

COLORADO RIVER RECOVERY PROGRAM
FY 2019 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 22f

- I. Project Title: Interagency standardized monitoring program assessment of endangered fish reproduction in relation to Flaming Gorge Dam operations in the middle Green and lower Yampa river-Yampa and middle Green River assessment of Colorado pikeminnow and razorback sucker larvae
- II. Bureau of Reclamation Agreement Numbers: R19AP00058 / R15PG00083
Project/Grant Period: Start date: 1 Oct. 2018
End date: 30 Sept. 2023
Reporting period end date: 30 Sept. 2019
Is this the final report? Yes No X
- III. Principal Investigators:
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- IV. Abstract:
The goal of Flaming Gorge flow and temperature recommendations (Muth et al., 2000) that were implemented in 2006 was to improve the status and prospects for recovery of endangered fish populations in the Green River. A major emphasis of those recommendations was to enhance the reproduction and recruitment success of endangered fishes in the middle Green River, in particular razorback sucker *Xyrauchen texanus* and Colorado pikeminnow *Ptychocheilus lucius*. This data will be used to assess effects of flow and temperature regimes on reproduction by razorback suckers and Colorado pikeminnow and to correlate abundance of larvae to abundance of juveniles in autumn. Larvae of razorback sucker and Colorado pikeminnow were captured in the Green River basin in spring and summer 2019. Razorback sucker sampling was conducted with light traps primarily in the Green River between Jensen and Ouray, and Colorado pikeminnow were sampled with drift nets in the lower Yampa River. Sampling was designed to provide a measure of timing of reproduction and a measure of annual reproductive success of each species. Diel variation in abundance of Colorado pikeminnow larvae in the drift was also assessed.
- V. Study Schedule: Ongoing in a new agreement began on 1 October 2018, similar sampling has been conducted since 1990 for Colorado pikeminnow except for 1997, and

since 1992 for razorback suckers. Anticipate continued annual sampling to build this valuable long-term monitoring dataset.

VI. Relationship to RIPRAP: Relationship to specific RIPRAP items:

Green River Action Plan: Mainstem

I. Provide and protect instream flows--habitat management.

I.A. Green River above Duchesne River.

I.A.1. Initially identify year-round flows needed for recovery while providing experimental flows.

I.A.2.a. Summer/fall flow recommendations.

I.A.3. Deliver identified flows.

I.A.3.a. Operate Flaming Gorge pursuant to the Biological Opinion to provide summer and fall flows.

I.A.3.d. Operate Flaming Gorge Dam to provide winter and spring flows and revised summer/fall flows, if necessary.

I.B. Green River below the Duchesne River.

I.B.1. Initially identify year-round flows needed for recovery while providing experimental flows.

I.B.2. State acceptance of initial flow recommendations.

I.B.2.a. Review scientific basis.

II. Restore habitat--habitat development and maintenance.

II.A. Restore and manage flooded bottomland habitat.

II.A.1. Conduct site restoration.

II.A.1.a. Old Charlie Wash.

II.A.1.a.(3) Monitor and evaluate success.

II.C. Enhance water temperatures to benefit endangered fishes.

II.C.1. Identify options to release warmer water from Flaming Gorge Reservoir to restore native fish habitat in the Green River.

V. Monitor populations and habitat and conduct research to support recovery actions--research, monitoring, and data management.

V.A. Conduct research to acquire life history information and enhance scientific techniques required to complete recovery actions.

Green River Action Plan: Yampa and Little Snake Rivers

I. Provide and protect instream flows--habitat management.

I.D. Yampa River below Little Snake River.

I.D.1. Initially identify year-round flows needed for recovery.

I.D.2. Evaluate need for instream flow water rights.

I.D.2.a. Review scientific basis.

Green River Action Plan: Yampa and Little Snake Rivers

V.A.1. Conduct standardized monitoring.

V.B.2. Conduct appropriate studies to provide needed life history information.

VII. Accomplishment of FY 2019 Tasks and Deliverables, Discussion of Initial Findings and

Shortcomings:
Project Objectives

1. Determine timing and duration of spawning by razorback suckers, timing of first presence (21 May), and abundance of larvae in the system as measured by capture of larvae in light traps. Additional sampling was also conducted in the Stewart Lake floodplain wetland in early summer and autumn under this project.
2. Determine timing and duration of spawning by Colorado pikeminnow and timing of first presence (12 July) and abundance of larvae in the system as measured by capture of larvae downstream of spawning areas in the lower Yampa River.

Task Description (FY 2019)

1. Collect light trap samples for razorback suckers. The U.S. Fish and Wildlife Service (USFWS) office in Vernal, Utah was responsible for this task.
2. Collect drift net samples for Colorado pikeminnow. The Larval Fish Laboratory was responsible for this task.
3. Identify light trap and drift net samples. Preliminary identifications will be conducted by the responsible sampling entity, with assistance from the LFL, as samples are collected to provide real-time data. Final specimen identification and curation will be conducted by the LFL.
4. Summarize specimen data collection in an annual report.

Accomplishments by Task.

1. Collect light trap samples for razorback suckers. Light trap samples were collected during May and June 2019 by the Vernal USFWS. Additional sampling was conducted in the Stewart Lake floodplain wetland in summer 2019.
2. Collect drift net samples for Colorado pikeminnow. Drift net samples were collected during June to August 2019 by the Larval Fish Laboratory.
3. Identify light trap and drift net samples.

Middle Green River light trap samples, 2015. The identification of 2015 samples was nearly complete by reporting time in 2015, and was reported in final form in 2016. We retain those 2015, 2016, and 2017 data in this report for comparison to now-available 2018 information; 2019 sample specimens have not yet been counted and measured. The duration of the sampling season was 5 May until 12 June, 2015. The first razorback sucker larvae of the season was captured on 7 May at Cliff Creek, the earliest date ever recorded since this sampling program began in 1992. That date of first appearance was in contrast to 2014, where first larvae appearance was 28 May, a relatively average date of first appearance, and to 2011 when the first larvae were detected late on 24 June. Flows in 2011 were extremely high and cold, which delayed reproduction by razorback suckers; flows were moderately high in 2014, and in 2015, were low in early May and warm, but

frequent and heavy rains increased river levels through May and into June. Dates of first appearance of razorback sucker larvae have been successfully used to make decisions regarding Flaming Gorge Dam water management in spring for several years. Larvae captured in 2015 light trap samples ranged from 10-19 mm total length. The relatively large specimens captured on the last few sampling days (10.8-16 mm TL) indicated that spawning may have finished some time before the last sampling date.

Abundance of razorback sucker larvae in 2015 was different than typical, as most larvae were captured prior to onset of high releases from Flaming Gorge Dam and increased Green River, Jensen, Utah, flows (Figure 2). One goal of those increased releases is to connect middle Green River floodplain wetlands with the river when razorback sucker larvae are produced, to aid in their growth and recruitment. Presence of larvae triggers higher releases from Flaming Gorge Dam in spring to support flows from the Yampa River, but typically higher numbers of larvae are present when flow releases peak. The relatively low production of juvenile razorback suckers in Stewart Lake wetland in 2015 could be associated with the lower abundance of larvae produced after flow levels increased.

We also prepared samples of razorback suckers captured for selenium analysis in 2014 and 2015 in conjunction with Recovery Program staff (McAbee).

Middle Green River light trap samples, 2016. The identification of 2016 samples was completed in early 2017 so we now report those results. The duration of the sampling season was mid-May until late June. First razorback sucker larvae of the season were captured on 28 May at Cliff Creek, 21 days after first larvae were collected in 2015 (7 May), and on the same date as larvae were first collected in 2014; 28 May is an average date of first collection. In contrast, first appearance of larvae in 2011 when flows were high and cold very late, was 24 June. Larvae captured in 2016 light trap samples ranged from 8-17 mm total length. Dates of first appearance of razorback sucker larvae have been used to make decisions regarding Flaming Gorge Dam water management in spring since 2012.

Number of razorback sucker larvae collected was down again in 2016 from earlier peaks in 2012 and 2013 (Figure 1), which is about when large numbers of razorback suckers stocked in 2009-2012 were detected at the middle Green River razorback sucker spawning area (Webber et al. 2014, Project 169 annual reports, Appendix I). The 2016 numbers were slightly higher than in 2015 and 2014. Accessibility to sampling sites and likely, lower fish density due to higher water may have been factors associated with those lower numbers. In the past, larger numbers of larvae were also associated with lower water years, including 2012 and 2013, as well as in 1994, when fewer and only wild fish were present. The lower 2016 total is in contrast to the high numbers of juvenile fish produced in Stewart Lake in 2016.

We also examined the potential role that reduced stocking rates may play in the trend for recently declining numbers of razorback suckers stocked from hatcheries. Based on PIT tag detections at spawning areas, hatchery fish take 3-4 years post stocking to make their

presence at the spawning areas (Smith et al. 2016, Project 169 data). Effects of lower numbers of fish stocked from 2013-2018 may only be evident in a couple more years when mortality begins to reduce abundance of larger groups of 2009-2012 stocked fish. However, those fish have been persistent and even increasing in abundance at the spawning bar based on PIT tag detections over the 2014-2018 period (Project 169 results, see Appendix I for those data); detection rates may have also increased over time and accounted for some of the apparent increase in abundance. It is difficult to correlate numbers of spawning adults detected at the spawning areas with larvae produced and captured in this study, because many of the smaller groups of fish recently stocked (2015-2018) may not be of spawning age yet. Continued monitoring of this relationship between numbers of stocked fish and numbers of larvae produced 3-4 years later is warranted in the future.

Abundance of razorback sucker larvae in 2016 was well-timed with increased Green River, Jensen, Utah, flows (Figure 2). Presence of larvae triggers higher releases from Flaming Gorge Dam in spring to support and enhance flows from the Yampa River. One goal of those releases is to connect middle Green River floodplain wetlands with the river when razorback sucker larvae are produced, in order to entrain larvae into productive floodplain wetlands and aid in their growth and recruitment. The higher abundance of larvae later in the season associated with higher flows is positively related to the relatively large number of juvenile razorback suckers (>2,000) produced in Stewart Lake in autumn 2016 (Project 165 annual reports).

Middle Green River light trap samples, 2017. The identification of 2017 samples was completed shortly after the 2017 annual report was due. First capture of razorback sucker was on 3 June at the Stewart Lake drain, and was from samples collected by Utah Division of Wildlife Resources as part of their Stewart Lake inundation studies (Project 165, those larvae were identified by B. Haines, USFWS, Vernal, Utah). First razorback suckers captured in Cliff Creek, in this study, were 6 June 2017. Sampling extended into July on Project 22f. A total of 321 razorback sucker larvae were captured in the regular monitoring samples in 2017. Larvae were captured from 6 June to 30 June, which was the last day of regular monitoring sampling. Additional razorback suckers were captured in Sheppard Bottom on 11 July 2017 (n = 33, 18-28 mm TL) as part of an evaluation of the utility of that wetland to support early life stage razorback suckers. One razorback sucker (44 mm TL) was also captured in Johnson Bottom on 12 July, and apparently was very fast growing, given first wild larvae were captured on 3 June. It is also possible that this juvenile was from batches of hatchery-reared and marked larvae used in release experiments conducted in early May. The Sheppard and Johnson Bottom fish were not included in annual capture totals (Figure 1, panel A) because they were outside of normal sampling efforts. Releases in 2017 were early, high, and constant to allow for large volumes of incoming snow melt and not timed for emergence of razorback sucker larvae.

Middle Green River light trap samples, 2018. The sorting and identification of 2018 samples (n = 138 total samples) was completed after annual reports were due in autumn 2018 so results are reported here. First capture of razorback sucker was on 17 May at the Stewart Lake outlet channel and the last captured was on 8 June. A total of 1,384

razorback sucker larvae was captured in light traps in 2018, a considerably higher number than any other year in the period 2013-2017. It is likely that increased captures in 2018 were due to lower flows and concentration of larvae, which increased sample sizes.

Middle Green River light trap samples, 2019. The sorting and identification of 2019 samples (n = 409 total samples) is not yet complete; sampling extended from 13 May to 28 June. First capture of razorback sucker larvae was on 21 May at the Stewart Lake outlet channel.

Lower Yampa River drift net sampling, 2015. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River (n = 246 total samples collected in 2015), the same site where samples were collected from 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2014. Sampling commenced on 17 June and extended through 16 August. The first Colorado pikeminnow larva was collected on 27 June, a relatively average date for first capture of larvae and not unexpected given the warm (but high discharge) water temperatures early in summer.

Abundance of Colorado pikeminnow larvae was about average in 2015, but less than that for 2013 and 2014 (Figure 3). Yampa River flows were moderate to low early in the reproductive season. We plotted capture dates of larvae as a function of time and overlaid that with Green River flow. Green River flows at Jensen, Utah, were relatively low in early July and near the level (about 3,000 cfs) when habitat conditions are suitable for good survival of young Colorado pikeminnow (Bestgen and Hill 2016). Presence of early lower flows may have increased survival of those larvae, because a large year-class of YOY pikeminnow in autumn was documented (Project 138 results). A flow spike in the Yampa River on 10 July 2015 may have reduced survival of pikeminnow larvae, similar to that for smallmouth bass upstream (Annual report, Project 140), because few pikeminnow larvae were captured from about 10-22 July. However, a bimodal peak of reproduction is not uncommon (see 2016 and 2017 data), so low abundance of larvae could also be due to lack of reproduction in the preceding days. About 50% or more of Green River, Jensen flows in July were from the Green River, and the remainder was from the Yampa River, the exception being the 10 July flow spike.

Abundance of YOY Colorado pikeminnow in 2015 in the middle Green River, Utah, ISMP samples collected in autumn was very high, especially when compared to recent years (M. Breen personal communication, Project 138 annual report). Above average abundance of larvae does not appear to be one of the reasons that YOY were so abundant, as similar levels of larvae were produced in 2016 and few YOY resulted (see below). One possible reason for increased YOY production in 2015 is that summer flows in the Green River, especially those early in July when pikeminnow were hatching, were moderate to low (Fig. 4). This is unlike 2016 and especially 2017 when early July flows were high (see below). Backwaters were also present and abundant at that time in 2015, and lower flow levels likely allowed for colonization by the invertebrate food base that Colorado pikeminnow require, which likely also assisted with production of a large YOY pikeminnow year class. This situation is in contrast to 2016 and 2017, years with similar levels of larvae production, but which had higher or very high flows in early July,

respectively. The YOY year classes in autumn essentially failed in those years in the Green River.

Lower Yampa River drift net sampling, 2016. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River (n = 233 total samples collected in 2016), the same site where samples were collected in 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2015. Sampling commenced on 23 June and extended through 16 August. The first Colorado pikeminnow larva was collected on 30 June, a relatively average date for first capture of larvae and not unexpected given the warm (but high discharge) water temperatures early in summer.

Abundance of Colorado pikeminnow larvae was about average in 2016, similar to that in 2015, but less than that for 2013 and 2014 (Figure 3). High Yampa River flows were present early in the reproductive season. We plotted capture dates of larvae as a function of time and overlaid that with Green River flow. Green River flows at Jensen, Utah, were high in early July and well above the flow levels when abundant backwater habitat is available. Even though flows were lower in the later portion of July, reduced or absent backwater habitat in early July likely reduced survival of those early larvae. About 50% of those early July flows were produced in the Yampa River, and the other half derived from releases from Flaming Gorge Dam.

Abundance of YOY Colorado pikeminnow in 2016 in the middle Green River, Utah, ISMP samples collected in autumn was very low (M. Breen personal communication, Project 138 annual report). Abundance of larvae does not appear to be one of the reasons for reduced YOY abundance as larvae were at average or higher than average abundances in 2016. One possible reason for reduced YOY production is that early July flows were high, during a period when about 50% of Colorado pikeminnow larvae were produced (Fig. 4). Thus, backwaters may not have been available during that time. Further, newly formed backwater habitat is likely food-poor because invertebrates have not colonized those areas and established populations, which would logically reduce survival of larvae. Flow patterns, especially timing of flows when larvae are first present, as well as magnitude, may be very important for production of good year classes of YOY pikeminnow.

Reasons for lack of YOY Colorado pikeminnow produced from larvae available in the later portion of 2016 are not known. Sampling in autumn 2016 indicated backwaters were arrayed in a different geomorphic pattern than normal, and some that were historically present were gone (Matt Breen, personal communication, Project 138 annual report). Habitat shifts may thus be an additional reason for poor production of YOY Colorado pikeminnow in 2016.

Most sampling data collected in this program (1990-2012, none in 1997) were recently incorporated into a report entitled "Reproduction, abundance, and recruitment dynamics of young Colorado pikeminnow in the Green River Basin, Utah and Colorado, 1979-2012." That report (Bestgen and Hill 2016) has been reviewed by the Biology Committee of the Upper Colorado River Endangered Fish Recovery program, comments

incorporated into a final report, which was approved and finalized.

Lower Yampa River drift net sampling, 2017. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River (n = 243 total samples collected in 2017), the same site where samples were collected in 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2016. Sampling commenced on 21 June and extended through 14 August. The first Colorado pikeminnow larva was collected on 1 July, a relatively average date for first capture of larvae and not unexpected given the relatively low water level and higher temperatures early in summer in the Yampa River. Flows were high and temperatures were low in the adjacent Green River well after pikeminnow larvae were first present due to extended and high releases from Flaming Gorge Dam.

Abundance of Colorado pikeminnow larvae was below average in 2017, and lower than was observed in 2016 or 2015 (Figure 3). Higher Yampa River flows were present early in the reproductive season but dropped relatively quickly. We plotted capture dates of pikeminnow larvae as a function of time and overlaid that with Green River flow (Fig. 4). Green River flows at Jensen, Utah, were high in early July and likely higher than when any backwater habitat is available. This was also coincident with the time of highest production of larvae, as 80% of all larvae produced in 2017 were present before base flows declined. Even after that, base flows remained relatively high through the summer. Even though flows were lower in the later portion of July, reduced or absent backwater habitat in early July likely reduced survival of those early larvae both in the middle and lower Green River. This was borne out by low numbers of YOY Colorado pikeminnow captured in autumn in the middle (n = 1) or lower (n < 25) Green River. This was not unlike 2016 as well, when abundance of YOY Colorado pikeminnow in the middle Green River, Utah, ISMP samples was very low (M. Breen personal communication, Project 138 annual report). One possible reason for reduced YOY production is that early July flows were high and backwaters were not available during that time. Further, newly formed backwater habitat is likely food-poor because invertebrates have not colonized those areas and established populations. Thus, suitable backwater habitat may not have been available for the few larvae that were available until later in 2017, if at all. Flow pattern timing, essentially reducing flows to adequate levels, as well as appropriate magnitude, may be very important for production of good year classes of YOY pikeminnow. A comparison of flows in 2015 to those in 2016 and 2017 shows starkly different patterns because 2015 flows were low early and resulted in a large year class, whereas 2016 and 2017 flows were high later, and resulted in essentially a year-class failure in the Green River. The reduction in abundance of larvae produced in the Yampa River and captured in 2017 is also worrisome.

Lower Yampa River drift net sampling, 2018. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River (n = 270 total samples collected in 2018), the same site where samples were collected in 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2017. Sampling commenced on 13 June and extended through 12 August. The first Colorado pikeminnow larva was collected on 20 June, a relatively early date of first capture but not unexpected given the relatively low water level and higher temperatures early in summer in the Yampa River. The last Colorado pikeminnow larva

captured was on 3 August, so reproduction occurred over a 44-day period. Flows in 2018 were moderate and relatively warm in the adjacent Green River due to lower releases than in 2017, when flows were extended late into the year and high due to releases from Flaming Gorge Dam.

Abundance of Colorado pikeminnow larvae was below average in 2018, and lower than was observed in 2016 or 2015 and only slightly higher than in the low abundance year 2017 (Figure 3). Higher Yampa River flows were present early in the reproductive season but dropped relatively quickly. We plotted capture dates of pikeminnow larvae as a function of time and overlaid that with Green River flow (Fig. 4). Green River flows at Jensen, Utah, were modest in late June when larvae first drifted downstream from the Yampa River. Based on modest flow present in the middle Green River in summer 2018, and presence of larvae, we anticipated a relatively strong recruitment year class to be present for Colorado pikeminnow in autumn ISMP sampling. This was not the case, as only a few ($n=6$) age-0 pikeminnow were captured in backwaters in autumn 2018 (personal communication, M. Breen, Utah Division of Wildlife Resources). This is in spite of a relatively large number of drift-net captured fish present in late June, and another pulse in mid-July. Perhaps numbers of larvae produced was too low for adequate recruitment in this low flow year. For example, numbers of larvae captured in the lower Yampa River in the high age-0 recruitment year 2015 (Project 138 annual report) were much higher than 2018, especially after fish abundance is adjusted using the flow-corrected transport index. While those index numbers are not yet available, July-August flows in 2015 were 5X as high as those in 2018, and fish numbers were twice as high as well, indicating that perhaps 10X as many larvae were produced and transported downstream in 2015. It may also be that larvae survival was poor after drifting downstream in the middle Green River. This has been documented in the past (1994, 2007, 2012), when relatively few larvae are produced from the spawning area and where their apparent survival in downstream Green River backwaters is low (Bestgen and Hill 2016). The reduction in abundance of larvae produced in the Yampa River and captured in 2018, as for previous years, is worrisome, and may be linked to recent reduced abundance of adult Colorado pikeminnow (see annual report, Project 128).

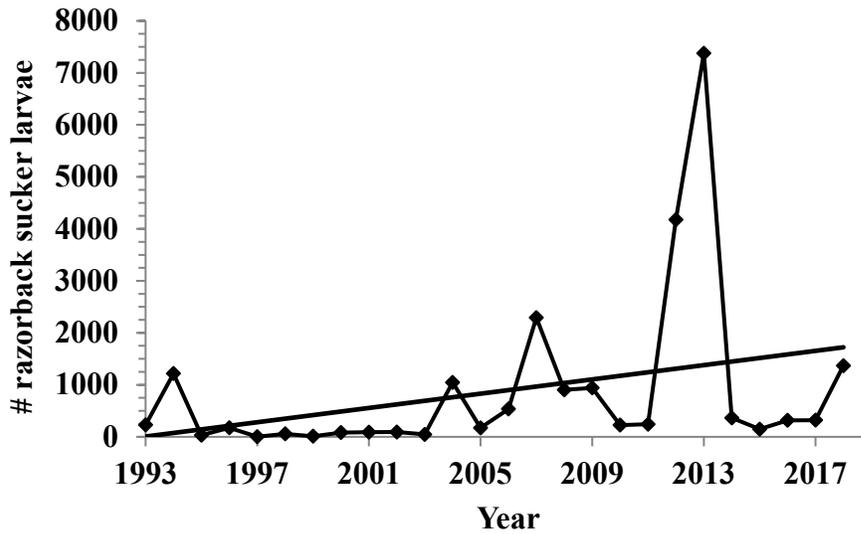
Lower Yampa River drift net sampling, 2019. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River ($n = 213$ total samples collected in 2019), the same site where samples were collected in 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2018. Sampling commenced on 3 July and extended through 21 August. The first Colorado pikeminnow larva was collected on 12 July, a relatively late date of first capture but not unexpected given the relatively high water level into late June and associated lower water temperatures early in summer in the Yampa River. Flows and water temperatures in 2019 were high and cool in early summer in the adjacent Green River due to later than normal releases. Samples have been identified but counts of fish and measurements of length have not been completed. While preliminary, numbers of larvae in samples is low. The low abundance of larvae produced in the Yampa River in this and previous years is worrisome, and may be linked to recent reduced abundance of adult Colorado pikeminnow (see annual report, Project 128).

- VIII. Additional noteworthy observations: Four razorback sucker larvae (8-18 mm TL) were captured in drift nets at the Yampa River drift net sampling site in 2016, a gravel bar formerly known to support reproduction by razorback suckers. Capture dates of larvae ranged from 30 June to 12 July. A few adult razorback suckers are detected there annually with portable PIT tag detectors (Smith et al. 2015; 2016, Project 169). We also have a possible razorback sucker larva in drift net samples in July 2019.
- IX. Recommendations: Continue sampling as planned in 2020. Continue to integrate this work into Colorado pikeminnow recruitment patterns noted for juveniles per Bestgen and Hill (2016). We have also begun analysis of Colorado pikeminnow larvae drift data in support of a study plan to implement managed base flows in the middle Green River in summer. The first presence of pikeminnow determined from drift net samples was used to evaluate flow and water temperature levels and relate that to subsequent recruitment patterns in autumn, which were estimated from ISMP data (Project 138 results). That analysis will lead to recommendations for experimental flow conditions to target to increase Colorado pikeminnow recruitment in the Green River. It would also be worthwhile to assess larval razorback sucker production in relation to reduced adult stocking rates in the future.
- X. Project Status: Ongoing and on-track.
- XI. FY 2019 Budget Status
- A. Funds Provided: \$ 127,608
 - B. Funds Expended: \$ 95,056
 - C. Difference: \$32,552 remaining funds for sample analysis that remains.
 - D. Percent of the FY 2019 work completed, and projected costs to complete: About 75% complete. Spring 2019 Green River drift sampling was not completed due to late arrival of the budget so that work was not completed. We anticipate that sampling to occur in spring 2020. The 2018 scope of work details the project and sampling effort, which is associated with bathymetric measurements and geomorphic modeling to better understand transport rates of razorback sucker larvae from the river to entrances of floodplain wetland mouths. We also have sample work to finish as well.
 - E. Recovery Program funds spent for publication charges: None.
- XII. Status of Data Submission: Data were made available to investigators.
- XIII. Signed: Kevin R. Bestgen 15 November 2019
Principal Investigator Date

APPENDIX: Major recent products based on these data include:

- Bestgen, K. R., and A. A. Hill. 2016. Reproduction, abundance, and recruitment dynamics of young Colorado pikeminnow in the Green River Basin, Utah and Colorado, 1979-2012. Final report to the Upper Colorado River Endangered Fish Recovery Program, Project FW BW-Synth, Denver, CO. Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins. Larval Fish Laboratory Contribution 183.
- Bestgen, K. R. 2015. Aspects of the Yampa River flow regime essential for maintenance of native fishes. Final Report submitted to the National Park Service, Fort Collins, CO, The Nature Conservancy, Boulder, CO, and Western Resource Advocates, Boulder, CO. Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins. Larval Fish Laboratory Contribution 181.
- Bestgen, K. R., K. A. Zelasko, and G. C. White. 2012. Monitoring reproduction, recruitment, and population status of razorback suckers in the Upper Colorado River Basin. Final Report to the Upper Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service, Denver. Larval Fish Laboratory Contribution 170.
- Bestgen, K. R., G. B. Haines, and A. A. Hill. 2011. Synthesis of flood plain wetland information: Timing of razorback sucker reproduction in the Green River, Utah, related to stream flow, water temperature, and flood plain wetland availability. Final report to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U. S. Fish and Wildlife Service, Denver, CO. Larval Fish Laboratory Contribution 163.

A.



B.

Green River razorback sucker stocking

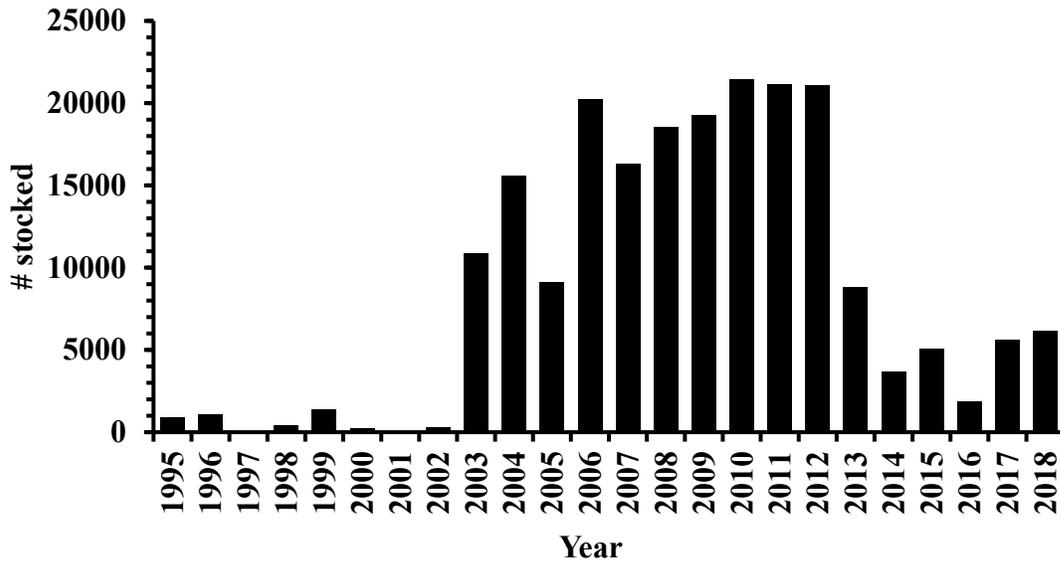
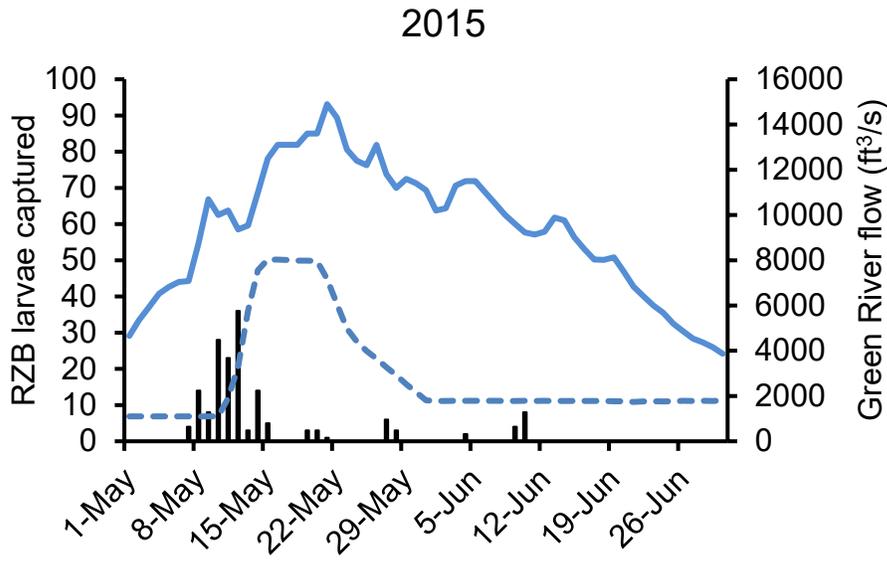
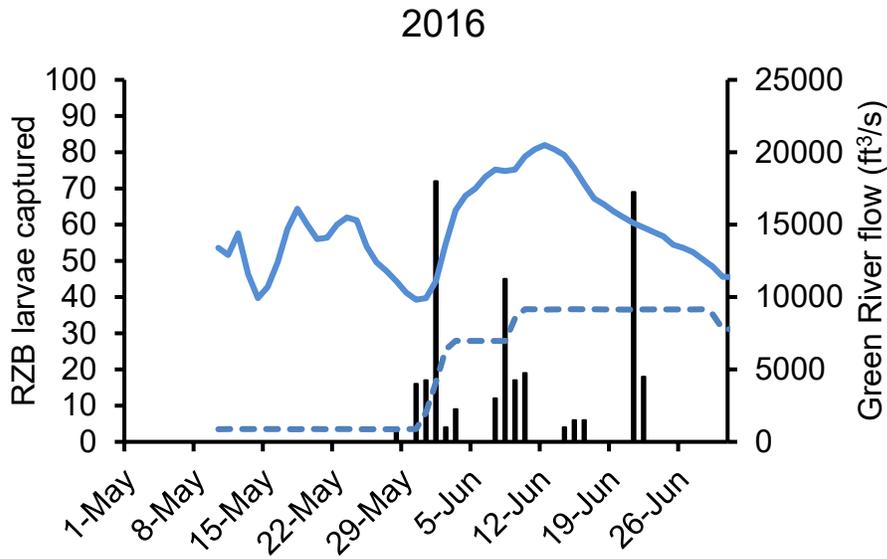


Figure 1. Panel A depicts number of razorback sucker larvae captured from 1993 to 2018 in the middle Green River, Utah, in light traps (all fish including those of questionable taxonomic identity included; 2019 sample identification is not finished so is not included here). Panel B depicts number of razorback suckers stocked each year throughout the Green River (about ½ in each of the middle and lower Green River each year), 1995-2018.

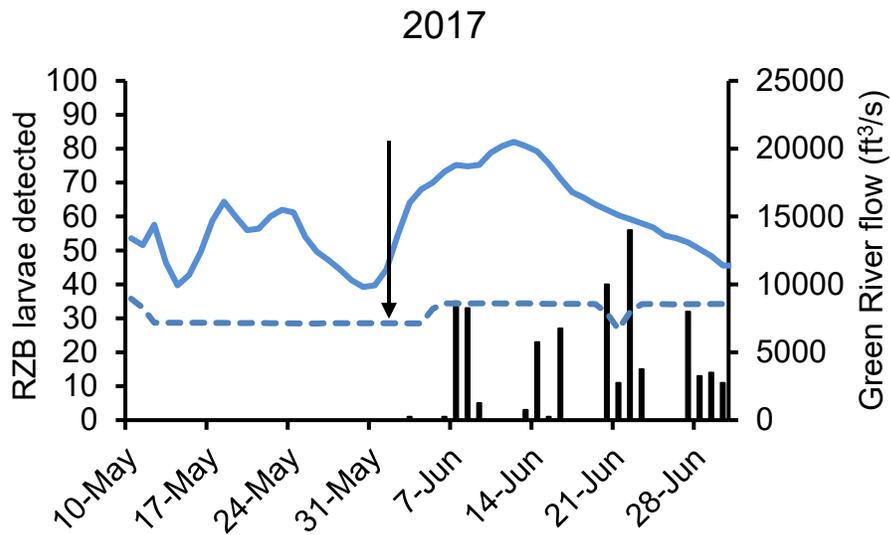
A.



B.



C.



D.

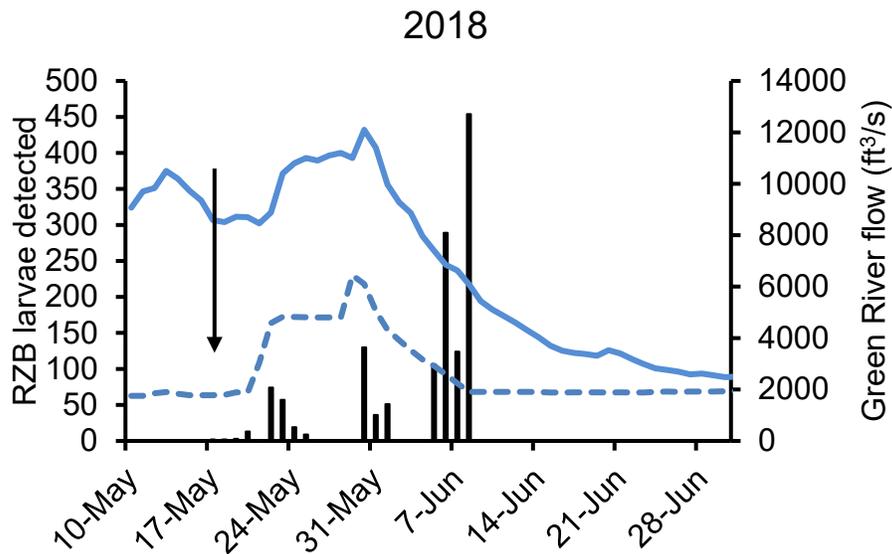


Figure 2. Seasonal distribution of razorback sucker larvae captured in 2015 (panel A), 2016 (panel B), 2017 (panel C), and 2018 (panel D) in middle Green River, Utah, in light trap samples (all fish including those identified as “razorback sucker?” were included). All samples from all locations were combined for each day. Gaps in captures after the first capture of razorback sucker larvae may indicate lack of sampling rather than absence of the species. Green River flows at Jensen, Utah (solid line) are plotted, as are releases from Flaming Gorge Dam (Greendale, Utah gauge, dashed line), with the difference in the two lines being mainly flows of the Yampa River.

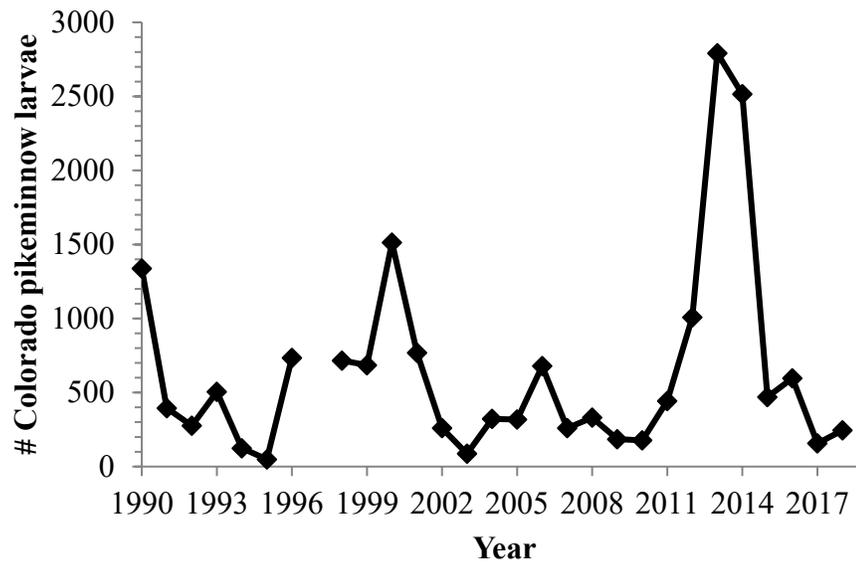
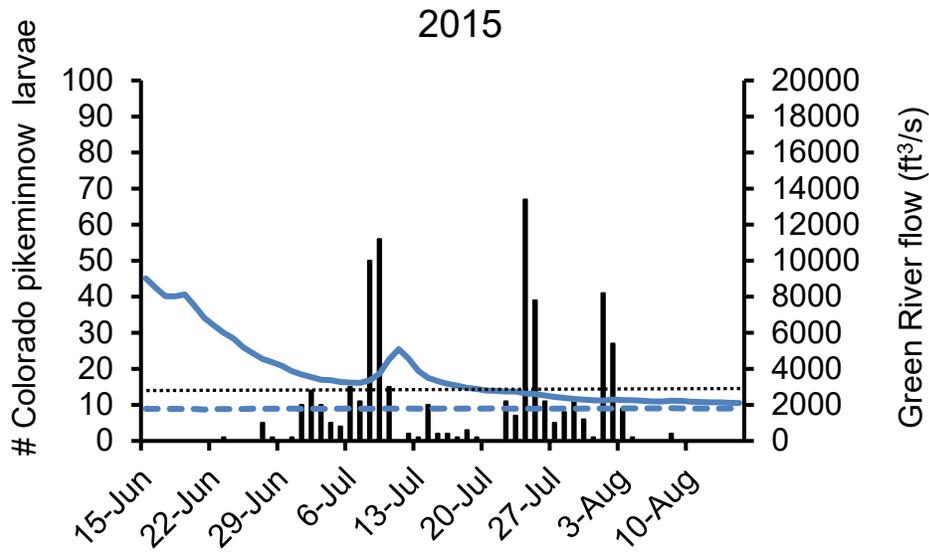
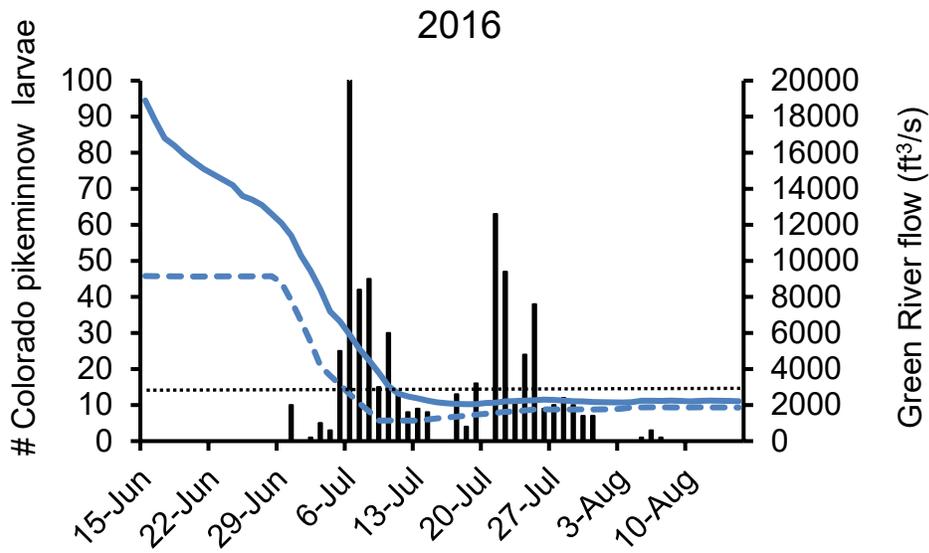


Figure 3. Number of Colorado pikeminnow larvae captured from 1990 to 2018 (no sampling in 1997, includes specimens from all diel samples, 2018 sample identification is complete) in the lower Yampa River, Colorado, during summer in drift nets.

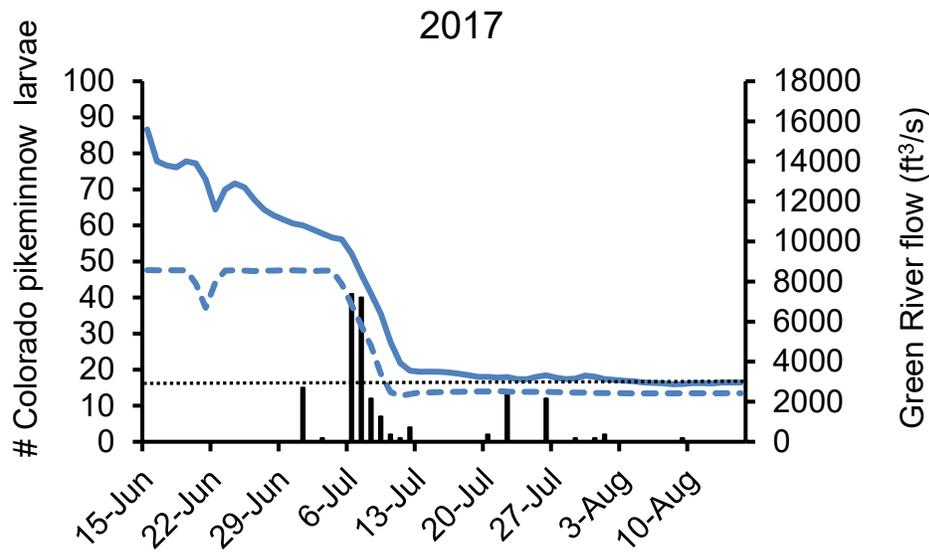
A.



B.



C.



D.

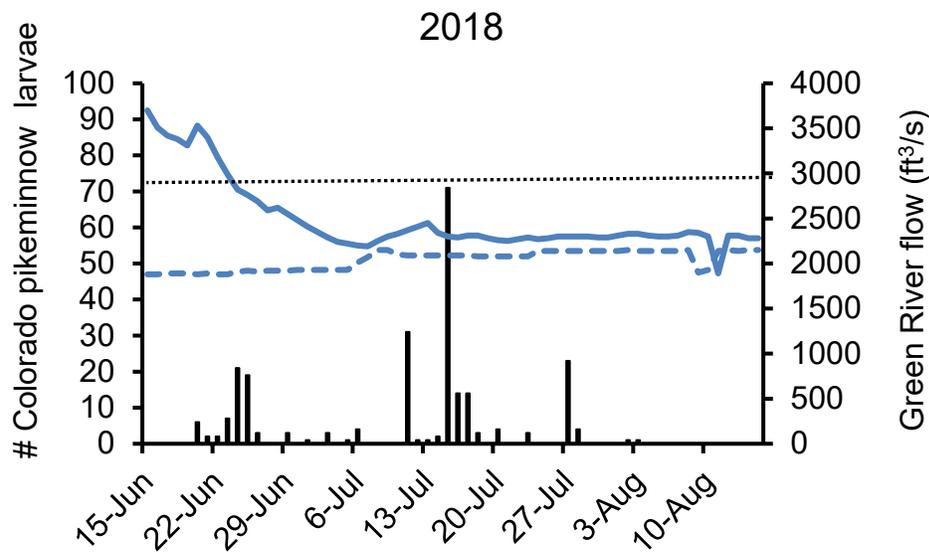


Figure 4. Seasonal distribution of Colorado pikeminnow larvae captured in 2015 (panel a), 2016 (panel b), 2017 (panel c), and 2018 (panel d) drift net samples from the lower Yampa River, Colorado. Sampling for 2015 began on 17 June and ended 16 August. Sampling for 2016 began on 23 June and ended 16 August. Sampling for 2017 began on 21 June and ended 14 August. Sampling for 2018 began on 13 June and ended 12 August. Several of the largest capture dates were diel sampling occasions (12 samples total each day). Flows of the Green River at Jensen (solid line) and Greendale (dashed line) are also depicted, with the difference in the two flows being the contribution of the Yampa River. Note the difference in scale for flows on the y-axis. The dotted black line is the upper end of flow levels recommended in the highest summer flow hydrologic scenario.

Appendix I. Detections of razorback suckers at Razorback Bar complex, middle Green River, Utah, from 2014-2018, showing abundance of various year-classes of fish stocked over time; graphs are from reports by Smith et al, for Project 169. Razorback suckers may take about 3 or more years post stocking to mature, based on first relatively high abundances of fish detected at spawning areas three years after stocking; an example is the 2012 year class abundance increase in 2015 compared to their abundance in 2014.

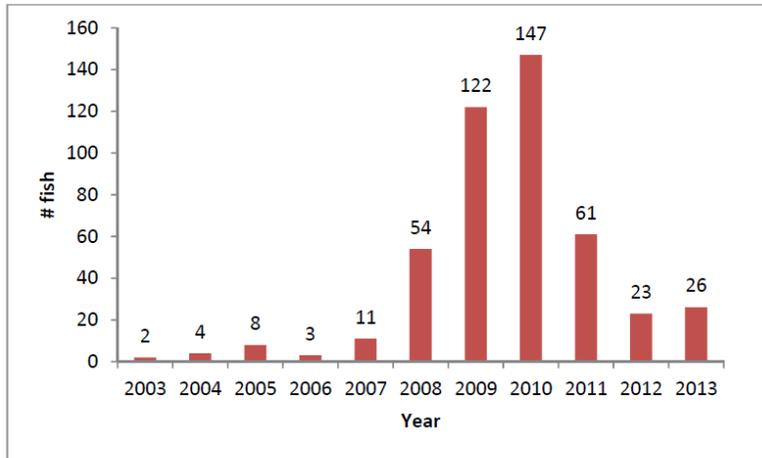


Figure 1. Year of stocking for razorback sucker detected with the PIT antennas in 2014.

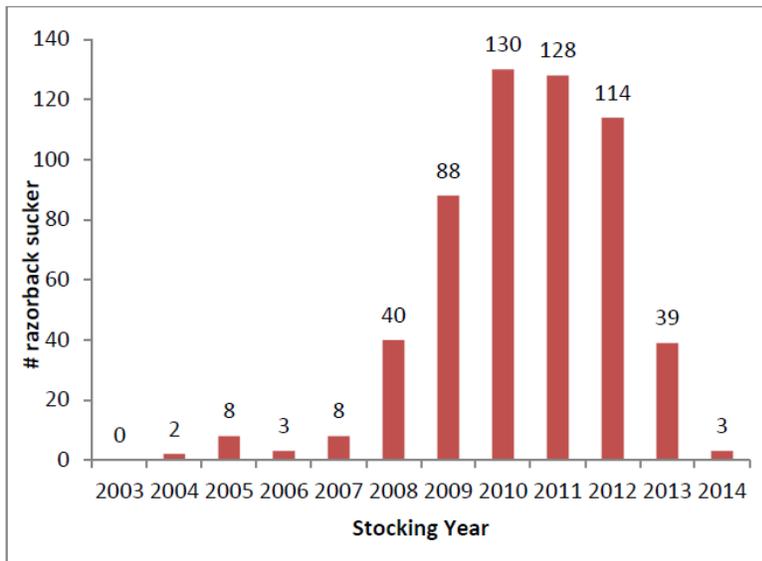


Figure 3. Year of stocking for razorback sucker detected at Razorback Bar PIT tag antennas in 2015.

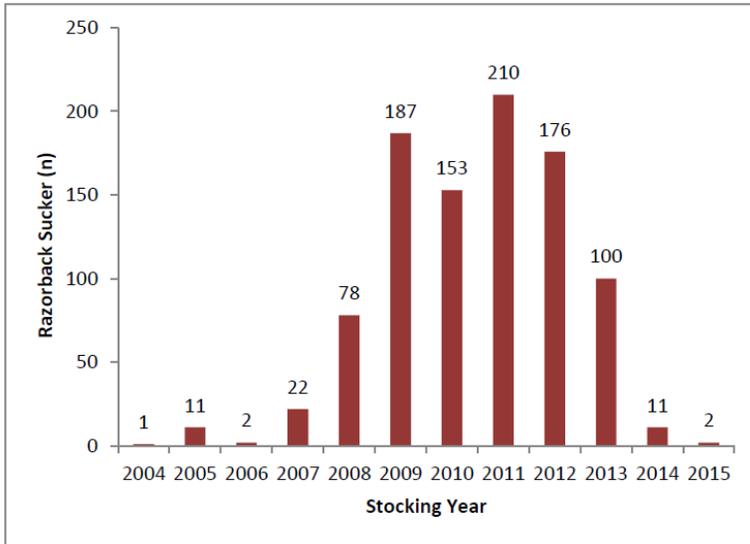


Figure 3. Year of stocking for razorback sucker detected at Razorback Bar PIT tag-antennas in 2016.

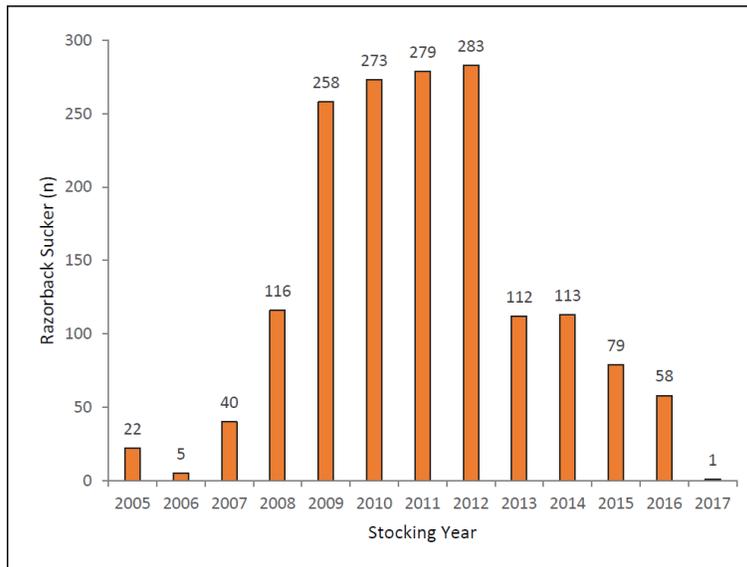


Figure 3. Year of stocking for razorback sucker detected at Razorback Bar PIT tag antennas in 2017.

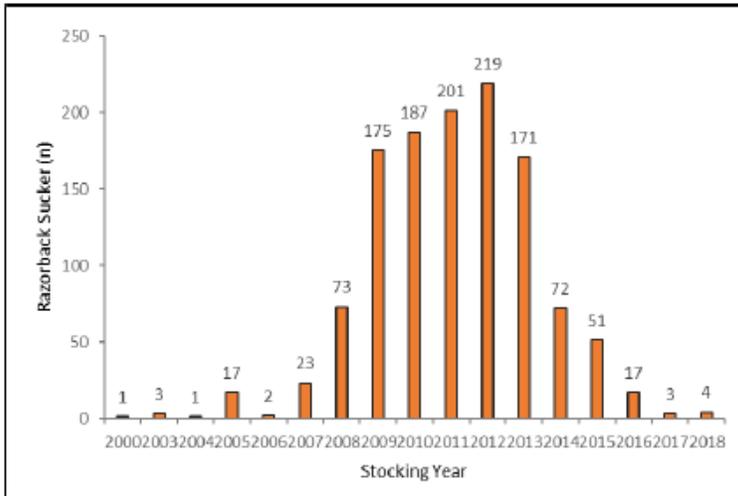


Figure 4. Year of stocking and number of unique detections for razorback sucker detected by Razorback Bar PIT tag antennas in 2018

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R19AP00058

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 22f

Project Title: Interagency standardized monitoring program assessment of endangered fish reproduction in relation to Flaming Gorge Dam operations in the middle Green and lower Yampa rivers.

Principal Investigator: Kevin R. Bestgen
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Project/Grant Period: Start date (Mo/Day/Yr): 1 Oct. 2018
End date: (Mo/Day/Yr): 30 Sept. 2023
Reporting period end date: 30 Sept. 2019
Is this the final report? Yes _____ No X

Performance: The goal of this project is to document timing and intensity of reproduction by razorback suckers and Colorado pikeminnow in the lower Yampa and middle Green rivers. Samples were collected in the Yampa River about 0.2 to 0.8 km upstream from the Green River (n = 213 total samples collected in 2019), the same site that samples were collected from in 1990 to 1996 (Bestgen et al. 1998) and in 1998 to 2018. Sampling commenced on 3 July and extended through 18 August. The first Colorado pikeminnow larva was collected on 12 July, a relatively late date of first capture but not unexpected given the high and cold flows into early summer in the Yampa River. We also received light trap samples collected by the U.S. Fish and Wildlife Service in spring 2019. Those samples are being analyzed at this time.

ANNUAL PERFORMANCE PROGRESS REPORT

BUREAU OF RECLAMATION AGREEMENT NUMBER: R15PG00083

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 22f

Project Title: Light trap and drift net sampling for razorback sucker and Colorado pikeminnow larvae

Principal Investigator: Chris Smith
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christian_t_smith@fws.gov; 435-789-0351

Project/Grant Period: Start date: 10/01/2014
End date: 09/30/2019
Reporting period end date: 09/30/2019
Is this the final report? Yes _____ No X

Performance:

US Fish & Wildlife Service Green River Basin FWCO completed our portion of Task 1, collect light trap and seine samples from the Green River and its wetlands. We began light trapping May 13 May, 2019 and continued sampling through June 28. All samples and data were delivered to CSU LFL on August 31.