

I. Project Title: Young-of-the-year Colorado pikeminnow monitoring

II. Principal Investigator(s):

Joseph A. Skorupski Jr. /Matthew J. Breen  
Utah Division of Wildlife Resources  
Northeastern Regional Office  
152 East 100 North  
Vernal, UT 84078  
Phone: 435-781-5315; Fax: 435-789-8343  
E-mail: [jskorupski@utah.gov](mailto:jskorupski@utah.gov)  
[mattbreen@utah.gov](mailto:mattbreen@utah.gov)

Katie Creighton/Paul Badame  
Utah Division of Wildlife Resources  
Moab Field Station  
1165 S. Highway 191 - Suite 4  
Moab, UT 84532  
Phone: 435-259-3780; Fax: 435-259-3785  
E-mail: [katherinecreighton@utah.gov](mailto:katherinecreighton@utah.gov)  
[paulbadame@utah.gov](mailto:paulbadame@utah.gov)

III. Project Summary:

Monitoring of young-of-year (YOY) Colorado pikeminnow (*Ptychocheilus lucius*) was initiated in 1986 within the upper Colorado River basin as part of the Interagency Standardized Monitoring Protocol (ISMP; USFWS 1987). The ISMP sampling was proposed to monitor recruitment success of first year endangered fishes, to correlate cohort strength and condition to abiotic and biotic parameters, and to provide data for a predictive model measuring future cohort strength. Since its inception, the ISMP protocol for YOY pikeminnow has been updated to refine its scope and methods to focus not only on pikeminnow but all small-bodied fishes allowing for assessment of other projects such as nonnative control.

As a result of decreased recruitment, control actions targeting nonnative gamefish species, primarily smallmouth bass (*Micropterus dolomieu*) and northern pike (*Esox lucius*), are being evaluated across the upper Colorado River Basin to determine the level of reduction necessary to minimize the threat to the recovery of Colorado pikeminnow and other endangered Colorado River fishes. Successful implementation of nonnative fish removal will likely be measured by the response of endangered fish and other native species (i.e., increased abundance). However, nonnative fish removal efforts are preliminary, thus the first observed response will likely be evident in early life-stages of the native fish community (Bestgen et al. 2007a). An adult response to nonnative

removal may not be detectable initially for a number of reasons, one of which is the large home range of adults (UDWR 2006). Furthermore, a positive response by adult endangered species may be difficult to measure statistically without extensive observations due to generation times of endangered fish populations (e.g. Bestgen et al. 2007b).

Data necessary to evaluate the recovery status of native fishes will be generated by current and future YOY sampling in conjunction with nonnative fish removal efforts. For instance, documenting size and relative abundance of YOY Colorado pikeminnow and other native species may provide valuable information about the probable survival of any particular year class. Together with existing YOY data compiled from ISMP sampling (1987 - present), results from this project should provide the basis for monitoring distribution and recruitment rates of YOY Colorado pikeminnow. Efforts to control nonnatives will likely have the greatest affect on YOY fish (i.e., decreased predation and increased survival). Therefore, monitoring this component of the Colorado pikeminnow population will provide information toward evaluating nonnative control projects. Additionally, this project ensures continuation of existing, standardized data series (ISMP) that document trends in abundance of early-life stage Colorado pikeminnow (USFWS 1987). Finally, response of early life-stages of native and small-bodied fish to removal of nonnative predators will serve as indicators of the response that would be experienced by endangered fish species occupying the same habitats.

The Utah Division of Wildlife Resources (UDWR) has been responsible for monitoring YOY Colorado pikeminnow abundance since 1986. In 2004, this project was expanded to explore linkages between trends in YOY abundance (collected in this study), with abundances of larval (current Project No. 22f) and juvenile pikeminnow (old ISMP data set; and current Project No. 128). Also, beginning in 2004, there was reference to the use of predictive modeling to correlate trends in these multiple life stages with environmental variables. Those analyses were not completed. In late 2008, in conjunction with uncertainties identified in the *Green River Study Plan*, the Recovery Program decided to conduct a separate comprehensive synthesis of the effect of changes in physical habitat (as a function of flow and flow variability) and other environmental conditions on the small-bodied fish community (emphasis on Colorado pikeminnow). That comprehensive synthesis was initiated in 2009, entitled *Historical assessment of factors affecting young Colorado pikeminnow abundance and physical habitat availability in the Green River, Utah*. The UDWR's analysis under Project 138 will once again focus on long term trends in YOY pikeminnow / small-bodied fish abundance and correlations with flow and temperature.

Lastly, response of early life-stages of native and small-bodied fish to removal of nonnative predators in the middle Green River was originally assessed under Project 144. Due to overlapping similarities in field sampling and biotic/abiotic variables affecting YOY community response, the Project 144 scope of work was subsumed by Project No. 138 in 2009.

IV. Study Schedule: It is anticipated that this study will continue indefinitely and will be a

component of studies designed to evaluate a variety of management actions.

- V. Relationship to RIPRAP: Reproduction and recruitment of early life stages are critical components of the life history of endangered Colorado pikeminnow. Understanding trends in reproductive success may help define status of Colorado pikeminnow in specific river reaches in the Colorado River Basin and should play a role in determining when recovery has been achieved.

Relationship to specific RIPRAP items:

#### 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

- VI. Accomplishment of FY 2011 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings

#### Project Objectives:

1. Determine size and relative abundance of YOY Colorado pikeminnow at the end of their first growing season to complement larval and juvenile sampling data.
2. Estimate the response of small-bodied and YOY native fish to removal of northern pike and smallmouth bass.
3. Determine relationships between YOY Colorado pikeminnow CPE abundance estimates with respect to flow and temperature.

Task Description (FY 2011):

1. Middle Green River (reach 4) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
2. Lower Green River (reach 3) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
3. Lower Colorado River (reach 1) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
4. Data entry.
5. Data analysis and report preparation.

Accomplishments by task (FY 2011).

*Task 1: Middle Green River: Reach 4*

Annual monitoring for YOY Colorado pikeminnow began on 27 September 2011 and was completed on 6 October 2011. Seining began at the uppermost sub-reach near river-mile (RM) 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). Not all 5-mile sub-reaches contained three backwaters. A total of 55 of 63 possible backwaters were sampled; 20 primary, 19 secondary, and 16 tertiary. Flow conditions impeded us from sampling eight backwaters, due to lack of backwater habitats meeting the criteria.

Green River mainchannel temperatures ranged from 12.9 to 20.2°C. Backwater temperatures ranged from 11.5 to 25.5°C. Discharge (USGS gauge near Jensen) ranged from 3,350 to 3,070 cfs during the sampling period. These flows are above the mean daily values (1,700 – 2,000 cfs) for this time of year based on the period of record for this gauge (Figure 1). It is likely that high flows reduced the presence and quality of backwater habitats and minimized the number of backwaters that could be sampled adequately. Many backwaters that were sampled were too deep to conduct seine hauls through the deepest point and the majority of the backwater area. Flow conditions in 2011 varied from 2009 and 2010 when discharge ranged from 2,089 – 2,570 cfs and pikeminnow were abundant.

We did not collect any YOY Colorado pikeminnow from backwaters sampled in 2011 (Table 1). However, three juvenile pikeminnow were captured in the first two backwaters of each five mile sub-reach. One additional juvenile was collected where a third replicate (overlapped the second) seine haul was conducted to see if any pikeminnow still remained in the backwater; this individual was not included in the data analysis. Juvenile pikeminnow captures demonstrate survival of the 2010 year class,

which was the highest abundance since 1990 (Table 2).

Additional YOY native species collected from primary backwaters included 57 flannelmouth sucker, 35 bluehead sucker, and one roundtail chub (Table 2). YOY native species collected in secondary and tertiary backwaters included 20 bluehead sucker, 49 flannelmouth sucker, three roundtail chub, three *Gila sp.* and 14 unknown native suckers (either bluehead or flannelmouth). The highest proportion of bluehead sucker, flannelmouth sucker and juvenile pikeminnow were found in primary backwaters, *Gila sp.* and unknown suckers were dominant in secondary backwaters and the greatest percentage of roundtail chub were found in tertiary backwaters (Figure 2). Flannelmouth and bluehead sucker YOY numbers were higher than many prior years, suggesting that high flows may have benefitted these species.

Although a higher abundance of native fish were observed in 2011, seine samples continue to be dominated by small-bodied nonnative cyprinids including fathead minnow, red shiner, and sand shiner (Figure 3). We collected a total of eight nonnative species in the first seine haul of the primary backwater (Table 3). Nonnative species collected included black bullhead ( $n = 5$ ), black crappie ( $n = 3$ ), common carp ( $n = 13$ ), fathead minnow ( $n = 867$ ), green sunfish ( $n = 14$ ), red shiner ( $n = 1682$ ), smallmouth bass ( $n = 2$ ), and sand shiner ( $n = 301$ ) (Table 3). Additional species collected in secondary and tertiary backwaters included white sucker ( $n = 18$ ), white sucker x flannelmouth sucker ( $n = 5$ ), brook stickleback ( $n = 2$ ) and channel catfish ( $n = 55$ ). Secondary and tertiary backwaters also included an additional 28 YOY smallmouth bass, which are rarely observed in our sampling (Table 3). Collection of these individuals could be an anomaly for this year; however, prolonged high flows in 2011 likely disrupted the timing in smallmouth bass spawning and subsequent development of YOY fish. This opportunistic finding provides evidence that smallmouth bass occupy slow-velocity areas for initial development before moving into riverine habitats, prior to when we typically sample backwaters. We hypothesize that movement of YOY smallmouth bass out of backwater habitats was delayed due to high flows, explaining a low abundance in our samples during previous years.

Species overlap is evident for small-bodied nonnatives and YOY natives. When native YOY species were present there was a lower proportion of red shiner, fathead minnow, black crappie, black bullhead, and common carp (Figure 4). However, sand shiner, green sunfish, white sucker and smallmouth bass were found in higher proportions (Figure 4). This information is preliminary, but demonstrates that natives were in higher abundance when certain small-bodied nonnatives were in lower abundance. In addition YOY smallmouth bass appear to overlap with YOY natives (Figure 4). This data only represents first seine hauls of all backwaters; nonnatives were only enumerated during this sampling effort, which only represented 15% of the YOY native fish captured.

### Task 2: Lower Green River: Reach 3

Annual monitoring for YOY Colorado pikeminnow in Reach 3 began on September 11, 2011 and was completed on September 13, 2011. Seining was conducted on the Green

River from river-mile 120 (Green River State Park) to river-mile 0 (confluence with the Colorado River). Sampling was conducted at two backwater habitats within every 5-mile sub-reach, as available. A total of 27 of 48 possible backwaters were sampled in 17 of 24 sub-reaches in the lower Green River. The total area seined in Reach 3 in 2011 (1796 m<sup>2</sup>) was lower than the 26-year average (3578 m<sup>2</sup>; Table 4). Reach 3 water temperatures ranged from 21 to 23 °C in the main channel and 22.5 to 28 °C in backwaters.

Lower Green River flows (measured at USGS Gage #9315000 in Green River) fluctuated between 5,290 cfs and 4,850 cfs over the three days of sampling. These flows are above the mean daily values (2,850 - 2,900 cfs) for this time of year based on the period since dam operation began (1964 - 2011) as well as above the mean daily values (2,810 - 2,970 cfs) for this time of year based on the period of record for this gauge (1894 - 2011). The lower Green River, measured at USGS Gage #9315000 in Green River, peaked this year on June 14 at 43,700 cfs (Figure 5). This is higher than both the 48-year mean peak (since dam operation began in 1964) of 22,949 cfs and the historical mean peak based on the period of record for this gauge (1894 - 2011) of 28,290 cfs.

At the time of sampling, some of the backwaters normally sampled were still inundated by the higher-than-usual main channel flows. These higher peak and seasonal flows and resulting changes to backwater habitats may help to explain the limited area of suitable habitat found to sample as well as the lower numbers and shorter lengths of Colorado pikeminnow captured.

In the lower Green River, 17 YOY Colorado pikeminnow were captured and measured. All fish were sorted, identified and enumerated in the field. Thirteen of the 17 fish were released alive; four died during the enumeration process. This is the lowest number of YOY Colorado pikeminnow captured in the 26 years of the study (17 were also caught in 2001). This is considerably lower than the 10-year average (193.70 fish/year), 15-year average (222.27 fish/year), and 26-year average (482.46 fish/year; Table 4). The CPUE this year was 0.95 fish/100m<sup>2</sup>, considerably lower than the 10, 15, and 26-year averages (6.34 fish/100m<sup>2</sup>, 6.34 fish/100m<sup>2</sup>, and 14.35 fish/100m<sup>2</sup>, respectively; Table 4). The average length of YOY Colorado pikeminnow was 22 mm, shorter than the 10, 15, and 26-year averages (41.77 mm, 39.27 mm, and 38.58 mm, respectively; Table 4). One flannelmouth sucker was also captured in the lower Green River (Table 5).

Nonnative captures were only enumerated during the first seine haul in each primary habitat in the lower Green River. Total catches in Reach 3 included six nonnative species and were once again dominated by nonnative cyprinids. These included red shiners ( $n = 1,842$ ), sand shiners ( $n = 1,096$ ), fathead minnows ( $n = 314$ ), common carp ( $n = 15$ ), black crappie ( $n = 8$ ), and channel catfish ( $n = 6$ ) (Table 6).

### Task 3: Lower Colorado River: Reach 1

Annual monitoring for YOY Colorado pikeminnow in Reach 1 began on September 12, 2011 and was completed on September 14, 2011. Seining on the Colorado River was conducted from river-mile 110 (Cisco Landing) to river-mile 0 (Confluence with the

Green River). Backwater habitats were sampled within every 5-mile sub-reach, as available. A total of 23 of 44 possible backwaters were sampled in 16 of 22 sub-reaches in the Colorado River. The total area seined in Reach 1 in 2011 (1195.2 m<sup>2</sup>) was lower than the 26-year average (3046 m<sup>2</sup>; Table 7). Reach 1 water temperatures ranged from 19 to 23 °C in the main channel and 18 to 30 °C in backwaters.

Colorado River flows (measured at USGS Gage #9180500 near Cisco) fluctuated between 5,300 cfs and 5,050 cfs over the three days of sampling. These flows are above the mean daily values (3,820 - 3,950 cfs) for this time of year based on the period of record for this gauge (1914 - 2011). The lower Colorado River, as measured at USGS Gage #9180500 near Cisco, peaked this year on June 9 at 48,500 cfs (Figure 6). This is higher than the 50-year mean peak of 28,753 cfs and the historical mean peak based on the period of record for this gauge (1914 - 2011) of 34,856 cfs.

In the lower Colorado River, 59 YOY Colorado pikeminnow were captured and measured. All fish were sorted, identified and enumerated in the field. All fish captured were released alive. The number of Colorado pikeminnow captured is higher than the 10-year average (41.7 fish/year) but lower than the 15-year average (63 fish/year), and the 26-year average (130.62 fish/year) (Table 7). The CPUE this year was 4.94 fish/100m<sup>2</sup>. This is higher than the 10-year average CPUE (1.94 fish/100m<sup>2</sup>), the 15-year average CPUE (1.91 fish/100m<sup>2</sup>), and the 26-year average CPUE (4.32 fish/100m<sup>2</sup>) (Table 7). The average length of YOY Colorado pikeminnow in 2011 was 24.15 mm, which is lower than the 10-year average (39.04 mm), the 15-year average (36.78 mm), and the 26-year average (37.65 mm) (Table 7).

Other native species captured in the Colorado River included 31 flannelmouth suckers, three *Gila* spp., and two speckled dace (Table 8).

Eight nonnative species were captured in the Reach 1 (Table 9). Nonnative captures were again only enumerated during the first seine haul in each primary habitat in the lower Colorado River. Nonnative fish captured included red shiners ( $n = 1,345$ ), sand shiners ( $n = 58$ ), fathead minnows ( $n = 24$ ), gizzard shad ( $n = 20$ ), Western mosquitofish ( $n = 12$ ), largemouth bass ( $n = 3$ ), black crappie ( $n = 6$ ), and common carp ( $n = 2$ ) (Table 9).

Task 4: Data entry was completed by November 1, 2011 for all reaches and database and management is ongoing.

Task 5: Data analysis and report writing is on track and the annual report will be provided by November 14, 2011.

## VII. 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.

- Determine whether data collected through this project is feasible for evaluating YOY native fish response to nonnative predator control measures in the middle Green River. Prolonged high flows that likely disrupted the timing in smallmouth bass spawning activities and subsequent YOY development in combination with an abundance of smallmouth bass YOY collected in 2011, raises some interesting questions regarding habitat overlap and our ability to detect a response with this data. Based on the timing of ISMP and Native Fish Response sampling (late September), habitat overlap between YOY native fishes and early life-stages of nonnative predators in the middle Green River is likely a limiting factor (at time of sampling) in comparison to other reaches in the upper Colorado River basin where native fish response is being assessed (e.g., Yampa River; Bestgen et al. 2007). We suggest that a separate study specifically focused on investigating YOY native species overlap with YOY nonnative predators on a temporal scale is necessary to determine whether detrimental interactions are occurring when they are most crucial (i.e., while nonnative predators are utilizing the same habitats).
- 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. Determine if temperature is as directly correlated to YOY survival as flow or major climatic events. If it is concluded that temperature is an important factor to consider, deploy Hobo temperature loggers to get more accurate data.
- Develop a measure or scale to describe localized hydrologic/climatic 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 habitat in the lower Green.

VIII. Project Status:

On track and ongoing

IX. FY 2011 Budget Status

- A. Funds Provided: \$53,659
- B. Funds Expended: \$53,659
- C. Difference: \$0
- D. Percent of the FY 2011 work completed: 100%
- E. Recovery Program funds spent for publication charges: \$0

X. Status of Data Submission: Data is formatted and has been QA/QC checked and will be

submitted to the USFWS by January 2012.

XI. Signed: Katie Creighton, Joseph A. Skorupski Jr. November 8, 2011  
Investigator Date

XII. Literature Cited

Bestgen, K.R., C.D. Walford, A.A. Hill, J.A. Hawkins. 2007a. Native fish response to removal of non-native predator fish in the Yampa River, Colorado. Colorado State University, Larval Fish Laboratory Contribution 150. Fort Collins, Colorado.

Bestgen, K.R., J.A. Hawkins, G.C. White, K.D. Christopherson, J.M. Hudson, M.H. Fuller, D.C. Kitcheyan, R. Brunson, P. Badame, G.C. Haines, J.A. Jackson, C.D. Walford, and T.A. Sorensen. 2007b. Population status of Colorado pikeminnow in the Green River Basin, Utah and Colorado. Transactions of the American Fisheries Society 136:1356-1380.

Utah Division of Wildlife Resources. 2006. Conservation and management plan for three fish species in Utah: addressing needs for roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*). Publication number 06-17. Salt Lake City, Utah.

USFWS. 1987. Interagency standardized monitoring protocol handbook. U.S. Fish and Wildlife Service. Grand Junction, CO.

Table 1. The middle Green River (Reach 4) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m<sup>2</sup>), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1990—2011. *To be consistent with previous years, information in this table contains only those individuals captured in the first two backwaters of a subreach.*

<b>Year</b>	<b>Colorado Pikeminnow Caught</b>	<b>Mean Length (mm)</b>	<b>Length Range (mm)</b>	<b>Total Area Sampled (m<sup>2</sup>)</b>	<b>CPUE (Fish/100m<sup>2</sup>)</b>
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	4259	10.7
2011	0	N/A	N/A	7852	0

Table 2. The middle Green River (Reach 4), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2011. Colorado pikeminnow abundance reflects captures from primary and secondary backwaters sampled in each subreach; 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

\*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

Table 4. The lower Green River (Reach 3) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m<sup>2</sup>), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2011.

<b>Reach 3</b>	<b>YOY Colorado</b>	<b>Mean Length</b>	<b>Length Range</b>	<b>Total Area</b>	<b>CPUE</b>
<b>Year</b>	<b>Pikeminnow</b>	<b>(mm)</b>	<b>(mm)</b>	<b>Sampled</b>	<b>(fish/100m<sup>2</sup>)</b>
	<b>Caught</b>			<b>(m<sup>2</sup>)</b>	
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	0.95

Table 5. The lower Green River (Reach 3), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2011. Species listed are: YOY Colorado pikeminnow (CS YOY; 10-99 mm), juvenile pikeminnow (CS JUV; 100-399 mm), and unidentified *Gila* spp. (CH), bonytail (BT), humpback chub (HB), 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.

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

Table 6. The lower Green River (Reach 3), total captures by year for nonnative fish during young-of-year monitoring from 1986-2011. Only fish enumerated in the first haul within each primary backwater are counted in these totals to provide consistency among years and reaches. Species listed are: 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

Table 7. The lower Colorado River (Reach 1) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m<sup>2</sup>), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2011. Missing data is being compiled from original records.

<b>Reach 1</b>	<b>YOY Colorado Pikeminnow</b>	<b>Mean Length</b>	<b>Length Range</b>	<b>Total Area Sampled</b>	<b>CPUE</b>
<b>Year</b>	<b>Caught</b>	<b>(mm)</b>	<b>(mm)</b>	<b>(m<sup>2</sup>)</b>	<b>(fish/100m<sup>2</sup>)</b>
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

Table 8. The lower Colorado River (Reach 1), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2011. 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), 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.

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

Table 9. The lower Colorado River (Reach 1), total captures by year for nonnative fish during young-of-year monitoring from 1986-2011. Only fish enumerated in the first haul within each primary backwater are counted in these totals to provide consistency among years and reaches. Species listed are: 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

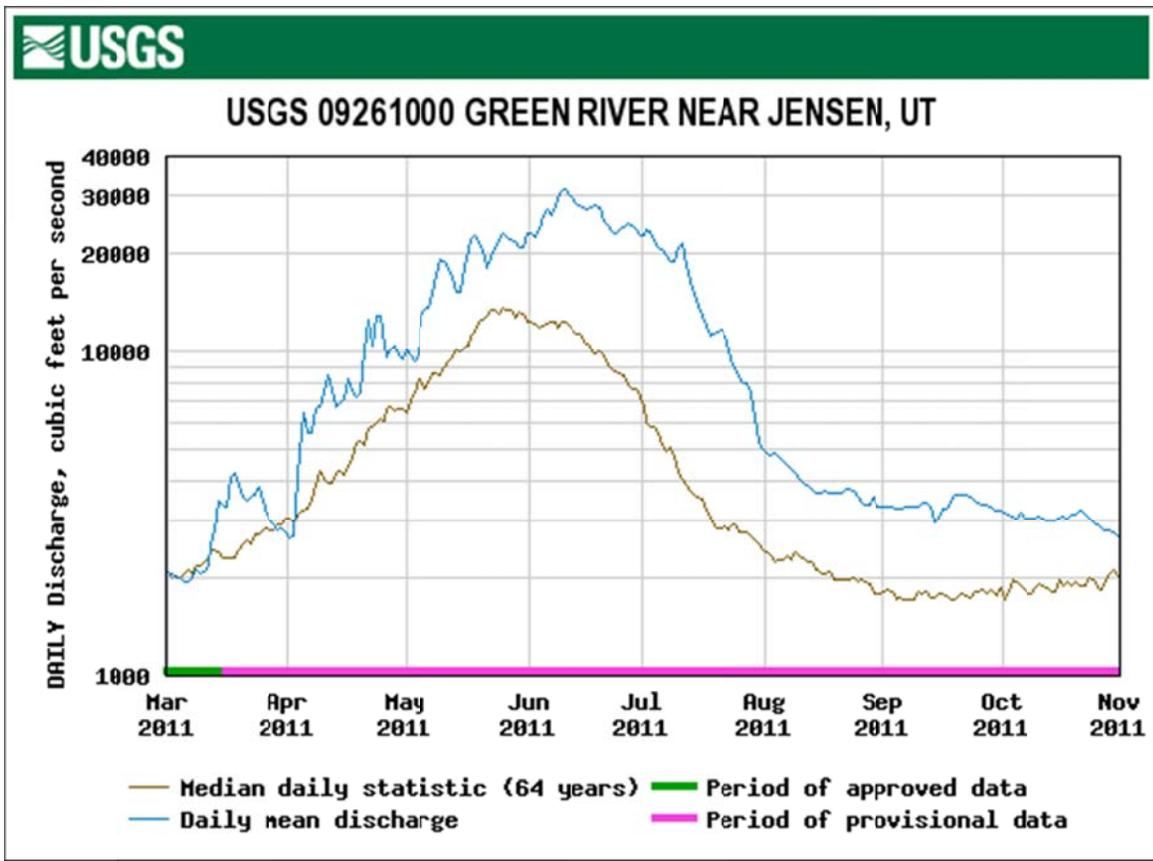


Figure 1. The Middle Green River (Reach 4) daily mean flows measured from USGS Gage at Jensen, Utah.

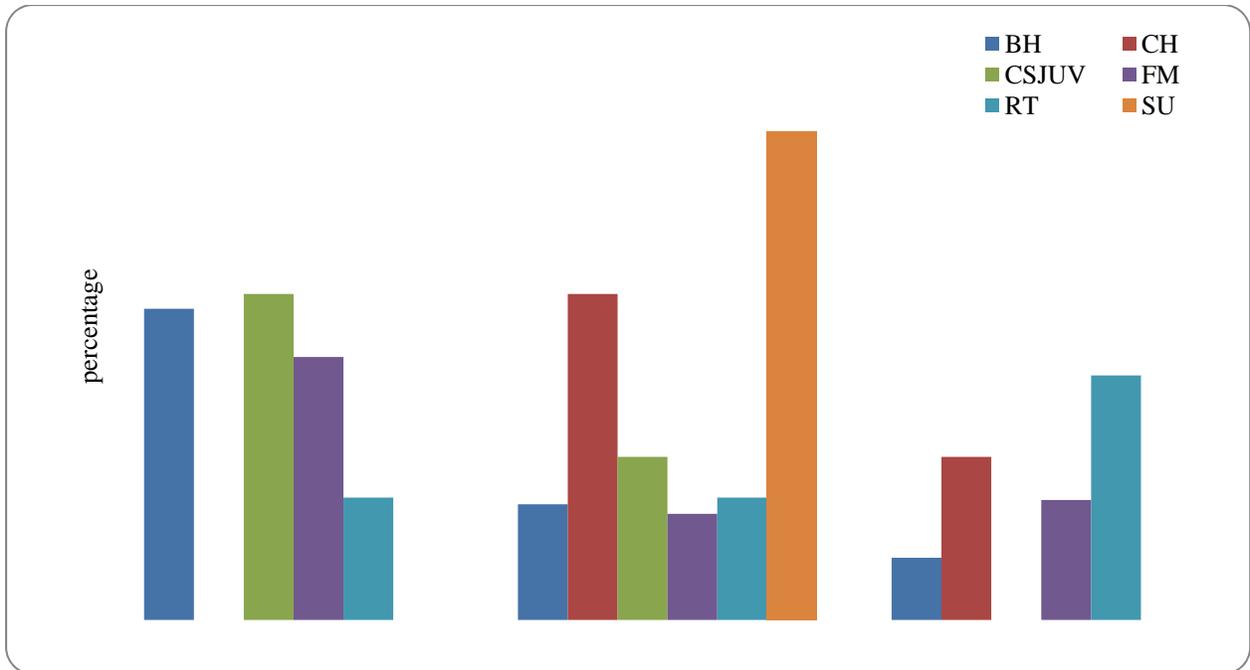


Figure 2. Proportional abundance (percent of species for all backwaters sampled in Middle Green River reach 4) of native species in primary, secondary and tertiary backwaters. Species include bluehead sucker (BH), juvenile pikeminnow (CSJUV), roundtail chub (RT), *Gila spp.* (CH), flannelmouth sucker (FM) and unknown suckers (bluehead or flannelmouth; SU).

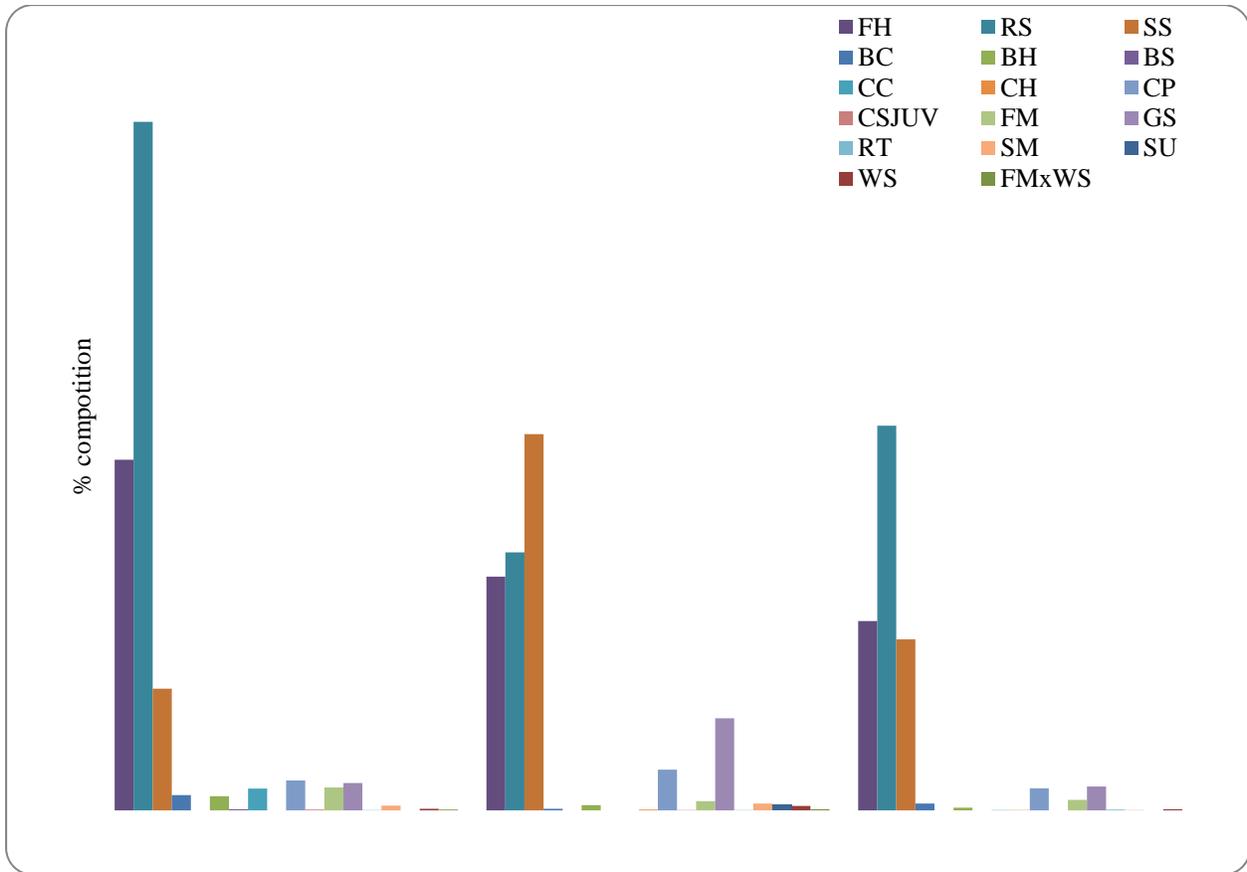


Figure 3. Community composition (percent of total for all backwaters sampled, Middle Green river reach 4) of primary, secondary and tertiary backwaters including native and nonnative fishes. Black bullhead was excluded due to a high abundance (~15,000 from one seine haul) estimation in a secondary backwater. Species include bluehead sucker (BH), juvenile pikeminnow (CSJUV), roundtail chub (RT), *Gila spp.* (CH), flannelmouth sucker (FM), unknown suckers (bluehead or flannelmouth; SU), black crappie (BC), channel catfish (CC), common carp (CP), fathead minnow (FH), green sunfish (GS), red shiner (RS), smallmouth bass (SM), sand shiner (SS), white sucker (WS), flannelmouth x white sucker (FMxWS) and brook stickleback (BS).

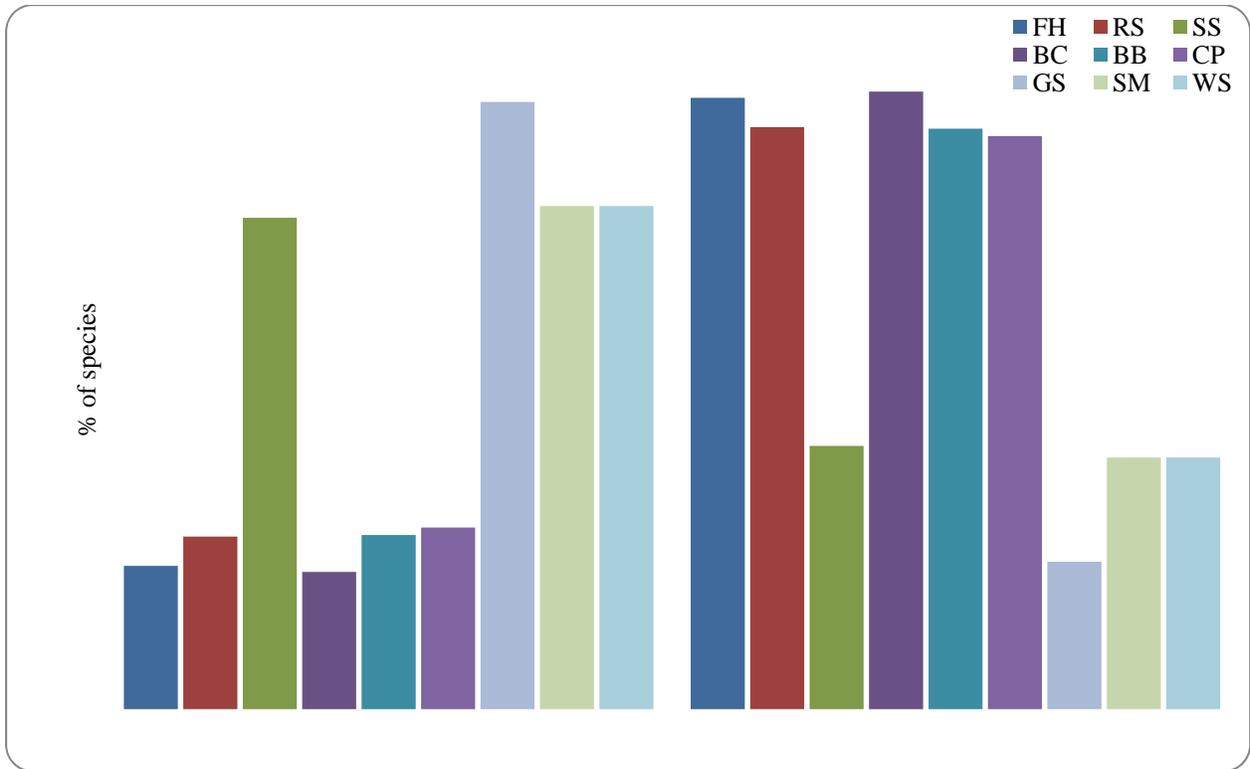


Figure 4. Proportion of small-bodied nonnatives found with and without YOY native fishes. Data represents first seine hauls of all backwaters sampled. Species include fathead minnow (FH), red shiner (RS), sand shiner (SS), black crappie (BC), black bullhead (BB), common carp (CP), green sunfish (GS), smallmouth bass (SM), and white sucker (WS).



### USGS 09315000 GREEN RIVER AT GREEN RIVER, UT

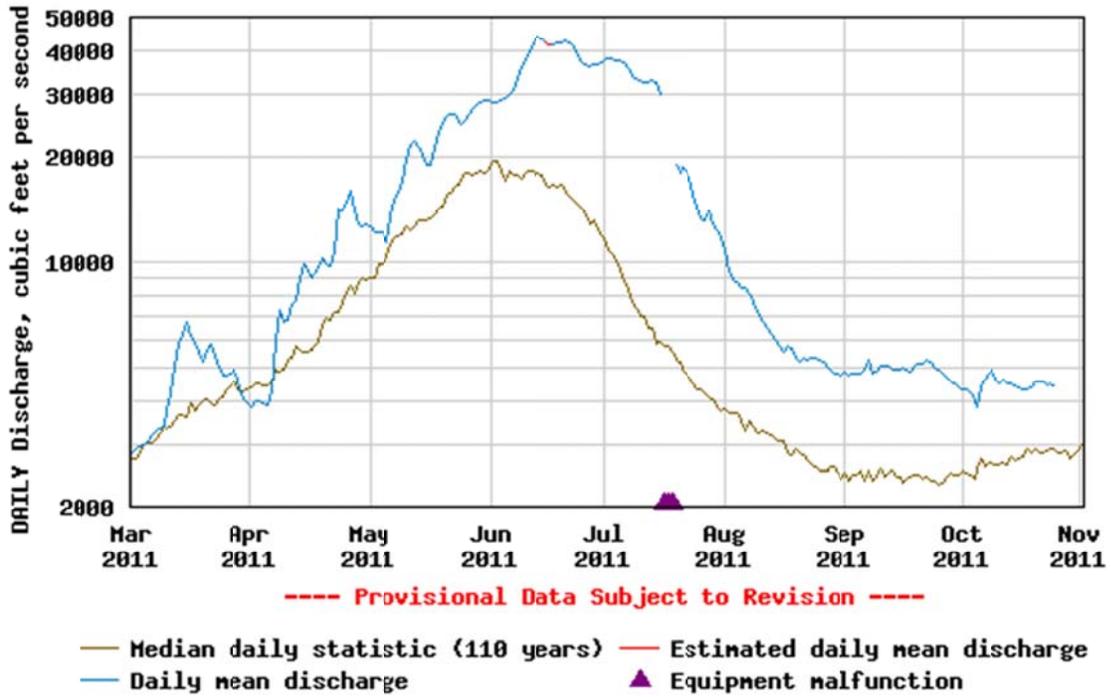


Figure 5. The lower Green River (Reach 3) daily mean flows measured from USGS Gage #09315000 at Green River, Utah from March 1, 2011 to November 1, 2011.

### USGS 09180500 COLORADO RIVER NEAR CISCO, UT

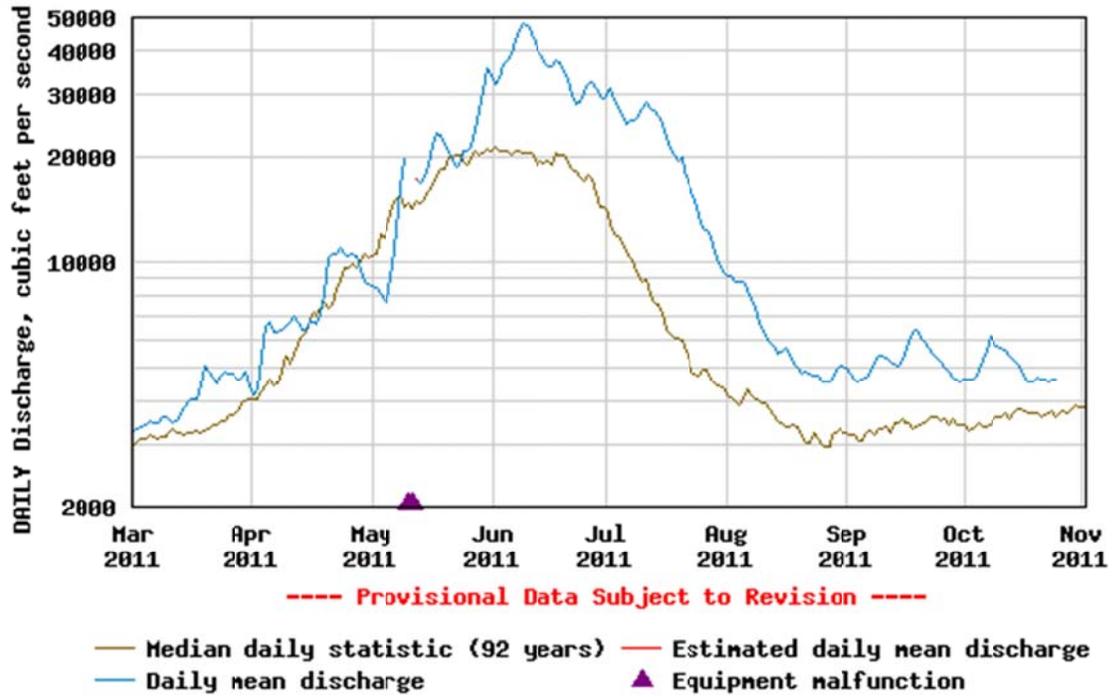


Figure 6. The lower Colorado River (Reach 1) daily mean flows measured from USGS Gage #09180500 near Cisco, Utah from March 1, 2011 to November 1, 2011.