COLORADO RIVER RECOVERY PROGRAM
FY 2014 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: FR165

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

II. Bureau of Reclamation Agreement Number(s): #R14AP00007

Project/Grant Period:
Start date (Mo/Day/Yr): 05/01/2014
End date: (Mo/Day/Yr): 09/30/2018
Reporting period end date: 09/30/2014
Is this the final report? Yes _____ No __X__

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IV. Abstract:

Razorback sucker (*Xyrauchen texanus*) larval drift coincides with high flows during spring runoff, allowing for entrainment in warm, productive floodplain nursery habitats essential for recruitment. Using floodgate structures to control flows and picket weirs to exclude large-bodied nonnative fishes, Stewart Lake was filled to capacity in 2014 during the larval drift period. After entrainment for 92 days, 749 razorback suckers were sampled returning to the Green River during drawdown of the wetland. For the second consecutive year, Stewart Lake has demonstrated the enormous potential of managed wetlands for razorback sucker recovery under the Larval Trigger Study Plan.

V. Study Schedule: FY2012–FY2018

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 2014 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Install, operate and maintain a picket weir in the Stewart Lake outlet: May 28—June 17, 2014

As Green River levels initially rose this spring, the Stewart Lake outlet gate was not closed in time to prevent six to 10 acre-feet (AF; 10 AF maximum calculated from ArcMap v. 10.2) of water from entering the wetland along with numerous carp and other nonnative fishes. On 8 May 2014, during barge electrofishing of the shallow channel in Stewart Lake to remove those nonnative fishes prior to filling, multiple (4 male, 2 female; 486-698 mm TL) spent adult Northern Pike (*Esox lucius*) were captured. In light of this evidence of successful pike spawning, it was feared that juvenile pike would be entrained in Stewart Lake along with the 2014 class of larval razorback suckers, resulting in loss of developing suckers to predation. With the filling of the wetland (as dictated by the larval trigger) anticipated around the end of May or beginning of June, we opted to apply rotenone to the small volume of water in Stewart Lake on 20 May 2014, to eliminate this threat. Our efforts were evidently successful, given that no pike were observed during subsequent inundation and draining.

Light trapping for razorback sucker larvae in the middle Green River by Vernal—CRFP (Project #22f) detected the first larvae at Cliff Creek on 28 May 2014. As per the Larval Trigger Study Plan (LTSP; Larval Trigger Study Plan Ad Hoc Committee 2012), confirmation of larval presence led the Bureau of Reclamation to begin stepping up releases from Flaming Gorge Dam on 30 May 2014, culminating in a peak release of approximately 9,000 cubic feet per second (cfs; as measured at the USGS Greendale Gage: 09234500) on 6 June 2014 (Figure 1). Maximum releases were maintained for 10 days, with step-down releases beginning on 16 June 2014.

To detect the first appearance of razorback sucker larvae staging to enter Stewart Lake, two light traps (2 mm openings) were set overnight at the confluence of the outlet channel and the Green River on 31 May 2014, in addition to two traps being set daily in the pool adjacent to the outlet structure for Project #22f. A single razorback sucker larva, and the first of the season to be detected on river right, was trapped at the confluence on 1 June 2014, prompting the opening of the outlet gate to begin filling the wetland. We delayed opening the Stewart Lake gate until a few days after the initial larval trigger in order to confirm increasing densities of larval razorback suckers near the gate to maximize entrainment. A second larva was confirmed at the same location on 2 June

2014. Beginning on 2 June 2014, 12 light traps were deployed inside Stewart Lake (along the margins of the deep channel leading away from the outlet gate and at several points in the interior of the wetland). The number of traps was increased to 16 on 3 June and 18 on 6 June 2014, including an assortment of traps with both 2 mm and 4 mm openings. This was done to test whether exclusion of nonnative juvenile cyprinids—through use of smaller trap openings—might reduce predation in the traps and increase larval catch. On 10 June 2014, three traps were redeployed in the wetland adjacent to the inlet gate and were reset daily until removal on 13 June 2014. The original traps near the outlet were removed on 12 June 2014. With an operational period of approximately 9 hrs in early June (sunset at 20:45 to sunrise at 05:45), total light trapping effort expended in Stewart Lake over 12 nights was 1,836 hrs.

During the beginning phase of light trapping, samples were taken to Vernal–CRFP to confirm razorback sucker identifications with Bruce Haines. The first confirmed razorback sucker larva was trapped inside Stewart Lake on 5 June 2014. On 6 June 2014, three razorback sucker larvae and two flannelmouth sucker larvae were recovered from three traps in Stewart Lake, with eight razorbacks in five traps on 7 June 2014. All captures were along the main outlet channel or in open water nearby; at no point were sucker larvae captured near the inlet. Once a steadily increasing daily capture of razorback sucker larvae was established, detailed analysis of each light trap sample for confirmation of identifications was discontinued. Light trap sampling ended on 13 June 2014 to prevent further destructive sampling of razorback suckers, upon accumulation of sufficient samples from traps with different opening sizes to test the cyprinid predation effect. The accumulated light trap samples from 2014 will be forwarded to the CSU Larval Fish Laboratory.

As in 2013 (Skorupski et al. 2013), a picket weir and two fish traps were installed in the outlet structure prior to opening the gate (Figure 2), and were monitored 24 hrs/day by rotating crews during inundation. The purpose of the structure was to allow fish larvae to enter Stewart Lake unimpeded, while trapping adult fishes so that large-bodied nonnatives would be prevented from entering. An "in-trap," with a v-shaped opening capturing inflowing river water, was bolted to the south wall of the concrete channel. An "out-trap," offset closer to the gate, was bolted to the north wall and opened toward the wetland to capture fishes attempting to return to the river. Space between the traps was spanned by an aluminum picket weir with openings no larger than ¼ inch. At the time of installation, with over 15,000 cfs in the Green River recorded at the Jensen gage, the water level at the outlet gate was approximately 10 cm higher than the 1.8 m rods in the picket weir. Consequently, wire mesh extensions and blocking nets were affixed to the top of the structure to raise its height. To allow personnel to net fishes at regular intervals with long handled nets, a floating dock was secured between the two traps. On 29 May 2014, backpack electrofishers were used to shock the sealed pool between the gate and weir structure in an attempt to remove any nonnatives trapped during weir installation (carp had been observed in the area), but the water was too deep to shock effectively. Although no fishes were captured, a small number of adult carp were later observed inside Stewart Lake after filling; either they eluded capture during electrofishing of the channel or entered through some other unknown breach. Regardless, no adult carp were trapped during drawdown, underscoring the effectiveness of our exclusionary weir system.

Once the outlet gate was opened and filling began on 1 June 2014, captured fishes were counted and measured (Table 1), typically every 2-3 hrs during daylight, until the outlet gate was closed on 12 June 2014 due to equilibration of water levels between the wetland and the outlet channel. The inlet gate, protected by a picket weir blocking system installed in the concrete channel on the wetland side of the gate, was opened on 8 June 2014. Because of its higher elevation (1-2 ft difference), the inlet gate was kept open well after the closing of the outlet gate, until 17 June 2014, when Stewart Lake reached capacity (as determined by water levels reaching the lowest points along the levee road, such that continued filling would have resulted in spillover back into the river). Only adult carp were captured during occasional netting of the concrete channel between the inlet gate and the picket weir (Figure 3); carp could always be observed in the channel on the river-side of the gate. During this period, regular adjustments were made to the inflow, in an attempt to fill as rapidly as possible (i.e., before flows receded) while still protecting the integrity of the weir structures and preventing violent hydraulics unfavorable to larvae. Once flows receded, visual inspection confirmed that structural damage to the weirs had been avoided. When the Green River reached peak flows approaching 20,000 cfs in early June, water began to trickle over two low spots on the levee road, but in anticipation of this possible breach blocking nets had already been deployed at these points to prevent large-bodied fishes from entering the wetland. Whereas an abundance of adult nonnative fishes entered Stewart Lake in 2012 before use of an exclusionary weir and trap system (Breen and Skorupski 2012), in 2014, as in 2013, the number of fish captures during filling were quite low, with only 61 fishes in total netted from the in-trap during 12 days of operation, none of them native species (Table 1). Skorupski et al. (2013) speculated that the weir and traps functioned as an obstruction that caused fish avoidance of the structure, minimizing capture in the traps but nevertheless successfully excluding large-bodied nonnatives from the wetland. Low capture rates during inundation in 2014 are consistent with this explanation.

Task 2: Sample the fish community in the Stewart Lake wetland and monitor post-connection water quality and habitat parameters: June 19—August 21, 2014

Following the conclusion of light trapping on 13 June 2014, fish sampling within Stewart Lake was temporarily suspended to allow razorback suckers to grow to a size that would allow capture with seines and baited traps. Beginning on 21 July 2014, four-day sampling periods were initiated on a bi-weekly basis and continued until commencement of draining. With the wetland filled to capacity, inundating large expanses of cattail and bulrush stands, determination of wetland area by walking the perimeter with handheld GPS was not feasible. Considering the patchy distributions of razorback suckers in Stewart Lake reported during previous sampling (Skorupski et al. 2013), we hoped that visual surveys might give insights into habitat use and guide the choice of netting localities. To this end, two snorkelers attempted a visual survey on 21 July in the main channel extending into the wetland from the outlet gate, which was quickly determined to be unfeasible due to reduced visibility from abundant phytoplankton, zooplankton, and filamentous algae. Thus, we resorted to seining and minnow trapping without the benefit of an underwater visual assessment. Following the decision of the Biology Committee, 2013 proposals to stock hatchery spawned razorbacks and assess capture efficiencies of various size classes were not pursued in 2014.

To assess the effectiveness of minnow traps baited with dog food, eight traps were set at various points throughout the wetland on 22 July 2014, and were recovered on the morning of 23 July 2014, after a soak time of approximately 18.5 hrs. Six of eight traps captured a combined total of 201 common carp, the only species captured. Notably, the two carp captured in the trap deployed at the deepest point in the channel adjacent to the outlet gate were dead upon retrieval, suggesting anoxic conditions in a stratified bottom layer at this location. Because only carp were captured, and reasoning that continued trapping might result in razorback sucker fatalities from entrapment in zones of anoxia, minnow trapping was subsequently abandoned as a sampling method.

Subsequent to these attempts, and having reviewed additional sampling methodologies found to be ineffective in 2013, seining was chosen as the fish sampling method for the remainder of the entrainment phase. Our seining protocol during each four-day sampling period consisted of 40 total pulls of a 4.67 m long seine over distances of 10-14 m, in sets of five pulls at eight different localities throughout the wetland. Seining locations were chosen to capture the diversity of habitat types represented in the wetland, and to be spatially distributed throughout the area of inundation. Seining surveys were conducted during three periods prior to draining: 21-24 July 2014, 4-7 August 2014, and 18-21 August 2014. Regarding species composition during seining (Tables 1 and 2), nonnatives vastly outnumber native fishes in the wetland, including several species known to prey on sucker larvae, including carp (superabundant) and green sunfish. Red shiners and fathead minnow in particular are aggressive predators of larval fishes (Ruppert et al. 1993; Tyus and Saunders 2000), and the abundance of these nonnatives may contribute to high mortality for razorback suckers in early growth stages, before they achieve sufficient size to limit vulnerability to these predators.

During the three seining periods, the number of razorback suckers captured and their size ranges were n=13, 28-44 mm TL in late July; n=29, 27-69 mm TL in early August; and n=4, 33-98 mm TL in late August (Table 1). It should be noted that seining during the third period was by different personnel who attempted to sample new, marginal habitats rather than established hotspots for razorback sucker collection; in light of this, the lower capture rate than in the first two periods is unsurprising. Last year, Skorupski et al. (2013) reported that seining was primarily restricted to main drainage channels due to low water levels, but that razorback suckers were distributed throughout the available habitat in low abundance. This year, with Stewart Lake filled to capacity, an extensive pool of open water habitat was amenable to seining, while the main outlet channel near the gate remained too deep to seine for the entire period of inundation (see Figure 4). Razorback sucker distribution this year, in contrast to 2013, appeared to be not just patchy, but uneven—with certain zones devoid of suckers entirely. The main such zone was in the southwest portion of the wetland, in shallow (approx. 1 m depth) open water bordered by dense stands of cattails and bulrushes. Two environmental factors distinguished this zone from other habitats in the rest of the wetland: (1) the presence of ash from a small burn of dead cattails, and (2) dense mats of benthic algae forming an unbroken layer over the entire bottom. Elsewhere, razorback suckers were consistently seined toward the northern limit of the main outlet channel along the margins of dense beds of the submerged macrophyte mare's tail (*Hippurus vulgaris*), and east of the main channel in open water zones abutting cattail and bulrush stands. In rare instances, small series of razorback suckers were seined together in single pulls: on 4 August, five individuals were captured in one pull through the side-channel extending northeast from the main outlet channel, and on 5 August, eight individuals were captured in one pull along the mare's tail bed to the north (Figure 5).

Surprisingly, two razorback suckers were seined on 7 August 2014 in the pool on the wetland side of the concrete inlet structure, separated from the main open water portion of the wetland by a vast expanse of dense cattail and bulrush. As no razorback sucker larvae were detected during light trapping at this far northeastern portion of the wetland, it is possible that juvenile razorbacks are utilizing shallow water habitat deep within cattail and bulrush stands and reaching even isolated patches of open water on the furthest margins of the wetland.

Although razorback sucker captures during seining were low (n=46 total in 2014 vs. n=53 total in 2013), perhaps due to a dilution effect from the enormous volume of habitat made available in a wetland filled to capacity, they still provide insight into growth rates through the period of entrainment (Figure 6). Notwithstanding the distorted median (owing to small sample size) during seining on 8/19-8/20, the range of sizes broadens dramatically over the course of one month. The maximum size observed more than doubles in that time, from 44 mm TL to 98 mm TL, despite the near constancy of the minimum end of the size range. In addition to intrinsic physiological variation within the cohort contributing to variable growth rates, environmental variation may also play a role. Temperature in particular has been shown to have a pronounced effect on razorback sucker growth rates (Bestgen 2008); temperature logging at two sites in Stewart Lake in July and August (see below) recorded thermal profiles sufficiently divergent that growth rates in the two habitats might be expected to vary by nearly a factor of two.

Our efforts to monitor water quality parameters in Stewart Lake included the deployment of two miniDOT loggers to continuously record temperature and dissolved oxygen (Figure 7). These were placed at the bottom of the water column at sites S15 (at the northern limit of the main channel extending from the outlet gate) and S10 (in the side channel extending northeast from the main outlet channel). Their placement at depth had the unfortunate effect of logging dissolved oxygen in a presumably narrow hypoxic to anoxic layer, capturing occasional photosynthetic spikes of dissolved oxygen that might represent algal growth on or near the sensor. An improved strategy for monitoring dissolved oxygen would utilize multiple loggers at various depths to reveal potential stratification and the extent of an anoxic hypolimnion. Despite being at similar depths, the two loggers revealed considerable temperature variation between the two sites, ranging between 18-20° C vs 22-25° C. Possible explanations for this variation could include wind-driven upwelling and/or the existence of submerged springs providing an influx of cooler water.

Additionally, in support of selenium monitoring efforts by the Utah Division of Water Quality, water samples were taken at three sites (S10, S15, and at the outlet gate; see Figure 5) in Stewart Lake on four occasions—the first day of each seining period and immediately prior to draining. Each iteration of sample collection, filtering, and preparation for overnight shipment required a full day for one member of our crew. The alternating drain and fill cycle currently in operation at Stewart Lake in support of razorback sucker recovery has the dual benefit of assisting in selenium remediation, as oxidation of surface sediments during dry periods converts selenium to a more mobile form prior to filling, resulting in increased selenium transport during draining (see Naftz et al. 2005). Adaptive use of both outlet and inlet gates to achieve maximum filling of Stewart Lake in 2014 may have been particularly beneficial. Extremely high specific conductivity (>3000 μS) measured in the outflow during the last hours of draining likely correlates to high levels of dissolved Se being flushed out of the wetland.

Task 3: Sample fishes exiting the Stewart Lake outlet during draw down with a picket weir: September 2—September 15

Following installation of a picket weir (with a 1/8 inch seine attached to prevent escapement) and trap box to capture exiting fishes (Figure 13), the Stewart Lake outlet gate was opened on 2 September 2014 to begin the process of draining. Drawdown continued until 15 September 2014. Sampling and gate operation during this period was necessarily experimental, given the large volume of water requiring a multi-week release period and rendering 24/7 staffing unfeasible. In the early stages of draining, all fishes passing through the outlet channel were trapped and netted, with slightly higher flows and more frequent net sweeps at regular intervals during the day, and reduced overnight flows (to prevent fish mortality in the trap) followed by a morning net sweep to process the previous night's catch. Native fishes were sorted out of each net sweep and segregated into buckets of fresh water, while nonnative fishes were collected in large coolers. All native fishes were measured (total length) and released alive into the outlet channel connecting to the Green River, while nonnative fishes were subsampled by volume to estimate total counts, and total lengths of the first 30 individuals of each species were measured each day. To subsample nonnative fishes, the contents of a cooler were stirred to ensure uniform mixing, and plastic canister was used to remove scoops of constant volume. When time permitted, the contents of three such scoops were identified and enumerated (at peak periods of fish emigration in the last days of draining, only one canister was counted). After counting the number of additional canisters of fishes left in the cooler, total numbers for each species were estimated using the formula: (total # of cans ÷ counted cans) × (# of fish counted). Intermittent sampling, alternating with periods of free release through a removable panel in the trap, was initially employed during low capture periods, then became more frequent in the final stages of draining when tens of thousands of juvenile carp began to overwhelm the trap. Flow measurements in the outlet channel were taken regularly during drawdown, and illustrate a greater than twofold difference between trapping and free-release flows (Figure 8). Having carefully monitored capture patterns throughout, staffed sampling shifts were scheduled to include peak periods of emigration, in particular late afternoon through nightfall. Over 14 days (336 hrs) of draining, trapping was operational (including some unstaffed overnight periods with reduced flows) for 178.5 hrs—or 53% of the time. Although actual numbers of both razorback suckers and nonnative species were necessarily much higher than our reported totals given periods of high-flow, un-trapped releases, we are confident that our sampling provides an accurate snapshot of relative abundance.

During the two weeks of draining, 110,299 nonnative fishes were trapped and processed, representing more than 99% of the total (Tables 1 and 2; Figures 9 and 10). Five species predominated: common carp (n=68,309), fathead minnow (n=28,801), red shiner (n=8,874), white sucker (n=2,156), and sand shiner (n=1,545). Incidental species, represented by fewer than 1,000 individuals, included green sunfish (n=329), redside shiner (n=148), brook stickleback (n=116), black bullhead (n=14), plains killifish (n=2), creek chub (n=2), brown trout (n=2), and channel catfish (n=1). As can be seen in Figure 9, patterns of emigration from Stewart Lake varied across species and timescales. On a daily cycle, fish emigration slowed overnight and through the day, with large pulses of fish exiting the wetland in the period from late afternoon until dusk. At a broader timescale, different species emigrated at different phases, with white suckers in particular emigrating primarily during the first week of draining and then trailing off, while carp numbers exploded in the final days of draining. The early pulse of white suckers was surprising because this species was not detected during seining surveys; a possible explanation for both early emigration and undetected presence at shallower sites in the wetland's interior might be habitat preference by white suckers for the deep main channel next to the outlet gate. For carp, which were sampled in abundance throughout the wetland, the delayed pulse in emigration suggests behavioral avoidance of swimming over the outlet gate until critical densities are reached as water levels drop.

Amongst the overwhelming numbers of nonnative fishes, 753 native fishes were netted from the outlet trap, comprising predominantly razorback suckers (n=729; an additional 20 mortalities were observed in the outlet channel upon completion of draining), with incidental captures of *Gila* sp. (n=11), native *Catostomus* sp. (n=10), and speckled dace (n=3). Native species represented less than 1% of the total catch (Tables 1 and 2; Figure 10).

Razorback sucker growth during entrainment in 2014 was exceptional (Figure 11). Having benefitted from over one month longer in the wetland than in 2013, outlying sizes at the maximum end of the range were nearly double those from the previous year (168 mm TL in 2014 vs. 89 mm TL in 2013). Mean sizes were 1.64 times larger (97 mm TL vs. 59 mm TL). As in 2013, a wide range of sizes was also observed, with the lower limit of the size range remaining very similar between 2014 (49 mm TL) and 2013 (42 mm TL). With such an abundance of large individuals, we were able to PIT tag 20 individuals prior to their release into the outlet channel. Razorback sucker emigration rates varied markedly through time (Figure 12), with no trappings in the first stages of draining and a large pulse of emigration in the final days of drawdown. During this late pulse, emigration rates were much higher in the afternoon and evening, with CPUE of razorback suckers approaching 80 fish/hr on the evening of 14 September 2014.

Task 4: Data entry, analysis and reporting

Recovery Program annual progress report submitted in November 2014.

VIII. Additional noteworthy observations:

- The results of seining surveys (Figure 3) seem to exhibit a bias toward capture of smaller individuals, which may be explained by razorback suckers of larger sizes being able to outswim the seine. Future sampling should explore additional low – mortality capture methods, such as cast-netting, that might not be subject to this bias.

- Despite filling Stewart Lake to capacity, water quality deterioration (evidenced by a dark black water color, oxygen-starved fishes "gulping" air at the surface, and extremely high specific conductivity, >3000 μS) in the final hours of draining resulted in a massive die-off of fishes (mostly carp) remaining in the wetland. Razorback sucker mortalities also occurred during this period, but a means of preventing such losses is not immediately evident.

- As further elaborated in the Project 138 Annual Report, five razorback suckers (73-128 mm TL) were seined in three backwaters during ISMP sampling in the period shortly after Stewart Lake was drained. Four of these were in close proximity to Stewart Lake (0.3 mi upstream), and one was 17.8 miles downstream. Assuming that at least some of these juvenile razorbacks emigrated from Stewart Lake, which seems likely, they provide evidence of successful transitioning from wetland to riverine habitat.

- Fall sampling of naturally functioning wetlands subject to inundation in 2014 was conducted to assess YOY razorback sucker survival elsewhere in the reach (see Tables 3 and 4 for summaries of the exclusively nonnative catch in Bonanza Bridge and Stirrup wetlands). Of the wetlands sampled, YOY razorback suckers (n=5) were captured only in Leota, by USFWS personnel (T. Jones, pers. comm.). Comparison of these results with the success at Stewart Lake suggests that modification of additional wetland breaches through installation of floodgates to control filling and improve water retention—in combination with blocking weirs to exclude adult nonnative fishes—would improve razorback sucker recruitment in these nursery habitats.

IX. Recommendations:

- In light of the extremely low numbers of adult fishes trapped in the in-box during the filling of Stewart Lake for the second consecutive year, we recommend using un-staffed blocking weirs during filling, with fish traps in use only during draining. This would greatly help us in budgeting limited personnel hours, and would allow for increased sampling efforts during more productive periods. Stationary PIT antennas near the weir wall should be installed if possible, to provide an estimate of adult native species attempting to enter the wetland.

- Recognizing the considerably larger sizes achieved by razorback suckers in 2014 with an extra month of entrainment, we recommend extending the inundation period of Stewart Lake for as long as possible, within the restrictions of the selenium remediation protocol, during years with a full water allotment.

- Given our unexpectedly large time commitment in 2014 to water sampling for selenium monitoring, we recommend either greater involvement in sampling by the Utah Division of Water Quality, or allotment of additional funds to support this activity.

- With the extent of inundated habitat and enormous fish biomass sampled this year, we suggest that stocking of razorback suckers in future years when the wetland is full is a viable option that will not subject entrained native fishes to resource limitation. Bonytail chub would also be good candidates for stocking, providing their introduction is delayed long enough for juvenile razorbacks to grow beyond sizes most vulnerable to predation.

- Having successfully used exclusionary weirs and floodgate control of Stewart Lake to rear large cohorts of wild-spawned razorback suckers for two years (with vastly different hydrology) under the Larval Trigger Study Plan, we suggest installing floodgates and weirs at additional wetland breaches in the Ouray reach of the Green River. Priority should be given to wetlands that experience connectivity with the river across the widest range of peak flow scenarios.

X. Project Status:

On track and ongoing.

XI. FY 2014 Budget Status

A. Funds Provided: $68,205
B. Funds Expended: $68,205
D. Percent of the FY 2014 work completed, and projected costs to complete: 100%
E. Recovery Program funds spent for publication charges: $0

XII. Status of Data Submission (Where applicable):

We will submit our data to the Recovery Program database manager in December 2014.

XIII. Signed: *Robert Schelly* 11/7/14
Principal Investigator Date

XIV. References:

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	Filling			Seining			Draining		
Species	% Comp.	TL (mm) Mean ± SD	TL (mm) Range	% Comp.	TL (mm) Mean ± SD	TL (mm) Range	% Comp.	TL (mm) Mean ± SD	TL (mm) Range
Black bullhead	-	-	-	-	-	-	0.01	139.3 ± 33.4	81-182
Brook stickleback	-	-	-	3.3	30.7 ± 3.9	22-39	0.1	48.6 ± 5.2	43-62
Brown trout	-	-	-	-	-	-	0.002	73 ± 4.2	70-76
Catostomus sp. (native)	1.6	72	72	2.9	45.3 ± 11	32-59	0.009	46.3 ± 4.6	38-51
Channel catfish	18	365 ± 61.8	295-470	-	-	-	0.001	126	-
Common carp	55.7	432 ± 219	47-660	61.9	73.7 ± 16.7	22-132	61.5	86.5 ± 23.3	47-194
Creek chub	-	-	-	-	-	-	0.002	61 ± 33.9	37-85
Fathead minnow	-	-	-	21.8	34.5 ± 10	17-60	25.93	50.8 ± 8.5	19-75
Gila sp.	-	-	-	-	-	-	0.01	54 ± 17.9	41-85
Green sunfish	3.3	58.5 ± 27.6	70-109	2.5	26.8 ± 4.4	18-37	0.3	66.1 ± 22.1	30-148
Iowa darter	-	-	-	0.08	54	-			
Plains killifish	-	-	-	-	-	-	0.002	65	-
Razorback sucker	-	-	-	3.5	39.9 ± 13	27-98	0.67	96.5 ± 21	47-168
Red shiner	-	-	-	2.2	47.8 ± 10.1	27-65	7.99	53.3 ± 8.1	33-82
Redside shiner	4.9	66 ± 20.1	52-89	1.5	46.9 ± 12.2	22-71	0.13	48.3 ± 7.1	37-70
Sand shiner	11.1	59 ± 1.73	57-60	0.3	38.3 ± 11.2	31-55	1.39	50.9 ± 5	32-64
Speckled dace	-	-	-	-	-	-	0.003	60.5 ± 36.1	35-86
White sucker	4.9	75 ± 28.7	42-94	-	-	-	1.94	62.1 ± 31.4	30-241

Table 1. Percent composition of various species and their size ranges during the three 2014 Stewart Lake sampling phases: filling, seining and draining.

	Filling	Seining	Draining
Species	Number Sampled		
Black bullhead	-	-	14
Brook stickleback	-	42	116
Brown trout	-	-	2
Catostomus spp. (native)	1	38	10
Channel catfish	11	-	1
Common carp	34	800	68309
Creek chub	-	-	2
Fathead minnow	-	282	28801
Gila spp.	-	-	11
Green sunfish	2	32	329
Iowa darter	-	1	-
Plains killifish	-	-	2
Razorback sucker	-	45	729
Red shiner	-	28	8874
Redside shiner	3	20	148
Sand shiner	7	4	1545
Speckled dace	-	-	3
White sucker	3	-	2156
TOTAL	61	1292	111052

Table 2. Total abundance for each species sampled during the three 2014 Stewart Lake sampling phases: filling, seining and draining.

Stirrup Wetland Sampling

Estimated Average Depth 1.2 m

Estimate of Sampled Area 102,290 m^3 / 83 acre-ft

Species	% Composition	Average TL (mm) ± SD	TL (mm) Range
Black bullhead	3.2	70.4 ± 56	43-244
Bonytail chub	0.079	215.9 ± 32.8	137-274
Common carp	46.8	73.6 ± 17.9	45-182
Fathead minnow	48.5	61.9 ± 5.7	50-73
Green sunfish	1.1	103.8 ± 27.3	57-164
Red shiner	0.38	64.1 ± 6.3	54-74

Total species caught per gear type

Species	Baited Hoop	Directional Fyke	Fyke	Trammel
Black bullhead	17	623	204	5
Bonytail	1	1	14	5
Common carp	209	11339	926	-
Fathead minnow	865	6065	5990	-
Green sunfish	16	232	24	16
Red shiner	1	25	75	-

Table 3. Species composition and size ranges, and capture number across gear types, for Stirrup wetland sampling, October 14-15, 2014.

Bonanza Bridge Fall Wetland Seining

Estimated Average Depth 0.3 m

Estimate of Sampled Area 3,264 m^3 / 2.6 acre-ft

Species	% Composition	Average TL (mm) ± SD	TL (mm) Range	Total individuals (n=)
Common carp	16	87.8 ± 12.7	69-97	4
Fathead minnow	76	50.2 ± 6.7	37-65	19
Green sunfish	8	44.5 ± 12.0	36-53	2

Table 4. Species composition and size ranges of fishes captured during seining of Bonanza Bridge wetland, October 15, 2014.

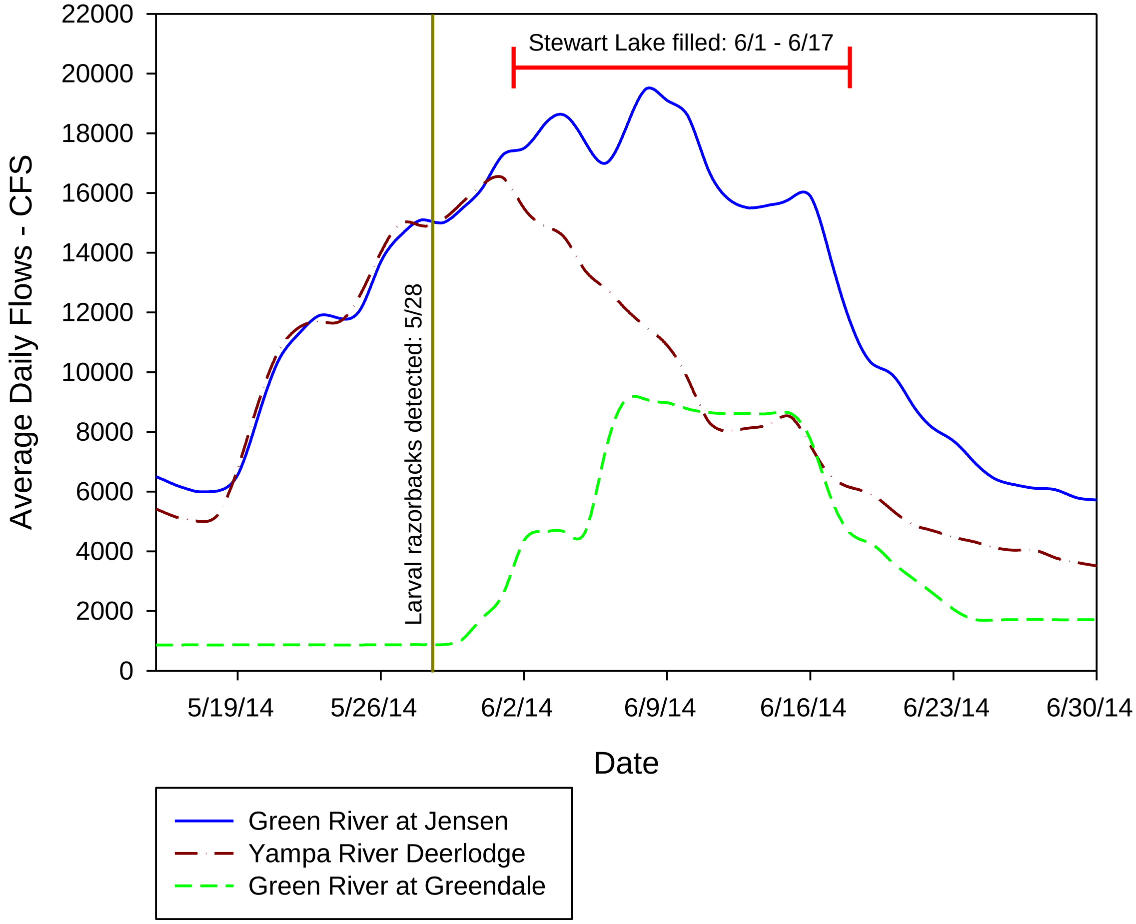


Figure 1. Hydrograph of 2014 spring flows under the Larval Trigger Study Plan, with first detection of drifting razorback sucker larvae and the Stewart Lake filling period highlighted. Flow data from USGS gages 09261000 (Jensen), 09260050 (Deerlodge), and 09234500 (Greendale).

Figure 2. Configuration of in- and out-traps connected by a picket weir (located at the outlet structure) during the 2014 filling of Stewart Lake.

Figure 3. Picket weir installed at the Stewart Lake inlet gate.

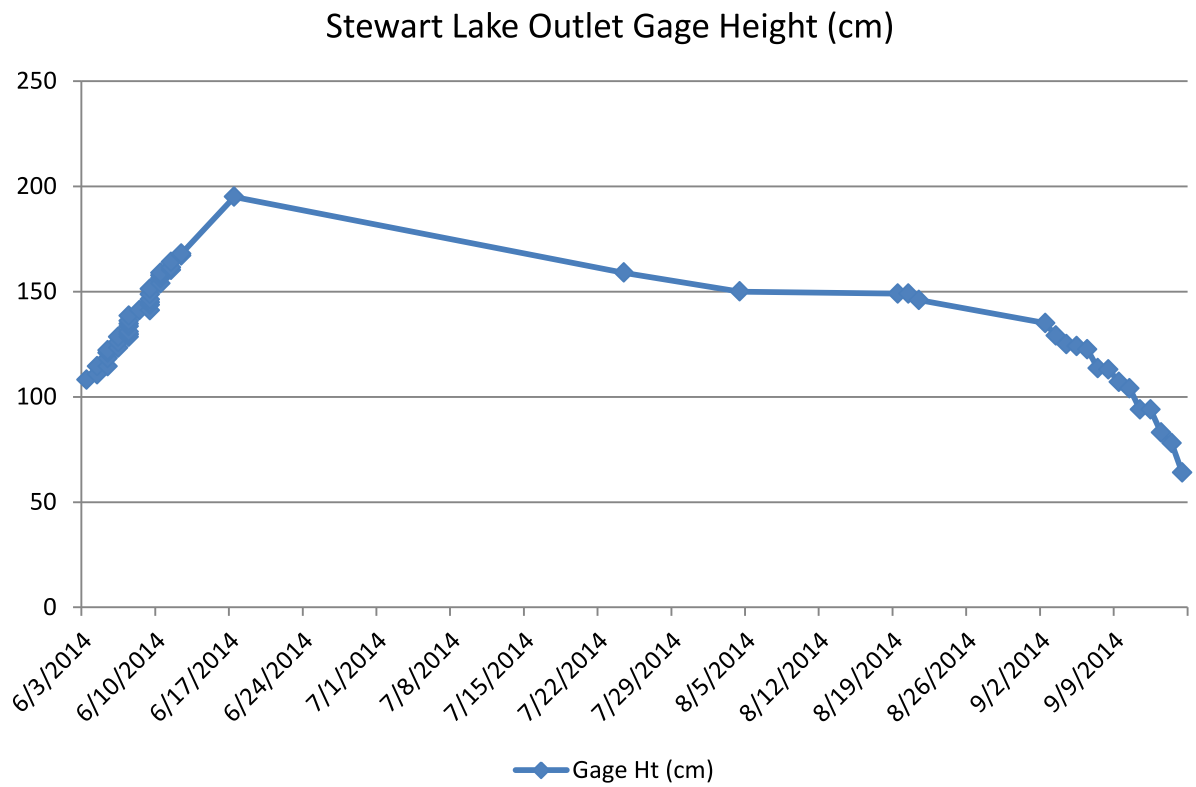


Figure 4. Depth measurements at the Stewart Lake outlet structure during the periods of filling, inundation, and draining in 2014.

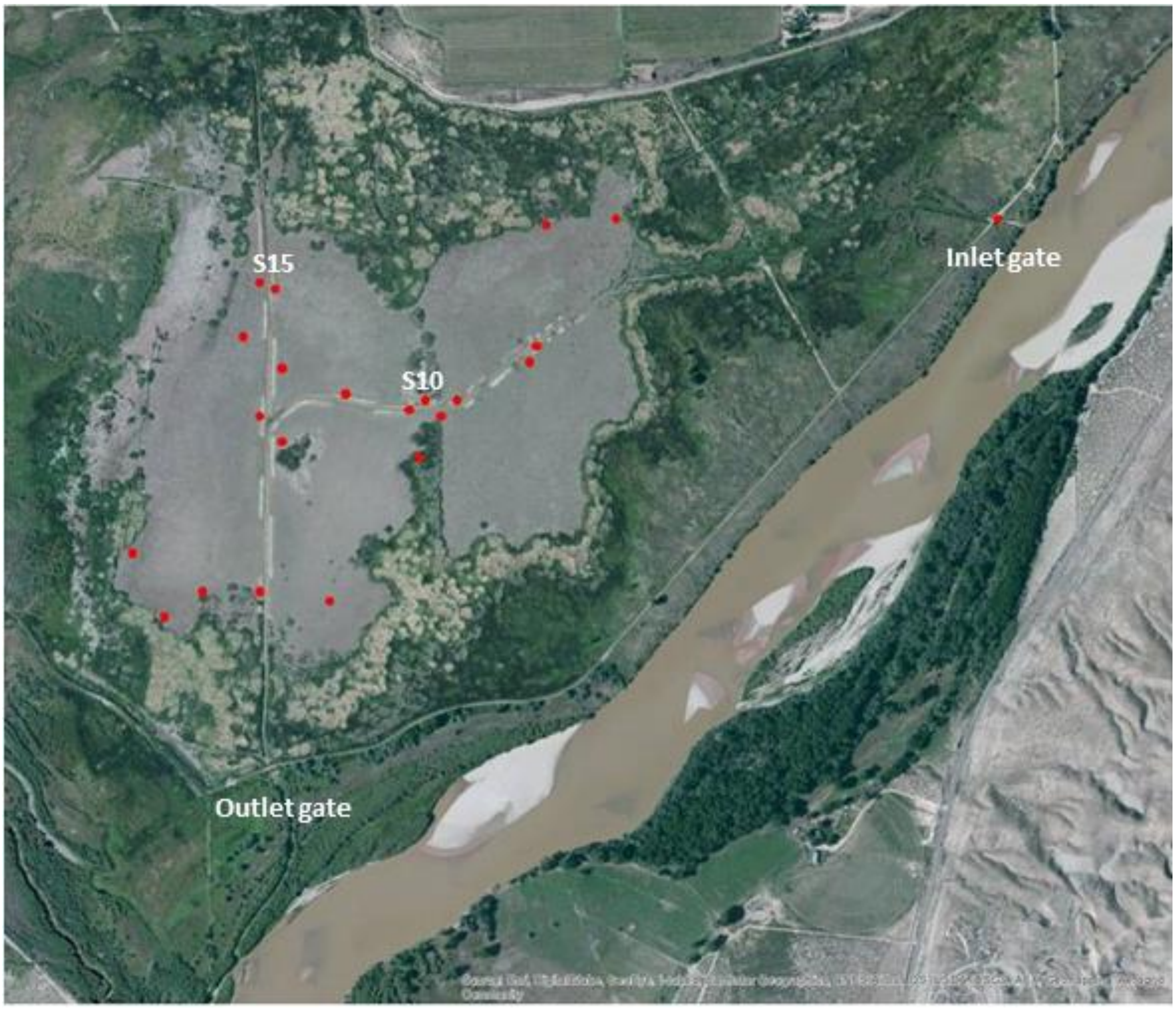


Figure 5. Map of Stewart Lake wetland showing inlet and outlet gates and seining localities.

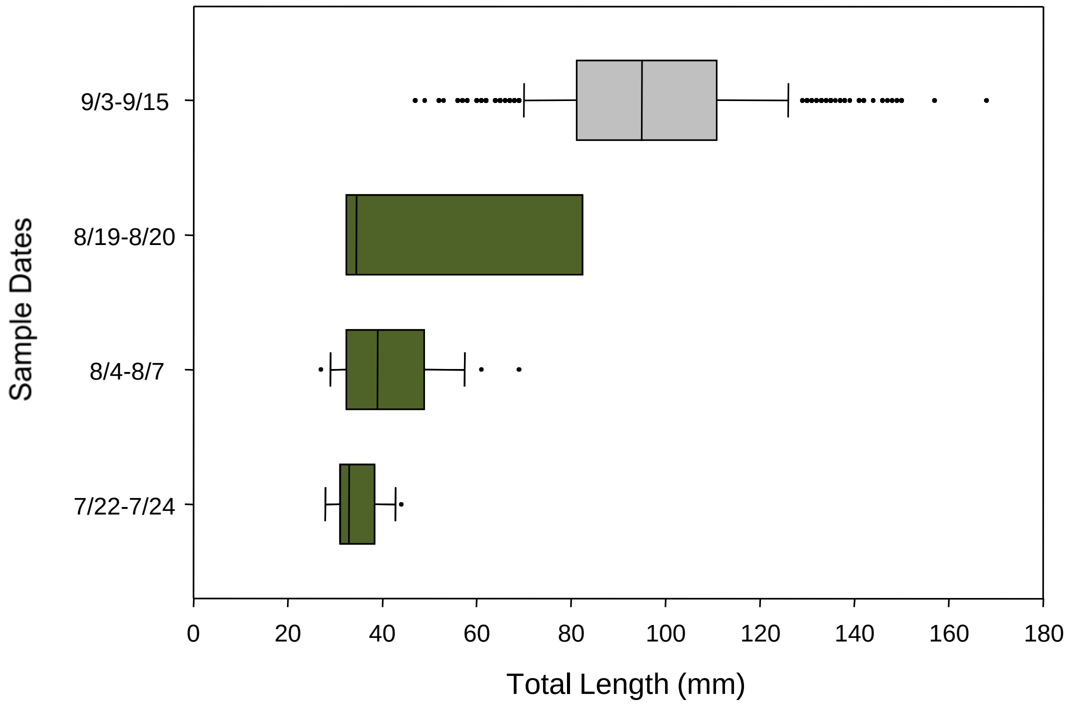


Figure 6. Size variation among juvenile razorback suckers in Stewart Lake sampled during three periods of seining (green) and during trapping at drawdown (grey). Lines within boxes represent the median. The left and right limits of boxes indicate the 25th and 75th percentiles, respectively, while the error bars extending beyond boxes indicate the 10th and 90th percentiles. Outlying points are plotted individually. Note that for the 8/19-8/20 period, sample size (n=4; 33-98 mm TL) was too small to compute 10th and 90th percentiles.

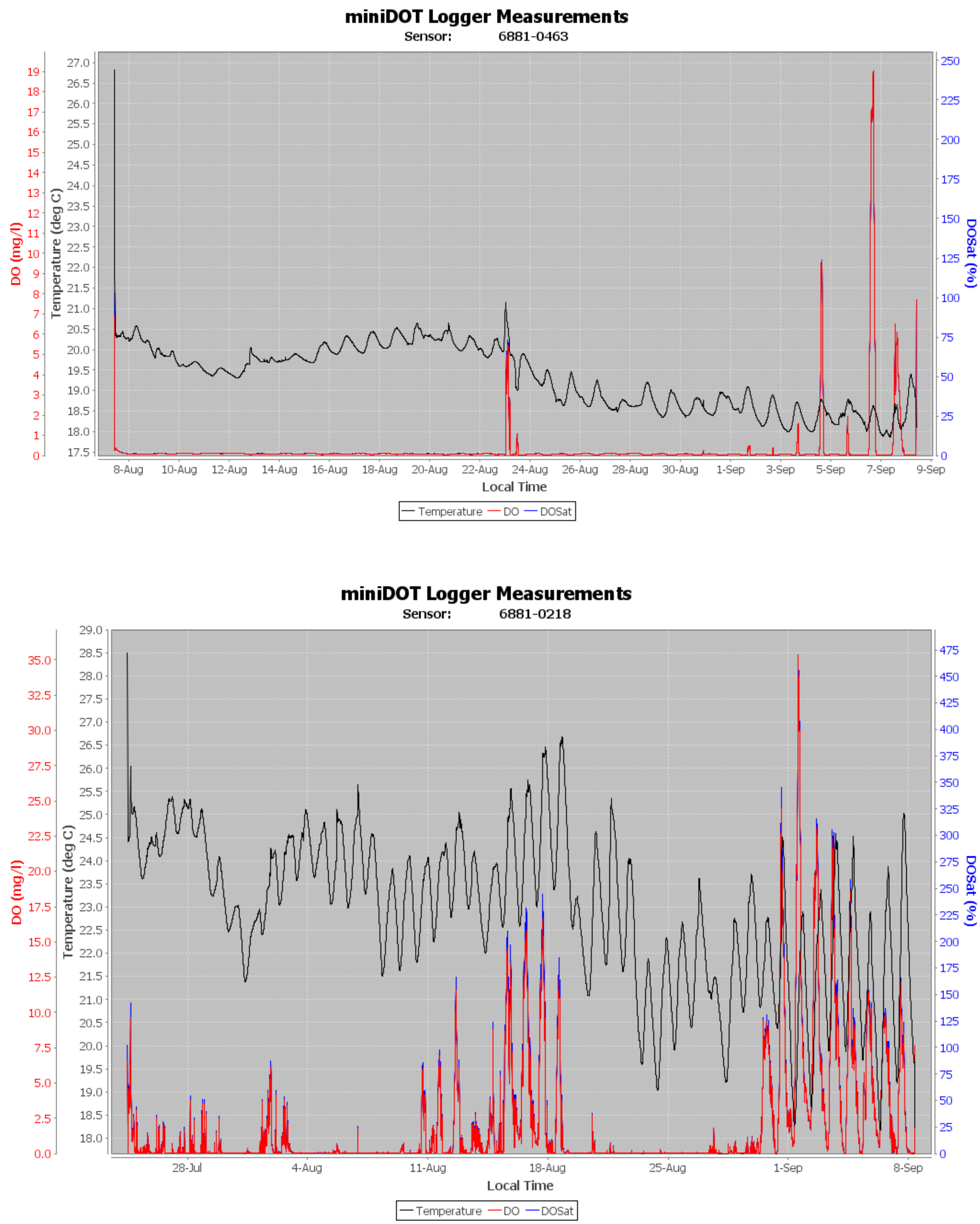


Figure 7. Plots of temperature and dissolved oxygen from Stewart Lake sites S15 (upper) and S10 (lower) during the latter period of inundation in 2014.

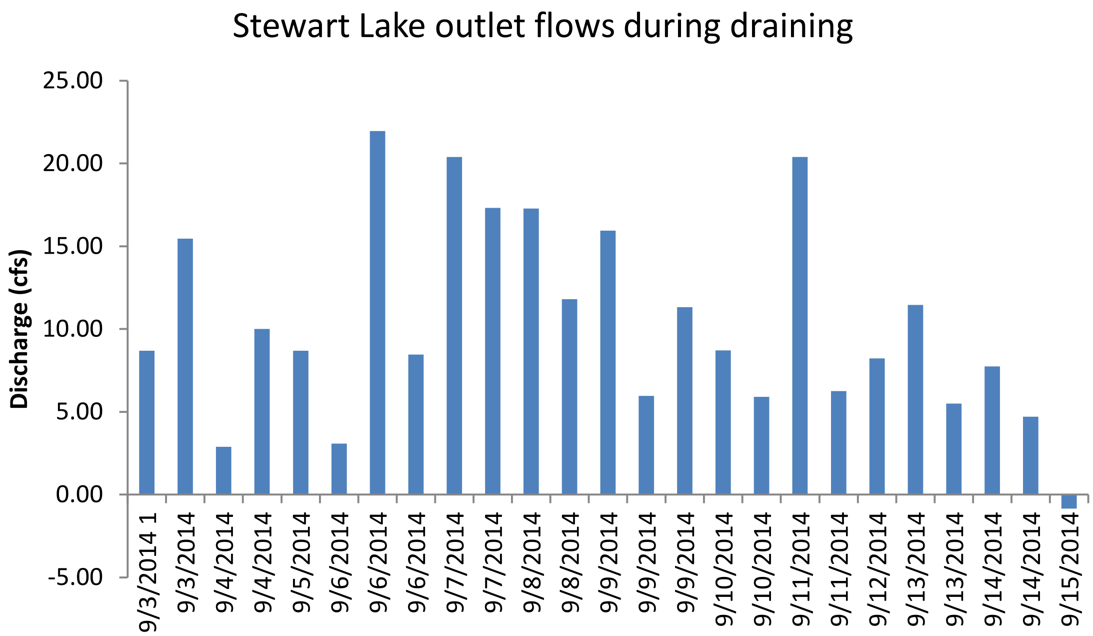


Figure 8. Flows measured at regular intervals in the Stewart Lake outlet channel during draining, illustrating our experimental approach to gate control with reduced flows during sampling periods and intermittent high flows during free release periods.

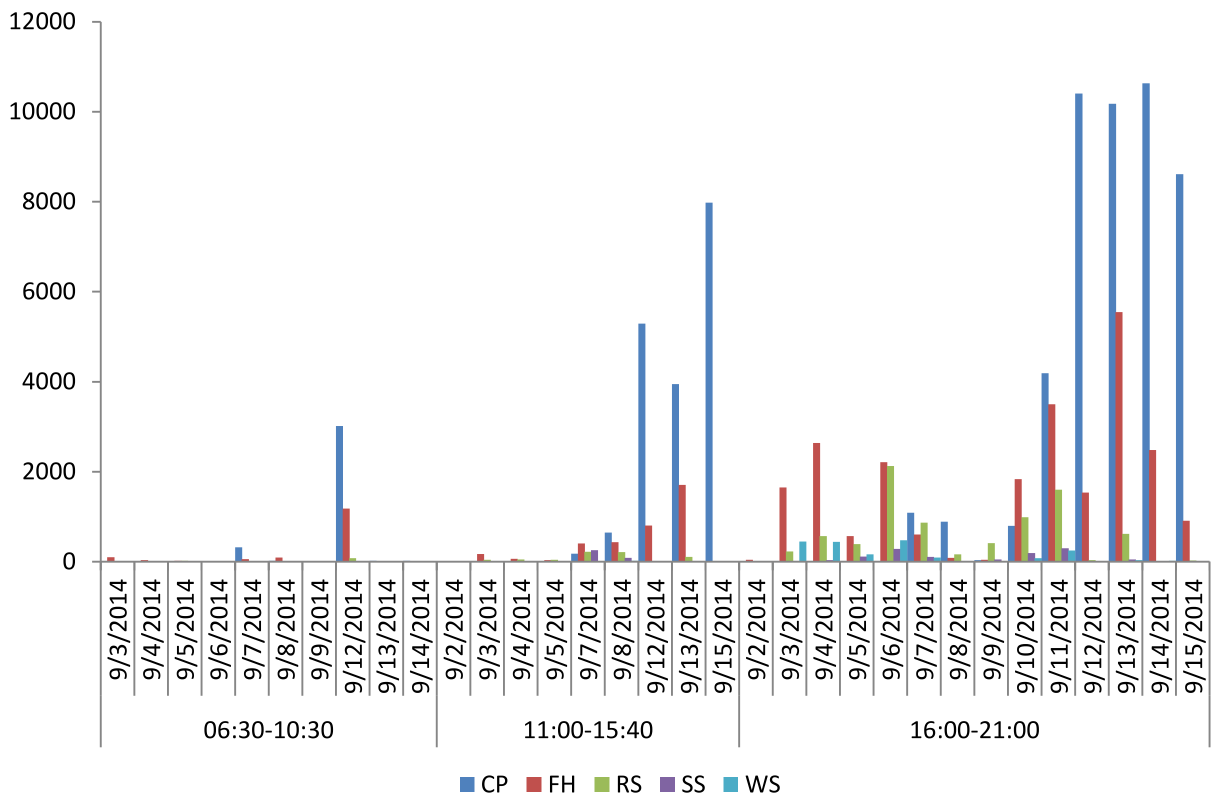
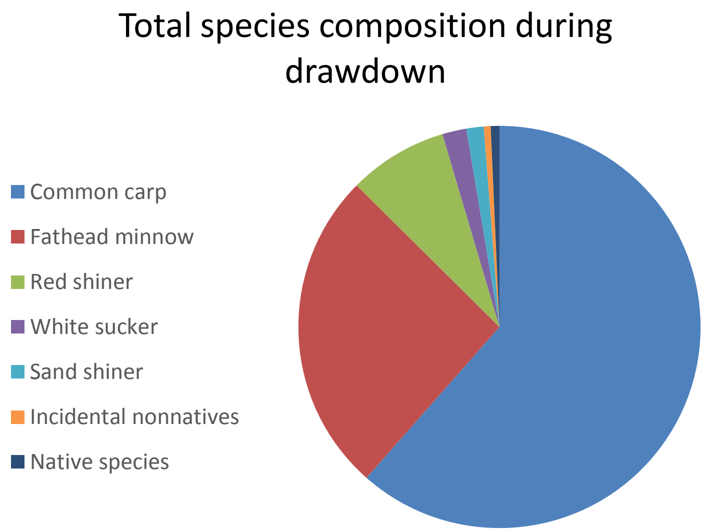


Figure 9. Nonnative trends through draining illustrated by total numbers sampled of predominant species through time.



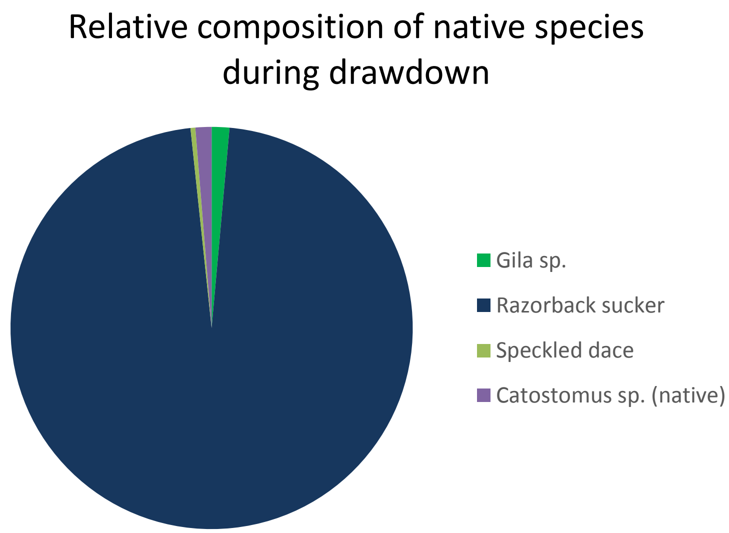


Figure 10. Relative species composition during draining for all species (top) and for native species only (bottom).

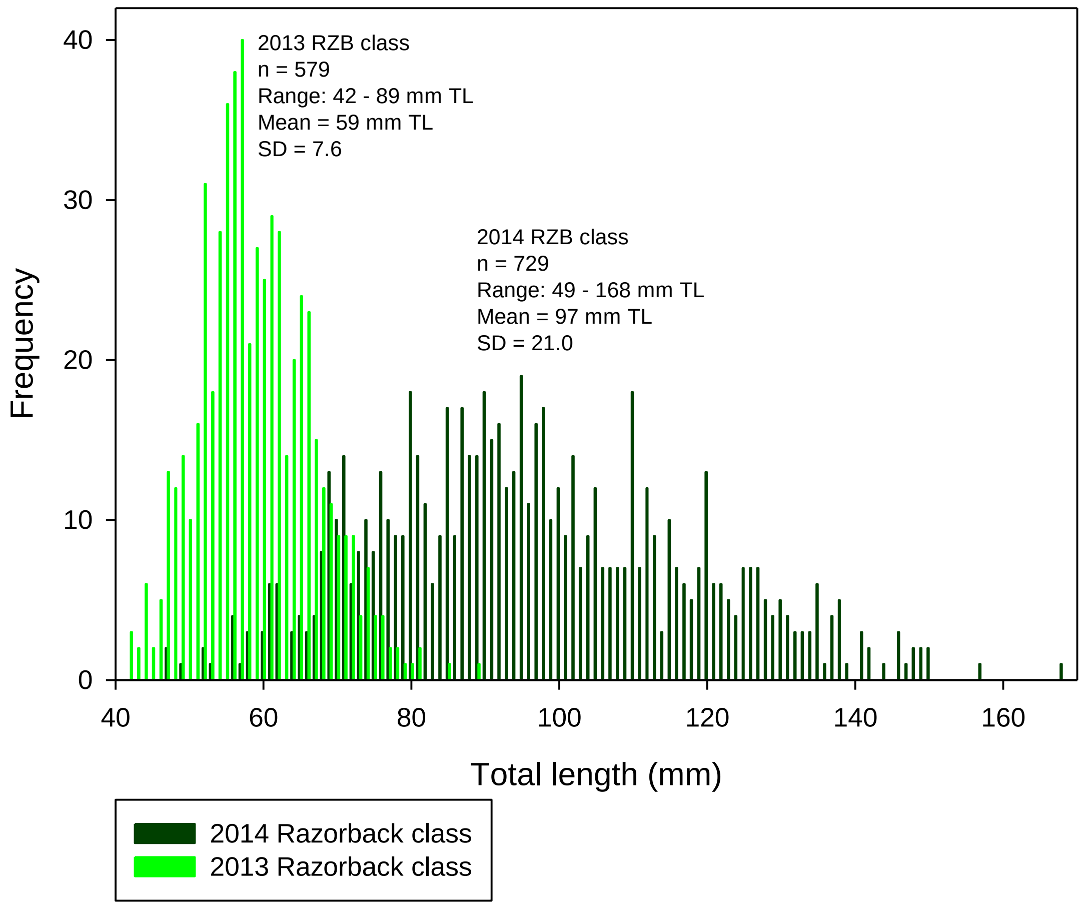


Figure 11. Comparative histogram of razorback sucker size classes sampled during Stewart Lake draining in 2013 vs. 2014.

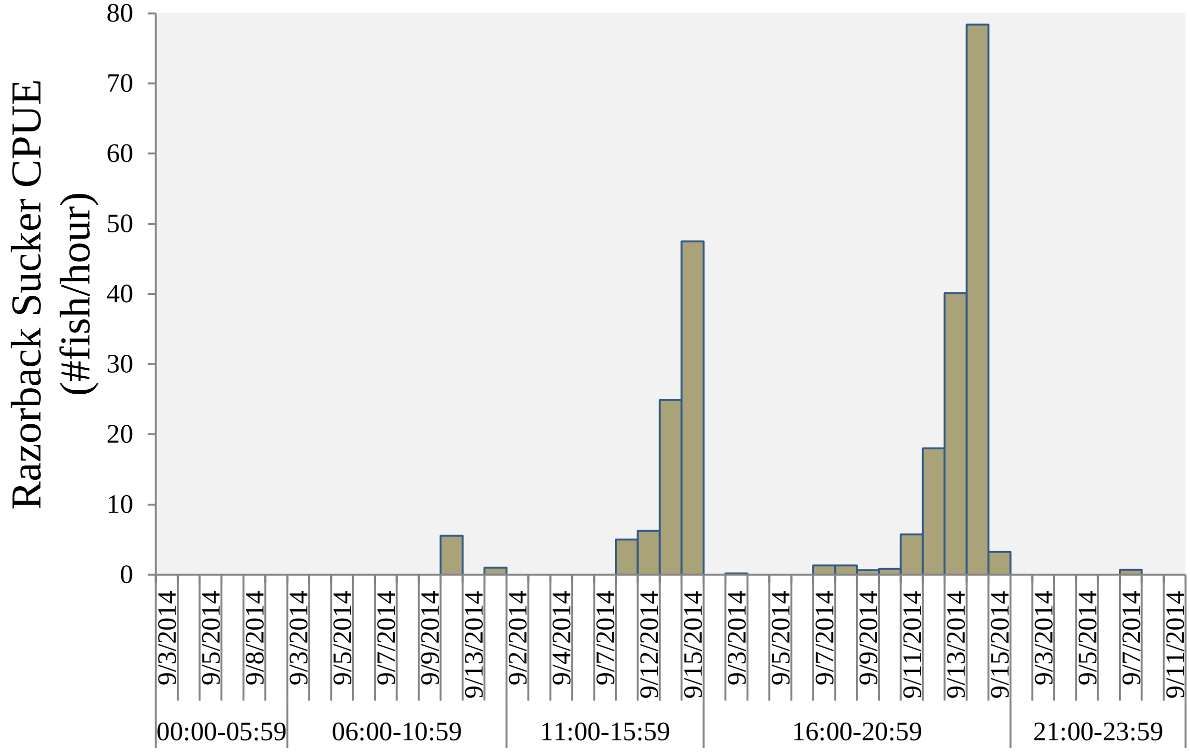


Figure 12. Catch-per-unit-effort (# of fish/hr) in the out-trap for razorback suckers during the 2014 draining of Stewart Lake.

Figure 13. Picket weir and out-trap box installation used to sample fishes during the draining of Stewart Lake.

Wild-spawned juvenile razorback sucker sampled during the 2014 draining of Stewart Lake, after only three months of entrainment!!!