COLORADO RIVER RECOVERY PROGRAM
FY 2013 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: FR165

I. Project Title: Use of the Stewart Lake floodplain by larval and adult endangered fishes

II. Bureau of Reclamation Agreement Number(s): R12AP40033

Project/Grant Period:
Start date (Mo/Day/Yr): 9/13/2012
End date: (Mo/Day/Yr): 11/30/13
Reporting period end date: 9/30/13
Is this the final report? Yes _____ No __X__

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IV. Abstract:

Reproduction by razorback sucker (*Xyrauchen texanus*) occurs on the ascending limb of the spring hydrograph as an adaptation for entrainment of larvae into highly productive floodplain habitats. Stewart Lake was one of two wetlands in the Ouray reach of the Green River to entrain flows in 2013 due to drought conditions. Through adaptive management of the wetland floodgate structures, operation of a picket weir and utilizing a secondary water source; wild-spawned razorback suckers were successfully entrained, reared for 54 days and 592 were released back to the Green River. Given the high level of success at Stewart Lake, even during difficult drought years, the Larval Trigger Study Plan shows great promise for recovery of razorback sucker.

V. Study Schedule: FY2012–FY2014

VI. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

II.A.1. Conduct inventory of flooded bottomlands habitat for potential restoration.
V. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).

GREEN RIVER ACTION PLAN

I.A.3.d.1. Conduct real-time larval razorback and Colorado pikeminnow sampling to guide Flaming Gorge operations.

I.D.1.	Develop study plan to evaluate flow recommendations.
I.D.1.a.	Evaluate survival of young and movement of sub-adult razorback suckers from floodplains into the mainstem in response to flows.
II.A.2.	Acquire interest in high-priority flooded bottomland habitats between Ouray NWR and Jensen to benefit endangered fish.
II.A.2.a.	Identify and evaluate sites.
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: Install, operate and maintain a picket weir in the Stewart Lake outlet; May–June 2013.

Razorback sucker larvae were detected by the USFWS on 26 May 2013 in the Jensen area of the middle Green River. Larval detection prompted the Bureau of Reclamation to increase flows at Flaming Gorge Dam beginning 29 May 2013, which reached power plant capacity on 30 May 2013 (Figure 1). Two and 78 larvae were detected at the Stewart Lake outlet gate by the USFWS on 28 and 29 May 2013, respectively. Thus, the outlet gate was opened 29 May 2013 at 19:05 for floodplain inundation to occur (Figure 1). Flow measurements were taken periodically at the outlet structure of Stewart Lake for the duration of inundation (Figure 2). On 1 June 2013 at 23:10 the outlet gate was closed when Green River discharge resulted in negative flows moving out of Stewart Lake (Figures 1 and 2). However, the gate was reopened 6 June 2013 for 14.5 hrs to entrain additional larvae due to a second peak in Green River flows (Figure 1). Although flows in the Green River maintained approximately 10,000 cubic feet per second (cfs), the outlet gate was closed 6 June 2013 at 23:00 upon observation of negative flows, suggesting that the inundation of Stewart Lake was maximized (Figures 1 and 2).

Light traps (2-mm openings) were set throughout Stewart Lake on 30 and 31 May 2013 to detect larval razorback sucker presence during inundation. Twenty-four and 23 traps were set the evening of 30 and 31 May 2013 respectively, and pulled the following mornings; each fishing for approximately 10 hrs with a total two day effort of 469 hrs. Fourteen of the 24 traps set 30 May, and 11 of the 23 traps set 31 May contained razorback sucker larvae, which were positively identified (Bruce Haines, Vernal-CRFP, personal communication). Due to multiple detections within Stewart Lake, light trapping ended until inundation was complete. Samples were sent to the CSU Larval Fish Laboratory for further identification and enumeration.

Prior to Stewart Lake inundation, a picket weir was installed at the outlet structure to monitor large-bodied native fish movement in and out of the lake and to exclude large-bodied nonnatives. The picket weir consisted of two fish traps, one capturing fish entering the lake (designated immigration trap), and one capturing fish leaving the lake (designated emigration trap), joined in the middle by a picket gate (Figure 3). The picket weir consisted of openings no larger than 1/4 inch to allow fish larvae to drift through unobstructed and to trap large-bodied nonnative and native fishes. The picket weir was manned 24 hrs /day during inundation. Fish were removed periodically from the trap boxes with long handled nets; all fish were enumerated and measured (Table 1). In comparison to the high numbers of nonnative fish observed in Stewart Lake in 2012 (Breen and Skorupski 2012), fish captures in the picket weir were unexpectedly low (Table 1). This is likely due to the design of the weir functioning more as an obstruction than a gradual funnel into the traps, resulting in fish avoiding the picket weir. Although capture rates were low, the picket weir provided its primary function of excluding large-bodied nonnatives from Stewart Lake.

Task 2: Sample the fish community in the Stewart Lake wetland and monitor post-connection water quality and habitat parameters; June–August 2013.

After floodplain connection, Stewart Lake was sampled using an assortment of techniques on a bi-weekly basis to monitor the fish community. Initially, 2-mm light traps were used from 10-24 June 2013 to determine if razorback sucker larvae were still present. Sixty sets were deployed with a total effort of 350 hrs. Sets were deployed for 19 hours, but were later set for shorter durations (1–19 hrs) due to high zooplankton density, predation from larval beetles and sample decay. Larval razorbacks were detected and verified in the two-hour sets (Bruce Haines, Vernal-CRFP, personal communication), therefore we concluded light trap sampling until fish were large enough to sample with other techniques. Samples are currently at CSU Larval Fish Lab for further identification and enumeration.

Time searches, seining and minnow traps were utilized beginning 9 July 2013 to sample the community composition. Time searches and minnow traps were used to sample a variety of habitats (i.e., dense vegetation) where seining was not feasible. However, a one-hour time search using dip nets was not successful at collecting razorback sucker, thus we abandoned the technique. Twenty minnow traps were set for short durations (2–7 hrs) over two days for 113 hrs. Traps baited with dog food and un-baited traps were paired and distributed throughout densely vegetated areas. Total catch consisted of common carp (n = 317), red shiner (n = 40), green sunfish (n = 24), fathead minnow (n = 1), sand shiner (n = 1), white sucker (n = 1), black bullhead (n = 1) and razorback sucker (n = 1). After experimenting with time searches and minnow trapping, we determined they were ineffective compared to seining. Seining occurred on 9, 15–18, and 30 July 2013, to monitor community composition and presence of razorback sucker. Initially sampling occurred throughout the lake to determine razorback sucker distribution. Seining occurred at 21 sites, but was primarily within the main drainage channels due to the loss of depth and habitat. Fish community composition is represented in Table 2. A total of 53 razorback sucker and 112 unknown suckers were collected; however 84 of the unknown suckers were represented in one seine haul. Razorback sucker (or unidentifiable sucker spp.) were collected in 14 of the 21 sites in low abundance. They were patchy but distributed throughout the lake. Patchiness could be a result of effectiveness of seining, habitat preference or low abundance. Depletion estimates were attempted on 30 July 2013 in an area with similar habitat to test the feasibility of seining razorback suckers. A depletion estimate was conducted without blocking an area, where nine consecutive seine hauls were completed and 17 razorbacks were collected with no apparent depletion. Thus, two blocked two-pass depletion estimates were conducted (Figure 4) for razorback sucker in similar habitat of the right channel (Figure 5). One additional blocked, two-pass depletion was completed in a different area (razorbacks previously collected) but yielded zero razorback suckers. The two estimates in the right channel were 3 and 8 razorback suckers, yielding an average of 5.5 razorback suckers in a 42.3 m^2 area. Therefore, if the similar habitat in the right arm was 0.5 acres, it harbored 263 ± 169 razorback suckers. This estimate is not definitive and cannot relate to the whole wetland due to patchiness, high variability and lack of samples, but does demonstrate potential methodology to systematically sample different habitat types to monitor juvenile razorback sucker within Stewart Lake once they reach a size susceptible to seining.

Razorback sucker growth was substantial over the month of July (Figure 6). Over the 4 sampling dates, the proportion of catch created unique modes along a length frequency that demonstrates fast growth rates. For example, on 9 July, the highest proportions of fish were 36-40 mm with few fish in other categories. On 15 and 17 July, we observed a decrease in 30-40 mm range and an increased number of fish from 46-60 mm. On 30 July, the greatest proportion of fish were ≥ 56-60 mm. Thus, the results represent the greatest proportion of razorback sucker shifting 20 mm in a three week period (Figure 6). Also, growth did not appear to decrease with degraded water quality conditions (see below).

We determined the total area of inundation during three time periods. To accomplish this, the perimeter was walked using a handheld GPS to collect waypoints which were plotted using ArcMap v.10.2 to map the wetland and the X-Tools Pro Package v.9.1 to create polygon shape files and calculate total area. Stewart Lake did not reach full capacity, instead filling a series of drainage channels and partially spilling over into large flats. On 10 June 2013 (immediately after the outlet gate was closed), 90.2 acres were inundated (16% capacity; Valdez and Nelson 2004) with maximum depths of 96 cm (near outlet gate) and 21 cm in the flats outside the channels (Figure 5). At a rate of ~5 cfs for five days, water was delivered on the north end of Stewart Lake from Red Fleet Reservoir to manage for selenium remediation; approximately 150 acre ft was delivered. Water delivery was discontinued until repairs were made to the delivery structure and when water was again available. Wetland area was again calculated on 15 July with 42.1 acres of water remaining (Figure 5). This date was chosen because delivery of Red Fleet water was scheduled to resume within a few days and we were attempting to determine pre- and post-delivery water levels; water was delivered from 17-22 July. Wetland area was not calculated until the end of July; however, depth was recorded at the outlet gate to monitor water delivery and water loss. Depths at the outlet structure were 87 (16 July), 88 (18 July), 91 (22 July; pipeline off, maximum water level), 82 (25 July), 73 (29 July) and 68 cm (30 July). Following the second filling event on 22 July the outlet structure was measured at 91 cm, which would have increased the wetland to an area approaching the original measurement of 90.2 acres. However, three days later the outlet gate measured 82 cm and the water level was less than prior to the five day filling event and continued to drop, which prompted the draining of Stewart Lake. By 29 July, only main drainage channels were inundated, which covered a total area of 5.7 acres (Figure 5). Although water was delivered over a 10-day period it was not sufficient to maintain or improve wetland inundation (Figure 5).

Water quality was continuously monitored in Stewart Lake from 26 June to 29 July 2013. We used two miniDOT Loggers (PME Inc., Vista, CA) to record data at 30-minute intervals, which we then averaged for each day to monitor changes in temperature and dissolved oxygen concentrations through time (Figures 7 and 8). One unit was placed near the outlet gate (Site 1), which was the area of greatest depth, and the second (Site 2) was placed at the junction of the main channel and the right channel (Figure 5). Temperatures were similar among sites and sustained at ~ 25 °C (Figures 7 and 8), which has been demonstrated to produce high growth rates of razorback sucker larvae (Bestgen 2008). However, dissolved oxygen varied through time (Figures 7 and 8). Generally, dissolved oxygen improved in the middle of the lake and degraded at the outlet structure through time. Two patterns occurred at both sites; dissolved oxygen levels improved while the lake was filling 17–22 July, but quickly decreased until the lake was drained (Figure 5). Water quality degradation toward the end of July can likely be explained by extensive vegetative uptake of floodplain water from monotypic stands of cattails in combination with drought-related evaporation and infiltration that quickly decreased the overall size of the wetland (Figure 5). However, the inflow of water did improve water quality conditions for a short period of time. The large swings in dissolved oxygen may be explained by primary productivity countered by respiration. As July progressed, both sites experienced large amounts of variability as demonstrated in standard deviation bars, but were much more irregular at the outlet gate (Figures 7 and 8); each day dissolved oxygen levels approached zero. We observed a change in the water conditions at Stewart Lake from June to the middle of July. Initially the lake was clear with dense populations of zooplankton. By mid-July, the lake was turbid with lower densities of zooplankton and extensive algal blooms. The outlet gate was deeper and protected from the wind, which likely resulted in larger dissolved oxygen variability from primary productivity, whereas the other site was much shallower and allowed for more surface mixing from wind. It is clear that the lake is very productive which could be linked to it functioning as a sink for nutrients in drought years. In 2012, high abundances of nonnatives, specifically adult common carp were present and decomposed within the lake. In addition we were only capable of draining a 5.7 acre area in 2013. It is likely that a complete fill and flush would greatly improve the nutrient load created in drought conditions and help mediate for selenium (Naftz et al. 2005). Although dissolved oxygen conditions were not optimal in 2013, razorback suckers were able to survive and grow within Stewart Lake which was an improvement from 2012. Given the conditions that rapidly developed from a limited amount of entrainment, 10,000 cfs (Figure 1) is insufficient to maintain water quality conditions. However, with the lack of large-bodied nonnatives and optimal temperatures razorback suckers are able to endure poor dissolved oxygen levels for a short duration.

Task 3: Sample fishes exiting the Stewart Lake outlet with a picket weir during draw-down, August 2013.

Due to the loss of water and poor water quality (Figures 5, 7 and 8), Stewart Lake was drained beginning on 31 July and ending 2 August 2013, which is close to a month earlier than anticipated. Because we were only interested in the emigration of fish from Stewart Lake, the weir was modified to use one trap capturing exiting fish. Also, due to the earlier draining date, it was expected that razorback suckers would be smaller. Thus, a 1/8 inch seine was attached to the picket gate to ensure we would capture the majority of fish exiting the lake during draw-down (Figure 9). The fish trap was periodically swept with nets, and fish were sorted into native and nonnative buckets. All native fish were individually processed and released alive to the Stewart Lake drain below the outlet structure; nonnatives were sub-sampled by weight and enumerated. Nonnative subsampling procedures were as follows. Once a bucket was filled with nonnatives the bucket was poured over two large ammo cans along the seam to effectively split the sample in two (Figure 10). One ammo can was randomly selected and set aside as a subsample. The remaining ammo can was weighed and discarded. This process was repeated with the subsample ammo can until a manageable subsample was obtained (approximately 300 fish). The final subsample was weighed, fish were counted by species, and the length of the first 30 individuals of each species was recorded. To enumerate fish, the following was calculated: ((# fish in subsample / subsample weight) X total sample weight = number of fish). A total of 60,330 nonnatives emigrated from Stewart Lake (Table 2). The dominant species throughout draining was similar to the overall community; however common carp emigration was delayed (Figure 11). The highest abundance of nonnatives emigrated at 13:08 on 31 July, but the greatest biomass did not occur until later (Figure 12). This is due to the large abundance and delayed emigration of common carp. Nonnatives emigrated similarly to razorback suckers except when peak emigration occurred. Regardless, many of the increases in catches occurred during similar time periods, which is likely a result of the outlet gate operation.

Initially, the outlet gate was lowered at 09:33 and closed at 21:00 31 July 2013. In the evening of the 31 July (~16:00), we observed a reduction in flow and catch rate of razorback suckers emigrating from the time of 15:26–19:11 (Figure 13). Therefore, the outlet gate was closed for a short duration (~60 minutes) to create a pulse of flow and prompt razorbacks to emigrate. The short closure produced high catch rates; therefore the gate remained closed overnight on 31 July (Figure 13). The gate was reopened at 06:00 on 1 August 2013, which produced the second highest razorback catch rate (Figure 13). For the remainder of draining the gate was closed for short intervals (~2 hours) to allow water from the upper extent of the lake to back fill at the gate creating a head of water. On the evening of 1 August, the gate remained open, which produced the lowest catch rate, thus demonstrating juvenile razorback suckers emigrated at a higher rate during the pulse flow events, rather than the lake draining slowly. Through our observations, every pulse event did not produce high catch rates of razorback suckers. However, it was apparent that the pulse events helped move fish out of the lake at a quicker rate and likely reduced the amount of razorbacks to be stranded in the upper extents of the shallow lake. On 2 August 2013 at 18:00 the weir was removed due to the majority of the wetland being drained, resulting in minimal flow and number of fish exiting the lake. A total of 613 (mean TL = 59 ± 7.7 mm; range = 30-89 mm) razorback sucker (including two unknown sucker spp.) emigrated over the three day period, 592 which were released alive back to the outlet channel. In addition to the captures in the weir, 145 deceased individuals were later counted in the lake by two people walking the perimeter of the wetland. The length frequency of razorback suckers demonstrates a wide range of lengths, but a lack of understanding why the range of sizes occurred. On 17 June 2013 razorbacks measuring 20-23 mm were captured in light traps, which suggest razorbacks had high growth rates; fish grew 2-4 times in approximately 54 days of entrainment (Figure 6 and 14). However, results do not explain the lower half of the length frequency observed during draining. Results could suggest multiple cohorts and/or differential growth rates among habitat types. Regardless, further studies would help understand the habitat needs, growth and survival of juvenile razorback sucker.

Task 4: Data entry, analysis and reporting

Recovery Program annual progress report submitted in November 2013.

VIII. Additional noteworthy observations: Observations are inserted within the text.

IX. Recommendations:

- We recommend that the Recovery Program strive for flow releases >10,300 cfs for a longer duration in order to successfully entrain a sufficient amount of water at Stewart Lake. To maximize inundation, we suggest a screen be constructed on the inlet gate so it can be utilized in low water years, but not allow the entrainment of large-bodied nonnatives. Through adaptive management, we have shown that floodplains are valuable and have the ability to entrain and recruit wild-spawned razorback suckers to a juvenile size class. However, with deteriorating water quality conditions, razorback suckers were released earlier than anticipated to the Green River. Through our results, it is likely additional entrainment time would have allowed them to grow a substantial amount, increasing their chances of survival.

- We suggest the development of a tagging study of wild razorback sucker to improve our understanding of habitat preferences, survival, movement, and dynamics of the population while draining. Utilizing VIE (Visible Implant Elastomer) tags, we would be able to uniquely identify a fish and pursue many of the above questions. Stewart Lake could be stratified by habitat type (i.e. depth, vegetation cover, area of lake, etc.) and fish would be tagged in associated areas to better understand habitat preference and movement between habitat types. In addition, when the lake is drained we would be able to determine where and how the fish are emigrating.

- Continue to utilize a picket weir to exclude large-bodied nonnatives, with minor modifications. The weir will be designed to improve functionality by increasing its length and angle to provide a more gradual funnel into the traps.

X. Project Status: On track and ongoing

XI. FY 2013 Budget Status

A. Funds Provided: $43,424
B. Funds Expended: $43,424
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:

We will submit our data to the Recovery Program database manager in December 2013.

XIII. Signed: *Joseph A. Skorupski Jr.* 10/14/2013
Principal Investigator Date

References:

Breen, M.J. and J.A. Skorupski Jr. 2012. Use of the Stewart Lake floodplain by larval and adult endangered fishes. Annual Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Bestgen, K.R. 2008. Effects of water temperature on growth of razorback sucker larvae. Western North American Naturalist 68(1):15-20.

Naftz D. L., Yahnke J., Miller J., and Noyes S. 2005. Selenium mobilization during a flood experiment in a contaminated wetland: Stewart Lake Waterfowl Management Area, Utah Applied Geochemistry 20: 569–585.

Valdez, R.A., and P. Nelson. 2004. Green River Subbasin Floodplain Management Plan. Upper Colorado River Endangered Fish Recovery Program, Project Number C-6, Denver, CO.

Table 1. Number of individuals and mean total length (TL) for fish captured in the picket weir

installed at the outlet structure of Stewart Lake.

Species	Count		TL (mm)
	Immigration	Emigration	
Black bullhead	23	2	156
Channel catfish	22	1	321
Common carp	22	16	473
Green sunfish	4	3	114
Northern pike	1	1	622
Speckled dace	2	0	89
White sucker	11	0	98
White x flannelmouth sucker	1	0	55

Table 2. Percent composition, mean total length ± standard deviation (mm), and range (mm) for sampling of Stewart Lake and during draining in 2013.

	Seining			Draining		
Species	% Comp.	Mean ± SD	Range	% Comp.	Mean ± SD	Range
Fathead minnow	46.0	29.5± 4.6	21-56	58.4	38.8 ± 3.6	32-48
Common carp	17.1	83.9± 17.4	46-198	10.7	100.6 ± 18.5	82-155
Red shiner	13.5	43.7 ± 10.8	23-65	11.1	48.7 ± 6.7	32-64
Unknown sucker spp.	8.6	34.7 ± 4.4	21-46	0.001	--	30-38
Green sunfish	6.0	27.1 ± 4.2	19-37	13.4	44.7 ± 3.1	39-52
Razorback sucker	4.1	49.0 ± 7.8	37-72	0.01	59± 7.7	42-89
Sand shiner	4.3	42.3 ± 4.0	31-51	4.5	43.7 ± 4.7	32-59
Brook Stickleback	0.5	25.8 ± 3.9	20-30	--	--	30
Flannelmouth sucker	0.1	--	49	--	--	--
Black bullhead	--	--	--	1.6	56.4 ± 5.4	48-65

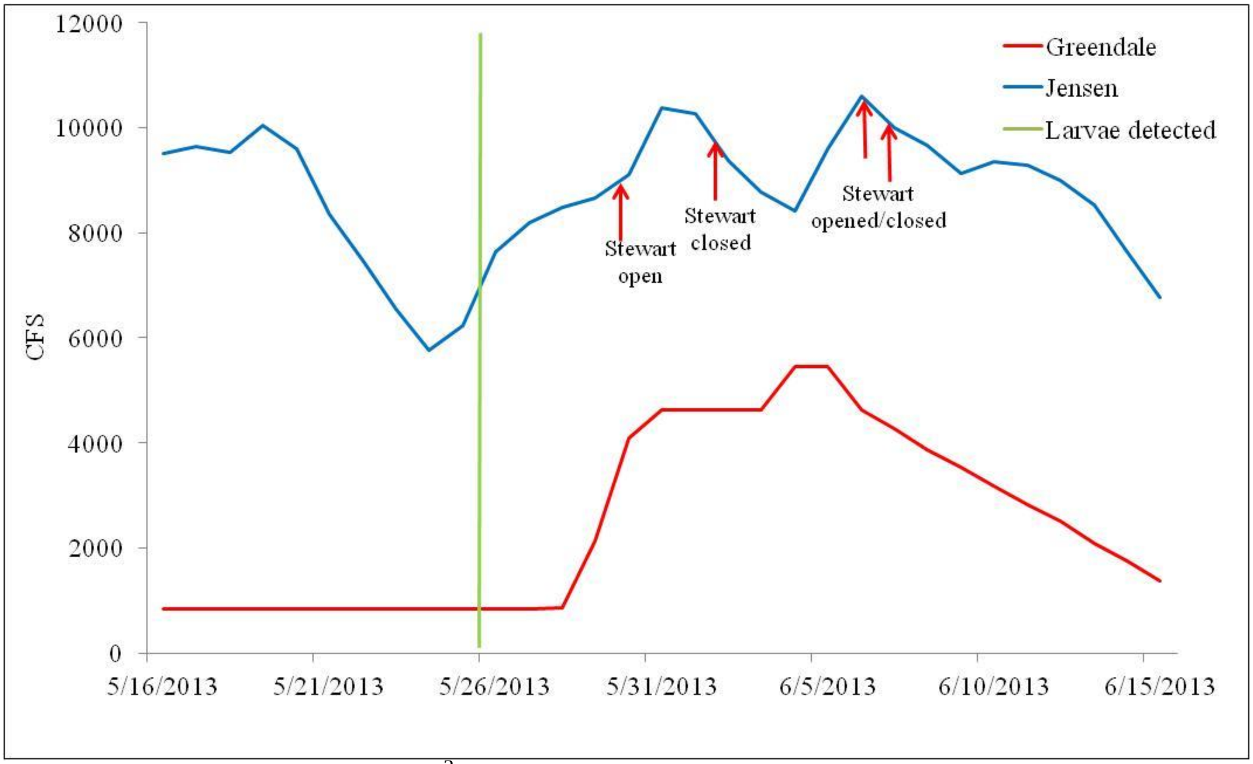

Figure 1. Mean daily discharge (ft^3/sec; CFS) recorded at the Jensen and Greendale, Utah USGS gauges. The green vertical bar represents larval razorback sucker detection by USFWS light trap sampling in the mainstem Green River near Jensen.

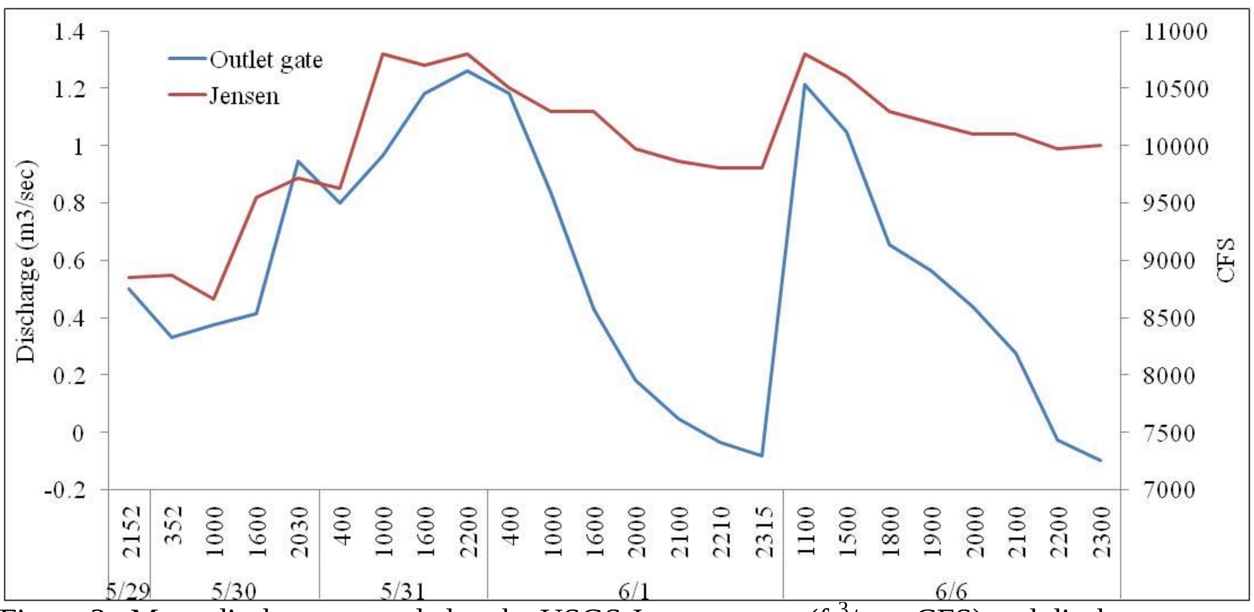

Figure 2. Mean discharge recorded at the USGS Jensen gauge (ft^3/sec; CFS) and discharge measured at the Stewart Lake outlet structure on several dates and times during 2013 peak flows. The outlet gate was closed 1 June at 23:15 and remained closed until 6 June at 11:00 for the second peak flow.

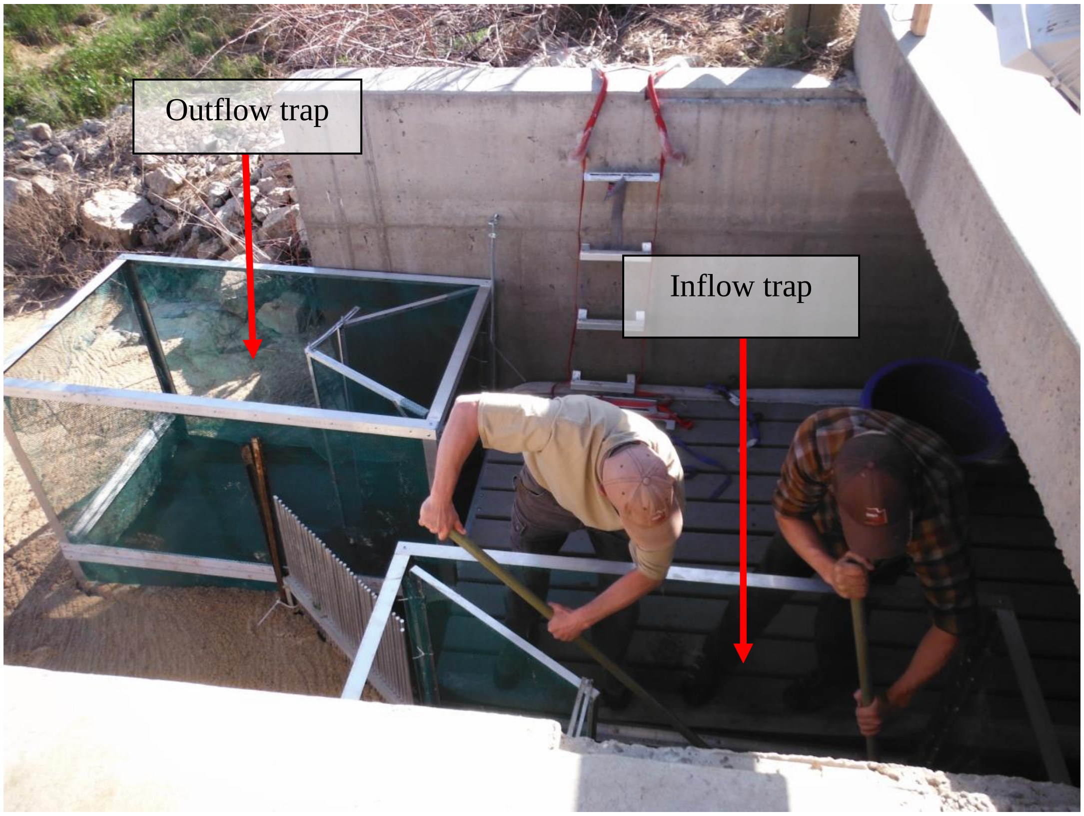

Figure 3. Picket weir installed at the outlet structure during flow entrainment at Stewart Lake. Arrows depict the immigration and emigration traps.

Figure 4. Area where a two-pass blocked depletion estimates occured in Stewart Lake.

Figure 5. The Stewart lake floodplain following entrainment of Green River flows in 2013. The three outlines represent a sequence of water loss from the time of inundation, until the lake was drained. Dates include 10 June (immediately after inundation), 15 July (following period of supplemental water (~150 acre feet) and loss of water due to evaporation, vegetative uptake and infiltration of entrained water) and 29 July (final inundation prior to draining). Site 1 and 2 represent data logger locations to monitor dissolved oxygen and temperature.

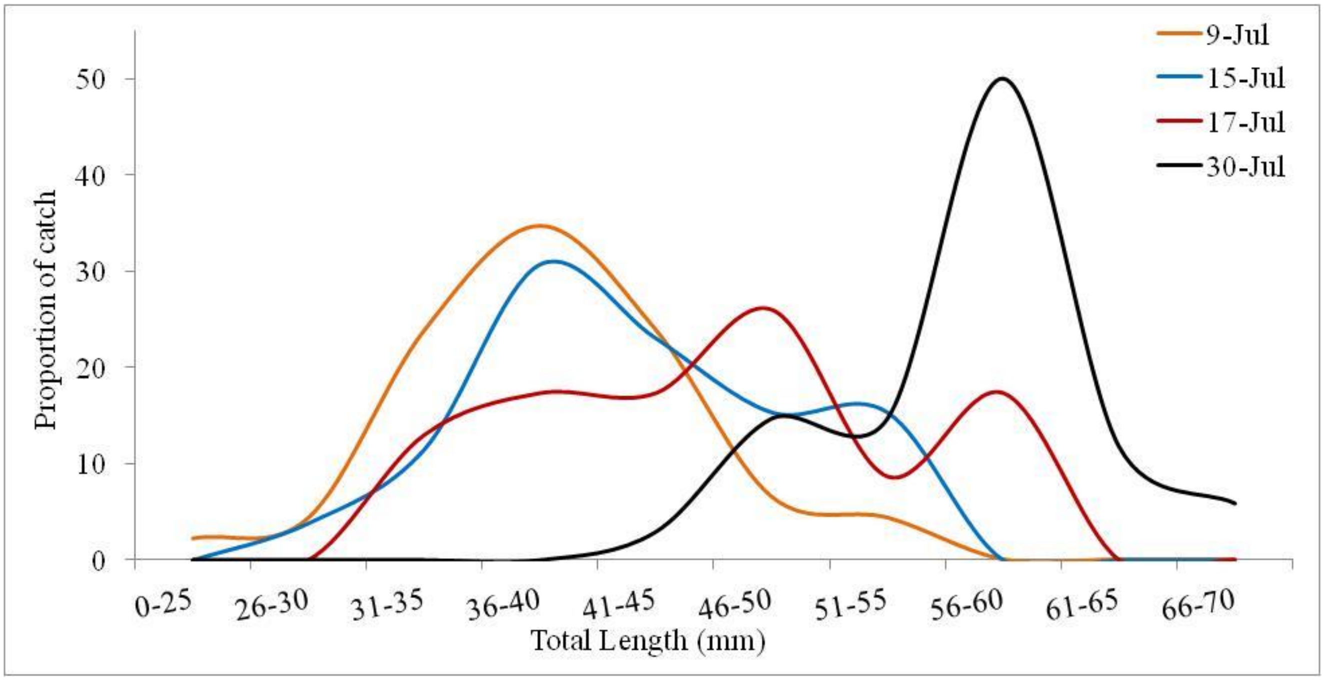

Figure 6. Proportion of razorback sucker juveniles during four sampling events in July 2013.

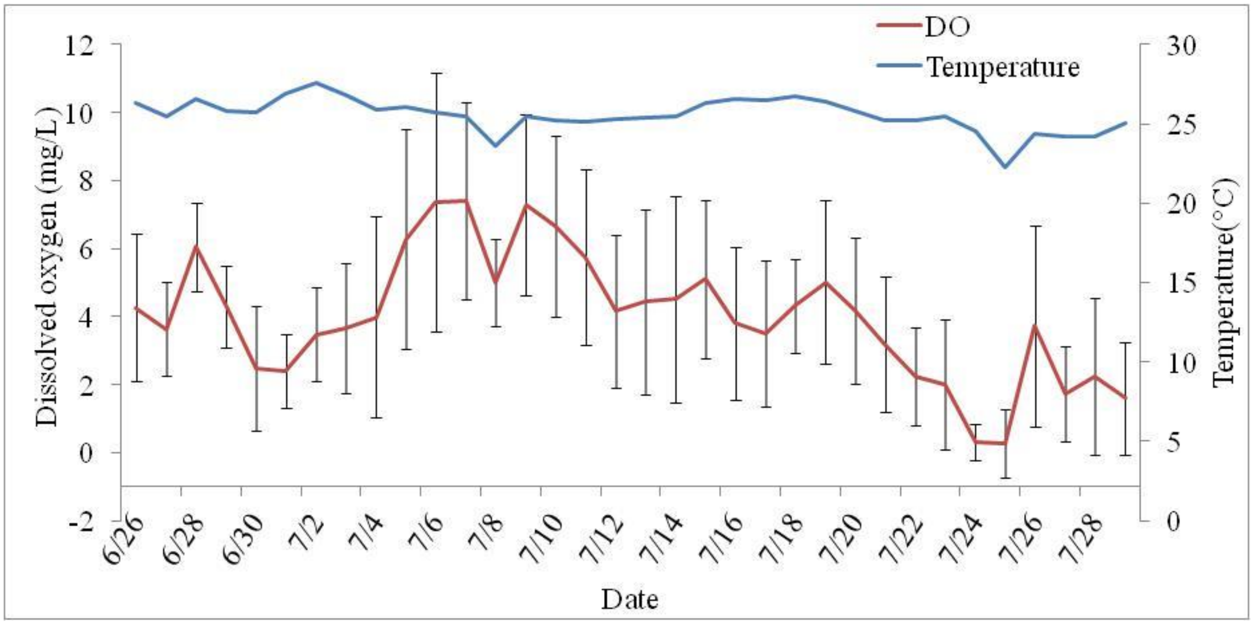

Figure 7. Mean (± SD) daily dissolved oxygen concentrations and temperature recorded from a data logger placed in Stewart Lake near the outlet gate (site 1; Figure 5).

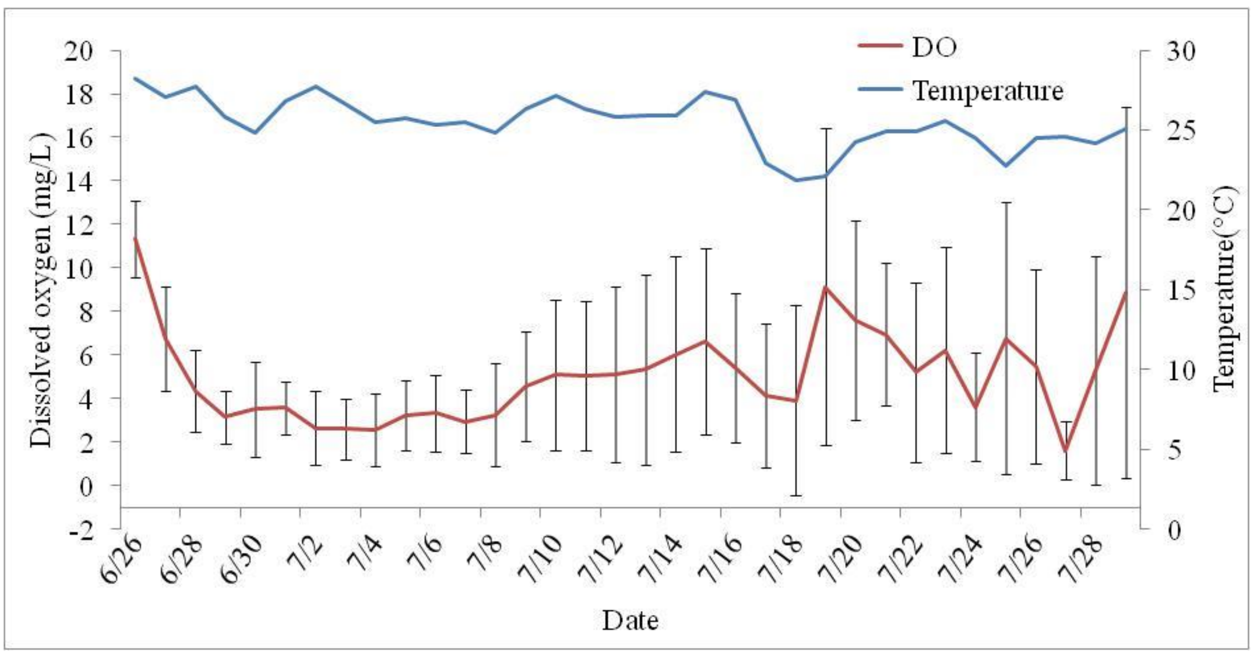

Figure 8. Mean (± SD) daily dissolved oxygen concentrations and temperature recorded from a data logger placed in the Stewart Lake at the junction of the two main channels in the center of the lake (site 2; Figure 5).

Figure 9. Picket weir installed at the Stewart Lake outlet structure during draining 31 July to 2 August 2013.

Figure 10. Nonnative sub-sampling technique to evenly split a batch of fish.

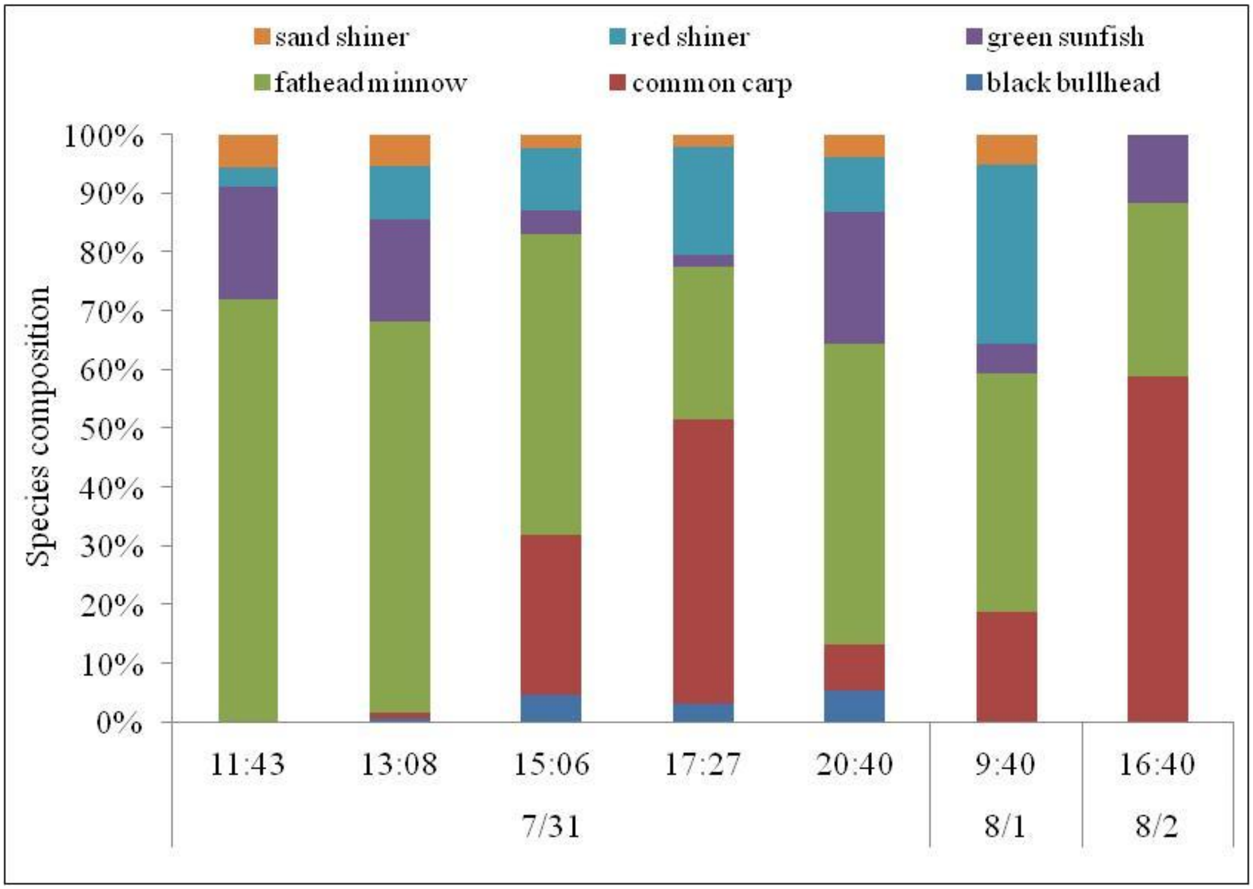

Figure 11. Nonnative fish species composition captured in picket weir over several dates and times while draining Stewart Lake 2013.

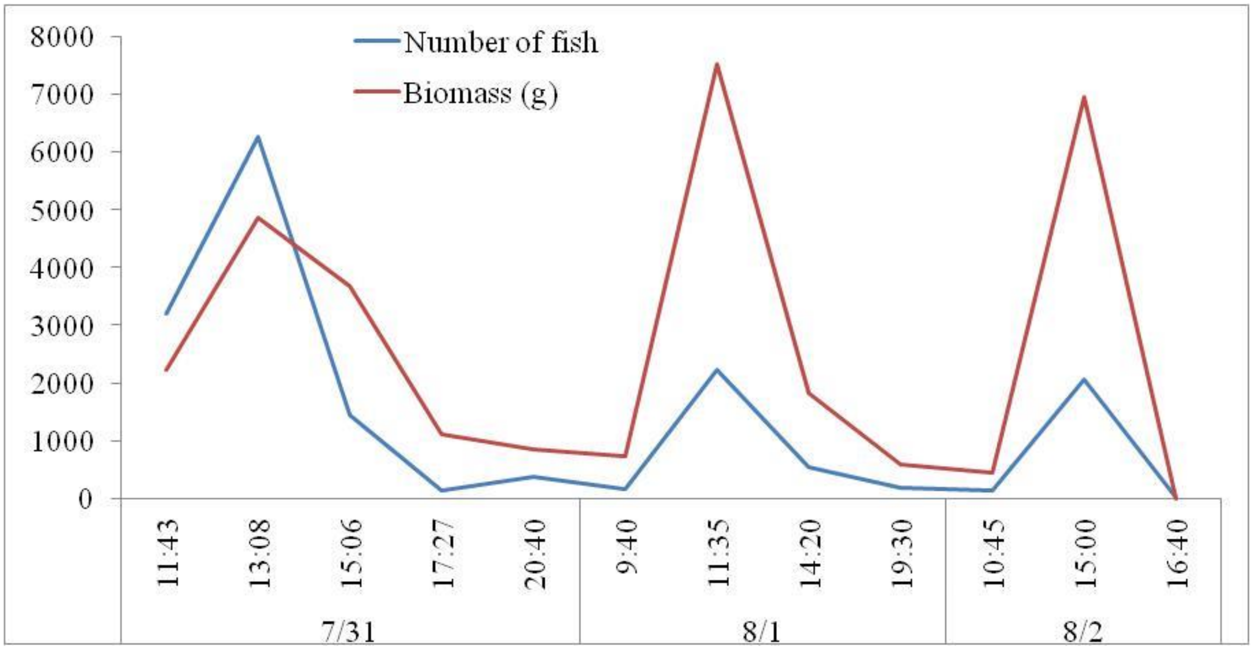

Figure 12. Number and biomass of non-native fish caught in picket weir on several dates and times while draining Stewart Lake 2013.

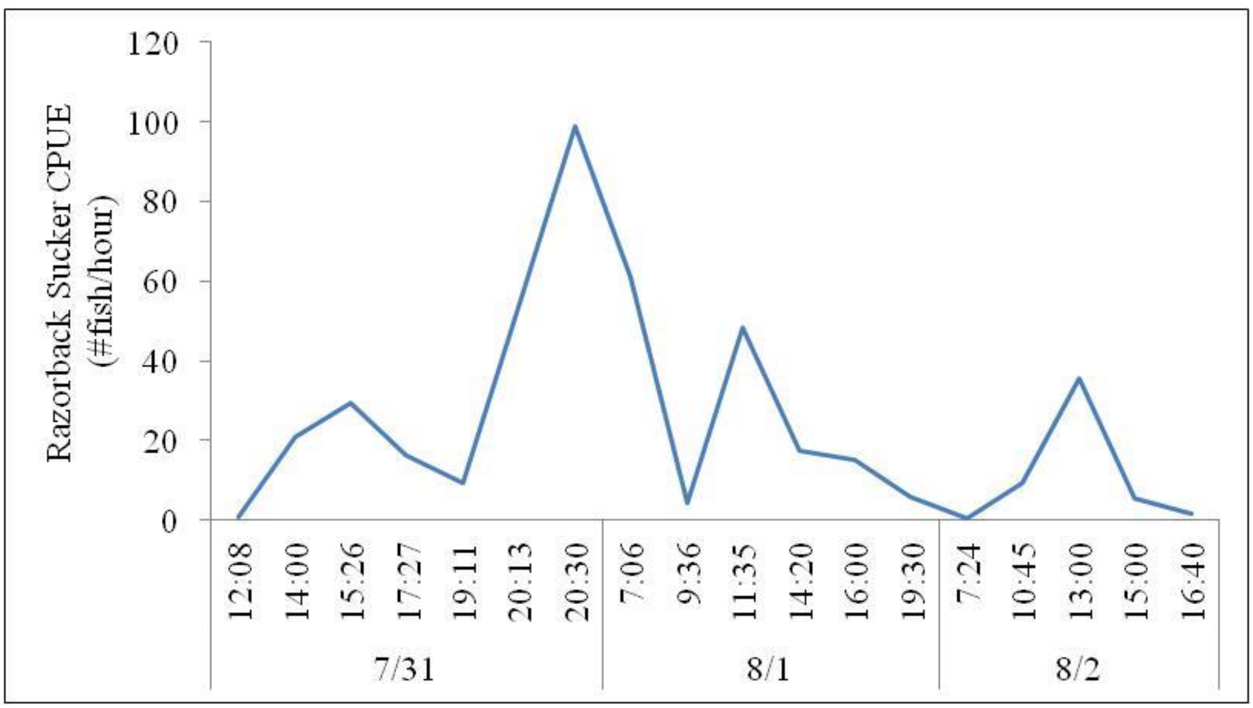

Figure 13. Catch-per-unit-effort (CPUE) of razorback suckers caught in picket weir over several dates and times while draining Stewart Lake 2013.

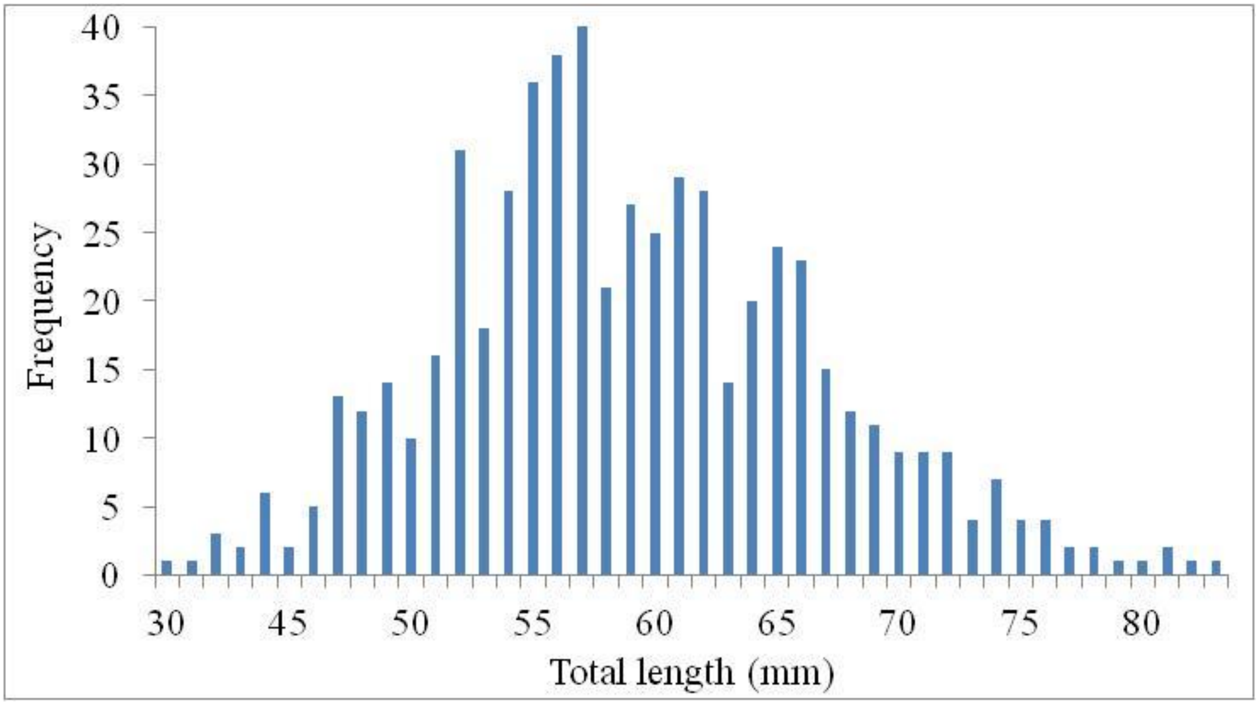

Figure 14. Length frequency of juvenile razorback suckers caught in picket weir while draining Stewart Lake 2013.