

COLORADO RIVER RECOVERY PROGRAM
FY 2013 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 138

I. Project Title: Annual Fall Monitoring of Young of Year Colorado Pikeminnow and Small-Bodied Native Fishes

II. Bureau of Reclamation Agreement Number: R09AP40847

Project/Grant Period: Start date (Mo/Day/Yr): 11/13/2008
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Is this the final report? Yes _____ No X

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IV. Abstract:

Monitoring of young-of-year (YOY) Colorado pikeminnow (*Ptychocheilus lucius*) is an ongoing project that was initiated in 1986 in the upper Colorado River basin as part of the Interagency Standardized Monitoring Protocol (ISMP; USFWS 1987) to monitor recruitment success of age-0 endangered fishes. In 2013, fall monsoonal rain events greatly affected flows and habitat conditions in the Colorado and Green rivers, which led to differential catch rates for YOY Colorado pikeminnow by reach. Specifically, catch rates were low in reaches one and three due to limited habitat availability with increased discharge, whereas catch rates exceeded the ten year average in reach 4, which may be explained by fluctuations in turbidity.

V. Study Schedule: 1986-on going. It is anticipated that this study will continue indefinitely and will be a component of studies designed to evaluate a variety of management actions.

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 2013 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Middle Green River – Reach 4

Annual monitoring for YOY Colorado pikeminnow began 23 September 2013 and was completed on 2 October 2013. Seining began at the uppermost sub-reach near river-mile 319 (Split Mountain boat ramp) and continued downstream by sampling three backwater habitats within every 5-mile sub-reach, concluding at river-mile 215 (Sand Wash). A total of 59 of 63 possible backwaters were sampled; 21 primary, 20 secondary, and 18 tertiary. Tertiary backwaters are only sampled in reach 4, in an attempt to demonstrate the effectiveness of nonnative control efforts within this same reach. Captures from only primary and secondary sites are reported for comparisons to previous years of YOY sampling, to maintain consistent methods throughout reaches and years. Four backwaters in three sub-reaches were not sampled due to lack of habitat availability.

Green River main channel temperatures averaged 16.3 °C (12.7–22.0 °C) and backwater temperatures averaged 17.6 °C (11.2–29.9 °C) during the sampling period. Mean daily discharge (USGS gauge #09261000) for the sample period was 1,683 cubic feet per second (cfs; range = 1,430–2,020 cfs), which was lower than the 66 year record of 1,983 cfs (Figure 1). Mean annual discharge for 2013 (2/28/13–10/29/13) was also lower than

the 66 year average for the same time period (2,995 and 5,223 cfs, respectively), making 2013 another moderately dry year (Figure 1).

In primary and secondary backwaters, we captured 97 YOY Colorado pikeminnow and did not collect any juvenile Colorado pikeminnow. The catch-per-unit-effort (fish/100 m²) for YOY Colorado pikeminnow (1.37) was higher than the 10 year average (0.85), but lower than the 24 year average (1.83; Table 1). The average length of YOY Colorado pikeminnow was 51.7 mm TL, larger than the 10 and 24 year average (TL = 49.1 and 45.7 mm, respectively; Table 1). Mean length was similar to 2012, also a low flow year with warmer temperatures (Figure 4) and a longer growing season. In comparison, 2012 and 2013 mean length was greater than 2009 and 2010 which experienced prolonged high flows and lower temperatures, likely slowing growth rates (Table 1). Sampling within tertiary backwaters accounted for the capture of an additional 30 YOY Colorado pikeminnow

Other native species captures are only reported for the first seine haul within primary backwaters, to match past data collection methods (Table 2); this included one flannelmouth sucker (TL = 58 mm), and one bluehead sucker (TL = 48 mm). Secondary and tertiary backwater catches included two bluehead sucker (TL = 44 and 59 mm), four flannelmouth sucker (mean TL = 67.8 mm), and one unknown *Gila* spp. (TL = 43 mm). Flannelmouth and bluehead sucker YOY abundance was lower than most years (Table 2), possibly suggesting that low flow conditions limited reproductive success, or that fish moved out of backwaters into main channel habitats prior to the sampling period given that they were larger in size. The highest proportion of native fishes was observed in secondary and tertiary backwaters including 100% of the Colorado pikeminnow catch (Figure 3). Furthermore, tertiary backwaters accounted for 60% of flannelmouth captures and 24% of YOY Colorado pikeminnow captures (Figure 3), demonstrating the importance of continual monitoring of a third backwater in each sub-reach.

Seine samples continue to be dominated by small-bodied nonnative cyprinids, mainly fathead minnow, red shiner, and sand shiner (Table 3). We collected a total of 10,553 nonnative fish comprised of 12 species in the first seine haul of the primary backwaters (Table 3). Additional species collected in subsequent seine hauls and backwaters included creek chub ($n = 7$), Iowa darter ($n = 1$), plains killifish ($n = 1$), and white x bluehead sucker hybrid ($n = 1$).

Task 2: Lower Green River – Reach 3

Sampling began on 16 September and concluded on 18 September 2013. Data was collected for the 120-mile reach of the Green River from Green River State Park (river-mile 120) to its confluence with the Colorado River (river-mile 0). Two backwaters were sampled in each 5-mile sub-reach, with 2 seine hauls performed within each habitat, when possible. Out of 24 total sub-reaches, 8 were not sampled due to a lack of suitable Colorado pikeminnow habitat. Twenty-two backwaters were seined out of 48 possible, with 35 seine-hauls completed out of 96 possible. A total area 2,381 m² of suitable

habitat was surveyed in 2013, which is considerably lower than the amount of habitat surveyed in 2012 (4,716 m²) and the 28-year average (3,565 m²). Main channel temperatures fluctuated between 21 and 24 °C (mean = 21.8 °C) and backwater temperatures varied between 21 and 27 °C (mean = 23 °C).

Discharge as measured at the USGS gaging station in the town of Green River (#09315000) steadily declined through the 3-day interval in which sampling took place (Figure 6). Mean flow for this 3-day period was 2,796.7 cfs which is similar to historic mean flows (1894-2013) of 2,623.3 cfs and post-dam mean flows (1964-2013) of 2,826.7 cfs for the same 3-day period. This year the Green River reached its peak flow of 11,500 cfs on 22 May (Figure 6). Mean peak flow based on 118 years of observation (1895-2013) is considerably higher at 28,094 cfs. Mean post-dam peak flow (1964-2013) is 22,710 cfs. The river reached its lowest flow (1,120 cfs) on 23 August (Figure 6).

Thirty-one YOY Colorado pikeminnow were captured along this 120-mile reach of the Green River (Table 4; all but two were released alive). Total abundance in 2013 is considerably lower than the 10-year (211.5), 15-year (224.5) and 28-year (459.6) averages. Catch-per-unit-effort for 2013 was 1.30 fish/100 m², well below that for 2012 (6.21 fish/100 m²) and the 10, 15 and 28-year averages (6.74, 6.20 and 13.59 fish/100 m² respectively). Mean length of YOY Colorado pikeminnow in 2013 was 52.83 mm (range = 22–80 mm), similar to that found in 2012 (50.27 mm) and substantially greater than the 10-year (41.27 mm), 15-year (41.17 mm) and 28-year (39.50 mm) average lengths (Table 4).

Colorado pikeminnow was the only native species collected within reach 3 in 2013 (Table 5). Nonnative captures totaled 13,587 fish representing 7 species and were dominated by nonnative cyprinids (Table 6); sand shiner (n=9,975), red shiner (n=2,550), and fathead minnow (n=1,025).

The area surveyed in 2013 was the 5th lowest on record. Habitat sampled this year was approximately half of that surveyed in 2012 and down 33% from the 28 year average. Total abundance of YOY pikeminnow and CPUE were both the 4th lowest on record (Table 4). Monsoonal weather patterns developed within the Green River watershed in early September and persisted through the period of study. At the time of sampling, some of the zero-velocity backwaters normally sampled were inundated and flowing. The resulting decrease in zero-velocity habitat may help to explain the limited amount of habitat sampled and consequent low YOY pikeminnow abundance.

Task 3: Lower Colorado River: Reach 1

Monitoring for YOY Colorado pikeminnow began on 17 September and ended on 20 September 2013. Researchers sampled Colorado pikeminnow habitat from Cisco Landing (river-mile 110.5) to the Colorado River's confluence with the Green River (river-mile 0). Two areas of suitable habitat were surveyed within each 5-mile sub-reach

and 2 seine hauls were performed per habitat when possible. Sixteen out of 22 sub-reaches were surveyed and 37 out of 88 possible seine hauls completed. A total area of 1,769 m² of suitable YOY Colorado pikeminnow habitat was surveyed in 2013, which is lower than the area surveyed in 2012 (2,240 m²) and the 28-year average (2,909.89 m²). For the sampling period, average main channel temperature was 20.36 °C (range = 18.5–21 °C) and habitat temperature was 21.07 °C (range = 17–26 °C).

Mean discharge on the Colorado River during the sampling period was 5,132.5 cfs, considerably higher than mean discharge for these dates based on 94 years of record (3,787.5 cfs) as measured at the gaging station near Cisco, Utah (# 09180500). The Colorado River peaked on 19 May 2013 at 11,900 cfs, which is lower than the mean maximum discharge of 23,500 cfs (Figure 7). Minimum discharge of 2,140 cfs occurred on August 22 (Figure 7).

One YOY Colorado pikeminnow was captured during ISMP within the 110.5 mile reach of the Colorado River. This is well below the 10, 15 and 28-year averages (Table 7; 44.7, 60, and 123.25 fish respectively). Likewise, CPUE of 0.05 fish/100 m² was below the 10, 15, and 28-year averages (Table 7; 2.1, 1.9 and 4.1 fish/100 m²). Total length of the individual captured was 31 mm, also lower than the 10, 15, and 28-year averages (Table 7; 38.09, 39.46, 38.13).

Two additional species of native fish were captured during ISMP within this reach in 2013 (Table 8). Crews netted five unidentified chub (*Gila* spp.), ranging in size from 35 mm to 115 mm and one bluehead sucker (57 mm). Eleven species of nonnative fish totaling 7,020 individual fish were captured and enumerated during ISMP (Table 9), mainly consisting of sand shiner (n=4,640), red shiner (n=1,566), and fathead minnow (n=666). Plains killifish (n=2) were captured for the first time since 2006.

The amount of habitat surveyed in 2013 was down 20% as compared to 2012 and down over 40% as compared to the 28 year record (Table 7). Moreover, 2013 ranks as the 3rd lowest year in abundance and CPUE of YOY pikeminnow (Table 7). Regional weather events in early September caused an abrupt increase in discharge and river height along the lower Colorado River during the time of sampling. Pulses in discharge flooded zero-velocity nursery habitat that would normally have been suitable YOY pikeminnow habitat. The lower-than-average pikeminnow abundance and CPUE is more likely a factor of limited habitat availability during the time of sampling than an indication of poor fall recruitment.

Task 4: Data Entry

Data entry was completed by November 1, 2013 for all reaches and database management is ongoing.

Task 5: Data analysis and report writing

Analysis is complete and the annual report will be provided by November 14, 2013.

VIII. Additional noteworthy observations:

Observations from our 2013 sampling suggest that walleye are now reproducing successfully in the middle Green River. One YOY walleye (TL = 76 mm) was collected from a backwater located at RM 249.5, which is approximately 1.5 miles upstream of the Duchesne River confluence. Considered to be a significant source due to Starvation Reservoir escapement (Brunson et al. 2007), the Duchesne River is not likely to be the origin of this age-0 walleye given that it was collected well upstream of the confluence. Red Fleet Reservoir is another possible source from upstream (Johnson et al. 2013), but not likely given the low flow operations during this moderately dry year and that this fish would have traveled > 50 miles to end up at this location. Whether or not reproduction is widespread at this point in the middle Green River, there has been a significant increase in the adult population (Skorupski et al. 2013) and this finding provides evidence that it is occurring at some level.

The past two years were both moderately dry with a comparable mean annual discharge of 3,095 and 2,995 cfs, respectively. However, we observed a 50 fold increase in YOY Colorado pikeminnow and a 20 fold increase in smallmouth bass (mean TL = 84.3 mm) captures from 2012 to 2013 (Tables 1 and 3). Temperatures from June to October remained consistent between the two years (Figure 2); however, discharge and turbidity, particularly for September were markedly different (Figures 4 and 5). From 25 June to 25 September 2012 discharge in the middle Green River dropped considerably (1,778–1,243 cfs) and was observed to have decreased backwater areas in the Middle Green River by up to 60%, and backwater depths up to 36%, while some backwaters remained unaffected (UDWR unpublished data). Conversely, discharge in the middle Green River increased considerably in September 2013 (1,307–1,971 cfs) due to monsoonal rain events, which likely increased backwater area, depth, and connectivity (Figure 4). Increased discharge may have influenced fish movement into low velocity habitats, and combined with increased habitat size and availability, may have influenced YOY Colorado pikeminnow and smallmouth bass captures in 2013. With increased turbidity for the months of August and September due to isolated rain events and subsequent flash floods (Figure 5), we suspect that predator avoidance of YOY Colorado pikeminnow led to greater survivability, as demonstrated with other endangered fishes in the Colorado River basin (e.g., Johnson and Hines 1999). For example, > 50% of the backwaters we sampled contained smallmouth bass and Colorado pikeminnow abundance was quite high relative to previous years (Table 1). Capture efficiencies may also have been higher as fish avoidance of the seine may have been reduced by turbid conditions.

Monsoonal weather patterns crossed southeast Utah during early September. The lower Colorado and Green River watersheds received a considerable amount of precipitation which produced a significant increase in flow. Gaging stations along several low volume tributaries recorded extreme increases in discharge. The Dolores River, a tributary of the Colorado River, peaked with a discharge of 4,970 cfs at 2:00 pm on 12 September (up

from 337 cfs at 1:00 am on the same day). The Price River, a small tributary of the Green River reached 2,140 cfs at 4:45 am on 12 September, up from 38 cfs on 9 September. These tributaries brought not only additional flow to reaches one and three, but also an increased sediment load and other debris.

The below-average number of captures of YOY Colorado pikeminnow is not necessarily a reflection of poor fall recruitment, but may be an artifact of increased river levels and consequent reduction in habitat quality and availability. On 7 September 2013 the USGS gage near Cisco registered 2,640 cfs, however, by 15 September the discharge of the Colorado River had increased to 6,590 cfs (Figure 7). This equates to a gage height rise of over 2 feet. According to the USGS gage at Green River, the river rose just over 1 foot within the week prior to sampling (5.5 feet on 7 September to slightly over 6.5 feet by 16 September). This increased flow allowed current to push through backwaters and embayments which would have otherwise been low or zero-velocity habitats (given previous flows). The monsoonal pulse in discharge and river height reduced the amount of habitat available for sampling and likely influenced the low numbers of YOY Colorado pikeminnow captured in 2013.

During the months of July and August, UDWR-Moab crews working on Recovery Program Project #160 (Lower Green River Razorback Sucker Larval and YOY Monitoring Pilot Study) captured 147 YOY Colorado pikeminnow while seining the same section of the lower Green River (Howard 2013). Researchers seined 4,976 m² of habitat (note: the habitat surveyed did not necessarily conform to ISMP protocol). Catch-per-unit-effort for Colorado pikeminnow was 2.95 fish/100 m². The mean flows during these surveys were 1,470 cfs and 1,270 cfs. Researchers noted the presence of more high quality backwaters and embayments with lower flows on the Green river. This data is an encouraging indication that below-average abundance of YOY Colorado pikeminnow found during 2013 ISMP sampling is not necessarily an indication of a below-average cohort but may be more directly linked to habitat availability during the time of sampling.

IX. Recommendations:

- Continue to monitor annual relative abundance of post-larval Colorado pikeminnow in the middle Green River, lower Green River and lower Colorado River to develop indices and determine the relationships between these indices and stream flow, water temperature, abundance of sympatric fishes, and physical characteristics of backwaters.
- Given that 2013 data suggests there may be a relationship between increased turbidity and catch rates, we recommend that turbidity measurements (in the backwater and main channel) become a new addition to the ISMP protocol. Collection of additional variables, especially when not time consuming, will greatly benefit future analyses for determining long-term patterns in Colorado pikeminnow recruitment.

- Data collected from this project is not ideal for evaluating YOY native fish response

to nonnative predator control measures in the middle Green River. ISMP sampling only provides a snapshot in time; interactions between YOY native fishes and early life-stage nonnative predators (i.e., habitat overlap) are not adequately captured (Skorupski et al. 2012). Furthermore, treatment and control reaches used to assess native fish response in other areas of the upper Colorado River basin (e.g., Bestgen et al. 2007) do not exist in the middle Green River. We recommend that a separate study specifically focused on investigating YOY native species overlap with YOY nonnative predators on a temporal basis is necessary to determine whether detrimental interactions are occurring when they are most crucial (i.e., while nonnative predators are utilizing the same habitats). A final report will be completed for project 158 in FY 2014; recommendations based on a complete analysis may provide further insight towards the potential development of a separate project for monitoring native fish response.

- Deploy main channel temperature data loggers in the lower Colorado and Green River reaches. Temperature trends on the lower Green River and lower Colorado River cannot be examined because continuous and accurate temperature data is not available from current local gages.
- Develop a measure or scale to describe localized hydrologic/climatic events, specifically flash flood events. Although the magnitude and timing of peak flows have been found to be related to YOY abundance and growth, we do not have an adequate measure for more localized hydrologic/climatic events that can affect a significant percentage of the zero-velocity habitats.

X. Project Status: On track and ongoing

XI. FY 2013 Budget Status

- A. Funds Provided: \$53,659
- B. Funds Expended: \$53,659
- C. Difference: \$0
- D. Percent of the FY 2013 work completed, and projected costs to complete: 100%
- E. Recovery Program funds spent for publication charges: \$0

XII. Status of Data Submission:

Data is formatted and has been QA/QC checked and will be submitted to the USFWS by January 2014.

XIII. Signed: Matthew J. Breen & Christopher M. Michaud 10/31/2013
Principal Investigators Date

References:

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Table 1. The middle Green River (Reach 4) total abundance, lengths and mean catch-per-unit-effort (CPUE; fish/100 m²), by year for young-of-year (YOY) Colorado pikeminnow collected during YOY monitoring for the period of 1990–2013. *To be consistent with previous years, information in this table contains only those individuals captured in the first two backwaters of a sub-reach.*

Year	Total Abundance	Mean Length (mm)	Range (mm)	Total Area Sampled (m²)	CPUE (Fish/100m²)
1990	341	45.4	28 – 80	5093	5.5
1991	524	38.2	21 – 65	5077	10.3
1992	183	43.1	26 – 133	4697	3.9
1993	305	36.4	21 – 59	3960	7.7
1994	15	67.2	60 – 80	4356	0.3
1995	75	34.5	21 – 48	3792	2.0
1996	79	39.4	25 – 60	3912	2.0
1997	22	36.0	28 – 49	3734	0.6
1998	73	38.5	22 – 61	4986	0.9
1999	12	33.7	25 – 45	3897	0.3
2000	31	50.9	37 – 76	3798	0.8
2001	8	46.9	36 – 67	4496	0.2
2002	0	N/A	N/A	5202	0
2003	2	52	52 – 52	4696	0.04
2004	60	43.8	31 – 63	4686	1.28
2005	8	48.6	35 – 60	4190	0.2
2006	5	45.8	36 – 50	7490	0.07
2007	3	73.3	69 – 76	5782	0.05
2008	18	43.9	36 – 56	4994	0.36
2009	325	43.7	22 – 71	7503	4.3
*2010	454	37.9	24 – 58	–	–
2011	0	N/A	N/A	7852	0
2012	2	53.5	39-68	7805	0.03
2013	97	51.7	35-82	6735**	1.37**

*Four YOY Colorado pikeminnow were not included because they were not measured.

**Total area does not include one backwater excluded due to lack of measurements. Five pikeminnow collected in this backwater were included in total abundance, but not CPUE.

Table 2. The middle Green River (Reach 4), total captures by year for native fish during young-of-year monitoring from 1986–2011. Colorado pikeminnow abundance reflects captures from primary and secondary backwaters sampled in each sub-reach; abundance of other native species reflects captures from primary backwaters only. In some years, species other than Colorado pikeminnow were only enumerated during the first seine haul within primary backwaters. Species collected include YOY Colorado pikeminnow (CS YOY; 10–99 mm), juvenile pikeminnow (CS JUV; 100–399 mm), unidentified *Gila* spp. (CH), bonytail (BT), roundtail chub (RT), flannelmouth sucker (FM), bluehead sucker (BH), and speckled dace (SD).

Year	CS YOY	CS JUV	CH	BT	RT	FM	BH	SD
1986	492	0	32	–	0	47*	47*	132
1987	209	10	19	–	0	67	277	2
1988	885	36	5	–	0	120	1	6
1989	62	0	41	–	0	16	80	3
1990	341	47	22	–	0	0	9	2
1991	524	0	7	–	0	0	0	0
1992	183	0	4	–	1	2	115	11
1993	305	0	40	–	0	54	80	7
1994	15	0	13	–	0	38	32	10
1995	75	0	6	–	0	20	62	33
1996	79	0	6	–	1	31	53	7
1997	22	0	42	–	0	12	73	8
1998**	73	0	63	–	0	25	49	6
1999	12	0	43	–	0	18	20	16
2000**	31	0	3	–	0	6	12	2
2001	8	0	23	–	0	78	0	0
2002	0	0	3	–	0	3	0	0
2003	2	0	2	–	0	4	2	0
2004	60	0	12	–	0	16	2	1
2005	8	2	13	–	0	7	3	2
2006	5	0	0	–	0	5	0	0
2007	3	1	2	–	0	10	11	0
2008	18	0	0	–	1	12	6	0
2009	325	0	0	–	13	57	36	1
2010	454	1	0	–	0	2	38	1
2011	0	3	0	–	1	57	35	0
2012	2	0	0	–	1	11	1	0
2013	97	0	0	–	0	1	1	0

*Suckers not identified to species, thus half of suckers were applied to bluehead and half to flannelmouth.

**One razorback sucker YOY was observed as well.

Table 3. Total abundance of nonnative fish collected during young-of-year monitoring in the middle Green River (Reach 4) from 1987–2011. Only fish enumerated in primary backwater first seine hauls are included. Species collected include black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1987	0	0	0	1	3	873	0	8	0	0	0	0	9757	0	462	0	0	0
1988	2	0	0	7	2	620	0	13	0	0	0	0	4072	0	159	0	0	0
1989	0	0	0	7	43	865	0	22	0	0	0	0	4025	0	284	0	0	0
1990	0	0	0	1	4	1386	0	0	0	0	0	0	5395	0	87	0	0	0
1991	0	0	0	14	5	1	0	1	0	0	0	0	64	0	0	0	0	0
1992	1	0	0	3	15	1653	0	5	0	0	0	0	3178	0	440	0	0	0
1993	0	0	0	17	13	1512	0	3	0	0	0	0	4677	0	49	0	0	0
1994	0	1	0	0	0	2757	0	1	0	0	0	0	28,903	0	1890	0	0	0
1995	0	0	0	0	6	1304	0	1	0	0	0	0	3229	1	188	0	0	0
1996	0	0	0	0	5	486	0	8	0	0	0	0	2871	0	1265	0	0	0
1997	0	4	0	0	11	1067	0	3	0	0	0	0	1010	1	1152	0	3	0
1998	7	11	0	3	8	1569	0	17	0	0	1	0	2400	0	474	0	1	0
1999	3	3	0	0	23	407	0	68	0	0	0	0	1832	0	533	0	0	0
2000	2	3	0	0	12	1436	0	15	0	0	0	0	10,860	0	8072	0	0	0
2001	1	10	0	6	0	371	0	0	0	0	0	0	4512	0	283	0	0	0
2002	0	5	1	0	1	1303	0	39	0	0	0	0	11,516	0	1059	0	1	0
2003	0	1	0	0	48	89	0	0	0	0	0	0	3847	0	49	0	0	0
2004	0	1	0	4	1	337	0	8	0	0	0	0	5524	0	1207	0	5	0
2005	0	18	0	1	1	204	0	0	0	0	0	0	3654	0	552	0	0	0
2006	0	7	3	0	98	1431	0	1	5	0	0	0	19,365	0	2060	0	3	0
2007	9	0	0	10	16	327	0	0	3	0	0	0	5754	6	3940	0	13	0
2008	1	16	0	3	40	155	0	102	0	0	0	0	1121	5	821	0	7	0
2009	0	4	0	0	17	108	0	1	2	0	0	0	2101	1	417	0	5	0
2010	1	0	0	1	38	231	0	15	0	0	0	0	3596	0	959	0	8	0
2011	5	3	0	0	13	867	0	14	0	0	0	0	1682	2	301	0	0	0
2012	0	0	0	6	1	189	0	0	22	0	0	0	2379	1	583	0	0	0
2013	0	4	0	1	1	323	0	21	1	0	0	0	6102	23	4018	1	55	0

Table 4. The lower Green River (Reach 3) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100 m²), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2013.

Reach 3	YOY Colorado	Mean Length	Length Range	Total Area	CPUE
Year	Pikeminnow	(mm)	(mm)	Sampled	(fish/100m²)
	Caught			(m²)	
1986	813	28.63		1964	41.40
1987	849	36.32		2831.8	29.98
1988	2892	39.41		3076.4	94.01
1989	1494	38.79		4261.8	35.06
1990	418	41.82		6516.6	6.41
1991	186	38.81		2822.2	6.59
1992	122	40.62		5181.6	2.35
1993	1616	37.36		4435.4	36.43
1994	354	37.36	14-74	3797.8	9.32
1995	56	49.98	23-99	2548	2.20
1996	410	24.94	13-45	2888.6	14.19
1997	39	41.4	19-75	2709.8	1.44
1998	252	33.1	19-40	3050.2	8.26
1999	384	32.1	18-68	4055.8	9.47
2000	705	26.8	15-38	5760	12.24
2001	17	37.9	21-88	5962	0.29
2002	22	43.2	30-68	4644.5	0.47
2003	124	64.9	22-90	4005.8	3.10
2004	80	60.1	30-96	1974	4.05
2005	63	46	26-84	2937.6	2.14
2006	331	31.2	23-41	4936	6.71
2007	686	40.3	23-80	3138	21.86
2008	60	44.8	26-95	2018	2.97
2009	423	35.32	20-46	2548	16.60
2010	131	29.86	15-45	2868	4.57
2011	17	22	15-26	1796	.95
2012	293	50.27	18-109	4716	6.21
2013	31	52.83	22-80	2381	1.30

Table 5. The lower Green River (Reach 3), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2013. Species listed are: YOY Colorado pikeminnow (CS YOY; 10-109 mm), juvenile pikeminnow (CS JUV; 110-399 mm), unidentified *Gila* spp. (CH), bonytail (BT), humpback chub (HB), razorback sucker (RZ), flannelmouth sucker (FM), bluehead sucker (BH), and speckled dace (SD). In most years species other than CS were only enumerated during the first haul within primary backwaters.

Year	CS YOY	CS JUV	CH	BT	HB	RZ	FM	BH	SD
1986	813	0	15	0	0	0	0	0	24
1987	849	9	1	0	0	0	5	1	0
1988	2892	109	0	0	0	0	2	0	2
1989	1494	59	1	0	0	0	17	0	0
1990	418	21	0	0	0	0	0	0	7
1991	186	3	0	0	0	0	0	2	2
1992	122	12	18	0	0	0	3	7	4
1993	1616	2	0	0	0	0	12	33	43
1994	354	0	7	0	1	0	0	1	6
1995	56	1	5	0	0	0	12	17	35
1996	410	1	0	0	0	0	1	21	20
1997	39	8	2	0	0	0	0	2	2
1998	252	0	0	0	0	0	0	3	30
1999	384	0	2	0	0	0	90	5	24
2000	705	3	1	0	0	0	0	0	5
2001	17	0	0	0	0	0	0	0	3
2002	22	0	1	0	0	0	4	0	4
2003	124	0	5	0	0	0	0	0	2
2004	80	0	0	0	0	0	1	1	0
2005	63	1	0	0	0	0	0	0	0
2006	331	0	6	0	0	0	0	0	0
2007	686	0	1	2	0	0	0	0	0
2008	60	1	0	0	0	0	8	0	1
2009	423	0	1	0	0	0	0	0	2
2010	131	3	0	0	0	0	7	3	12
2011	17	0	0	0	0	0	1	0	0
2012	293	0	2	0	0	2	9	0	0
2013	31	0	0	0	0	0	0	0	0

Table 6. The lower Green River (Reach 3), total captures by year for nonnative fish during young-of-year monitoring from 1986-2013. Only fish enumerated in primary backwater first seine hauls are included to maintain consistency among years and reaches. Species listed: black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1986	7	0	0	4	12	87	0	9	0	0	0	0	663	0	4	0	0	0
1987	0	0	0	1	0	34	0	5	0	0	0	0	1,303	0	4	0	0	0
1988	1	0	0	110	2	1,790	7	1	0	0	0	0	4,317	0	38	0	0	0
1989	1	0	0	73	1	170	0	3	0	0	0	0	5,826	0	113	0	0	0
1990	1	0	0	37	4	228	0	0	0	0	0	0	9,599	0	129	0	0	0
1991	0	0	0	8	3	314	0	2	0	0	0	0	7,746	0	1,123	0	0	0
1992	1	0	0	24	1	500	0	0	0	0	0	0	2,737	0	180	0	0	0
1993	1	0	0	11	1	249	0	0	0	0	0	0	3,443	0	1,362	0	0	0
1994	0	0	0	6	8	500	1	8	0	0	0	0	8,007	0	1,196	0	0	0
1995	7	0	0	4	16	363	0	6	0	0	0	0	3,478	0	969	0	0	0
1996	0	0	0	0	0	1,097	2	2	0	0	0	0	11,858	0	3,751	0	0	0
1997	0	0	0	17	1	79	4	3	0	0	0	0	855	0	320	0	1	0
1998	0	6	0	0	1	120	17	0	0	0	0	0	1,709	0	178	0	0	0
1999	0	1	0	2	37	340	1	0	0	0	0	0	845	0	156	0	0	0
2000	3	0	0	12	3	234	0	1	0	0	0	0	3,591	0	574	0	4	0
2001	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	122	2	14,721	0	1	0	0	0	0	26,710	0	2,135	0	0	0
2003	5	0	0	11	1	201	0	12	0	0	0	0	4,707	0	43	0	0	0
2004	3	0	0	7	0	215	0	1	0	0	0	0	297	0	190	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	2	1	0	6	3	1,187	1	4	0	1	0	0	8,623	0	0	0	0	0
2007	0	0	0	23	0	2,183	0	0	1	2	0	0	8,807	0	35	0	0	0
2008	0	2	0	13	116	1,074	0	0	1	1	0	0	4,458	0	250	0	0	6
2009	0	0	0	3	0	1,044	0	0	1	0	0	0	2,766	0	15	0	0	0
2010	0	0	0	0	0	150	0	5	4	0	0	0	1,028	0	1,025	0	0	0
2011	0	8	0	6	15	314	0	0	0	0	0	0	1,842	0	1,096	0	0	0
2012	8	0	0	5	5	3,085	0	4	15	0	0	0	2,043	0	8,620	0	0	3
2013	0	0	0	19	6	1,025	0	6	6	0	0	0	2,550	0	9,975	0	0	0

Table 7. The lower Colorado River (Reach 1) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m²), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2013.

Reach 1	YOY Colorado	Mean Length	Length Range	Total Area	CPUE
Year	Pikeminnow	(mm)	(mm)	(m²)	(fish/100m²)
	Caught				
1986	192	27.86	17-36	1343.6	14.29
1987	176	40.93		2225.8	7.91
1988	172	47.98		3786.8	4.54
1989	132	42.67		3739.2	3.53
1990	179	41.90		2565.8	6.98
1991	150	34.17		2271	6.61
1992	151	33.55		3663.2	4.12
1993	206	32.28	22-47	2858.8	7.21
1994	142	64.07	32-96	3139.8	4.52
1995	85	20.46	11-35	2890	2.94
1996	866	39.6	20-81	4113.8	21.05
1997	12	18.3	13-34	2774.8	0.43
1998	88	34.5	20-60	4663.8	1.89
1999	13	25	19-43	4710	0.28
2000	398	45.7	25-82	6389.6	6.23
2001	17	42.3	23-65	4046.8	0.42
2002	25	57.2	32-87	3033.8	0.82
2003	0	N/A	N/A	2837.8	0.00
2004	16	47	33-63	1620	0.99
2005	19	36.1	28-48	1722	1.10
2006	4	42	27-53	1682.4	0.24
2007	24	37.2	28-47	2802	0.86
2008	0	N/A	N/A	2568	0.00
2009	243	32.75	15-63	2193.4	9.46
2010	27	35.93	26-61	2630.4	1.03
2011	59	24.15	18-36	1195.2	4.94
2012	54	56.65	53-83	2240	2.41
2013	1	31	31	1769	0.05

Table 8. The lower Colorado River (Reach 1), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2013. Species listed are: YOY Colorado pikeminnow (CS YOY; 10-99 mm), juvenile pikeminnow (CS JUV; 100-399 mm), unidentified *Gila* spp. (CH), bonytail (BT), humpback chub (HB), razorback sucker (RZ), flannelmouth sucker (FM), bluehead sucker (BH), and speckled dace (SD). In most years species other than CS were only enumerated during the first haul within primary backwaters.

Year	CS YOY	CS JUV	CH	BT	HB	RZ	FM	BH	SD
1986	192	0	194	0	0	0	0	0	41
1987	176	2	27	0	0	0	2	7	2
1988	172	37	11	0	0	0	4	0	0
1989	132	7	130	0	0	0	2	3	2
1990	179	11	6	0	0	0	4	2	0
1991	150	0	8	0	0	0	1	0	5
1992	151	1	45	0	0	0	2	25	9
1993	206	3	216	0	0	0	69	198	23
1994	142	0	15	0	0	0	0	11	1
1995	85	0	119	0	0	0	2	176	28
1996	866	0	30	0	0	0	3	87	29
1997	12	0	4	0	0	0	1	12	4
1998	88	0	11	0	0	0	1	8	9
1999	13	2	1	0	0	0	0	1	0
2000	398	9	21	0	0	0	1	58	0
2001	17	0	1	0	0	0	0	0	1
2002	25	0	35	0	0	0	0	1	0
2003	0	0	0	0	0	0	0	0	0
2004	16	0	4	0	0	0	9	5	0
2005	19	0	0	0	0	0	0	0	0
2006	4	0	0	0	0	0	9	1	3
2007	24	0	0	0	0	0	2	0	0
2008	0	0	0	0	0	0	4	8	0
2009	243	0	0	0	0	0	5	3	1
2010	27	3	2	0	0	0	15	0	0
2011	59	0	3	0	0	0	31	0	2
2012	54	0	0	0	0	3	39	4	0
2013	1	0	5	0	0	0	0	1	0

Table 9. The lower Colorado River (Reach 1), total captures by year for nonnative fish during young-of-year monitoring from 1986-2013. Only fish enumerated in primary backwater first seine hauls are included to maintain consistency among years and reaches. Species listed: black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1986	0	0	0	4	0	456	2	0	0	1	0	6	1,077	0	240	0	0	0
1987	1	0	0	10	1	233	1	0	0	0	0	0	2,159	0	428	0	0	0
1988	0	0	0	0	4	10,650	0	1	0	0	0	36	1,786	0	2,161	0	0	0
1989	11	0	0	8	12	3,613	0	2	0	0	0	9	6,973	0	951	0	1	0
1990	2	0	2	11	4	5,698	1	1	0	1	0	10	6,593	0	889	0	0	0
1991	1	0	0	8	1	2,632	0	0	0	0	0	6	4,368	0	1,652	0	1	0
1992	1	0	0	0	1	2,809	2	7	0	0	0	7	6,470	0	3,991	0	1	0
1993	3	0	0	1	8	2,091	4	1	0	0	0	0	3,870	0	1,449	0	2	0
1994	1	0	0	1	2	4,795	14	34	0	0	0	0	4,393	0	2,520	0	2	0
1995	2	0	0	17	3	1,105	71	2	0	1	0	0	1,079	0	926	0	0	0
1996	0	0	2	1	0	2,591	3	15	0	1	0	8	3,851	0	5,998	0	0	0
1997	0	0	0	12	2	37	3	0	0	2	0	0	1,244	0	224	0	0	0
1998	0	0	0	1	0	265	1	6	0	0	0	2	6,297	0	8,751	0	0	0
1999	0	1	1	21	3	137	1	1	0	0	0	2	1,891	0	2,303	0	0	0
2000	4	0	0	0	1	1,265	24	2	0	1	0	0	15,099	0	22,343	0	1	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	1	0	0	4	3	4,963	1	0	0	0	0	1	11,691	0	2,920	0	0	0
2003	2	0	0	0	1	2,192	4	0	0	0	0	7	788	0	1,162	0	0	0
2004	0	0	0	0	1	352	0	0	0	0	0	0	625	0	535	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	1	2	0	4	1	159	94	10	0	2	0	1	3,030	0	103	0	0	1
2007	1	0	0	1	5	597	52	0	15	0	0	0	1,063	1	0	0	6	0
2008	0	0	0	1	5	280	1	0	17	1	0	0	536	0	5	0	1	1
2009	3	7	0	0	6	260	36	0	57	0	0	0	3,124	0	12	0	0	0
2010	0	0	0	2	0	377	3	0	174	5	0	0	657	0	622	1	0	0
2011	0	6	0	0	2	24	12	0	20	3	0	0	1345	0	58	0	0	0
2012	36	0	0	15	14	3,182*	2	6	70	2	0	0	471*	0	5,204*	0	0	0
2013	5	0	0	24	1	666	0	1	116	1	0	2	1,566	2	4,640	0	0	0

*1,990 nonnative cyprinids were not identified to species. Based on the percentage of sand shiner (58.8%), fathead minnow (35.9%), and red shiner (5.3%) positively identified in this reach, these fish were applied proportionately to sand shiner ($n = 1,117$), fathead minnow ($n = 682$), and red shiner ($n = 101$).

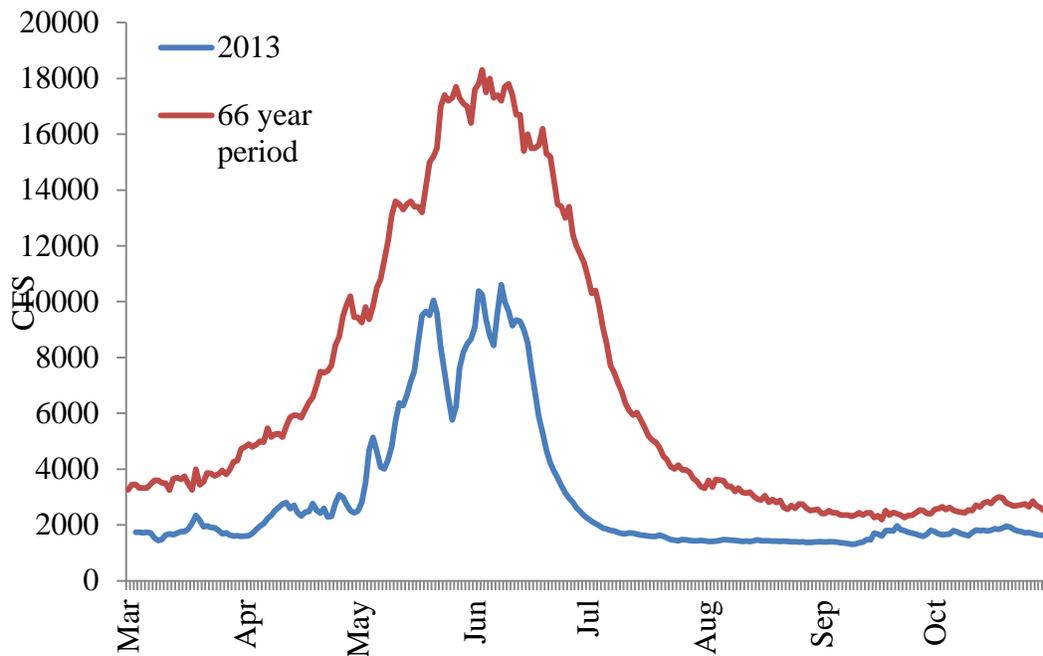


Figure 1. The Middle Green River (Reach 4) daily mean discharge measured from USGS Gage at Jensen, Utah. Note that 2013 data used to create this figure is listed as provisional at the time of this report.

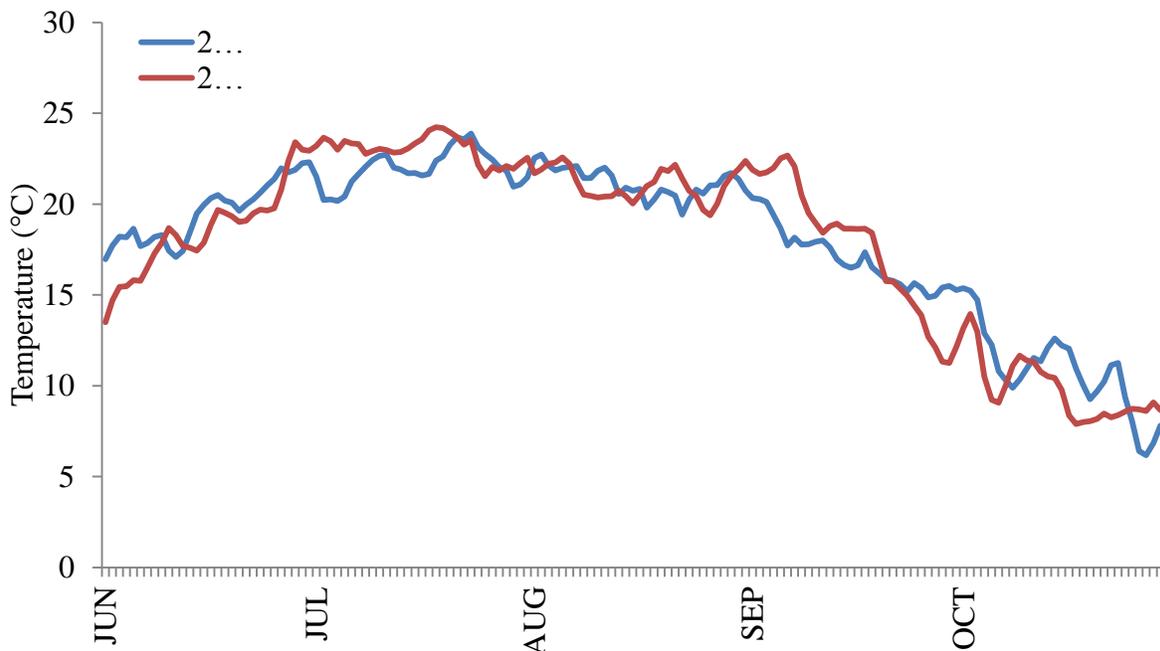


Figure 2. The Middle Green River (Reach 4) daily mean temperatures (°C) from 2012 and 2013 taken from the USGS gauge at Jensen, Utah. Note that 2013 data used to create this figure is listed as provisional at the time of this report.

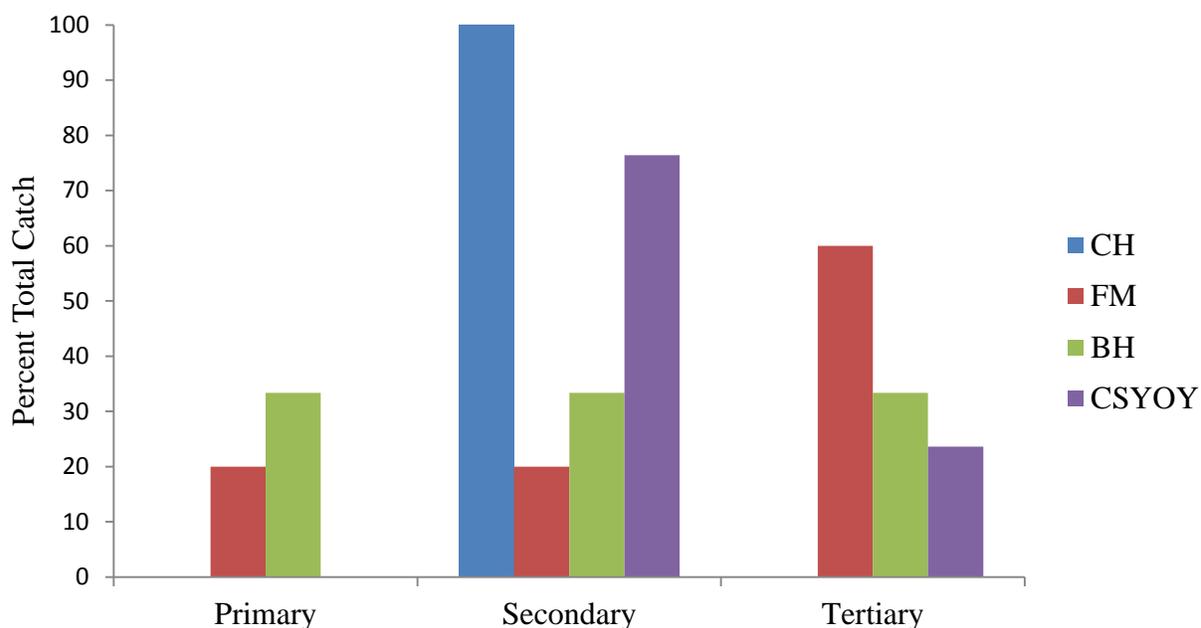


Figure 3. Proportional abundance (percent of species for all backwaters sampled in Middle Green River reach 4) of native species in primary, secondary and tertiary backwaters. Species include bluehead sucker (BH), YOY pikeminnow (CSYOY), *Gila* spp. (CH), and flannelmouth sucker (FM).

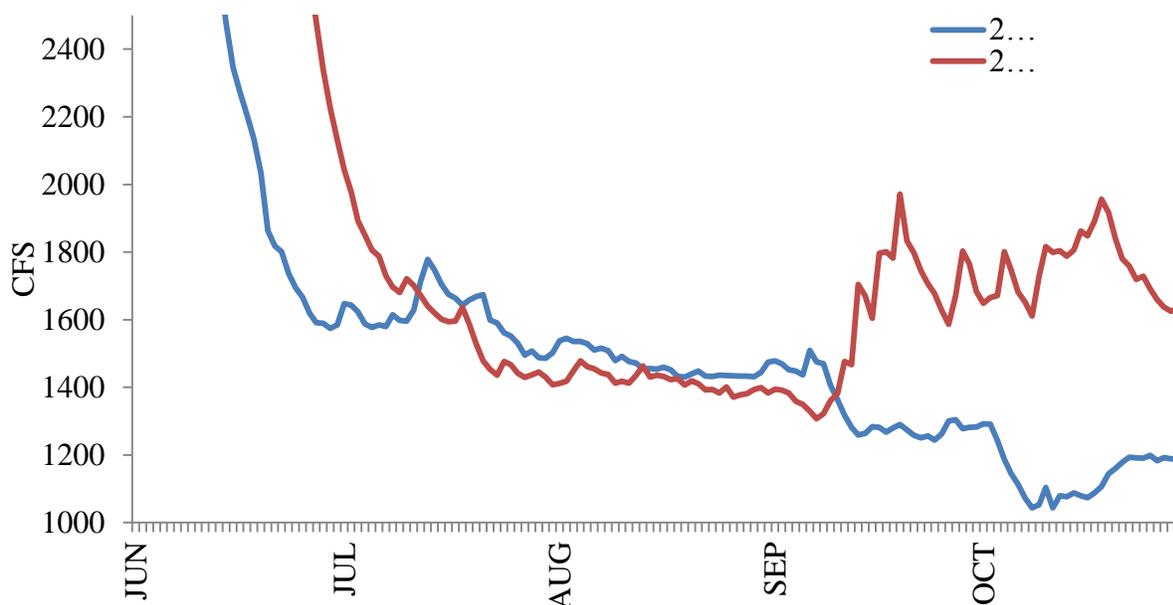


Figure 4. The Middle Green River (Reach 4) daily mean discharge for 2012 and 2013, from June – October taken from the USGS gauge at Jensen, Utah. Note that 2013 data used to create this figure is listed as provisional at the time of this report.

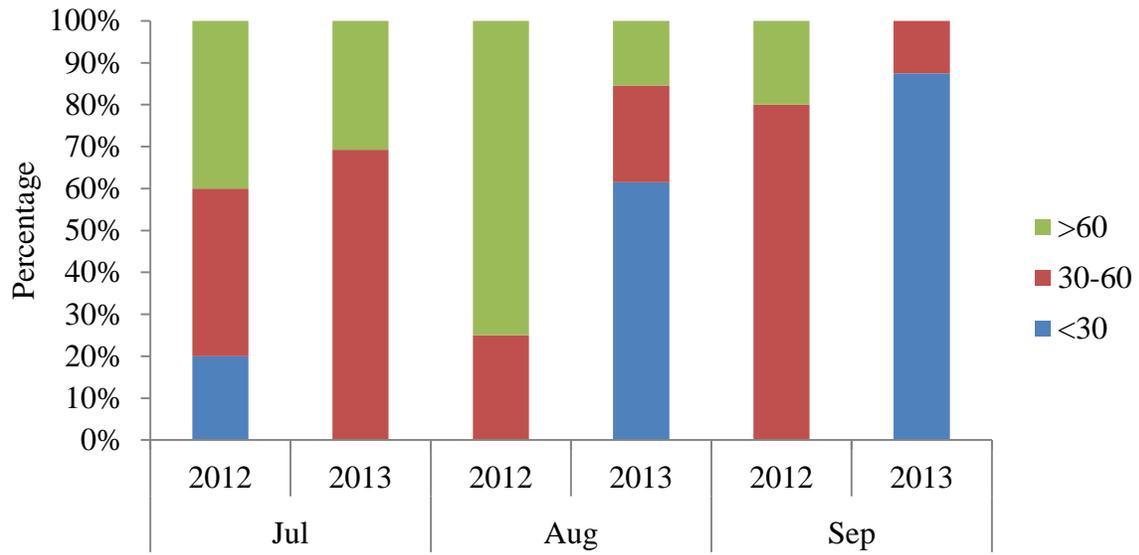


Figure 5. Percentage of days a month for 2012 (July n = 5; August n = 12; September n = 5) and 2013 (July n = 13, August n = 13; September n = 8) that maximum daily turbidity measurements (depth of visibility) fell into the following categories: < 30 cm, 30–60 cm, > 60 cm. Measurements are representative of Split Mountain boat ramp to above the White River (RM 319.8–245.8).



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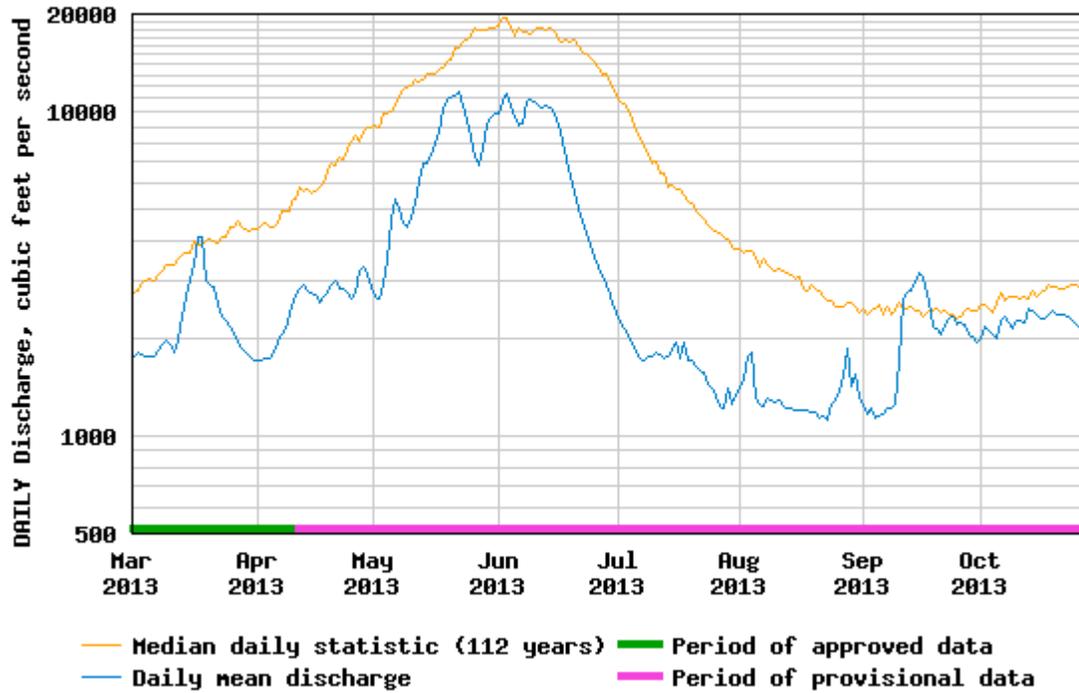


Figure 6. The lower Green River (Reach 3) daily mean flows measured from USGS Gage #09315000 at Green River, Utah from 1 March 2013 to 27 October 2013.

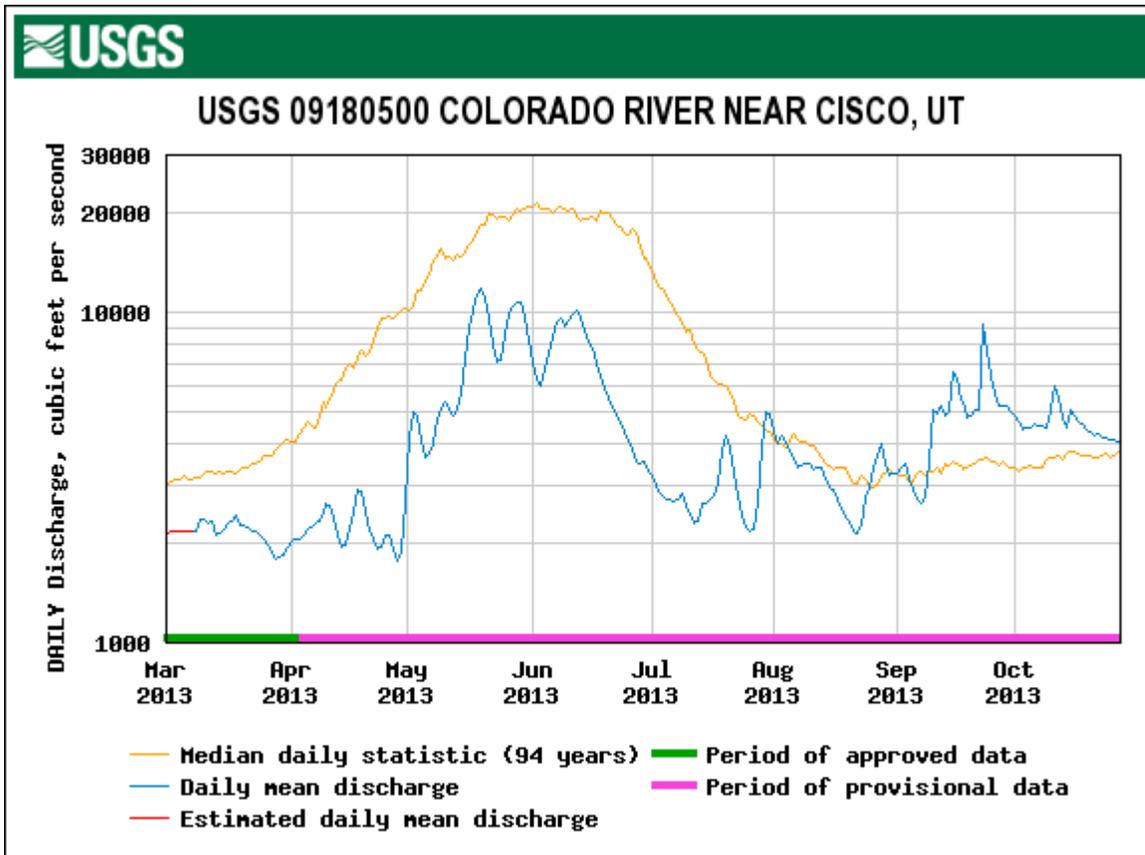


Figure 7. The lower Colorado River (Reach 1) daily mean flows measured from USGS Gage #09180500 near Cisco, Utah from 1 March 2013 to 27 October 2013.