish releases and escapement into the San Juan River, floodplain, and tributaries (Recovery Management Action #5).

i. The SJRIP's efforts to finalize a cooperative agreement for stocking nonnative fish species in the San Juan River Basin and construction of escapement barriers for Lake Nighthorse and Morgan Lake are positive steps to regulate nonnative fish releases and escapement into the San Juan River Basin.

e. Minimize the risk of hazardous-materials spills in critical habitat (Recovery Management Action #7).
    i. We recognize that some tasks to minimize the threat of hazardous-materials spills in critical habitat may be beyond the authority of the SJRIP to implement. However, we recommend the SJRIP develop a plan to provide a response to potential future hazardous material spills.
f. Remediate water quality problems (Recovery Management Action #8).
    i. We recognize that remediation of these contaminants is beyond the scope and capabilities of the SJRIP and will require 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.
    ii. Conservation measures, RPMs, and terms and conditions of future BOs related to water quality issues within the San Juan River Basin will address specific management actions to minimize and further understand the effects of mercury and selenium on Colorado pikeminnow and razorback sucker.
g. Minimize the threat of hybridization with white sucker (Recovery Management Action #10).
    i. Given the rarity of white sucker and their hybrids in the San Juan River, we do not consider the current threat level of this species to be substantial to warrant further management. However, the proposed genetic assessment of razorback – flannelmouth sucker hybridization will provide some insight into the degree of hybridization that is occurring with native suckers and an assessment of the accuracy of identifying these hybrids in the field.

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 in the San Juan River Basin based on the improved status of these fish following the successful implementation of management actions as summarized above. 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, there remains much to learn to achieve recovery in the shortest possible time frame. If releases from Navajo Reservoir continue to be unable to meet high flow targets at the recommended frequency in the San Juan River, the SJRIP will need to explore options to protect and potentially acquire flows necessary for recovery or develop non-flow alternatives to provide the same habitats provided by high flows. Given the lack of wild-recruitment, we urge the SJRIP to prioritize research to determine and mitigate impediments limiting wild-recruitment in the San Juan River Basin. Additionally, we recommend the SJRIP continue to use science-based management to guide its activities and improve the efficiency of efforts to move towards recovery more expeditiously. Finally, with the cooperative agreement for the SJRIP set to expire in 2023 and the uncertain implementation of future recovery management actions, we have serious concerns about maintaining the progress toward recovery the SJRIP has attained to date and 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 2020a). A sustained funding commitment to implement successful recovery activities has factored heavily into our determination of sufficient progress (FWS 2006, FWS 2010, FWS 2013, FWS 2019) and the current status each species (FWS 2018a, FWS 2020a). We fear that ESA compliance provided by a 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. In order to maintain

progress toward recovery and ESA compliance for existing projects, we urge the 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 planned, 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.

TABLES

Table 1. Number of days per year that attained each of the four spring flow targets (highlighted in grey) as outlined in the San Juan River flow recommendations (Holden 1999). Table and flow statistics courtesy of S. Behery.

	Annual duration (number of days meeting target)			
Flow target (cfs)	**10,000**	**8,000**	**5,000**	**2,500**
Minimum duration criteria	**5 days**	**10 days**	**21 days**	**10 days**
Recommended frequency criteria	**20% of years**	**33% of years**	**50% of years**	**80% of years**
Maximum frequency criteria	**10 years**	**6 years**	**4 years**	**2 years**
1998	0	4	35	66
1999	0	1	31	72
2000	0	0	6	40
2001	0	4	36	56
2002	0	0	0	0
2003	0	0	0	14
2004	0	0	1	26
2005	11	18	52	85
2006	0	0	8	24
2007	0	3	21	56
2008	6	25	62	121
2009	0	0	20	41
2010	0	0	0	19
2011	0	7	12	29
2012	0	0	6	10
2013	0	0	0	0
2014	0	0	0	22
2015	0	1	16	38
2016	0	7	35	53
2017	0	7	49	73
2018	0	0	0	0
2019	6	9	25	63
2020	0	0	0	4

Table 2. Age-0 and Age-1+ Colorado pikeminnow annually stocked in the San Juan and Animas Rivers 2002-2019 (Furr 2020a). Annual stocking goals for age-0 and age-1+ Colorado pikeminnow are also included. Note that in 2019 the SJRIP made a decision not to stock age-0 Colorado pikeminnow because wild young-of-year Colorado pikeminnow were collected in the fall (Barkalow et al. 2020). In 2010 age-0 Colorado pikeminnow were not stocked in the San Juan River due to hatchery disease precautions. These fish were held over at SNARRC and stocked in 2011 as age-1 fish.

	Age-0		Age-1+	
Year	Number stocked	Stocking goals	Number stocked	Stocking goals
2002	210,418	250,000	0	
2003	175,928	300,000	1,005	
2004	280,000	300,000	1,219	
2005	302,270	300,000	4,541	
2006	313,854	300,000	12,693	3,000
2007	475,970	300,000	3,256	3,000
2008	270,234	300,000	4,857	3,000
2009	468,000	300,000	6,000	3,000
2010	0	300,000	353	3,000
2011	426,588	400,000	218,444	
2012	395,640	400,000	0	
2013	439,264	400,000	0	
2014	393,442	400,000	429	
2015	402,087	400,000	0	
2016	432,443	400,000	1,520	
2017	200,736	400,000	0	
2018	430,273	400,000	0	
2019	0	0	1,230	

Table 3. Number of razorback sucker stocked in the San Juan and Animas Rivers 1997-2019 (Furr 2020a). A 5-year augmentation effort was implemented in 1997 calling for stocking a total of 73,482 fish but no annual goals (Ryden 1997). During an interim stocking period (2002-2008), annual stocking goals were 11,400 fish > 300 mm total length (TL) but there was no goal for the entire period. An 8-year augmentation effort started in 2009 called for stocking a total of 91,200 fish or 11,400 fish annually (Ryden 2003a). The two plans total numbers represent the number of razorback sucker actually stocked and stocking goals for 1997-2001, 2002-2008, and 2009-2016. The recently completed augmentation plan finalized in 2020 calls for annually stocking at least 4,800 fish ≥ 300 mm TL (Furr 2020b), but there were no annual or total stocking goals established for the interim 2017-2019 time period. In 2006 and 2007 a total of 10,959 razorback suckers were stocked in the San Juan River without PIT tags. These fish are not included in the table. There were 4,021 razorback sucker stocked in 2010 as part of the 2009 stocking effort. In 2012, a total of 2,295 razorback sucker stocked as a group where high mortality was observed are not included in the table.

	Number stocked		Stocking goals	
Year	**Annual**	**Plan total**	**Annual**	**Plan total**
1997	2,883			
1998	1,275			
1999	0	5,890		73,482
2000	1,044			
2001	688			
2002	140		11,400	
2003	887		11,400	
2004	2,979		11,400	
2005	1,993	41,093	11,400	
2006	13,764		11,400	
2007	16,906		11,400	
2008	4,424		11,400	
2009	8,316		11,400	
2010	28,419		11,400	
2011	18,782		11,400	
2012	13,516	103,413	11,400	91,200
2013	15,341		11,400	
2014	6,165		11,400	
2015	5,208		11,400	
2016	7,666		11,400	
2017	10,326			
2018	10,111			
2019	6,716			

FIGURES

Figure 1. Map of San Juan River Basin highlighting major tributaries and river mile (RM) reference for select geographical locations or features. Stars indicate select U.S. Geological Survey (USGS) gauging stations.

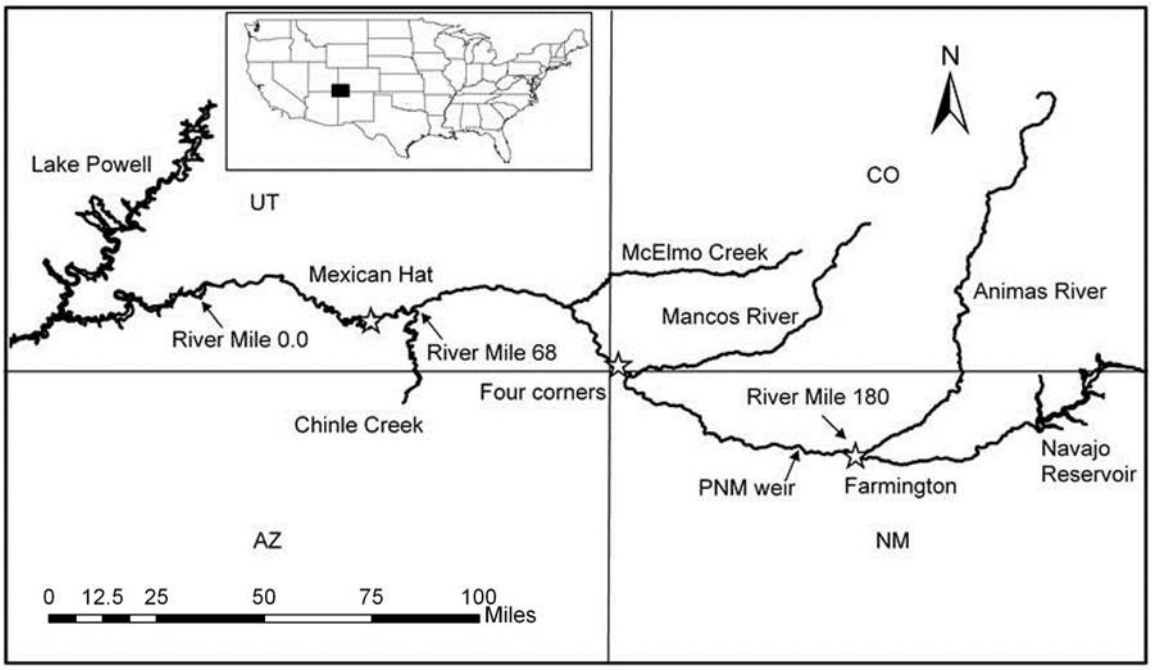


Figure 2. Model predicted response of frequency of off channel backwaters and flowing secondary channels and area of off channel and main channel backwaters to spring flow targets outlined in the Flow Recommendations (top panel). Because the few number of years that the 8,000 cfs and 10,000 cfs targets were met, they are combined under the 8k metric (SJRIP unpublished data). The "<2.5K" represents years none of the spring targets were attained. Model predicted response of area of off channel backwaters and frequency of flowing secondary channels to standardized flow at mapping (as z-scores; bottom panel). Flow at mapping served as a proxy for baseflow (SJRIP unpublished data).

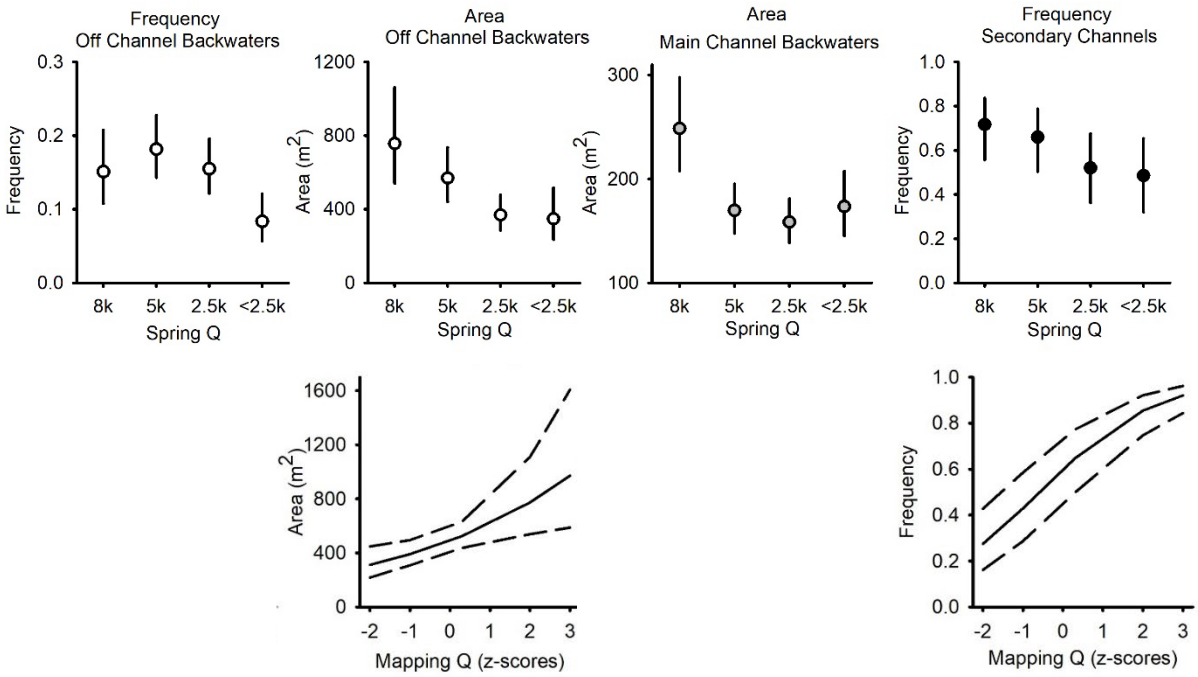
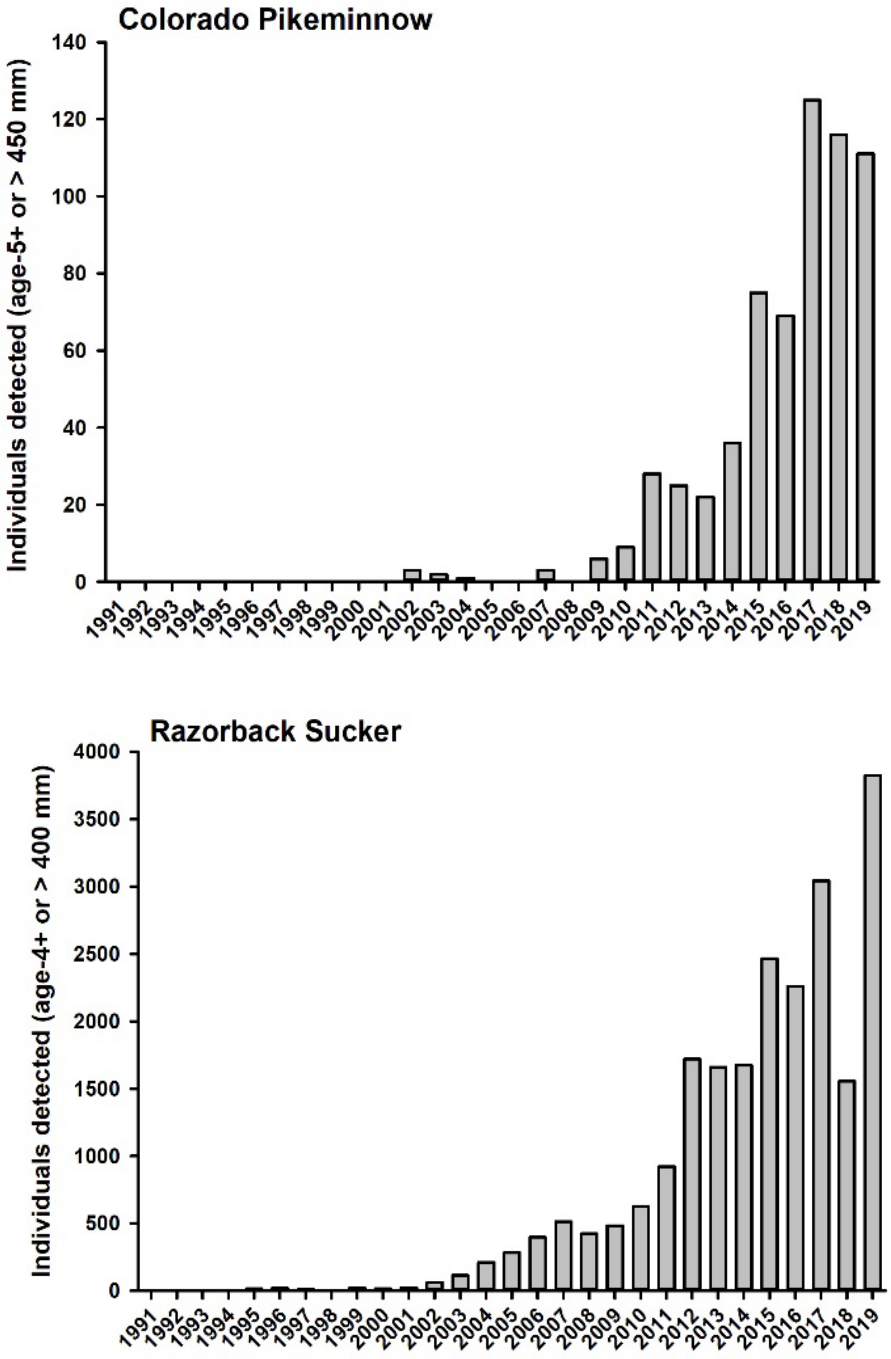


Figure 3. Catch rate (CPUE, fish/hour) of adult Colorado pikeminnow and adult razorback sucker during annual standardized monitoring based on raft electrofishing (Schleicher 2018).



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