

**Monitoring Large-Bodied, Young-of-Year, and Larval Fishes
of the Upper Colorado River and the Lower Gunnison River,
Colorado in Response to Reoperation of the Aspinall Unit
Reservoirs 2011-2016**

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LIST OF KEY WORDS

Aspinall Unit, Colorado pikeminnow, Gunnison River, flow recommendation,
Razorback sucker

EXECUTIVE SUMMARY

Monitoring of the fish community in the 18-mile reach of the Colorado River (confluence of the Colorado and Gunnison rivers downstream to Loma, Colorado) and the lower Gunnison River began in 2011 in response to reoperation of the Aspinall Unit reservoirs on the Gunnison River. The reoperation plan for the Aspinall Unit includes both base flow targets to allow for the operation of the fish passage facility at Redlands Dam and the operation of fish screens which prevent entrainment of fish into the Redlands Canal along with peak flow targets intended to benefit listed fish species by improving critical habitat. The basis for the peak flow recommendations were primarily research, i.e. McAda 2003 and Pitlick et al 1999, funded by the Upper Colorado River Endangered Fish Recovery Program. In 2012, the Record of Decision (ROD) for the Aspinall Unit Operations Final Environmental Impact Statement was signed. From 2012 to 2016, the predicted inflow to Blue Mesa Reservoir was only sufficient to trigger half-bankfull or bankfull releases during two years (2014 and 2016). Mean daily flow by month was lower in the five years (2012-2016) after the ROD was signed than for the five years (2007-2011) preceding the ROD.

The total number of captures and recaptures of bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*) within the Gunnison River is low and are insufficient to complete a mark-recapture population estimate of these species. Abundance estimates of Colorado pikeminnow and razorback sucker for the Colorado River are calculated during Project 127. If/when a sufficient number of endangered fishes are present in the Gunnison River, the number of sampling passes per year may be increased to facilitate calculation of a multiple-pass population estimate in the lower Gunnison River. Catch rates of non-endangered native species, bluehead sucker (*Catostomus discobolus*),

flannelmouth sucker (*C. latipinnis*) and roundtail chub (*G. robusta*), are similar to catch rates found in two previous studies (Burdick 1995 and Osmundson 1999).

Collections of larval and young-of-year (YOY) endangered fishes were also rare. A single YOY Colorado pikeminnow was captured in both the Colorado River and Gunnison River in 2015. The current scope-of-work specifies seining for YOY fishes occur consistent with the ISMP protocol. As such, all YOY seining occurred in backwater type habitats. As main-channel habitats were not sampled, no comparison of non-endangered native species YOY abundance was undertaken. A total of 42 larval razorback suckers were collected in the Colorado River from 2011 to 2016. Number of larval razorbacks collected by year in the Colorado River ranged from zero in 2011 and 2015 to 36 in 2012. Only two larval razorback suckers were captured in the Gunnison River portion of the study area, with both captures occurring in 2014.

Monitoring data for the lower Gunnison River indicate few juvenile or adult endangered fishes are present within this reach. Catch rates of non-endangered native species are similar to catch rates found during the 1990s when compared to most recent years of data collection. The lack of sufficient predicted inflow into Blue Mesa Reservoir to trigger half-bankfull and bankfull flows in most years of the study period preclude assessment of the effects of the flow recommendations on endangered fishes.

INTRODUCTION

The Aspinall Unit consists of three reservoirs (Blue Mesa, Morrow Point, and Crystal) on the upper Gunnison River near Gunnison, Colorado. The three reservoirs were authorized in 1956 as part of the Colorado River Storage Project Act with construction beginning in 1961 and continuing until 1976 (USBR 2000). The most upstream and largest of the three reservoirs (Blue Mesa) has a capacity of 940,800 acre feet (AF) and provides water storage, flood control, and hydroelectric power production. Morrow Point Reservoir, located approximately 12 miles below Blue Mesa Dam, has a capacity of 117,190 AF and provides water storage, flood control, and hydroelectric power production. The most downstream reservoir (Crystal) located approximately six miles below Morrow Point Reservoir has a capacity of approximately 25,236 AF and primarily serves to stabilize flows below the three reservoirs while also producing hydroelectric power.

The Programmatic Biological Opinion (PBO) (ES/GJ-6-CO-09-F-0001) for operation of the Aspinall Unit was completed in December 2009 (USFWS 2009). The Record of Decision (ROD) for the Aspinall Unit Operations Final Environmental Impact Statement (FEIS) was signed 03 May 2012 (USBR 2012) and describes Aspinall Unit operations for subsequent years based on the projected April to July inflow forecast for Blue Mesa Reservoir. Operations under the preferred alternative in the ROD are designed to provide sufficient releases of water at times, quantities, and duration necessary to avoid jeopardy to endangered fishes, avoid adverse modification of their designated critical habitat in the lower Gunnison River and to assist in recovery of endangered fish species (USBR 2012). The Aspinall Unit is upstream of historically occupied habitat of the four endangered fishes (bonytail [*Gila elegans*], Colorado pikeminnow

[*Ptychocheilus lucius*], humpback chub [*G. cypha*], and razorback sucker [*Xyrauchen texanus*]) of the upper Colorado River basin. Designated critical habitat for both Colorado pikeminnow and razorback sucker on the Gunnison River extends from the confluence with the Colorado River at Grand Junction, Colorado upstream to the confluence with the Uncompahgre River (river mile [RM] 56.3) at Delta, Colorado (59 FR 13374:March 21, 1994).

Flow objectives for Gunnison River spring peak and base flows are measured at the U. S. Geological Survey (USGS) stream gage (09152500) at Whitewater, Colorado (RM 14.6). Peak flow targets include desired peak flow levels, durations at those peak flow levels and durations at half-bank full levels for wetter years (Table 1). Additional caveats exist for spring peak and duration targets during drought conditions. See USBR 2012 and USFWS 2009 for additional details.

The Gunnison River base flow target is 1,050 cubic feet per second (cfs) at the Whitewater gage during most years. During dry and moderately dry years, base flow targets are a minimum of 750 cfs year-round with additional releases occurring from March to October to provide flows for the operation of the Redlands fish passage (100 cfs), which allows passage of fish upstream of Redlands Power and Water Company's Diversion Dam (Redlands Dam), and the fish screen (40 cfs) which prevents fish entrainment into Redlands Canal. Additional caveats exist for base flow targets during drought conditions. See USBR 2012 and USFWS 2009 for details concerning base flow targets during dry and moderately dry years.

Naturally produced Colorado pikeminnow were present in the Gunnison River until the mid-1990's (Burdick 1995). Naturally produced razorback sucker were last captured in the Gunnison River in 1981 near Delta, Colorado (Holden et al. 1981). Redlands Dam (RM 3.0) was constructed in the early 1910's and prevented upstream movement of fishes until a fish passage

structure was completed in 1996. Currently, Colorado pikeminnow are rare in the Gunnison River above Redlands Dam. Bonytail and razorback sucker are present in the Gunnison River upstream of Redlands Dam as the result of ongoing augmentation efforts. Between 1995 and 2017, 54,088 razorback sucker were stocked in the Gunnison River upstream of the Redlands Dam or in Butch Craig Pond (RM 12.5) Species Tagging Research and Monitoring System (STReaMS) 7/28/2018). Butch Craig Pond is an off-channel pond that connects to the Gunnison River when flows are approximately 3,000 cfs as measured at U. S. Geological Survey (USGS) stream gage (09152500) at Whitewater, Colorado. From 2009 to 2017, 6,356 bonytail were also stocked upstream of Redland Dam at either Delta, Colorado or in Butch Craig Pond (STReaMS 7/12/2018). Bonytail, Colorado pikeminnow and razorback sucker have also been released above Redlands Dam after being captured at the fish passage structure. No humpback chub population exists above Redlands Dam, but a single humpback chub was captured in 1993 at RM 22.0 (Burdick 1995) and another was captured at the Redlands Dam fish ladder in 2010 (Francis 2016).

Flows in the Colorado River downstream of the Gunnison/Colorado River confluence are highly influenced by Gunnison River flows, and therefore this river reach is included in this study. The Colorado River portion of the study area extends from the Colorado/Gunnison River confluence (RM 170.9) downstream to the Colorado/Utah Stateline (RM 131.9), and is designated critical habitat for both Colorado pikeminnow and razorback sucker. Colorado pikeminnow are present within the Colorado River portion of the study area and are naturally recruiting (Elverud et al. 2020). Bonytail and razorback sucker are also present in the Colorado River as a result of ongoing augmentation efforts. Although listed in the scope of work for this project, abundance estimation of razorback sucker within the Colorado River is conducted and

reported under Upper Colorado River Endangered Fish Recovery Program (Program) Project 127. Designated critical habitat for bonytail and humpback chub is present from Black Rocks (RM 136) downstream to the Fish Ford (RM 105.8), where a humpback chub population exists (reported under Program Projects 131 and 132). In addition to endangered fishes, numerous native and nonnative fish species occur within the study reaches. Three previous studies (Valdez et al. 1982, Burdick 1995, and Osmundson 1999) examined the fish community in the study area covered under this report. Two of the studies provide historical context and fish community data collected in years 1992, 1993, 1994 (Burdick 1995) and 1995 (Osmundson 1999) represent baseline conditions with which to compare data collected during this project (2011 to 2016). No comparisons were made between this study and Valdez et al. (1982) due to substantial differences between in sampling methods.

OBJECTIVES

The goal of this study is to assess the effects of Aspinall Unit operations under the 2012 ROD on fish populations in downstream river reaches as identified in the Aspinall Unit Study Plan (Study Plan, Aspinall Unit Study Plan ad hoc Committee 2011). The study accomplishes this goal with the following objectives:

- 1) Conduct long-term monitoring for sub-adult and adult endangered fishes in the lower Gunnison River, focusing on Colorado pikeminnow and razorback sucker. As noted above, density estimates for Colorado pikeminnow and razorback sucker on the Colorado River are covered under Program Project 127.

- 2) Evaluate reproductive success of endangered fishes in the Gunnison and upper Colorado rivers by conducting early-life-stage abundance monitoring through systematic collections of larvae (hand seining) and young-of-the-year (beach seining).
- 3) Conduct monitoring of the fish community in the Gunnison River and 18-mile reach of the upper Colorado River, including both large- (electrofishing) and small-bodied (beach seining) fishes using protocols modeled after Burdick (1995), Osmundson (1999), and Interagency Standardized Monitoring Protocol (ISMP) young-of-year sampling (McAda et al. 1994).

METHODS

Adult and Sub-adult Monitoring

Electrofishing was used to sample sub-adult and adult fish communities in the rivers (objectives 1 and 3). Study methods were designed to optimize data collection under budget constraints and were based on previous studies in the area (Burdick 1995; Osmundson 1999). Subreaches in each river were identified for community sampling, in which all fish were netted. In all other subreaches (if sampled), only endangered fish were netted. At the end of each sampling reach, each fish was identified to species, weighed to the nearest gram (g) and total length (TL) was measured to the nearest millimeter (mm). Endangered fishes were scanned for a Passive Integrated Transponder (PIT) tag, and a PIT tag was implanted if the fish did not contain one at the time of capture. Centrarchids, nonnative catostomids, and gizzard shad (*Dorosoma cepedianum*) were euthanized. Non-endangered native species, ictalurids, and salmonids were weighed, measured and released.

Although outside of the scope of the Aspinall Unit monitoring plan, data from the STReaMS have been summarized and presented in the results section. This information documents all other known endangered species activity in the Gunnison and 18-mile reach sections including stocking, antenna detections, and transfers of fish into higher reaches of the Gunnison River to provide context for results of this study.

Gunnison River

The Gunnison River was sampled twice per year (early August and late-September or early October) from Delta, Colorado (RM 57.1) to the downstream-most boat ramp (RM 3.9) above the impassible Redlands Dam (RM 3.0) (Figure 1). The Gunnison River was stratified into six strata based on geomorphology. Each stratum was then separated into multiple reaches with each reach containing a single riffle/run sequence (see Osmundson 1999). Within each stratum, three reaches were randomly selected as community monitoring reaches for a total of 18 community sampling reaches on the Gunnison River. The community reaches of stratum three were previously sampled by Osmundson (1999). Raft-mounted electrofishing units were utilized with Smith-Root GPPs during sampling in 2011 and 2012. Beginning in 2013, ETS MBS-1D electrofishing units were employed, consistent with Program electrofishing guidelines (Martinez and Kolz 2018). Each crew consisted of one rower and one netter, and each shoreline was sampled simultaneously by separate crews.

Colorado River

Electrofishing sampling on the Colorado River occurs within the 18-mile reach (Colorado/Gunnison River confluence (RM 170.9) to Loma, Colorado (RM 152.6; Figure 2). Within the 18-mile reach, three reaches were sampled annually in mid- to late-September. Reaches sampled were RMs: 163.1-162.0, 159.7-158.5, and 154.1-153.0. These reaches were

selected as they were previously established by Osmundson (1999). Electrofishing crews consisted of three people; two netters and one boat operator. Each shoreline of the river was sampled by a separate crew. From 2011 to 2013, jon boat electrofishing equipment with a Coffelt model VVP-15 electrofishing unit was utilized for sampling. Beginning in 2014, jon boat electrofishing equipment with ETS electrofishing units were employed, consistent with Program electrofishing guidelines (Martinez and Kolz 2018). Electrofishing crews attempted to net all species observed in the three Colorado River electrofishing reaches.

Data Analysis

Catch-per-effort (CPE) was used as a tool to estimate trends in abundance for each species. Fishes collected during electrofishing sampling were separated into age classes (juvenile and adult) for analysis. Due to size selectivity of boat-mounted electrofishing sampling, young-of-year (YOY) catch was excluded from electrofishing data analyses. Total length at age from Burdick (1995) was utilized to determine age class for all species collected with the exception of Colorado pikeminnow. Burdick (1995) classified adult Colorado pikeminnow as being > 400 mm TL. The currently recognized total length for adult Colorado pikeminnow is 450 mm TL (USFWS 2002a). Catch-per-effort data was only calculated for species or hybrids for which captures occurred in the majority of sample units to warrant the analysis.

The most common species present in the Colorado and Gunnison rivers were compared between years within this study (2011-2016) and to data collected during the previous studies of Burdick (1995) and Osmundson (1999). Only data collected by Burdick (1995) and Osmundson (1999) that overlap spatially and seasonally with the current study were utilized for comparison in the analysis. The common fish species compared between years and across studies in the

Colorado River were bluehead sucker (*Catostomus discobolus*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), flannelmouth sucker (*C. latipinnis*), roundtail chub (*G. robusta*), white sucker (*C. commersonii*), and white sucker hybrids. In the Gunnison River, fish species compared between years and across studies were bluehead sucker, common carp, flannelmouth sucker, roundtail chub, white sucker, and white sucker hybrids. White sucker x flannelmouth sucker hybrids and white sucker x bluehead sucker hybrids were combined into a white sucker hybrid category because of concerns about the reliability of identification of *Catostomus* spp. hybrids in the field. Mean catch rate by species was compared using Analysis of Variance with pairwise comparisons made with the Tukey-Kramer multiple comparison test ($P < 0.05$; SYSTAT 13).

Life Stage Monitoring

Young-of-year and larval sampling (outlined below) document life-stages naturally occurring in the river, but also provide information about the geographical extent of reproduction and recruitment occurring in the system. Sampling for these two life-stages on the Gunnison River began at Delta, Colorado (RM 57.2) and extended downstream to Colorado/Gunnison River confluence (Gunnison RM 0.0). Sampling on the Colorado River began at the Colorado/Gunnison River confluence (Colorado RM 170.9) and extended downstream to the Colorado/Utah stateline (RM 131.9). To assess reproduction and recruitment over a large geographic area, sampling areas in both rivers are larger than those for the adult and juvenile monitoring. Data from YOY and larval endangered species sampling are presented below; all other results are available in the appendices.

Young-of-Year Sampling

Sampling for YOY fishes was conducted in both the Gunnison and Colorado rivers, consistent with ISMP protocol (USFWS 1987). The ISMP seining protocol was designed to monitor YOY Colorado pikeminnow abundance and not the entire YOY fish community. Crews attempted to sample two backwater habitats in each five-mile section of both the Colorado and Gunnison Rivers (see McAda et al. 1994), completing two seine hauls in each backwater. Due to the scarcity of backwater habitat in the Gunnison River, additional backwaters (where available) were sampled in some of the five-mile sections. Crews attempted to identify fishes captured during YOY sampling to species in the field, with the exception of bonytail, humpback chub and roundtail chub which were combined into one category, *Gila spp.* Native fishes captured during YOY sampling were measured to the nearest millimeter. Nonnative fishes were enumerated only. When YOY sampling resulted in the capture of fishes too small to reliably identify in the field, specimens were preserved in ethanol and sent to the Colorado State University Larval Fish Laboratory (CSU-LFL) for identification. In addition to number and size of fishes captured, seine haul length, seine width, backwater width and backwater length were collected to calculate CPE data for YOY sampling.

Data Analysis

Colorado pikeminnow hatch date (A) and spawning date were calculated using methods described by Nesler et al. (1988). Hatch date of Colorado pikeminnow < 22 mm TL was calculated with the equation $A = -76.7105 + 17.4949L - 1.0555L^2 + 0.0221L^3$ where L = total length. Hatch date for Colorado pikeminnow ≥ 22 mm TL was calculated with the equation $A = -26.6421 + 2.7787L$. Following hatch date calculation using these formulas, five additional days were subtracted to predict spawning date (Nesler et al. 1988).

Larval Sampling

Hand seines, a net suspended between two handles that is operated by a single person (approximately 3 ft. tall by 3 ft. wide with 0.5 mm mesh), were utilized to collect larval fishes, and crews sampled a minimum of three zero-velocity habitats, when available, in each five-mile section of both the Colorado and Gunnison rivers (see Osmundson and Seal 2009). When this project was initiated, seven sampling passes were completed each year with sampling beginning in early May and ending in early July to cover the suspected period of razorback sucker larvae availability. Beginning in 2014, the larval sampling period was extended to early August to cover the suspected period of Colorado pikeminnow availability. Ten sampling passes are now completed annually. All larval fishes collected in each slackwater habitat were combined into a single sample. Larval fishes were identified to species, when possible, by the CSU-LFL.

Hydrology and Flow Targets

Because this study is designed to assess the biological response to Aspinall Unit operations, hydrologic and flow target data are presented for context. The forecast and observed inflow data were extracted from BOR's annual operating plans (USBR 2013, 2014, 2015, 2016, and 2017). Flow data were calculated from USGS stream gage (09152500) at Whitewater, Colorado. For a description of the methods used for calculation and prediction of flow targets, see USBR 2012 and USFWS 2009.

RESULTS

Gunnison River

Endangered Fish

Three of the four species of endangered fish (bonytail, Colorado pikeminnow and razorback sucker) were captured by electrofishing in low numbers in the Gunnison River between 2011 and 2016 (Table 2). Fifteen bonytail were captured between 2011 and 2016, five in 2011 and 10 in 2014. For reference, 90 bonytail were translocated above Redlands Dam between 1996 and 2016 (Francis and Ryden 2016). From 2003 to 2017, 6,356 PIT-tagged bonytail were stocked in the Gunnison River basin upstream of Redlands Dam (STReaMS 7/12/2018). One bonytail did not contain a PIT tag at the time of capture. The untagged bonytail may have been a stocked fish that lost its PIT tag after stocking, or may have been stocked into Butch Craig Pond as an excess untagged YOY in a prior year. Thirteen of the 14 bonytail containing a PIT tag when captured were collected during the same year in which they were stocked. One bonytail stocked in 2010 was captured in 2011 close to Butch Craig Pond (where it was stocked), providing the only evidence of bonytail overwinter survival in this study. Bonytail were not captured during previous sampling on the Gunnison River during the 1980s and 1990s as these studies were conducted prior to initiation of bonytail augmentation in the Gunnison River. The Gunnison River is not critical habitat for bonytail, but they have been stocked in the Gunnison River in an attempt to increase retention of these fish in the Colorado River downstream of the Colorado/Gunnison Rivers confluence.

Colorado pikeminnow captures are rare in the Gunnison River upstream of Redlands Dam. Only four Colorado pikeminnow were captured between 2011 and 2016 in this study (Table 3). For reference, 44 Colorado pikeminnow were captured entering the Redlands

selective fish passage and moved upstream to Delta, Colorado between 2014 and 2016 and five of those were detected on stationary PIT tag antennas in Roubideau Creek in 2016 and 2017 (a tributary to the Gunnison). One Colorado pikeminnow was captured at Redlands Dam in both 2010 and 2012 before being captured in the Gunnison River upstream of Redlands Dam in October 2012. Two of the four Colorado pikeminnow captured upstream of Redlands Dam were recaptured in the Gunnison River within eight days of being captured at Redlands Dam and released upstream (Table 3). No record of when the fourth Colorado pikeminnow captured in the Gunnison River was released above Redlands Dam could be located.

One hundred eight razorback sucker captures occurred on the Gunnison River above Redlands Dam from 2011 to 2016 (Table 2). For reference, 13,092 razorback sucker were stocked into the Gunnison River or Butch Craig Pond during the study period (STReAMS 7/19/19). Two of the 106 individual razorback sucker were captured during both the summer and fall sampling trips within the same year, but no razorback sucker were captured across years during this study. Seven (7%) of the 106 individual razorback sucker did not contain a PIT tag when captured in the Gunnison River. The seven untagged razorback sucker are likely stocked razorback sucker that lost their PIT tag after stocking. Of the 106 individual razorback sucker captured with a PIT tag, 68 (64%) were captured within the same calendar year in which they were stocked, and 26 (25%) were captured after persisting in the river for one or more over-winter period. Five PIT-tagged razorback sucker were captured in the Gunnison River for which no PIT tagging or stocking record could be located. The longest duration from stocking date to capture in the wild for a razorback sucker in the Gunnison River was 12 years.

In the summer of 2016, a Passive Interrogation Array (PIA) was placed in Butch Craig Pond. During the 38 days the PIA was active, 109 individual razorback sucker and two

individual bonytail were detected. The two bonytail were initially stocked in the Gunnison River at Delta, Colorado in 2014. Forty-six of the 109 individual razorback sucker were stocked in Butch Craig Pond from 2006 to 2012. Sixty-two of the 109 individual razorback sucker were stocked at Delta, Colorado. The time elapsed since stocking the razorback sucker detected in Butch Craig varied from 1-15 years. One razorback sucker detected in Butch Craig was captured and tagged in the Gunnison River in 2012. One additional PIT tag was detected by the PIA, but no record of the tag being implanted in a fish could be located. Although the placement of the PIA in Butch Craig Pond was not part of a formal study plan, the data collected indicate Butch Craig Pond is supporting a number of razorback sucker that are not available to our typical sampling in the Gunnison River. Furthermore, those fish are persisting in a habitat with a large number of nonnative predators and competitors such as largemouth bass (*Micropterus salmoides*) and white sucker.

Young-of-Year Sampling

The number of backwaters sampled each year in the Gunnison River ranged from a low of seven in 2013 to a high of 15 in 2015. A single YOY Colorado pikeminnow (TL = 20 mm) was captured during seining efforts in the Gunnison River at RM 21.3 on 10 September 2015 and was identified from a sample submitted to CSU-LFL. The back calculated spawning date for this single YOY Colorado pikeminnow was 8 August 2015. No razorback sucker YOY were collected during YOY seining efforts. Fish identified as YOY *Gila* spp. are likely roundtail chub instead of bonytail or humpback chub, which are extremely rare in the Gunnison River portion of the study area of this project.

Larval Sampling

The number of larval samples collected with a hand seine in the Gunnison River ranged from a low of 162 in 2012 to a high of 230 in 2013. Two razorback sucker larvae were captured in 2014 (Appendix A). A single larval razorback sucker was captured at RM 16.2 on 10 July 2014, and the second capture occurred at RM 8.7 on 5 August 2014. No other endangered species larvae were captured during the study period.

Non-endangered Native Fish

Total number and percent of catch in the Gunnison River of juvenile and adult large-bodied fish species collected during electrofishing efforts are summarized in Table 4. Catch rates of flannelmouth sucker, roundtail chub, and bluehead sucker were compared to catch rates from 1992, 1993, 1994, and 1995 (Burdick 1995), 1994 and 1995 (Osmundson 1999) and to catch rates throughout this study (2011-2016). Catch rates of these three species are significantly different in some years to catch rates found during the two previous studies (Figure 3-5). Catch rates of flannelmouth sucker were significantly higher ($P < 0.05$) in the first year of this study (2011) compared to all other years. Catch rates of roundtail chub were significantly higher ($P < 0.05$) in 2011 than in both 2012 and 2016, but were not significantly different from the other sampling years. Catch rates of bluehead sucker remained similar throughout the study period. The lack of statistical difference between the historical and current CPE measures may be the result of large confidence intervals in the historical data.

Nonnative Fish

Total number and percent of catch in the Gunnison River of juvenile and adult large-bodied fish species data are summarized in Table 4. Catch rates of common carp, white sucker and white sucker hybrids were compared to catch rates from 1992, 1993, 1994, and 1995

(Burdick 1995), 1994 and 1995 (Osmundson 1999) and to catch rates throughout this study (2011-2016). No significant difference in the catch rate of common carp was detected (Figure 6). A significant increase in the catch rate of both white sucker ($P < 0.05$; Figure 7) and white sucker hybrids ($P < 0.05$; Figure 8) has been observed relative to sampling conducted by Burdick 1995 and Osmundson 1999.

Colorado River

Endangered Fish

One bonytail was captured during electrofishing sampling for this project in the Colorado River. The single bonytail was stocked into the Colorado River from the 24 Road Hatchery approximately six months prior to being captured during this project in 2016. As the only capture of a bonytail in the Colorado River for this study was the result of within-year stocking, no further analysis of bonytail was attempted for the Colorado River dataset.

Two Colorado pikeminnow were captured during sampling on the Colorado River, with one capture occurring in each 2011 and 2016 (Table 5). The Colorado pikeminnow captured in 2011 was tagged in 2005 and recaptured seven additional times between 2008 and 2013 between Fruita, Colorado and Redlands Dam on the Gunnison River. The Colorado pikeminnow captured in 2016 was initially tagged in 1995 and was recaptured seven additional times between 1999 and 2016. All captures of this Colorado pikeminnow occurred within a 2.1 mile reach of the Colorado River. Colorado pikeminnow abundance within the Colorado River is monitored under Upper Colorado River Basin Recovery Program project 127. As only two Colorado pikeminnow were captured in the Colorado River during this project, no comparison of catch rate between years was made.

Twenty-nine captures of razorback sucker occurred on the Colorado River during this project from 2011 to 2016 (Table 5). One razorback sucker was captured in two years (2012 and 2014). Three (10%) of the 28 individual razorback sucker did not contain a PIT tag when captured. These three razorback sucker were likely the result of stocked fish that lost their PIT tag after stocking. One additional razorback sucker was captured that was tagged when it was captured during another study. Eight (32%) of the 25 individual razorback sucker captured with a PIT tag were captured during the same calendar year in which they were stocked. Seventeen (68%) of the 24 individual razorback for which stocking data was available were captured greater than one over-winter period from their stocking date. The longest length of time from stocking date to capture in the wild in the Colorado River was 14 years. As all razorback sucker captured in the Colorado River during this project are likely the result of augmentation efforts, no comparison was made between years.

Young-of-Year Sampling

The number of backwaters sampled per year in the Colorado River ranged from a low of 10 in 2016 to a high of 16 in 2013. A single YOY Colorado pikeminnow (TL = 22 mm) capture occurred in the Colorado River in 2015 during this project. The capture occurred at the Colorado/Utah stateline (RM 131.9) on 14 September and was identified from a sample submitted to the CSU-LFL. The back calculated spawning date for this single YOY Colorado pikeminnow was 5 August 2015. No additional YOY endangered fish captures occurred during this project on the Colorado River. Fish identified as YOY *Gila spp.* are likely roundtail chub instead of bonytail or humpback chub.

Larval Sampling

The number of larval samples collected in the Colorado River ranged from a low of 98 in 2011 to a high of 268 in 2013. A total of 42 razorback sucker larvae were captured (Appendix B). The total number of razorback sucker larvae collected each year ranged from zero in 2011 and 2015 to 36 in 2012. Additional collections of razorback sucker larvae included three in 2013, two in 2014 and one in 2016. No other endangered species larvae were captured during the study period.

Non-endangered Native Fish

Total number and percent of catch in the Colorado River of juvenile and adult large-bodied fish species data are summarized in Table 6. Catch rates of bluehead sucker, flannelmouth sucker, and roundtail chub were compared to catch rates from 1994 and 1995 (Osmundson 1999) and to catch rates throughout this study (2011-2016). No significant differences exist in the catch rates of flannelmouth sucker (Figure 9) or roundtail chub (Figure 10) from Osmundson 1999 to present. Catch rates of flannelmouth sucker and roundtail chub have also remained similar during this study in the Colorado River. A significant decline ($P > 0.05$) in bluehead sucker catch rate was observed from Osmundson 1999 compared to 2013, 2014, and 2016 (Figure 11). No difference in catch rate was found in bluehead sucker between Osmundson 1999 and 2011, 2012 and 2015 data (Figure 11). While no significant difference in catch rate was detected for flannelmouth sucker and roundtail chub, the catch rates appear to be declining for both of these species (Figures 9-10). The lack of statistical difference between the historical and current CPE measures may be due to large confidence intervals in the historical data.

Nonnative Fish

Total number and percent of catch in the Colorado River of juvenile and adult large-bodied fish species data are summarized in Table 6. Catch rates of channel catfish, common carp, and white sucker were compared to catch rates in 1994 and 1995 (Osmundson 1999). No differences exist in the catch rates of these three species from the previous sampling period (Osmundson 1999) compared to data collected for this project (Figures 12-14). In addition, no significant difference was found in catch rates of these three species during sampling for this project from 2011 to 2016 (Figures 12-14).

Hydrology and Flow Targets

From 2012 to 2016, the BOR operated the Aspinall Unit to meet Gunnison River flow targets established in the 2012 ROD. As indicated in Table 7, basin runoff was below-normal in four of five years (hydrology classified as ‘Dry’ to ‘Average-Dry’, based on projected April-July inflow to Blue Mesa Reservoir), while in only one year was runoff above-normal (2014, ‘Moderately Wet’).

Due to limited inflows to Blue Mesa Reservoir, Aspinall Unit releases to supplement peak flows and “half-bankfull” flows downstream were required by the ROD in only two of five years, 2014 and 2016. In 2014, peak flows at the Whitewater, Colorado gage fell short of the target peak (12,500 versus 14,350 cfs), as did the duration of the 8,070 cfs half-bankfull flow (22 versus 40 days). In 2016, spring peak flows exceeded targets for both peak flow magnitude (8,070 cfs) and duration (10 days).

In all five years, base flows during the critical July to October period largely met corresponding targets (which range from 790 to 1,500 cfs at the Whitewater gage, depending upon the month and hydrologic year type) (Table 7). Overall, fewer than 2% of these days failed

to meet targets. In all years flows during the irrigation season were adequate to keep the fish ladder and screen at the Redlands Dam operational, with the exception of April 2013. Flows fell below the base flow target at the Redlands Dam for a total of 107 days in 2013, but all of these days were outside of the irrigation season.

The lack of captures of endangered fishes, and information on endangered fish location, movement, and habitat use in the Gunnison are inadequate to assess how these Aspinall Unit operations affected endangered fish. However, the fact that spring peak flows met the half-bankfull magnitude of 8,070 cfs on only 29 days over this five-year period, and exceeded 10,500 cfs in only one year (for comparison, this magnitude was exceeded in four of the seven previous years), suggests that 2012-2016 spring flows provided limited channel-rejuvenation and habitat-maintenance benefits. Mean daily flow by month was lower in the five years after the signing of the ROD (2012-2016) than in the five years preceding the signing of the ROD (2007-2011; Table 8). The largest decrease in mean daily flow occurred in the month of May (3261 cfs). The smallest decrease in mean daily flow occurred in October (219 cfs).

DISCUSSION

Endangered Fish

Bonytail are rare in the Gunnison River and stocking has not resulted in establishment of a population. The lack of success of bonytail augmentation resulting in establishing a population in the Gunnison River is similar to results for this species in other rivers in the upper Colorado River basin.

Colorado pikeminnow captures within the Gunnison River are currently rare. Colorado pikeminnow released above Redlands Dam often do not remain upstream of the dam. A total of

180 Colorado pikeminnow captures occurred at Redlands Dam from 1996 to 2016 (Francis and Ryden 2016). Fifty-four (37%) of the 145 unique Colorado pikeminnow captured at Redlands Dam and moved upstream of the dam have since been recaptured downstream of the dam. Ninety-one (63%) of the 145 unique Colorado pikeminnow translocated above Redlands Dam have not been captured or detected since they were moved above the dam.

Reasons for Colorado pikeminnow returning to the Colorado River below Redlands Dam are unclear. Potential forage availability for Colorado pikeminnow is higher in the Gunnison River than within the Colorado River (Osmundson 1999), so a lack of suitable prey does not appear to be a limiting factor for Colorado pikeminnow in the Gunnison River upstream of Redlands Dam. Other factors such as temperature suitability, absence of preferred habitat, or a combination of factors (e.g. relatively short reach of river with suitable temperature) may be responsible for Colorado pikeminnow leaving the Gunnison River. The timing of Colorado pikeminnow captures at Redlands Dam (typically after Colorado pikeminnow spawning season) along with the size class (sub-adult or small adult) of many of the captured Colorado pikeminnow is not consistent with Colorado pikeminnow migrating into the Gunnison River for the purpose of spawning. As the current density of adult Colorado pikeminnow in the Colorado River is much lower than the density of adult Colorado pikeminnow during the 2000's (Elverud et al. 2020), space limitation in the Colorado River also does not appear to be driving the movement of Colorado pikeminnow into the Gunnison River.

Colorado pikeminnow were stocked in the Gunnison River in 1984, 2003 and 2004. Approximately 11,000 Colorado pikeminnow (55-140 mm TL) were stocked in 1984. A total of 1,047 Colorado pikeminnow were stocked in 2003, and 1,200 Colorado pikeminnow were stocked in 2004 (STReAMS 8/1/2018) at Delta, Colorado (RMI 57.1). The stocking events in

2003 and 2004 were largely unsuccessful as they did not result in establishment of a Colorado pikeminnow population above Redlands Dam. Of the 2,247 Colorado pikeminnow stocked in the Gunnison River in 2003 and 2004, only 16 were recaptured more than one year after the stocking date. All 16 were captured downstream of Redlands Dam (STReaMS 8/1/2018).

The San Juan River Basin Recovery Implementation Program has successfully reestablished Colorado pikeminnow in the San Juan River through an extensive stocking program. Analysis of Colorado pikeminnow stocking data in the San Juan River basin indicates stocking large numbers of YOY Colorado pikeminnow in the late fall is more cost-effective for reestablishing Colorado pikeminnow (Durst 2009) than stocking age 1+ Colorado pikeminnow as was done in the Gunnison River. While stocking of Colorado pikeminnow in the Gunnison River was unsuccessful at establishing a population when attempted historically, results from the successful augmentation in the San Juan River may provide useful insight into potentially establishing a population in the Gunnison River in the future. While stocking has successfully reestablished Colorado pikeminnow in the San Juan River, the amount of critical habitat above Redlands Dam on the Gunnison River is considerably shorter (~53 RMs) compared to that found on the San Juan River (~180 RMs).

A single YOY Colorado pikeminnow was collected on the Gunnison River during this project. The YOY fish was collected in 2015 during larval sampling and identified by the CSU-LFL. The presence of a single YOY fish indicates at least two of the Colorado pikeminnow captured at Redlands Dam and translocated upstream were able to successfully reproduce. Larval sampling on the Gunnison River was not completed until two weeks after the back-calculated spawning date for the YOY collected in the Gunnison River, but no Colorado pikeminnow were identified from larval collections. Flows in both the Gunnison and Colorado

rivers in 2015 were somewhat abnormal with higher flows and cooler water temperatures persisting through summer relative to a typical year.

Another YOY Colorado pikeminnow was captured in the Colorado River during the same year. The back-calculated spawning dates for both of the YOY Colorado pikeminnow were in early August, after completion of larval sampling on the Colorado River. Catch rate of YOY Colorado pikeminnow on the lower Colorado River in Utah in 2015 was the highest recorded since 1986 (Breen et al. 2015) indicating that flow conditions in 2015 may have been optimal for young Colorado pikeminnow.

The razorback sucker capture rate in the Gunnison River upstream of Redlands Dam remains low. Antenna detections in both Butch Craig Pond and Roubideau Creek indicate that some razorback are persisting in the basin that have not been captured using traditional sampling methods. While few razorback sucker appear to remain in the Gunnison River post-stocking, razorback sucker stocked in the Gunnison River upstream of Redlands Dam have been captured in the Colorado River, Lake Powell and the Green River (STReaMS 7/31/2018).

Non-endangered Native Fish

Catch rates of juvenile and adult bluehead sucker, flannelmouth sucker, and roundtail chub within the Gunnison River portion of the study area are relatively similar to previous studies (Burdick 1995 and Osmundson 1999). In the Colorado River, a significant decline in bluehead sucker catch rates has occurred since the mid-1990s, but catch rates of flannelmouth sucker and roundtail chub are similar to the previous study (Osmundson 1999).

Nonnative Fish

The increase in the catch rates of white sucker and white sucker hybrids in the Gunnison River are a concern for the native fish community, though the impact on endangered fish is

unknown. While white sucker and white sucker hybrids are lethally removed during sampling for this project, nonnative fishes are only netted during the sampling of community reaches that comprise approximately one third of the river between Delta and Redlands Dam. White sucker are also common upstream of our study area in the Gunnison River where no removal efforts are occurring. The proportion of white sucker and white sucker hybrids in the Gunnison River portion of the study are likely to continue to increase into the future based on the current increasing trend and absence of control measures in place on the Gunnison River.

With the exception of white sucker and white sucker hybrids, nonnative fish species presence/absence and abundance within the Gunnison River upstream of Redlands Dam appear similar to previous studies (Burdick 1995 and Osmundson 1999). Smallmouth bass are present in Ridgway Reservoir, as a result of illegal stocking, but this illicit introduction has not resulted in the establishment of a smallmouth bass population in the Gunnison River. Colorado Parks and Wildlife holds an annual fishing tournament to decrease the population, and the Ridgway Reservoir spillway was screened in 2022 to prevent escapement of smallmouth bass into the Uncompahgre River, a tributary of the Gunnison River near Delta, Colorado. No smallmouth bass were collected during this project in the mainstem Gunnison River.

In the Colorado River portion of the study area, relative percentage of nonnative species and catch rates are similar to the previous study (Osmundson 1999) despite ongoing nonnative removal efforts. Additional nonnative species are present that were not found by Osmundson (1999), such as gizzard shad and smallmouth bass, but these species remain a small percentage of the fish community in our study reaches during most years. The catch rates of the three most common nonnative species captured during electrofishing sampling (common carp, channel catfish and white sucker) are also similar to Osmundson (1999). Centrarchids, gizzard shad, and

white sucker are opportunistically removed during Program funded projects (Projects 127 and 163) and during projects specifically targeting nonnative fishes (Projects 126a and 126b) in the Colorado River which may be preventing increases in abundance of nonnative species targeted for removal.

CONCLUSIONS

Few changes have occurred in the fish community in either the 18-mile reach of the Colorado River or the lower Gunnison River following implementation of flows described in the 2012 Aspinall Unit ROD. Captures of all life-stages of endangered fishes are still uncommon in the Gunnison River, but stocking of razorback sucker is resulting in a gradual increase in the total number of adult captures each year. Due to the lack of significant differences in catch rate of native species between this study and previous studies, no attempt was made to assess the effects of the flow targets on native species. Data on fish locations, movement, and habitat use in the Gunnison are inadequate to assess how these Aspinall Unit operations affected endangered fish. Additionally, low-flow conditions suggest that 2012-2016 spring flows provided limited channel-rejuvenation and habitat-maintenance benefits. Sampling design of this study also does not allow for assessment of young-of-year non-endangered native fishes abundance, as we utilize the ISMP protocol which was developed specifically for monitoring young-of-year Colorado pikeminnow. The ISMP protocol focuses sampling in backwater habitats that meet a specific set of criteria, and observations suggest YOY of other native fishes may move into main channel habitats by the time our sampling occurs.

Non-endangered native fishes remain common in the lower Gunnison River, but the catch rate of white sucker and white sucker hybrids is increasing. The apparent increase in white

sucker abundance will likely continue to affect native sucker populations. The effect of the increasing abundance of white sucker on endangered fishes or the suitability of habitat to support endangered fishes is unknown.

RECOMMENDATIONS

- 1) Consider conducting a systematic habitat assessment for Colorado pikeminnow in the Gunnison River to determine if habitat is suitable to reestablish a population as forage availability for Colorado pikeminnow is high and temperatures in the reach immediately upstream of Redlands Dam appear suitable for the species.
- 2) Continue to implement flow recommendations included in the Final Gunnison River Basin Programmatic Biological Opinion for the benefit of listed fish species with an emphasis on meeting the bankfull targets when the forecast inflow to Blue Mesa indicates water is available to meet the bankfull targets.
- 3) Continue to stock razorback sucker in the Gunnison River near Delta, Colorado. All razorback suckers captured in the Gunnison River upstream of Redlands Dam are the result of stocking efforts and discontinuation of stocking would likely result in a decrease of razorback abundance in the lower Gunnison River.
- 4) Consider larval drift netting as an alternative to the current method of hand seining as larval drift netting has been effective in other studies for monitoring Colorado pikeminnow production (Bestgen and Hill 2016) and may be useful in the Gunnison River for monitoring razorback sucker larvae production.
- 5) Consider funding additional seine sampling in the main-channel of the Gunnison River to facilitate monitoring of young-of-year non-endangered native fishes. The current SOW

specifies utilizing the ISMP protocol, which was designed for monitoring young-of-year Colorado pikeminnow with sampling occurring only in backwater type habitats.

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TABLES

Table 1. Spring peak, half bankfull, and bankfull duration targets for the range of forecasted inflows for the Gunnison River at Whitewater, Colorado (USBR 2012).

| Blue Mesa Reservoir Forecasted April-July Inflow (acre-feet) | Desired Peak at Whitewater (cfs) | Duration of Half Bankfull (8,070 cfs) in Days | Duration at Peak Flow in Days |
|--|----------------------------------|---|-------------------------------|
| < 381,000 | 900 | 0 | 0 |
| 381,000 to 516,000 | 2,600 to 8,070 | 0 | 0 |
| 516,001 to 709,000 | 8,070 | 10 | 0 |
| 709,001 to 831,000 | 8,070 to 14,350 | 20 | 2 |
| 831,001 to 1,123,000 | 14,350 | 40 | 10 |
| >1,123,000 | 14,350 | 60 | 15 |

Table 2. Total number of electrofishing captures of endangered fishes by species in the lower Gunnison River.

| Gunnison River Endangered Species Captures | | | |
|--|----------|---------------------|------------------|
| Year-Trip | Species | | |
| | Bonytail | Colorado Pikeminnow | Razorback Sucker |
| 2011-Summer | 1 (1) | 0 (NA) | 0 (0) |
| 2011-Fall | 4 (2) | 0 (NA) | 11 (10) |
| 2012-Summer | 0 (0) | 0 (NA) | 1 (0) |
| 2012-Fall | 0 (0) | 1 (NA) | 24(17) |
| 2013-Summer | 0 (0) | 0 (NA) | 4 (0) |
| 2013-Fall | 0 (0) | 0 (NA) | 17 (15) |
| 2014-Summer | 7 (7) | 3 (NA) | 7 (0) |
| 2014-Fall | 3 (3) | 0 (NA) | 11(9) |
| 2015-Summer | 0 (0) | 0 (NA) | 3 (1) |
| 2015-Fall | 0 (0) | 0 (NA) | 3 (0) |
| 2016-Summer | 0 (0) | 0 (NA) | 8 (0) |
| 2016-Fall | 0 (0) | 0 (NA) | 19 (16) |
| Total | 15 (13) | 4 (NA) | 108 (68) |

Numbers in parenthesis are fish captured during the same year in which they were stocked.

Table 3. Colorado Pikeminnow Captures in the Gunnison River above Redlands Dam, 2011-2016.

| Date of Capture in Gunnison River | Capture River Mile | Total Length | Redlands Fish Ladder Capture Date | Other Captures |
|--|--------------------|--------------|-----------------------------------|-------------------------------------|
| 10/4/2012 | 15.2 | 645 | 7/29/2012 | Redlands Fish Ladder, 7/29/2010 |
| 8/13/2014 | 30.4 | 490 | 8/12/2014 | |
| 8/14/2014 | 16.0 | 495 | 8/6/2014 | |
| 8/15/2014 | 6.0 | 480 | Unknown* | Colorado River, RM 168.8, 5/14/2015 |
| *No tagging record could be found for this Colorado pikeminnow. No record could be located of when the fish was moved above Redlands Dam. The capture in the Colorado River in 2015 indicates the PIT tag number is valid. | | | | |

Table 4. Number and relative percentage of fishes combined by species and year (2011-2016) in the Gunnison River (E = Endangered, N = Native, NN = Nonnative).

| Species | Status | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
|------------------------------------|--------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|
| | | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Black Bullhead | NN | 0 | 0.0% | 1 | 0.0% | 4 | 0.1% | 9 | 0.1% | 1 | 0.0% | 1 | 0.0% |
| Bluehead Sucker | N | 2075 | 26.5% | 2379 | 40.3% | 2110 | 33.2% | 1723 | 27.5% | 1474 | 27.3% | 1873 | 39.5% |
| Brown Trout | NN | 340 | 4.3% | 164 | 2.8% | 125 | 2.0% | 119 | 1.9% | 292 | 5.4% | 251 | 5.3% |
| Bonytail | E, N | 5 | 0.1% | 0 | 0.0% | 0 | 0.0% | 10 | 0.2% | 0 | 0.0% | 0 | 0.0% |
| Channel Catfish | NN | 0 | 0.0% | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Common Carp | NN | 263 | 3.4% | 362 | 6.1% | 229 | 3.6% | 122 | 1.9% | 132 | 2.4% | 68 | 1.4% |
| Colorado Pikeminnow | E, N | 0 | 0.0% | 1 | 0.0% | 0 | 0.0% | 3 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Flannemouth Sucker | N | 1945 | 24.9% | 1162 | 19.7% | 1045 | 16.4% | 1148 | 18.3% | 975 | 18.1% | 950 | 20.0% |
| Flannemouth/Bluehead Sucker Hybrid | N | 42 | 0.5% | 19 | 0.3% | 38 | 0.6% | 59 | 0.9% | 17 | 0.3% | 27 | 0.6% |
| Grass Carp | NN | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Green Sunfish | NN | 14 | 0.2% | 4 | 0.1% | 6 | 0.1% | 15 | 0.2% | 13 | 0.2% | 0 | 0.0% |
| Largemouth Bass | NN | 1 | 0.0% | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.0% |
| Longnose Sucker | NN | 68 | 0.9% | 22 | 0.4% | 40 | 0.6% | 45 | 0.7% | 13 | 0.2% | 15 | 0.3% |
| Northern Pike | NN | 0 | 0.0% | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Rainbow Trout | NN | 8 | 0.1% | 2 | 0.0% | 2 | 0.0% | 3 | 0.0% | 3 | 0.1% | 2 | 0.0% |
| Roundtail Chub | N | 1096 | 14.0% | 486 | 8.2% | 764 | 12.0% | 1110 | 17.7% | 808 | 15.0% | 598 | 12.6% |
| Razorback Sucker | E, N | 11 | 0.1% | 25 | 0.4% | 21 | 0.3% | 18 | 0.3% | 6 | 0.1% | 27 | 0.6% |
| White Sucker | NN | 1472 | 18.8% | 989 | 16.7% | 1477 | 23.2% | 1112 | 17.8% | 990 | 18.3% | 375 | 7.9% |
| White Sucker/Native Sucker Hybrid | NN | 477 | 6.1% | 287 | 4.9% | 492 | 7.7% | 763 | 12.2% | 673 | 12.5% | 551 | 11.6% |
| Total | | 7818 | 100.0% | 5906 | 100.0% | 6353 | 100.0% | 6259 | 100.0% | 5397 | 100.0% | 4739 | 100.0% |
| Native Total and Percent | | 5174 | 66.2% | 4072 | 68.9% | 3978 | 62.6% | 4071 | 65.0% | 3280 | 60.8% | 3475 | 73.3% |

Table 5. Total number of electrofishing captures of endangered fishes by species in the 18-mile reach of the Colorado River.

| Colorado River Endangered Species Captures | | | |
|--|----------|---------------------|------------------|
| Year | Species | | |
| | Bonytail | Colorado Pikeminnow | Razorback Sucker |
| 2011 | 0 | 1(NA) | 1(0) |
| 2012 | 0 | 0 | 2(0) |
| 2013 | 0 | 0 | 11(6) |
| 2014 | 0 | 0 | 8(1) |
| 2015 | 0 | 0 | 6(1) |
| 2016 | 1(1) | 1(NA) | 1(0) |
| Total | 1(1) | 2(NA) | 29(8) |

Numbers in parenthesis are fish captured during the same year in which they were stocked.

Table 6. Number and relative percentage of fishes combined by species and year (2011-2016) in the 18-mile reach of the Colorado River. (E = Endangered, N = Native, NN = Nonnative).

| Species | Status | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
|-----------------------------------|--------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|
| | | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Black Bullhead | NN | 1 | 0.4% | 0 | 0.0% | 1 | 0.4% | 7 | 1.9% | 2 | 0.5% | 3 | 0.8% |
| Black Crappie | NN | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.2% | 3 | 0.8% |
| Bluehead Sucker | N | 63 | 27.9% | 68 | 23.9% | 59 | 20.8% | 23 | 6.3% | 74 | 18.0% | 56 | 15.0% |
| Bluegill | NN | 1 | 0.4% | 0 | 0.0% | 0 | 0.0% | 6 | 1.6% | 2 | 0.5% | 1 | 0.3% |
| Bonytail | E, N | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.3% |
| Brown Trout | NN | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 4 | 1.0% | 5 | 1.3% |
| Channel Catfish | NN | 1 | 0.4% | 2 | 0.7% | 11 | 3.9% | 8 | 2.2% | 5 | 1.2% | 4 | 1.1% |
| Common Carp | NN | 9 | 4.0% | 18 | 6.3% | 14 | 4.9% | 49 | 13.4% | 24 | 5.8% | 51 | 13.7% |
| Colorado Pikeminnow | E, N | 1 | 0.4% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.3% |
| Flannelmouth Sucker | N | 126 | 55.8% | 159 | 55.8% | 132 | 46.5% | 126 | 34.4% | 219 | 53.2% | 143 | 38.3% |
| Flannelmouth / Razorback Hybrid | N | 1 | 0.4% | 0 | 0.0% | 0 | 0.0% | 2 | 0.5% | 4 | 1.0% | 0 | 0.0% |
| Green Sunfish | NN | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 16 | 4.4% | 10 | 2.4% | 9 | 2.4% |
| Gizzard Shad | NN | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 8 | 2.2% | 6 | 1.5% | 12 | 3.2% |
| Largemouth Bass | NN | 0 | 0.0% | 1 | 0.4% | 0 | 0.0% | 43 | 11.7% | 26 | 6.3% | 48 | 12.9% |
| Longnose Sucker | NN | 0 | 0.0% | 0 | 0.0% | 3 | 1.1% | 3 | 0.8% | 0 | 0.0% | 0 | 0.0% |
| Rainbow Trout | NN | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.3% | 0 | 0.0% | 0 | 0.0% |
| Roundtail Chub | N | 6 | 2.7% | 3 | 1.1% | 13 | 4.6% | 20 | 5.5% | 8 | 1.9% | 9 | 2.4% |
| Razorback Sucker | E, N | 1 | 0.4% | 2 | 0.7% | 11 | 3.9% | 8 | 2.2% | 6 | 1.5% | 1 | 0.3% |
| Smallmouth Bass | NN | 0 | 0.0% | 0 | 0.0% | 7 | 2.5% | 2 | 0.5% | 1 | 0.2% | 4 | 1.1% |
| White Sucker | NN | 10 | 4.4% | 20 | 7.0% | 24 | 8.5% | 30 | 8.2% | 10 | 2.4% | 10 | 2.7% |
| White Sucker/Native Sucker Hybrid | NN | 6 | 2.7% | 12 | 4.2% | 9 | 3.2% | 14 | 3.8% | 10 | 2.4% | 12 | 3.2% |
| Total | | 226 | 100.0% | 285 | 100.0% | 284 | 100.0% | 366 | 100.0% | 412 | 100.0% | 373 | 100.0% |
| Native Total and Percent | | 198 | 87.6% | 232 | 81.4% | 215 | 75.7% | 179 | 48.9% | 311 | 75.5% | 211 | 56.6% |

Table 7. Blue Mesa Reservoir Forecast and Observed Inflow, Spring Peak Targets, Half Bankfull and Bankfull Duration Targets, and Days Achieved, at Whitewater, Colorado (2012-2016). * A May-July inflow forecast for Blue Mesa Reservoir was not included in the 2012 operating plan as this was before the ROD was signed, therefore, no flow targets are available to include in the table for the year of 2011.

| Year | Hydrologic Condition (May 1) | Peak Flows v. Peak Targets at Whitewater Gage Location | Base Flows v. Base Targets at Whitewater Gage Location |
|-------|------------------------------|--|--|
| 2011* | N/A | <u>Peak flow:</u> Target: N/A Achieved: 2 days \geq 14,350 cfs <u>Shoulder peaks:</u> Target: N/A Achieved: 24 days \geq 8,070 cfs | <u>Targets:</u> N/A |
| 2012 | Dry | <u>Peak flow:</u> Target: 900 cfs (daily mean) Achieved: 2,500 cfs <u>Shoulder peaks:</u> Target: None applicable | <u>Targets:</u> July: 900 cfs Aug, Sep: 890 cfs Oct: 790 cfs <u>Achieved:</u> Targets achieved >98% of days |
| 2013 | Dry | <u>Peak flow:</u> Target: 900 cfs (daily mean) Achieved: 3,150 cfs <u>Shoulder peaks:</u> Target: None applicable | <u>Targets:</u> July: 900 cfs Aug, Sep: 890 Oct: 790 <u>Achieved:</u> Flows dropped below baseflow targets on 107 days in 2013, but base flow targets were achieved 100% of days July-Oct |
| 2014 | Moderately Wet | <u>Peak flow:</u> Target: 10 days @ 14,350 cfs Achieved: 12,500 cfs peak one-day <u>Shoulder peaks:</u> Target: 40 days @ 8,070 cfs Achieved: 22 days @ 8,070 | <u>Targets:</u> July, Aug: 1,500 cfs Sep, Oct: 1,050 <u>Achieved:</u> Targets achieved 100% of days |
| 2015 | Moderately Dry | <u>Peak flow:</u> Target: 4,991 cfs (daily mean) Achieved: 10,000 <u>Shoulder peaks:</u> Target: None applicable Achieved: 10 days @ 8,070 | <u>Targets:</u> July: 1,050 cfs Aug, Sep: 890 Oct: 790 <u>Achieved:</u> Targets achieved >96% of days |
| 2016 | Average Dry | <u>Peak flow:</u> Target: 8,070 cfs (daily mean) Achieved: 9,920 <u>Shoulder peaks:</u> Target: 10 days @ 8,070 cfs Achieved: 10 days @ 8,070 | <u>Targets:</u> July: 1,500 cfs Aug, Sep, Oct: 1,050 <u>Achieved:</u> Targets achieved >95% of days |

Table 8. Mean daily flow (cfs) by month for the Gunnison River at U. S. Geological Survey (USGS) stream gage (09152500) at Whitewater, Colorado (RM 14.6).

| | Month | | | | | | | | | | | |
|-----------------------|-------|------|-------|-------|-------|-------|------|------|------|------|------|------|
| | Jan. | Feb | March | April | May | June | July | Aug | Sept | Oct. | Nov | Dec |
| Pre-ROD 2007-2011 | 1614 | 1678 | 1792 | 3579 | 6445 | 5266 | 2438 | 1893 | 1981 | 1981 | 1543 | 1567 |
| Post-ROD 2012-2016 | 1214 | 1104 | 1160 | 1789 | 3184 | 4221 | 1726 | 1493 | 1700 | 1762 | 1267 | 1188 |
| Difference | -400 | -573 | -632 | -1790 | -3261 | -1045 | -712 | -400 | -281 | -219 | -275 | -379 |

FIGURES

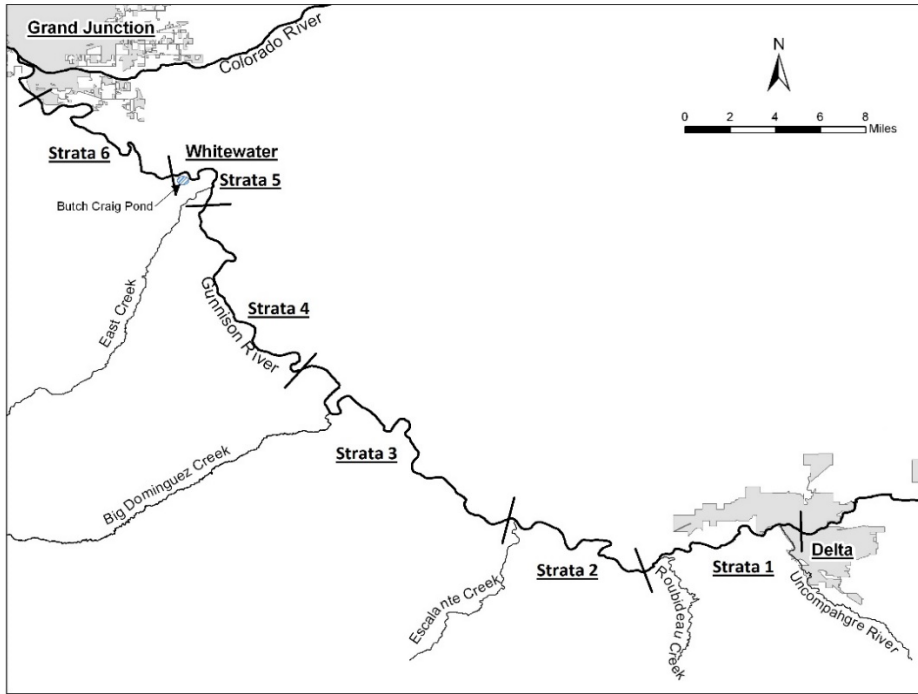


Figure 1. Map of the Gunnison River portion of the study area.

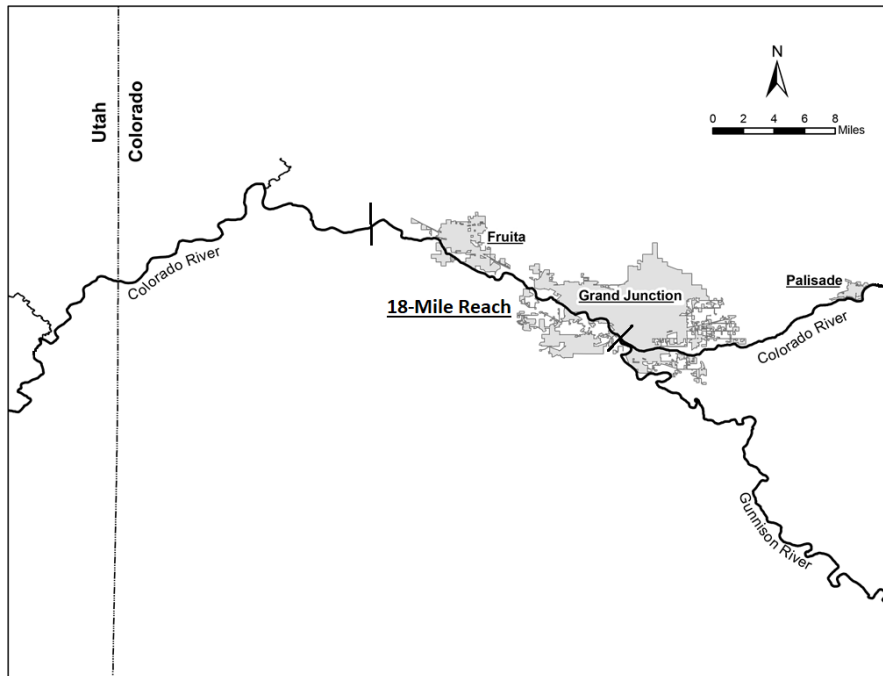


Figure 2. Map of the Colorado River portion of the study area.

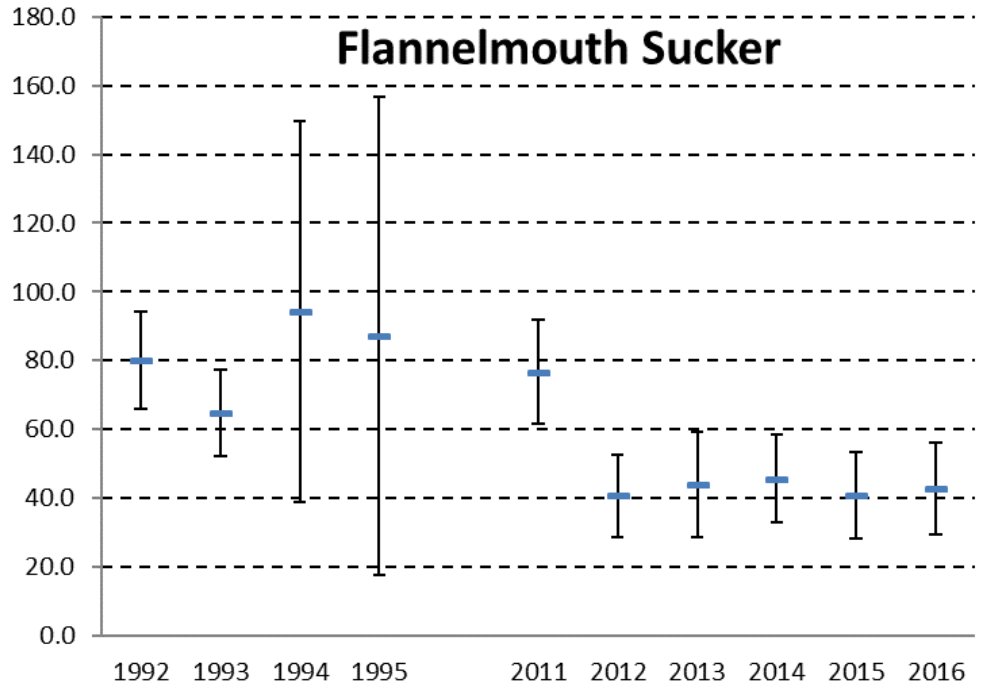


Figure 3. Catch rate (fish/hour) of Flannelmouth Sucker in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

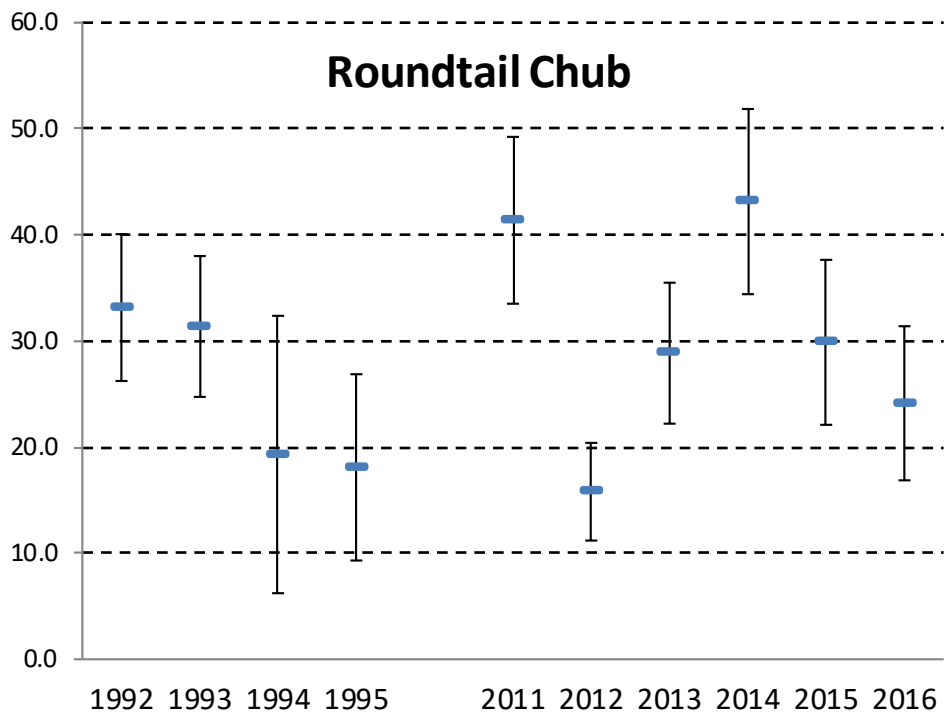


Figure 4. Catch rate (fish/hour) of Roundtail Chub in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

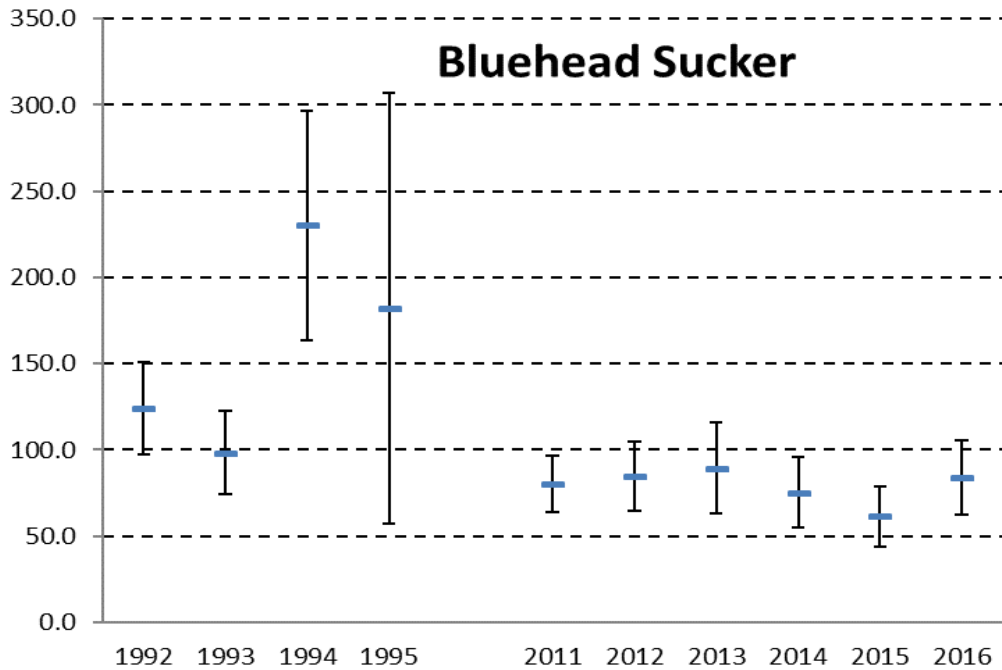


Figure 5. Catch rate (fish/hour) of Bluehead Sucker in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

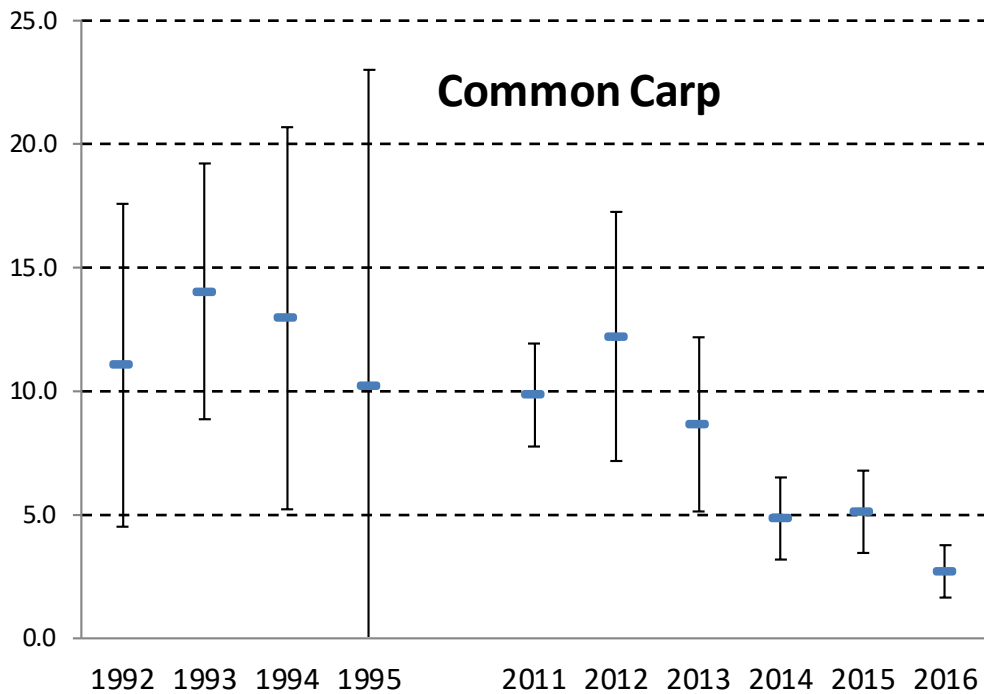


Figure 6. Catch rate (fish/hour) of Common Carp in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

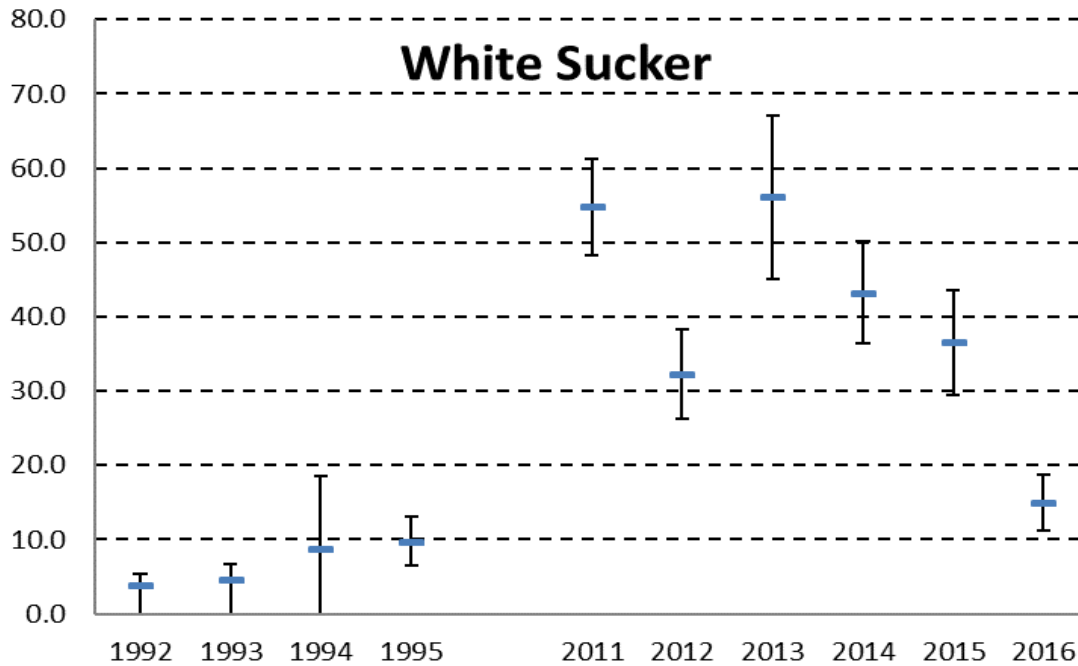


Figure 7. Catch rate (fish/hour) of White Sucker in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

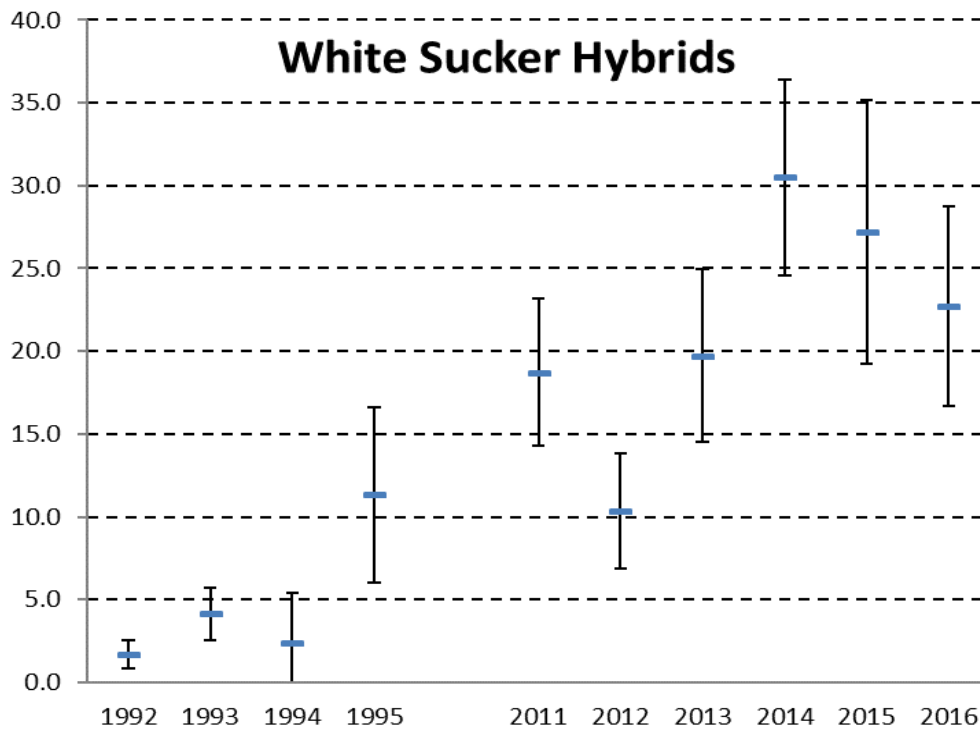


Figure 8. Catch rate (fish/hour) of White Sucker Hybrids in the lower Gunnison River (1992-1995, 2011-2016). Error bars represent the 95% confidence intervals.

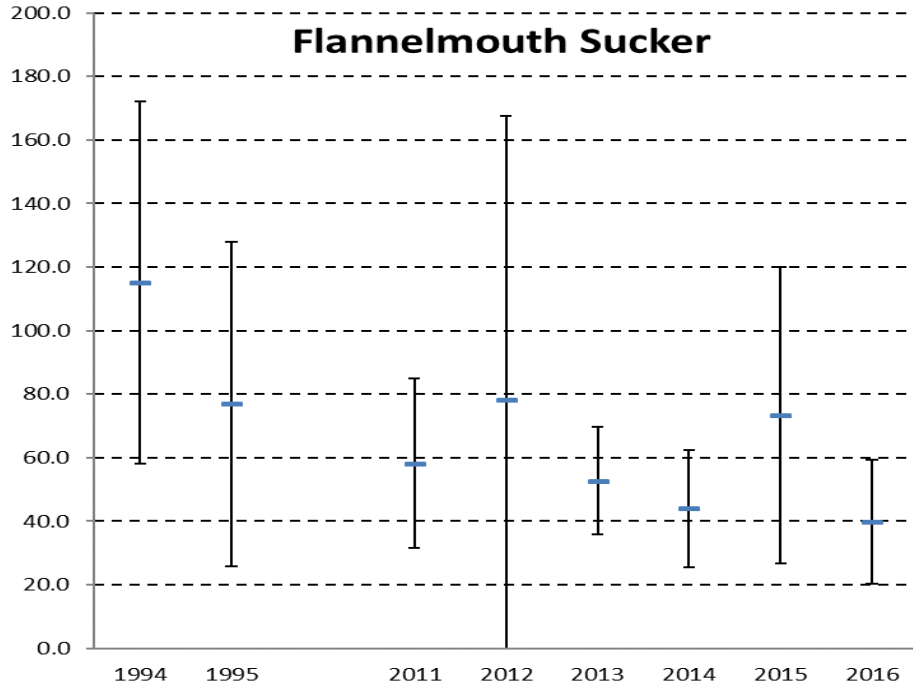


Figure 9. Catch rate (fish/hour) of Flannelmouth Sucker in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

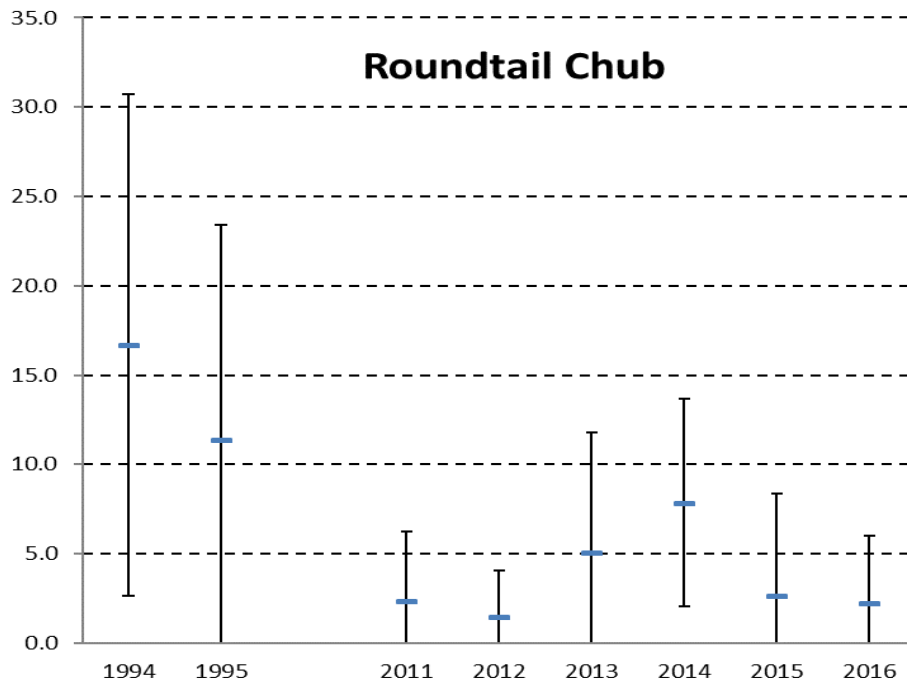


Figure 10. Catch rate (fish/hour) of Roundtail Chub in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

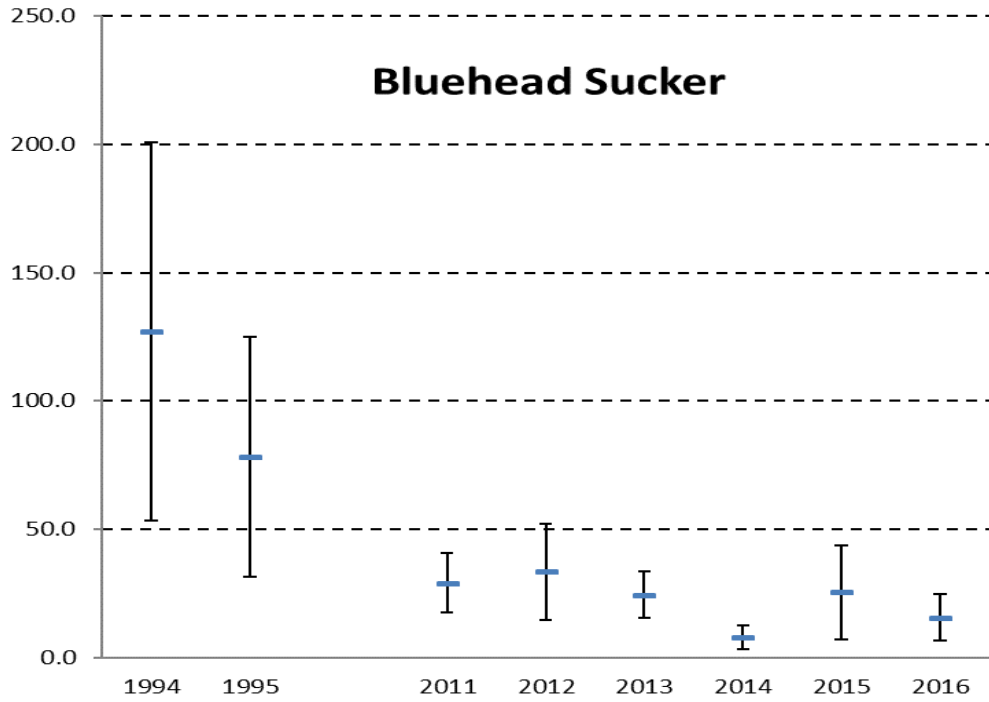


Figure 11. Catch rate (fish/hour) of Bluehead Sucker in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

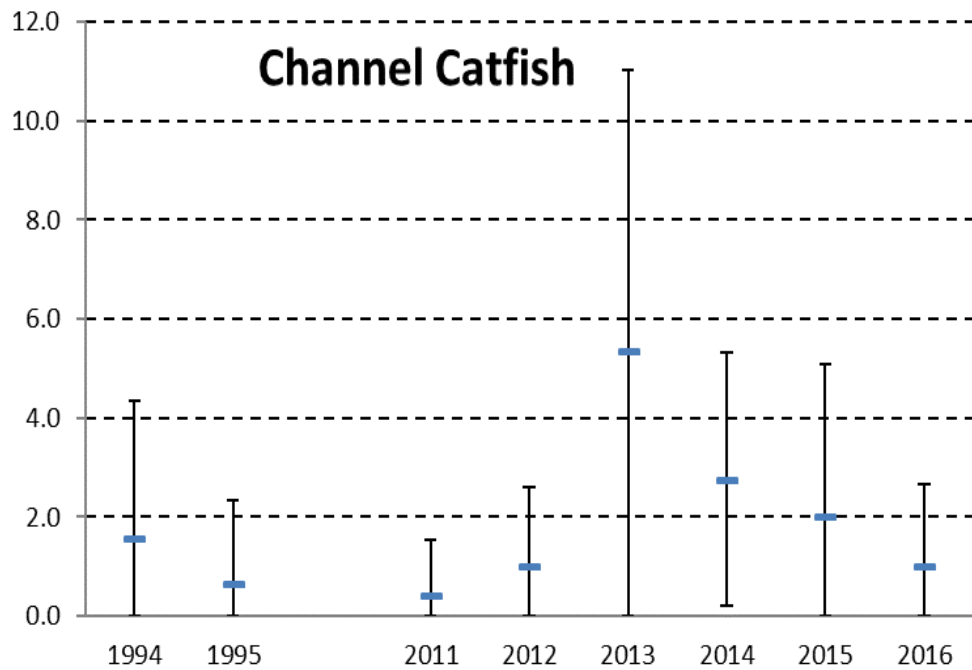


Figure 12. Catch rate (fish/hour) of Channel Catfish in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

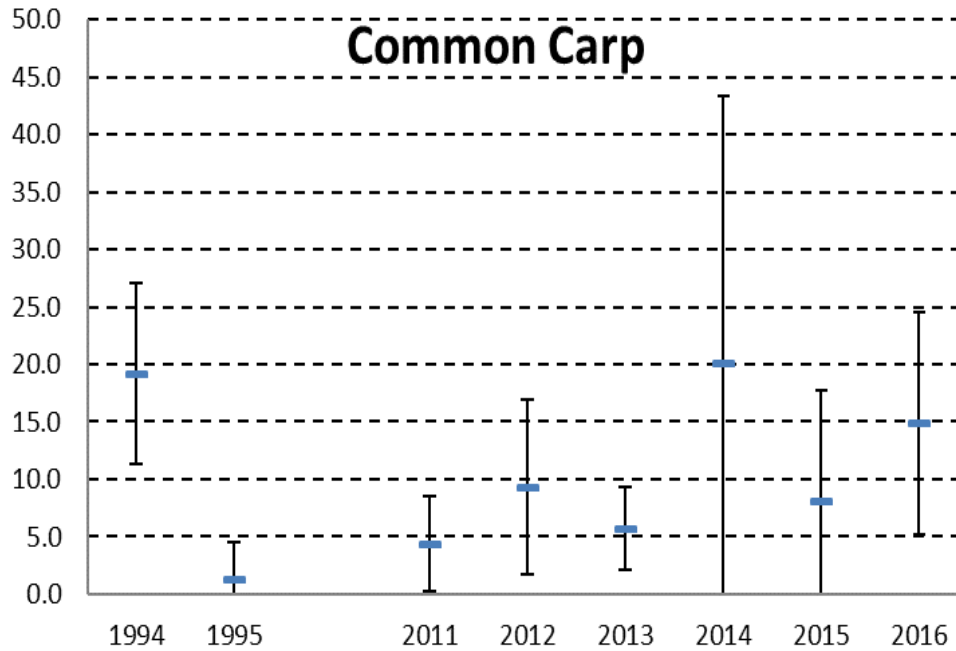


Figure 13. Catch rate (fish/hour) of Common Carp in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

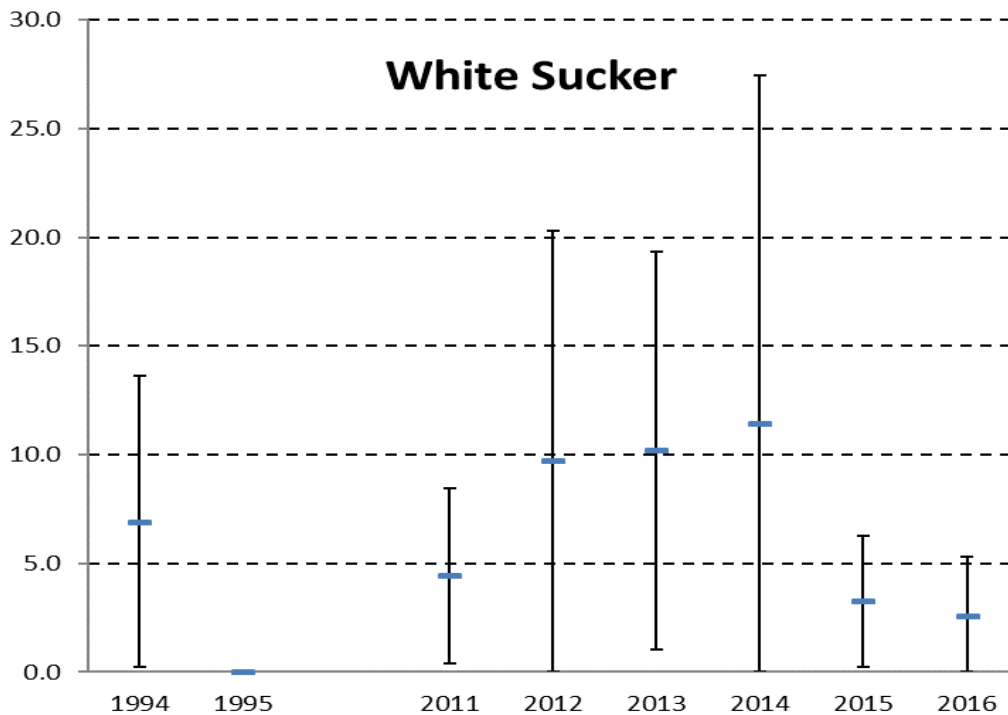


Figure 14. Catch rate (fish/hour) of White Sucker in the 18-mile Reach of the Colorado River, (1994-1995, 2011-2016). Error bars represent the 95% confidence intervals.

APPENDICES

Appendix A. Catch of Larval Fish by Species and Year in the Gunnison River. Status (E=Endangered, N=Native, NN=Nonnative)

| Species | | | Year | | | | | | |
|----------------------|-------------------------------|--------|------|------|------|------|------|------|-------|
| Common Name | Scientific Name | Status | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
| Bluehead Sucker | <i>Catostomus discobolus</i> | N | 2195 | 200 | 116 | 544 | 1740 | 267 | 5062 |
| Brook Stickleback | <i>Culaea inconstans</i> | NN | 0 | 6 | 1 | 2 | 0 | 0 | 9 |
| Common Carp | <i>Cyprinus carpio</i> | NN | 0 | 41 | 39 | 2 | 1 | 0 | 83 |
| Fathead Minnow | <i>Pimephales promelas</i> | NN | 19 | 390 | 671 | 270 | 102 | 223 | 1675 |
| Flannelmouth Sucker | <i>Catostomus latipinnis</i> | N | 558 | 42 | 15 | 150 | 46 | 90 | 901 |
| Gila spp. | <i>Gila spp.</i> | N | 100 | 171 | 394 | 378 | 311 | 135 | 1489 |
| Longnose Sucker | <i>Catostomus catostomus</i> | NN | 3 | 0 | 0 | 1 | 0 | 0 | 4 |
| Mottled Sculpin | <i>Cottus bairdii</i> | N | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| Nonnative Cyprinid | - | NN | 0 | 68 | 254 | 70 | 3 | 20 | 415 |
| Plains Killifish | <i>Fundulus zebrinus</i> | NN | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| Razorback Sucker | <i>Xyrauchen texanus</i> | E, N | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| Red Shiner | <i>Cyprinella lutrensis</i> | NN | 11 | 0 | 5 | 43 | 82 | 7 | 148 |
| Sand Shiner | <i>Notropis stramineus</i> | NN | 0 | 3 | 18 | 7 | 7 | 0 | 35 |
| Speckled Dace | <i>Rhinichthys osculus</i> | N | 167 | 968 | 242 | 347 | 486 | 64 | 2274 |
| Western Mosquitofish | <i>Gambusia affinis</i> | NN | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| White Sucker | <i>Catostomus commersonii</i> | NN | 1164 | 1821 | 580 | 286 | 373 | 1063 | 5287 |

Appendix B. Catch of Larval Fish by Species and Year in the Colorado River. Status (E=Endangered, N=Native, NN=Nonnative)

| Species | | | Year | | | | | | Total |
|----------------------|-------------------------------|--------|------|------|------|------|------|------|-------|
| Common Name | Scientific Name | Status | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | |
| Bluehead Sucker | <i>Catostomus discobolus</i> | N | 304 | 770 | 650 | 132 | 314 | 254 | 2424 |
| Brook Stickleback | <i>Culaea inconstans</i> | NN | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Channel Catfish | <i>Ictalurus punctatus</i> | NN | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Common Carp | <i>Cyprinus carpio</i> | NN | 0 | 39 | 53 | 0 | 1 | 0 | 93 |
| Fathead Minnow | <i>Pimephales promelas</i> | NN | 19 | 1010 | 323 | 49 | 8 | 15 | 1424 |
| Flannelmouth Sucker | <i>Catostomus latipinnis</i> | N | 502 | 160 | 235 | 297 | 46 | 111 | 1351 |
| Gila spp. | <i>Gila spp.</i> | N | 36 | 43 | 156 | 122 | 12 | 22 | 391 |
| Gizzard Shad | <i>Dorosoma cepedianum</i> | NN | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| Largemouth Bass | <i>Micropterus salmoides</i> | NN | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Nonnative Cyprinid | - | NN | 12 | 244 | 1614 | 184 | 59 | 69 | 2182 |
| Razorback Sucker | <i>Xyrauchen texanus</i> | E, N | 0 | 36 | 3 | 2 | 0 | 1 | 42 |
| Red Shiner | <i>Cyprinella lutrensis</i> | NN | 22 | 47 | 991 | 315 | 23 | 32 | 1430 |
| Sand Shiner | <i>Notropis stramineus</i> | NN | 4 | 326 | 600 | 135 | 4 | 29 | 1098 |
| Speckled Dace | <i>Rhinichthys osculus</i> | N | 153 | 2192 | 741 | 293 | 276 | 67 | 3722 |
| Western Mosquitofish | <i>Gambusia affinis</i> | NN | 11 | 9 | 40 | 24 | 50 | 0 | 134 |
| White Sucker | <i>Catostomus commersonii</i> | NN | 103 | 135 | 298 | 77 | 46 | 343 | 1002 |