COLORADO RIVER RECOVERY PROGRAM
FY 2018 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 160

I. Project Title: **Assessment of Stocked Razorback Sucker Reproduction in the Lower Green and Lower Colorado Rivers**

II. Bureau of Reclamation Agreement Number: R14AP00007

Project/Grant Period: Start Date: 05/01/2014
End date: 09/30/2018
Reporting period end date: 09/30/2018
Is this a final report? Yes____ No__X__

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IV. Abstract: Determining the location, timing, extent, and success of razorback sucker spawning is essential for evaluating the effectiveness of the stocking program, identifying recruitment, and guiding future management. This study was designed to determine the spawn timing as well as presence/absence and distribution of larval, young-of-year (YOY) and age-1+ razorback suckers in the Green River downstream from the town of Green River and in the Colorado River downstream of Moab. The study was prompted by increasing razorback sucker encounters, the presence of multiple age classes, and congregations of ripe razorback suckers (2001 – 2003 and 2006 – 2008; Bestgen et al 2012, UDWR unpublished data) during Colorado pikeminnow surveys. Larval razorbacks have been successfully collected every year since the beginning of the project. Total number of larvae captured annually by light trapping has increased on both the Green and Colorado rivers since sampling began in 2009 and 2014, respectively. In 2018, YOY razorback suckers were captured during seining efforts on both the Green and Colorado Rivers, although no age-1+ razorback suckers were captured.

V. Study Schedule: Initial year 2009, ongoing.

VI. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

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

V.A. Measure and document population and habitat parameters to determine status and biological response to recovery actions.

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

GREEN RIVER ACTION PLAN: MAINSTEM

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.

COLORADO RIVER ACTION PLAN: MAINSTEM

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.

VII. Accomplishment of FY 2018 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Lower Green River light trap sample collection:

Larval light trap samples were collected at 15 sites between river miles 19.7 (Deadhorse Canyon) and 119.6 (Saleratus Wash) during three sampling events from 5/4/2018 – 6/12/2018. These sampling events occurred in conjunction with Green River Colorado pikeminnow estimates (Project #128). A total of 113 light trap samples were collected. Seven of the traps contained no larval fish. The 106 samples that contained larval fish were sent to Colorado State University Larval Fish Laboratory (CSU LFL) for identification. During sampling, main channel water temperatures ranged from 17.0°C to 24.0°C with a median temperature of 20.0°C. Water temperatures within the sampled habitats ranged from 17.5°C to 28.0°C, with a median temperature of 20.0°C.

The total number of razorback larvae captured on the lower Green River in 2018 was 6,779 (Figure 1; Table 1). The mean catch per unit effort (CPUE) in 2018 was 60 larvae per trap night (Figure 2). The mean CPUE for a given sampling year has varied over the course of this study, ranging from 1 to 159 larvae per trap night. There is a distinct difference when comparing the mean CPUE from 2009 – 2011 (3.2 larvae per trap night) to 2012 – 2018 (72.2 larvae per trap night). The CPUE at each reach has varied over time (Figure 3). Catch per unit effort was highest in the San Rafael (river miles 94-99) reach in 2018. Further research into what variables may affect the CPUE of razorback sucker larvae in the lower Green River could aid in management decisions.

The 2018 total number of larvae caught is more than that of each of the previous nine years with the exception of 2015, during which record numbers of larvae were captured, and CPUE was at a record high on the lower Green River. These high numbers of larvae in 2015 could simply be attributed to setting traps at a particularly opportune time after spawning and hatching, or the total numbers of larvae could be inflated by one or two highly productive traps. For example, one trap in 2015 contained 2,144 razorback larvae. The nature of our sampling timing is sporadic and does not always align with the time during which the maximum number of larvae are present which could lead to variable

results over the years. Another explanation for high capture rates in 2015 is the relatively low average and peak streamflow on the lower Green River. More investigation into what could have made 2015 relative to other years such a successful season for capturing razorback larvae could aid in understanding what might be favorable conditions for spawning and hatching success on the lower Green River.

We estimated spawning and hatch dates for captured razorback suckers using formulas developed by Muth et al. (1998) and Bestgen et al. (2002) with data presented by Bozek et al. (1990). This formula is explained in more detail in the 2017 Project 160 Annual Report (Burke & Caldwell 2017), and is based on larval length at capture and mean daily growth rates from hatching. In general, razorback suckers spawn in the lower Green River from early April through early May when water temperatures are between 10.0°C and 16.0°C and when degree days range between 350 – 1100 (Bestgen et al. 2002). Degree days are the sum of instantaneous water temperatures between 1 January and the earliest date of spawning (Bestgen et al. 2002). Spawning generally begins 28 to 78 days prior to the highest flow day during spring runoff and nearly always before water temperatures reach 14.0°C (Bestgen et al. 2002).

In 2018, we estimated spawning to have begun on March 25th, 69 days prior to peak spring runoff (6/02/2018) and when degree days were at approximately 390 (Figure 4). Estimated spawning peaked on May 2nd, 31 days prior to peak runoff and when the 10-day rolling average (of the previous 10 days) water temperature was at 16.1°C. Mean daily water temperature during the 2018 estimated spawning period ranged from 10.0°C to 21.0°C. The median mean daily water temperature during this period was 15°C and the average daily water temperature was 15.8°C ± 0.4°C. The number of larvae captured reached a maximum on May 23rd following an early period of decreasing flow rates and 10 days prior to peak spring runoff. Water temperature and discharge data were taken from the USGS gauge 09315000 Green River at Green River, UT.

In 2018 on the lower Green River, mean daily discharge began steadily increasing in April as is typical in a snowmelt influenced river system. As discharge increased in April, daily instantaneous water temperatures were at or above 10.0°C. In contrast to 2017 when flows began increasing during February in an atypical manner due to releases from Flaming Gorge Dam, it appears that in 2018 conditions for razorback larvae incubation and hatching were adequate and reproductive success was likely (Zelasko, et al. 2011; Bozek et al. 1990).

The mean total length of razorback larvae that were captured on the lower Green River and measured at CSU LFL was 11.8 mm ± 1.2 mm (n = 4,447; maximum number measured per sample was 100). This is consistent with mean larvae total length from the last six years which has been between 10 and 12 mm.

As part of larval sampling and in an effort to continue sampling habitat that has been sampled in the past, larval seines were pulled at locations where light traps could not be set. Two larval seine hauls were completed at lower Anderson Bottom (RMI 30.9) on 6/12/2018. A total of 10 m² was seined in these two hauls. Both hauls contained larval

fish that were preserved and sent to CSU LFL. There were no razorback larvae in these samples. The samples contained one flannelmouth sucker and two red shiners. The effectiveness of larval seining in this instance was low, however it has been quite effective in the past. In 2015, 119 and 289 razorback larvae were caught using larval seines on the Green River and Colorado River respectively. This historic data confirms that larval seining may still be an effective back-up sampling method to use when light traps cannot be set.

Additional native and non-native species captured during 2018 light trapping efforts on the lower Green River can be found in Table 1 and Table 3 respectively. Other non-native fish captured (not reported in Table 3) include: red shiner, sand shiner, and fathead minnow.

Task 2: Lower Green River sampling for YOY and age 1+ razorback sucker:
Seine samples were collected between river miles 4.3 (Water/Shot Canyon) and 119.6 (Saleratus Wash) during one sampling trip, 7/22/2018 – 7/25/2018. A second seining pass for the Green River did not occur as a result of funding reallocations to Southwestern Native Aquatic Resources and Recovery Center (SNARRC) and Utah Division of Wildlife Resources for Colorado pikeminnow brood stock collection. In the single sampling trip, a total of 1,291 m² was seined in 41 seine hauls within 26 individual habitats. These habitats included backwaters, which constituted 81.5% of all areas sampled, shorelines (11.1%), embayments (3.7%), and flooded tributaries (3.7%). During sampling, main channel water temperatures ranged from 26.0°C to 30.0°C with a median temperature of 29.0°C. Water temperatures in the sampled habitats ranged from 26.0°C to 33.0°C with a median temperature of 29.0°C.

During the seining effort, one YOY fish was preserved and sent to CSU LFL for fish identification. This fish was identified as a YOY razorback sucker with a length of 42 mm (Figure 9, Table 2). There were no age 1+ razorback suckers captured during seining. This is the second consecutive year that YOY razorback suckers have been captured on the lower Green River since 2014. Although only one YOY razorback was captured in 2018, it should be noted that a small total area (38% of average) was seined relative to past years (average seined area from 2009 through 2018 is 3,406 m^2).

It is notable that there were a total of nine "unknown suckers" captured, measured and released alive during the seining effort (Table 2). These "unknown suckers" ranged in total length from 25 to 38 mm, with a median total length of 30 mm. These fish were determined not to be razorback suckers in the field (hence not preserved) and were not identified to species level due to the difficulty of identifying between flannelmouth and bluehead sucker species when under 40 mm total length.

Despite high numbers of larval captures, the consistently low numbers of juvenile razorback suckers found during seining efforts and the lack of young, wild razorback suckers captured outside of managed habitats suggests that razorback suckers may not be surviving past their larval stage or we are not successful at capturing older life stages (Zelasko et al. 2018). Other young sucker species have been captured in faster moving,

shallow, cobble-bar habitats that are difficult to seine. More investigation into other sampling techniques for capturing YOY and age 1+ razorback suckers and experimentation with these techniques could be useful. Additionally, expanding the sampling range and types of habitat sampled could indicate where to focus our effort.

Additional native and non-native species captured during 2018 seining efforts on the lower Green River can be found in Table 2 and Table 3 respectively. Other non-native fish captured (not reported in Table 3) include: red shiner, sand shiner, and fathead minnow.

Task 3: Colorado River light trap sample collection:
Light trap samples were collected at 11 sites between river miles 21.2 and 63.8 (Courthouse Wash) during two sampling events from 5/14/2018 – 6/03/2018. Due to low river flows, we were unable to complete a third sampling pass as we have in the past. A total of 50 light trap samples were collected. Four samples contained no larval fish. The 46 samples containing larval fish were preserved and sent to CSU LFL for identification. During sampling, main channel water temperatures ranged from 17.0°C to 22.0°C with a median temperature of 19.5°C. Water temperatures in the sampled habitats ranged from 18.0°C to 24.0°C with a median temperature of 21.3°C.

The total number of razorback larvae captured on the Colorado River in 2018 was 3,592 (Figure 5; Table 1). The mean catch per unit effort (CPUE) was 72 larvae per trap night (Figure 6). The total number of razorback larvae captured on the Colorado River has increased since 2014. CPUE has also increased, with 2018 demonstrating relatively high numbers of razorback larvae and a relatively high CPUE in the Colorado River. The total number of razorback larvae captured increased 90% from 2017 and 437% from 2014. The CPUE (total larvae per trap night) increased 135% from 2017 and 332% from 2014. In 2018, CPUE was highest in the Moab reach, and all reaches had a greater CPUE than in each of the previous years of sampling (Figure 7).

In 2018 the annual average discharge from the Colorado River was 3,468 CFS, whereas from 2014 through 2017 average annual discharge was relatively stable, from 6,251 to 6,711 CFS. In 2018, spring runoff reached a maximum of 8,470 CFS, whereas in 2014 through 2017 peak spring runoff was between 25,100 and 37,500 CFS. All discharge data are from the USGS gauge 09180500 Colorado River near Cisco, Utah.

The 2018 sampling efforts on the Colorado River may be difficult to compare to other years because of the low discharge. Howard (2012) hypothesized that high numbers of larvae caught in low water years may be attributed to the limited amount of flooded tributary habitat available for larvae to occupy. Thus, 2018 low water conditions may have resulted in higher rates of capture as a result of larvae being concentrated in the few habitats available.

In 2018, spawning was estimated to have begun on March 22nd about 53 days prior to peak spring runoff (05/14/2018) and when degree days were at approximately 350 (Figure 8). Estimated spawning peaked on April 17th, 27 days prior to peak runoff and

when the 10-day rolling average (of the previous 10 days) water temperature was at 12.8°C. Instantaneous daily water temperatures during the 2018 estimated spawning period ranged from 9.5°C to 18.4°C. The median instantaneous daily water temperature during this period was 13.4°C and the average daily water temperature was 13.9°C ± 0.3°C. The number of larvae captured reached a maximum on May 14th, the first day light traps were set for the season and the same day as peak spring runoff. The 2018 spawning period on the Colorado River began relatively early compared to past years. Water temperature and discharge data were taken from the USGS gauge 09180500 Colorado River near Cisco, Utah.

The mean total length of razorback larvae that were captured on the Colorado River and measured at CSU LFL was 12.7 mm ± 1.8 mm (n = 2,439; maximum number measured per sample was 100).

As part of larval sampling and in an effort to continue sampling habitat that has been sampled in the past, larval seines were pulled at locations where light traps could not be set. A total of six larval seine hauls were completed at Courthouse Wash (RMI 63.8), Long Canyon (RMI 50.8), and Culvert Canyon (RMI 53.7) on 6/19/2018. A total of 29 m^2 was seined in these six hauls. Three hauls contained larval fish that were preserved and sent to CSU LFL. These samples contained a total of two larval razorback suckers. The total length of these two razorbacks was 10 and 22 mm. These samples also contained eight bluehead suckers, one speckled dace, and numerous fathead minnows and shiners. Again, it may be noted that the effectiveness of larval seining was not high in this instance, but it is recommended to continue larval seining efforts in the future when light traps cannot be placed, as it has yielded high numbers of razorback larvae in the past.

Additional native and non-native species captured during 2018 light trapping efforts on the Colorado River can be found in Table 1 and Table 3 respectively. Other non-native fish captured (not reported in Table 3) include: red shiner, sand shiner, and fathead minnow.

Task 4: Colorado River sampling for YOY and age 1+ razorback sucker:
Seine samples were collected between river miles 3.4 (Salt Creek) and 63.8 (Courthouse Wash) during one sampling event, between 7/10/2018 – 7/12/2018 and on 7/25/2018. A second seining pass for the Colorado River did not occur as a result of funding reallocations to Southwestern Native Aquatic Resources and Recovery Center (SNARRC) and Utah Division of Wildlife Resources for Colorado pikeminnow broodstock collection. A total of 1,199 m^2 was seined in 37 seine hauls within 20 habitats. These habitats included backwaters, which constituted 65% of all areas sampled, flooded tributaries (5%), shorelines (5%), isolated pools (20%), and island tips (5%). Thirteen samples were sent to CSU LFL for fish identification. During sampling, main channel water temperatures ranged from 26.0°C to 27.5°C with a median temperature of 27.0°C. Habitat water temperatures ranged from 25.0°C to 31.0°C with a median temperature of 28.0°C.

Young-of-year razorback suckers were documented on the Colorado River during this study for the second year in a row. Young-of-year razorbacks were captured between river miles 10.2 to 54 (Gold Bar). A total of 13 individuals were found with total lengths ranging from 33 to 81 mm, a median total length of 52 mm, and an average total length of 54.8 ± 3.5 mm (Figure 9, Table 2). There were no age-1+ razorback suckers captured during seining. Catch per unit effort was 1.1 fish per 100 m^2 and was the highest CPUE that has been recorded during this study on both the Colorado and Green Rivers.

In 2017, on the Colorado River, seven YOY razorback suckers were captured during this study with a similar median total length of 50 mm and an average total length of 49 ± 4.9 mm. Prior sampling from 2014 through 2016 yielded no YOY razorback captures during seine sampling on the Colorado River. These two consecutive years of YOY captures could either be the result of our sampling effectiveness improving or that more razorback larvae are surviving into early juvenile stages. The extremely limited numbers of YOY and age-1+ captures over the course of this study, however, greatly limits our ability to make inferences about razorback recruitment from larvae to juvenile stages and into adulthood.

The high CPUE and total capture of YOY razorbacks in 2018 is similar to the relatively high CPUE (0.62 fish per 100 m^2) and total capture (n=6) reported in 2012 on the lower Green River during another low discharge year. Howard (2012) suggested that this may be due to an extended growing season created by the warmer water temperatures that occur during low discharge years. Howard also pointed to the encounters of YOY razorbacks during 2012 project 138 (ISMP) as supporting this notion (2012 is the only year YOY razorbacks have been captured during ISMP). However, during the high discharge year of 2011 (highest average flow and peak flow during this study) on the lower Green and during the average discharge year of 2017 on both reaches, between seven and nine total YOY razorbacks were captured (Figure 9). Additionally, during 2013 on the lower Green (a low discharge year) there were no YOY razorback captures. Howard (2013) attributed the lack of YOY captures in 2013 to heavy monsoonal activity affecting "quality and usage of backwater and flooded tributary habitat". Further research could help determine what conditions contribute to high YOY razorback captures in our study area. This may then aid in developing a hypothesis for what conditions support survival of razorback sucker from larval to early juvenile stages.

Additional native and non-native species captured during 2018 seining efforts on the Colorado River can be found in Table 2 and Table 3 respectively. Other non-native fish captured (not reported in Table 3) include: red shiner, sand shiner, and fathead minnow.

Task 5: Preliminary sample identification, data entry, analysis and reporting:
All data has been entered. Collected samples were submitted to the CSU LFL for identification, and results are reported here.

VIII. Additional noteworthy observations:

Colorado River Inflow to Lake Powell Sampling Effort:

Similar to 2017, one additional exploratory sampling trip was conducted around the inflow area of the Colorado River into Lake Powell. As spring runoff increases the level of Lake Powell, water backs up along shorelines providing potentially beneficial habitat for YOY and juvenile native fish. Light trap and larval seine samples were taken between river miles 167.7 (North Wash / lake mile 140) and 196.6 (Gypsum Wash), during one sampling trip (6/20/2018 – 6/21/2018; river miles from the Belknap Canyonlands River Guide). During sampling, main channel water temperature was approximately 24.0°C and habitat water temperatures ranged from 23.0°C to 32.0°C.

A total of 11 light trap samples were collected in four unique habitats. Habitats sampled included the shorelines of a flowing tributary stream (Dirty Devil), backwaters, and flooded tributaries. All 11 samples were preserved and sent to CSU LFL for identification of larval fish. A total of 57 larval razorback suckers were identified in these samples. Forty-four of the razorback larvae were captured at the Dirty Devil (RMI 169.7, flowing tributary stream), and 13 of the larvae were captured at Brown's Bottom (RMI 167.7, backwater). The light trapping CPUE was 5.2 razorback larvae per trap night.

There were 13 larval seine samples taken at 11 unique habitats. A total of 82 m^2 was sampled. Habitats sampled included backwaters, embayments, isolated pools, and shorelines. Identifiable fish were sorted and enumerated in the field. Any specimens that could not be identified were preserved in ethanol. Fish were preserved from 11 samples and sent to CSU LFL for identification. Twelve razorback sucker larvae were identified within these samples. All of these razorback larvae were captured near Brown's Bottom (RMI 167.7).

During this brief, small-scale effort of light trapping and larval seining at the Lake Powell inflow, a total of 69 larval razorback suckers were captured (Table 1). Total length of larvae ranged from 9 to 16 mm with a mean total length of 13.4 mm ± 1.3 mm. The slightly longer mean total length of these larvae compared to those captured on the Green and Colorado Rivers upstream is likely due to the fact that they were captured at a later date. With this, it should be noted that it is difficult to compare this effort to sampling on the lower Green and Colorado (discussed in Task 1 and Task 3) due to differences in the timing of sampling. Generally, we do not sample for larvae at the end of June when some razorback larvae have already grown into YOY fish.

Compared with Lake Powell inflow sampling in 2017, fewer total numbers of larvae were captured during 2018 sampling and CPUE was slightly lower (2017 CPUE was 7.7 razorback larvae per trap night). However, only 11 light traps were set during the 2018 effort, whereas 30 light traps were set during the 2017 effort. As was the case in 2017, the presence of razorback larvae is notable and demonstrates that there are razorbacks utilizing this habitat.

On June 16th, 2017, 40,900 CFS of discharge was measured at the Colorado River above the Dirty Devil. On May 30th, 2018, 18,200 CFS of discharge measured at the same location. Discharge data were taken from field measurements at the USGS gauge

09328990 Colorado River above the Dirty Devil River near Hite, UT. This data (and the streamflow data discussed in Task 3) demonstrates that water levels were generally lower at the Colorado River inflow in 2018 versus 2017. At the lower levels in 2018, less habitat was likely available due to a lack of flooding as was apparent in the 2017.

Additionally, with 2018 being a low water year at the Colorado River inflow, the confirmed presence of larval razorbacks during 2018 and 2017 demonstrates that razorback larvae utilize this habitat in a range of hydrologic conditions. It may be beneficial to expand our sampling effort to incorporate sites below the Colorado and Green River confluence because of the continued presence of larvae in the inflow area.

Additional native and non-native species captured during 2018 light trapping and seining efforts at the Colorado inflow to Lake Powell can be found in Tables 1 and 3. Other non-native fish captured (not reported in Table 3) include: red shiner, sand shiner, and fathead minnow.

YOY Colorado pikeminnow abundance on the Lower Green and Colorado Rivers: During 2018 seine sampling (7/10/2018 – 7/25/2018), a total of 244 and 158 YOY Colorado pikeminnow were captured on the lower Green and Colorado Rivers, respectively. An effort was made to release all captured pikeminnow alive, however one fish was preserved for identification in the lab and five mortalities occurred during processing in the field. The catch per unit effort was 18.9 pikeminnow caught per 100 m^2 and 13.2 pikeminnow caught per 100 m^2 on the lower Green and Colorado respectively.

IX. Recommendations:

- Continue sampling via light trapping for larval razorback sucker in both the Colorado and Green Rivers (May-June) to determine the annual success and timing of reproduction.
- Continue seining in both the Colorado and Green Rivers (July-September) to determine successful recruitment of YOY and juvenile razorback suckers.
- Consider expanding sampling via light trapping (May-June) below the confluence of the Green and Colorado Rivers, particularly between river miles 167.7 (North Wash / lake mile 140) and 196.6 (Gypsum Wash), in an effort to capture larvae and determine the annual success and timing of reproduction.
- Consider an experimental sampling trip (July-September) below the confluence of the Green and Colorado Rivers, particularly between river miles 167.7 (North Wash / lake mile 140) and 196.6 (Gypsum Wash) in an effort to capture YOY and juvenile razorback sucker via seining or alternative methods.
- Consider using alternative sampling methods to document recruitment success in areas that are difficult to sample via seine. Alternative methods may include using a trawl to sample cobble bars and higher velocity habitats.
- Consider conducting further research to help determine what conditions contribute to high YOY razorback captures in our study area. This may then aid in developing a hypothesis for what conditions support survival of razorback sucker from larval to early juvenile stages.

X. Project Status: On track and ongoing.

XI. FY 2018 Budget Status

A.	Funds Provided:	$ 60, 611
B.	Funds Expended:	$ 60, 611
C.	Difference:	$ 0
D.	Percent FY 2018 work completed:	100%
E.	Recovery Program funds spent for publication charges:	$ 0

XII. Status of Data Submission: All data has been submitted.

XIII. Signed: Karen Burke — 11/03/2020
Principal Investigator — Date

XIV. Literature cited:

Bestgen, K.R., Zelasko, K.A., White, G.C. 2012. Monitoring reproduction, recruitment, and population status of razorback sucker in the upper Colorado River basin. Final report of Colorado State University Larval Fish Laboratory to Upper Colorado River Endangered Fish Recovery Program, Denver, CO.

Bestgen, K.R., G.B. Haines, R. Brunson, T. Chart, M. Trammell, R.T. Muth, G. Birchell, K.Christopherson, and J.M. Bundy. 2002. Status of wild razorback sucker in the Green River Basin, Utah and Colorado, determined from basinwide monitoring and other sampling programs. Draft Report of Colorado State University Larval Fish Laboratory to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

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Table 1. Number of larval native fish captured via light trapping and larval seining at all three reaches sampled (n is the number of light traps and larval seine hauls). Fish were only included that were identifiable to species level (or to the genus level for the "unknown chub" i.e. *Gila sp.*).

Reach	razorback sucker	flannelmouth sucker	bluehead sucker	unknown chub	Colorado pikeminnow	speckled dace
Green River (RMI 19.7-119.6) n=115	6779	244	170	6	1	38
Colorado River (RMI 21.2-63.8) n=56	3594	36	560	1	0	2
Lake Powell Inflow (RMI 167.7-196.6) n=24	69	0	29	2	2	1
All	10442	280	759	9	3	41

Table 2. Number of YOY and age-1+ native fish captured via seining on the lower Green and Colorado Rivers (n is the number of seine hauls). Apart from the unknown suckers, fish were only included that were identifiable to species level (or to the genus level for the "unknown chub" i.e. *Gila sp.*).

Reach	razorback sucker	flannelmouth sucker	bluehead sucker	unknown sucker	unknown chub	Colorado pikeminnow	speckled dace
Green River (RMI 4.3-119.6) n=41	1	30	0	9	0	244	2
Colorado River (RMI 3.4-63.8) n=37	13	507*	0	0	1	158	4
All	14	537	0	9	1	402	6

*Estimated count due to large numbers (>100) flannelmouth being captured at the same time. In an effort to release fish alive, total number of fish was estimated.

Table 3. Number of identifiable non-native fish captured for all methods at all three reaches sampled. Fish were only included that were identifiable to species level.

Reach	black crappie	black bullhead	bluegill	channel catfish	common carp	western mosquitofish	green sunfish	gizzard shad	largemouth bass	white sucker
Green River (RMI 4.3-119.6)	0	36	0	229*	19	0	34	0	1	1
Colorado River (RMI 3.4-63.8)	1	602*	1	1	97	60	1	66	15	10
Lake Powell Inflow (RMI 167.7-196.6)	0	0	0	0	10	0	0	136	1	0
All	1	638	1	230	126	60	35	202	17	11

*Estimated count due to large numbers (>100) of these species being captured at the same time.

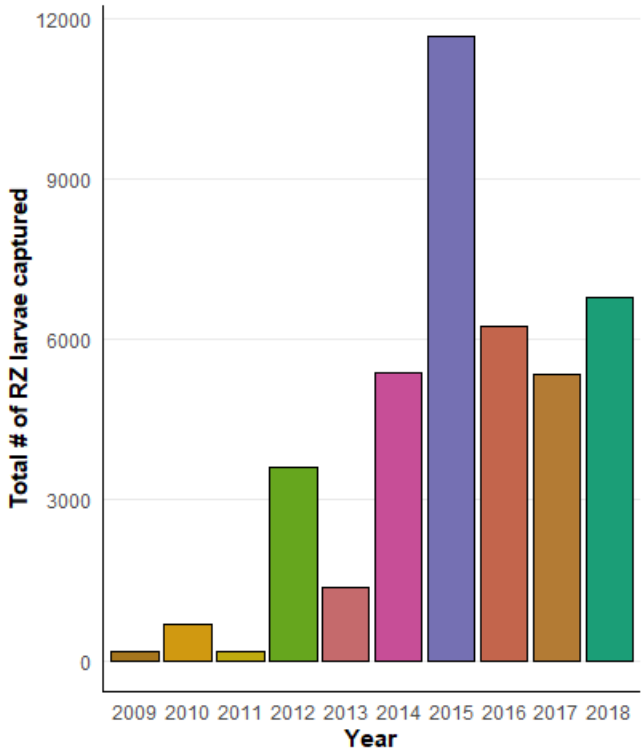

Figure 1. Total number of razorback sucker larvae captured by light trapping at all sites on the lower Green River by year.

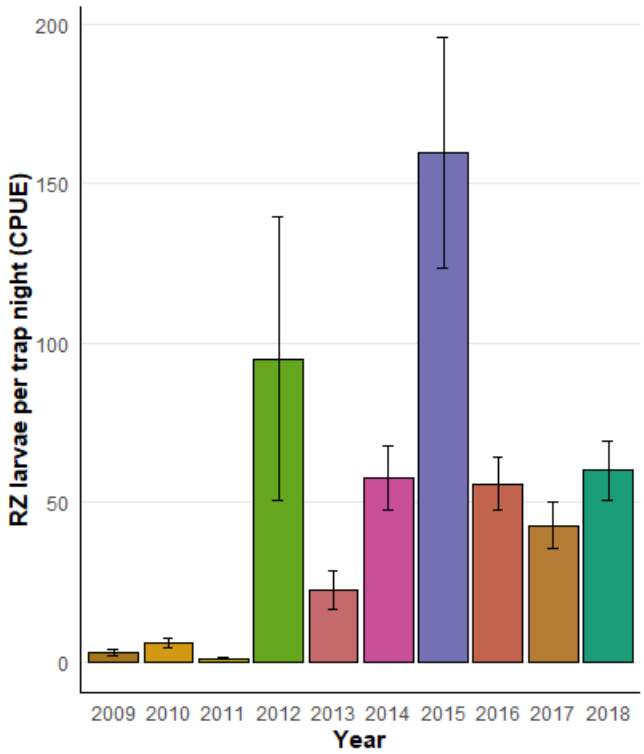

Figure 2. Mean catch per unit effort (number of razorback sucker larvae per trap night) for larval light trapping by year for all sites on the lower Green River. Error bars represent standard error.

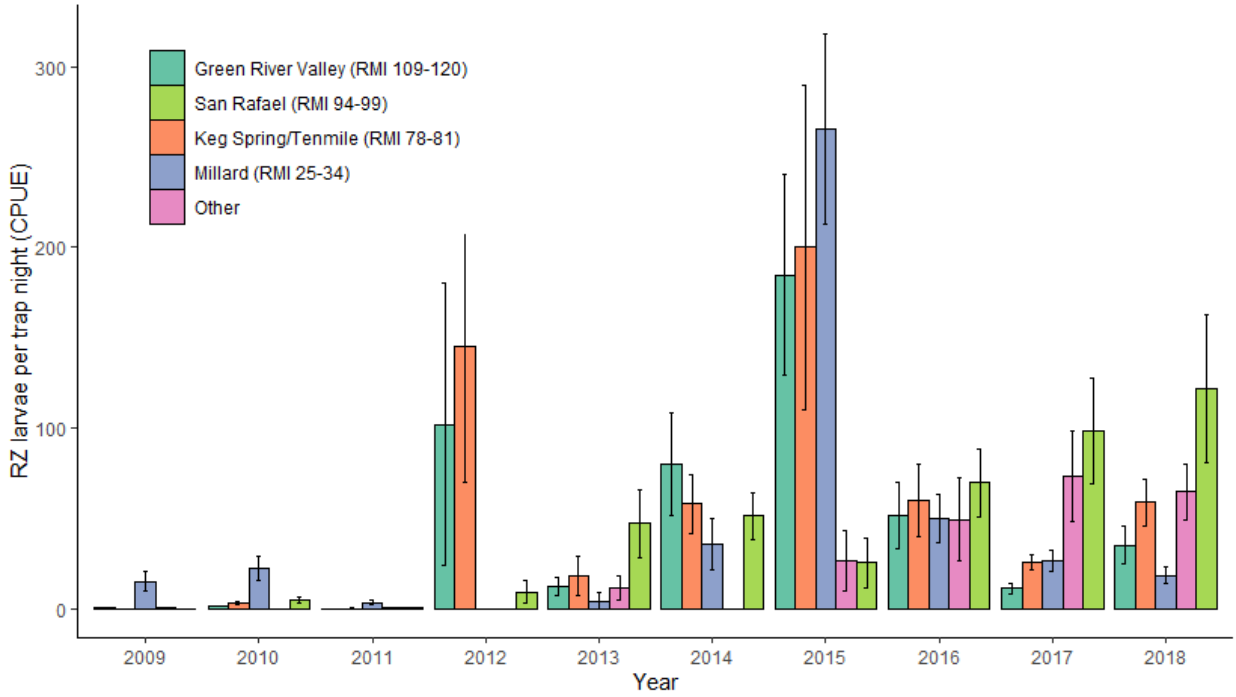

Figure 3. Catch per unit effort (razorback sucker larvae per trap night) for larval light trapping by year and by reach on the lower Green River. "Other" sites are additional sites sampled outside of the established reaches and are dispersed throughout the river from RMI 4.2 to RMI 105.4.

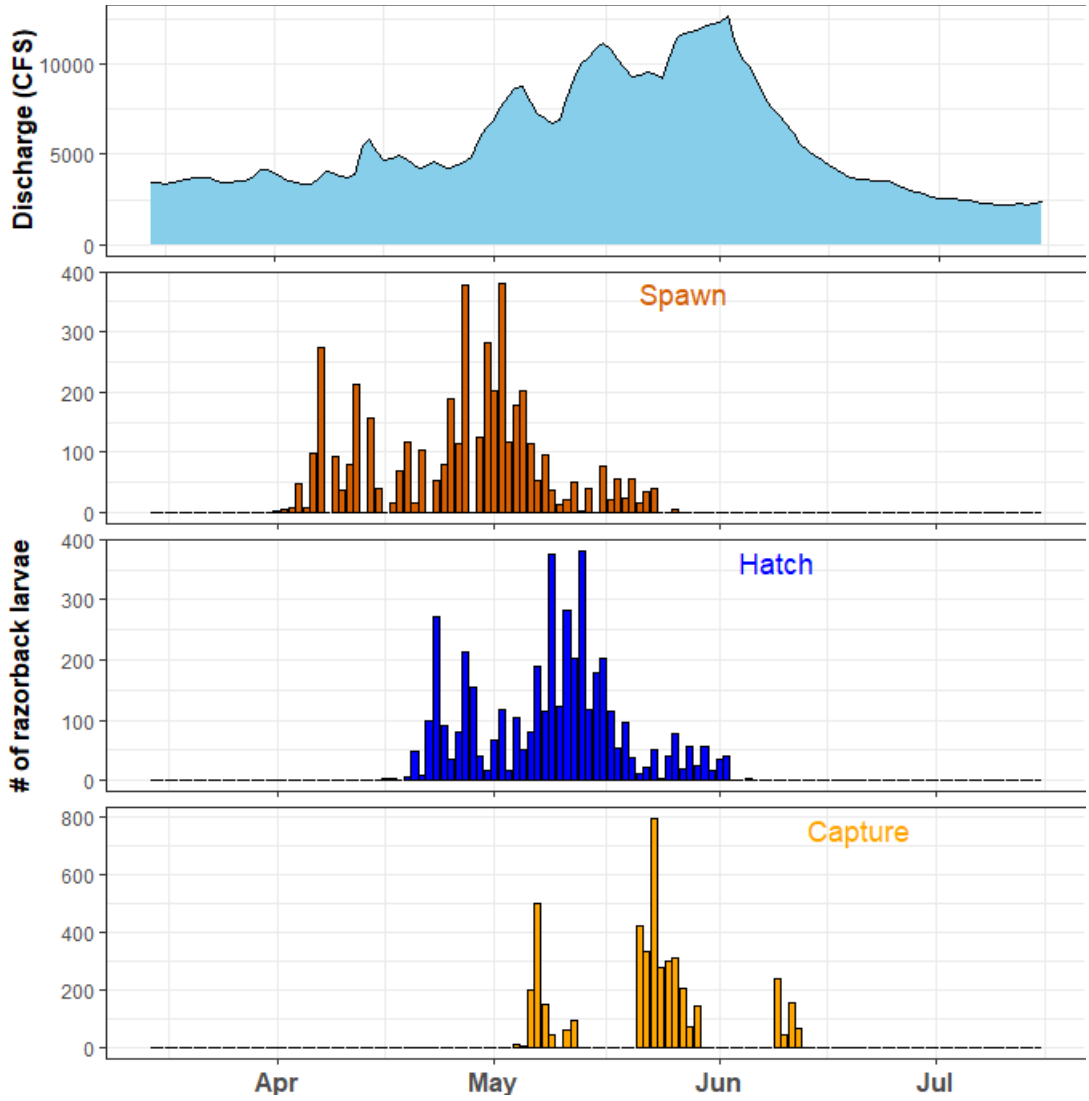

Figure 4. Estimates for the number of razorback sucker larvae per hatching and spawning date, and the number of razorback sucker larvae per capture date in the lower Green River and corresponding mean daily discharge from USGS gauge 09315000 at Green River, UT.

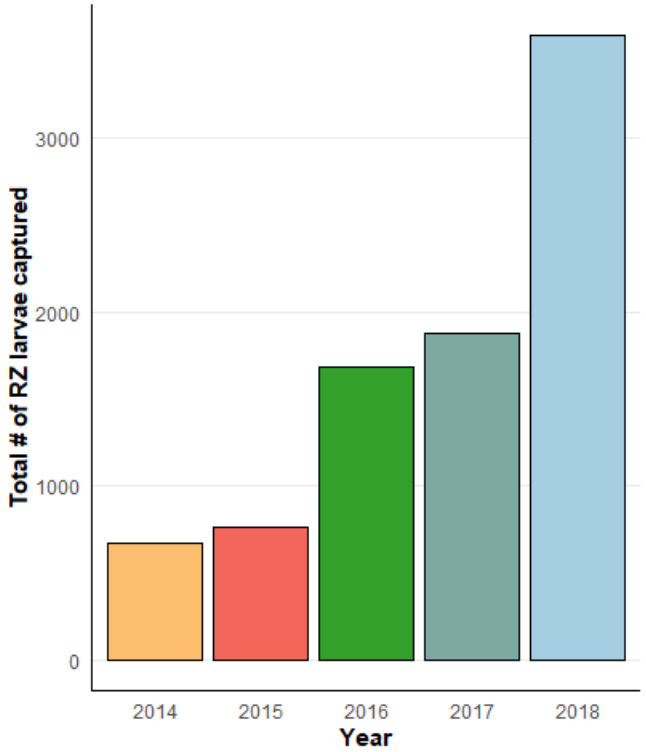

Figure 5. Total number of razorback sucker larvae captured by light trapping at all sites on the Colorado River by year.

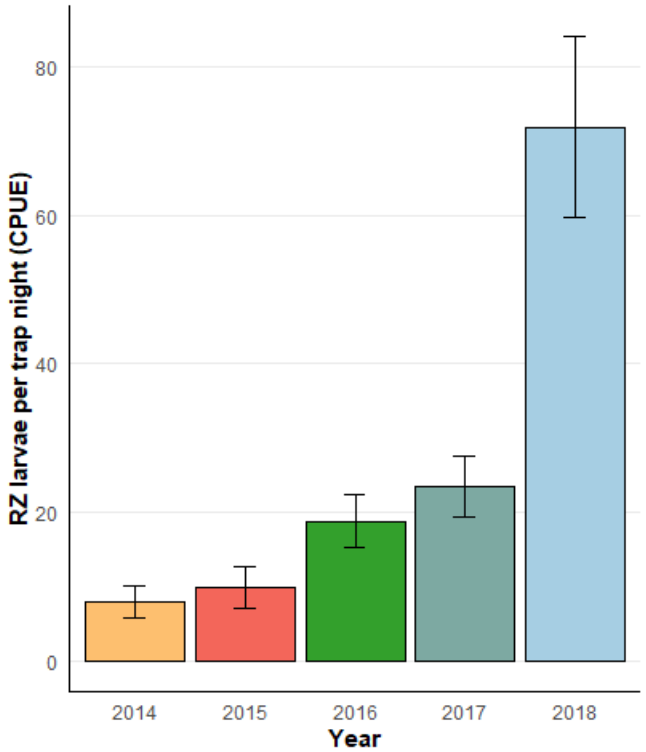

Figure 6. Mean catch per unit effort (number of razorback sucker larvae per trap night) for larval light trapping by year for all sites on the Colorado River. Error bars represent standard error.

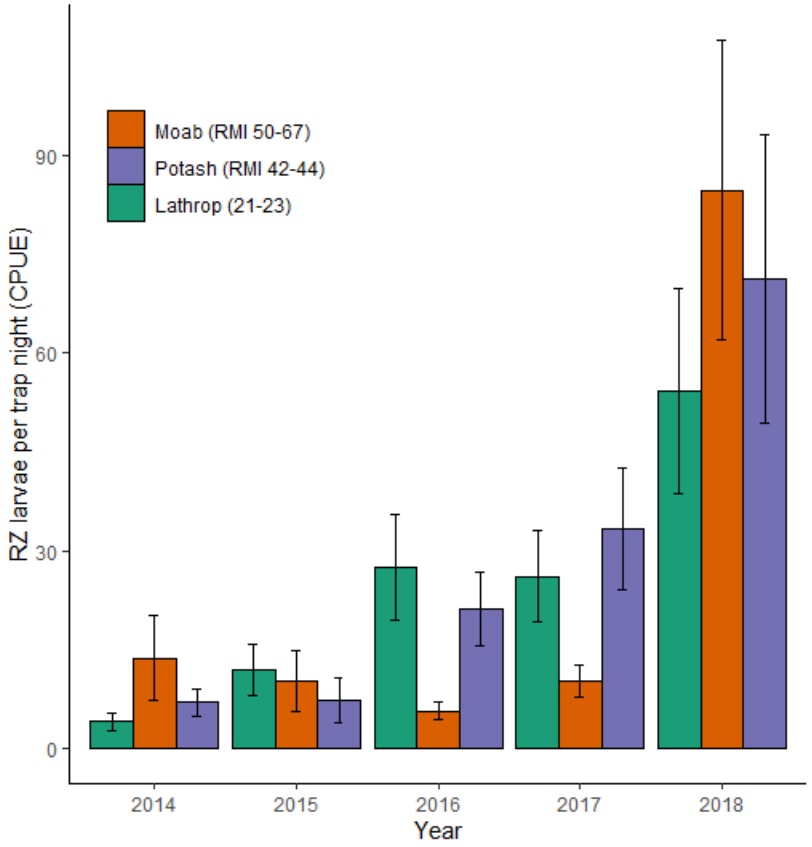

Figure 7. Catch per unit effort (razorback sucker larvae per trap night) for larval light trapping by year and by reach on the Colorado River.

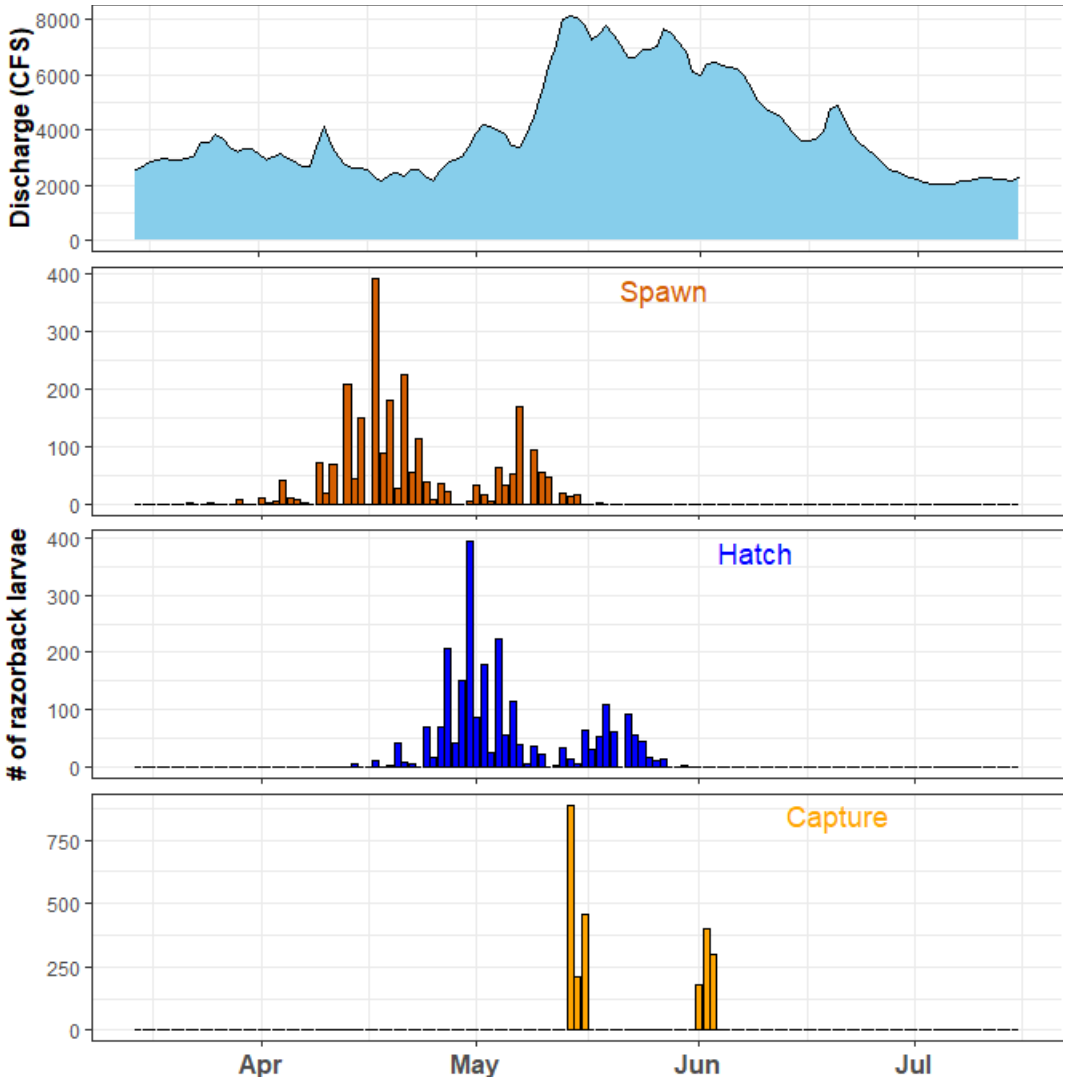

Figure 8. Estimates for the number of razorback sucker larvae per hatching and spawning date, and the number of razorback sucker larvae per capture date in the Colorado River and corresponding mean daily discharge from USGS gauge 09180500 Colorado River near Cisco, Utah.

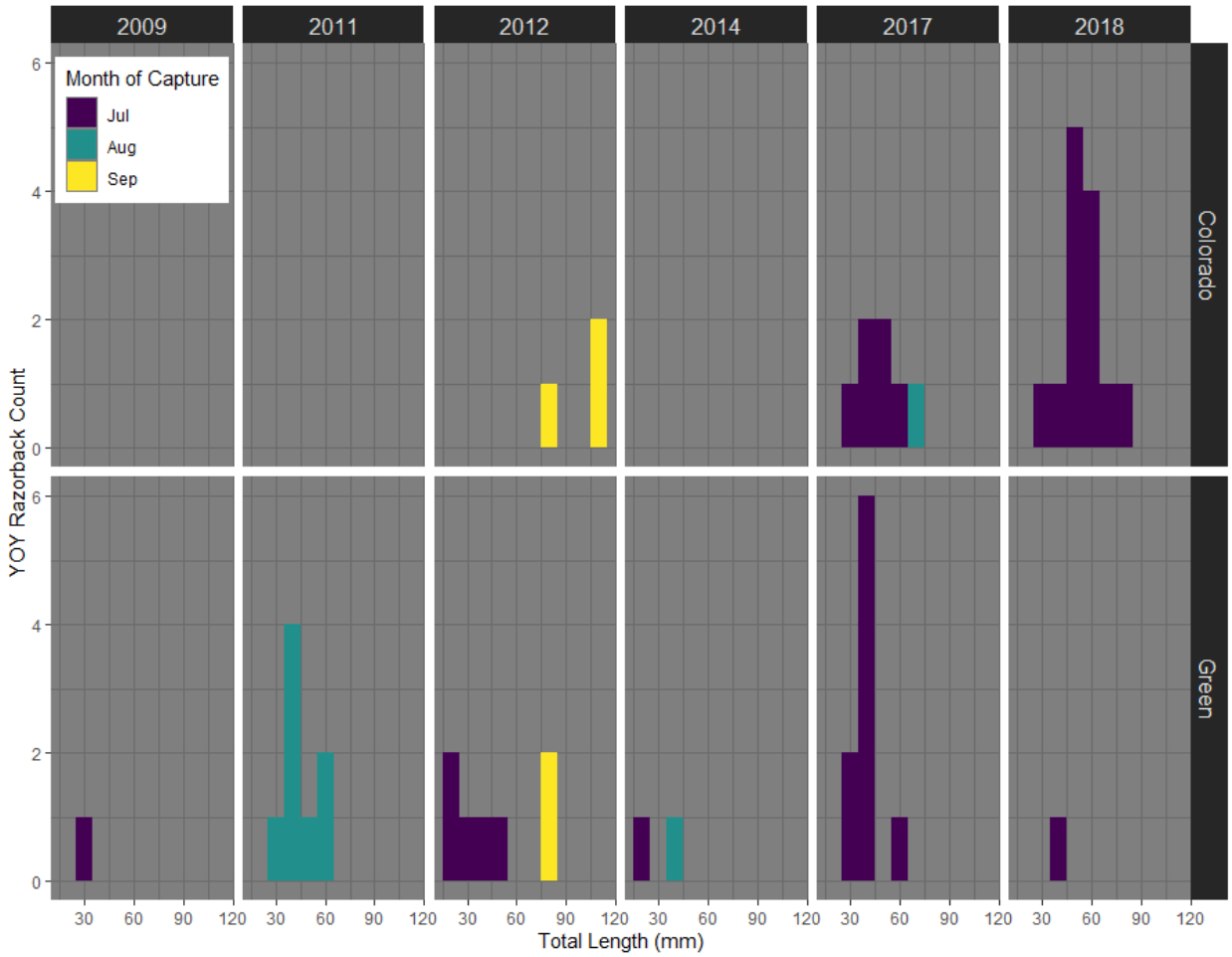

Figure 9. Young of year (YOY) razorback sucker captures from seine sampling for this study (project 160) and project #138 (ISMP sampling) combined, by reach and year. YOY razorbacks are plotted by total length. There have been numerous years during which no YOY razorbacks have been captured (2010, 2013, 2015, 2016), these years are not displayed on this figure. Also, note that sampling for project #160 on the Colorado River did not begin until 2014. One razorback captured in 2012 on the lower Green River is not included in this figure because total length was not measured.