COLORADO RIVER RECOVERY PROGRAM
FY 2017 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: 09/30/2017
Is this the final report? Yes _____ No __X__

III. Principal Investigator(s):

Richard R. Staffeldt, Michael S. Partlow, Bradley R. Anderson, and Matthew J. Breen
Utah Division of Wildlife Resources
Northeast Region
318 North Vernal Ave.
Vernal, Utah 84078
Phone: 435-781-9453; Fax: 435-789-8343
E-mail: rstaffeldt@utah.gov

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 flood gates to control flows and weirs to exclude large-bodied nonnative fishes, Stewart Lake was filled approximately two feet lower than capacity in 2017 during the larval drift phase. After an entrainment period over three months ending on 2 October 2017, endangered fish production was low with only two young-of-year (YOY) Razorback Suckers and 13 YOY *Gila* spp. (awaiting Larval Fish Laboratory verification). Encroachment of cattails and bulrushes continues to shrink the amount of open water habitat available for fish production and survival; prompt management actions are crucial to ensure future recovery success at Stewart Lake.

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 2017 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Install, operate and maintain a picket weir in the Stewart Lake outlet: 9 March-June 20 2017.

In early March 2017, an attempt was made to drain water built up in Stewart Lake from snowmelt and run-off before the installation of a newly designed permanent picket weir. At the time, the wetland side gate was open and completely flush with the ground, held in place with an aluminum safety foot, leaving the riverside gate to hold the wetland back. To drain the wetland, this configuration needs to be reversed, utilizing the wetland side gate to hold back the head of water in the wetland. With this configuration switched so that the riverside gate was flush with the ground and held in place with an aluminum safety foot, we slowly lowered the wetland gate allowing water to spill over both structures to exit the wetland. Upon draining, water pressure immediately built up under the riverside gate, ejecting the aluminum safety foot from its seated position and flipping the gate over in the opposite direction. Flow was then cut off with the wetland side gate in order to reposition the riverside gate upright, leaving it in place to hold back the river until high flows and larvae arrived. Due to safety issues posed by the aluminum footer (i.e., attachment point too close to the riverside gate fulcrum), we were no longer be able to use this system to drain the wetland. In a second attempt to empty Stewart Lake (~3.8 ft at the outlet guage) prior to high flow entrainment, we borrowed an 8” diesel water pump from the Green River Basin Fish and Wildlife Conservation Office (GRBFWCO). With the pump running 24 hrs/day, approximately 10 days in duration, efforts proved unsuccessful (20-30 March 2017).

Installation of our picket weir took place on 9 March 2017, and represented the latest model in weir and trap design, which has evolved since 2013. Past configurations included variations of experimental fish traps combined with an exclusionary weir structure to allow researchers to selectively move adult endangered fishes into the wetland (Skorupski et al. 2013; Schelly et al. 2014). Low catch rates of adult endangered fishes in experimental traps installed at the outlet channel during previous filling phases (Skorupski et al. 2013; Schelly et al. 2014; Schelly and Breen 2015; Schelly et al. 2016)

convinced us to abandon a fish trap design and install only an exclusionary weir guided at eliminating large-bodied nonnative fish entrance into the wetland. This new Stewart Lake outlet weir is a 10’ x 10’ square structure fabricated out of aluminum channeling designed to fit between the two concrete support walls of the outlet gate with 1/8” expanded aluminum sheets containing 1/4” tall by 7/8” wide diamond openings, allowing larval fish to access the wetland while excluding large-bodied fishes (Figure 1).

Due to an above average snowpack in the upper Green River basin, Flaming Gorge Dam (FGD) operations during the Razorback Sucker larval drift period were largely dependent on reservoir elevation and dam safety. Under the Larval Trigger Study Plan (LTSP; Larval Trigger Study Plan Ad Hoc Committee 2012), the Bureau of Reclamation (BOR) begins stepping up FGD releases to help with entrainment of larval Razorback Suckers after the first detection of drifting larvae in light traps. In 2017, the first larval Razorback Sucker was detected in Cliff Creek by GRBFWCO on 6 June 2017 during Project #22f. The BOR began increasing flows to full bypass on 2 June 2017, reaching a 8,600 cubic feet per second (cfs) target on 5 June 2017 (Figure 2). With the exception of two days when BOR dropped flows by 2,000 cfs to assist local law enforcement officials with a recovery operation, releases were consistent for the entire month of June and ultimately maintained at high levels until 4 July 2017 to compensate for Flaming Gorge Reservoir inflows (Figure 2).

To detect larval Razorback Suckers staging to enter Stewart Lake, two light traps were set overnight in the pool adjacent to the outlet structure beginning on 29 May 2017, in addition to two traps set daily at the confluence of the outlet channel and the Green River starting on 30 May 2017. Once larvae were detected in the outlet channel and near the outlet gate, we began to fill Stewart Lake on the evening of 5 June 2017. Due to late detection of Razorback Sucker larvae (i.e., typically mid-May; K. Bestgen, Colorado State University [CSU], personal comm.) and a Green River forecast of declining flows, we began filling Stewart Lake soon after detection to move as much water and larvae as possible into Stewart Lake.

To document larval Razorback Sucker entrainment in Stewart Lake, crews deployed 12 light traps each day from 6-10 June 2017. All traps were positioned in the wetland, staggered along the dredged channel leading from the outlet gate. On the morning of 7 June 2017, seven larval Razorback Suckers were confirmed in three out of 12 traps (verification by Bruce Haines, GRBFWCO). Although anecdotal observations that Razorback Sucker larval densities appeared higher in the wetland in 2016 compared to 2015 (Schelly et al. 2016; Schelly and Breen 2015), even lower capture rates in 2017 may suggest lower larval densities entrained in Stewart Lake compared to previous years. To limit mortality, once we documented larval entrainment, light trapping in Stewart Lake was halted. Final identification of larvae in 2017 samples will be determined by the Larval Fish Laboratory (LFL; CSU).

The outlet canal at Stewart Lake offers a better probability of larval entrainment compared to the inlet (Breen and Skorupski 2012). More specifically, the inlet canal confluence is located directly adjacent to main stem Green River flows, sweeping larval

fish by in the faster current. In contrast, the outlet canal confluence with the Green River is located directly downstream of a large sandbar that creates a zero-velocity backwater environment and reprieve from faster current. The outlet canal itself consists of approximately 0.25 miles of low-velocity habitat leading up to the outlet structure, where larvae can swim up and congregate during the larval drift period. For these reasons and others, LTSP objectives are best accomplished by filling the wetland from the outlet canal (Speas et al. 2017). Soon after we began filling Stewart Lake (described above), Green River flows increased, threatening to breach two low elevation locations along the raised levee road prompting us to install temporary block net structures to exclude adult nonnatives. However, discharge never exceeded 19,000 cfs (Figure 2), leaving the levee absent of a breach. After filling exclusively from the outlet channel for 12 days, Stewart Lake only reached a depth of 4.9 ft at the outlet gate structure. With a higher elevation at the inlet gate structure (1-2 ft > than the outlet), continued filling of the wetland is possible after Green River flows recede and inflow to the outlet structure is cut off (Schelly et al. 2014). With a forecast of rapidly receding flows and a wetland depth 2.5 ft below the maximum fill, the inlet gate was opened on the morning of 17 June 2017. Returning that afternoon, crews discovered water backing up at the inlet structure because the wetland side of the inlet channel was completely choked out with vegetation to the point of inhibiting inflow (Figures 3 and 4). Arrangements were made for a site visit by Utah Division of Wildlife Resources (UDWR) Habitat personnel, and on 19 June 2017 it was determined that the inlet channel was too saturated to operate heavy machinery necessary for clearing the vegetation (M. Hanberg, UDWR, personal comm.). On 21 June 2017 the outlet gate was closed after filling for 16 days (Figure 2), leaving the remainder of inflow to the wetland to be delivered from the inlet structure with reduced functionality (i.e., only a trickle of water). The inlet gate was finally closed on 10 July 2017 (Figure 2), allowing Stewart Lake to fill (at a reduced rate after 21 June 2017) for a total of 35 days and reaching a maximum depth of 5.39 ft at the outlet gauge on 29 June 2017.

Two Biomark 3' remote submersible antennas were deployed on 28 March-29 June 2017 in the outlet channel (~50 ft from the picket weir) to detect PIT-tagged fish attempting to enter the wetland. In 2017, antennas detected 1,321 unique PIT tags compared to 40 in 2016 and 28 in 2015 (Schelly and Breen 2015; Schelly et al. 2016). On 11 May 2017, there was a stocking event by Ouray National Fish Hatchery in the Stewart Lake outlet channel inflating our detection numbers. Of the 1,321 unique detections, 1,067 were Bonytail stocked in the outlet channel, leaving 254 other unique detections. Excitingly, of remaining fishes attempting to enter the wetland in 2017, 110 were age-0 Razorback Suckers tagged in 2016 during Stewart Lake draining (Table 1). Other fishes detected by submersible antennas included one Flannelmouth Sucker, two Colorado Pikeminnow, 25 Bonytail (not from the aforementioned stocking event) and 113 Razorback Suckers representing year classes from 2004-2011, 2013, and 2015 (2008 represented 30% of detections). Interestingly, one Razorback Sucker (3DD.003BBE80F3) was first captured and originally tagged in 1999, recaptured in 2016 and then detected in the Stewart Lake outlet canal in 2017. The increase of detections in 2017 could have been due to the prolonged spring releases from FGD, inundating off channel habitats for longer, increasing the likelihood of more detections.

Task 2: Sample the fish community in the Stewart Lake wetland and monitor post-connection water quality and habitat parameters: June 21-October 2 2017.

Post-entrainment sampling of the Stewart Lake fish community began on 25 July 2017 after allowing fish to grow to a catchable size. Beginning in 2015, increasingly dense aquatic submergent macrophyte beds prevented effective seining in Stewart Lake (Schelly and Breen 2015). Similar to 2015 and 2016, open water habitat continued to shrink due to expansion of submergent vegetation and encroaching cattails and bulrushes (Figures 5 and 6; Schelly and Breen 2015; Schelly et al. 2016). For the second year in a row, seining was abandoned and sampling opportunities were limited to a variety of stationary traps. Starting on 25 July 2017 a single directional fyke net with ¼" mesh and a 50' central wing extending from the middle of the net mouth was set where the dredged channel meets open water (located ~200 m from the outlet structure). After capturing only a single PIT-tagged adult Bonytail and a variety of small-bodied nonnatives, sampling was increased to assess effectiveness of other gear types. On 26 July 2017 we deployed one directional fyke (un-baited), along with two hoop nets and two minnow traps baited with a handful of dog food, at a variety of open water locations within the wetland. Traps were set in the afternoon and soaked for approximately 24 hrs. After a total soak time of ~94 hrs for all traps combined, native fish were absent.

After failing to capture entrained Razorback Suckers and only collecting one adult Bonytail in the first week of sampling (25-27 July 2017) in Stewart Lake, personnel attempted to trap and monitor native fishes for a second time from 7-9 August 2017. On 7 August 2017 one directional fyke net (un-baited), along with two hoop nets and two minnow traps baited with dog food, were placed in different wetland locations than the first sample period. However, the directional fyke net was set in the same location during both sampling periods due to limitations related to the lack of open water. More specifically, where the dredged outlet channel meets open water was the only location deep enough to allow water to overtop the throat of the net. The smaller, more versatile hoop nets and minnow traps allowed for exploration of different wetland habitats, giving us the potential to capture a snapshot of habitat association. After a total soak time of ~185 hrs for all traps combined, only the fyke net produced a single adult Bonytail (3DD.003BF915FA). Combining both sample periods, the directional fyke net captured 89.75% of the fish during post-entrainment sampling, proving again to be the most effective sampling method when seining is not an option. Regarding species composition, nonnatives dominated the fish assemblage in the wetland. Species included Brook Stickleback, Common Carp, Fathead Minnow, Green Sunfish and White Sucker (Table 2). 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 avoid predation.

As mentioned above, Stewart Lake did not receive a complete fill from Green River flows in 2017, attaining a depth approximately two feet less than the maximum. To maintain adequate water quality and depth in the wetland, supplemental water delivery was requested on 22 June 2017 from the Uintah Water Conservancy District (UWCD)

with confirmed flows from the Burns Bench pipeline on 25 June 2017. Supplemental water was delivered continuously (with the exception of one brief interruption) until 28 September 2017. With the addition of a 48-hr flow pulse in the latter stages of draining, a total of 433.1 acre-ft of supplemental water was delivered in 2017 (J. Hunting, UWCD, personal comm.). To monitor water quality during the entrainment period, three mini-DOT (dissolved oxygen and temperature) loggers were deployed in the top third of the water column; one near the outlet structure, one in the dredged channel closer to the center of the wetland, and one in the northwestern extremity of the wetland where the inlet canal comes in. At all three locations there were long periods of low dissolved oxygen. Specifically in the open water near the outlet gate, dissolved oxygen fluctuated greatly, plummeting to levels around 0 mg/L for most of July and the beginning of August (Figure 7). This is likely attributed to the mini-DOT slipping down the t-post into the benthos, no longer suspended in the water column. Once the mini-DOT was righted back in the water column, dissolved oxygen remained relatively steady with average readings between 2-3 mg/L, with a steady increase into October (Figure 7). With the abundance of submergent aquatic vegetation, finding good locations for the mini-DOTs in open water was challenging (Figure 6).

Task 3: Sample fishes exiting the Stewart Lake outlet during draw down with a picket weir: October 2-October 24, 2017.

A newly designed picket weir and trap box featuring a 1/8” steel plate on one side of the intake (opposite of the trap door) designed to create a dead space within the trap was installed in the outlet channel to capture fishes exiting the wetland (Figures 8 and 9). Draining through the outlet structure began on 2 October 2017, several weeks later than in previous years. This was to allow for at least three months of growth in the wetland following a later filling period in 2017 (Figures 1 and 10); this timeframe is also in line with selenium remediation protocols. Draining ended on 24 October 2017, after 22 days of continuous fish trap operation. For the second year in a row, experimental flushing flows (see above) of ~5 cfs to improve water quality during the latter stages of draining were delivered on 15 October 2017, and a total 39.2 acre-ft was added to the wetland (J. Hunting, UWCD, personal comm.). Flushing flows had the desired effect: a noticeable drop in conductivity (from an instantaneous value of 993 µS to 440 µS) and improvement in water quality was observed during this time period. We could not completely drain Stewart Lake in 2017 due to misplacement of gate-holding safety pins installed during mid-summer repairs made by BOR. With an elevated pin placement, the riverside outlet gate could not sit completely flush to the ground when the draining configuration was desired, leaving a 45 cm gap from the concrete to the top of gate and creating an undesired “fish kettle” effect (Figures 11 and 12). The lowest observed elevation at the outlet gauge that crews were able to achieve was 1.54 ft, leaving a pool of water in the wetland that could not be drained, while stranding fish within the wetland. Towards the end of the draining process, crews pulled a 4.67 m seine (1/8” mesh) in the remaining pools of water to salvage any natives stranded in the wetland; native fish were absent from 10 seine hauls.

Fish trap operation was similar to 2015 and 2016 with the exception of additional net

sweeps implemented in the newly created “fish kettle” intermittently throughout the draining process. The removable trap door remained closed for the duration of draining, with the exception of daily cleaning periods, lasting only a few minutes, when it was pulled out to scrape off accumulated debris. During brief cleaning periods, the wetland gate was closed, reducing flows to a trickle to allow crews to safely climb down inside the trap and to limit fish escapement during cleaning. The same outlet gate adjustment protocols were followed during “fish kettle” net sweeps. As for diel emigration patterns, the vast majority of species swam over the gate at dusk, and were netted from the trap in the late evening (i.e., last check typically 1-2 hrs after sunset); first trap check was made each morning. With the newly designed weir panel that offered complete coverage of the outlet complex, we suspect that fish escapement around the trap box was minimal, with the exception of small cyprinids that could fit through the mesh of the structure itself; all native fish were of a larger size preventing this scenario.

Sampling protocols followed those employed for the past three years. Because most fish emigrate during low light conditions, two sampling shifts beginning at ~08:00 and ~16:00 were staffed during draining, with unstaffed periods at midday and overnight. Outflows were adjusted upward at the end of the morning shift and downward at the end of the evening shift, to juggle dual goals of maximizing release volume while preventing fish injury in the trap during peak periods of fish emigration. The increased structural integrity of the new picket weir and trap structures (Figures 1 and 9) allowed crews to increase the volume of water released during midday low-emigration periods compared to 2015 and 2016 (Schelly and Breen 2015; Schelly et al. 2016). With each net sweep of the trap, native species were segregated and kept in buckets of fresh water, while nonnative species were collected in coolers. Native species deemed large enough were scanned for a PIT tag, measured (total length [TL]) and weighed (g). All native fishes were released in the outlet channel downstream of the fish trap. After taking TL measurements of the first 20 individuals of each species encountered during a sampling period, nonnative fishes were sub-sampled by volume to estimate total numbers, and then disposed of. More specifically, after thoroughly mixing the sample, a plastic container was used to scoop a consistent volume of fish from the cooler, and the number of scoops was enumerated. One scoop was poured out and every fish identified and counted; counts from the subsample scoop were multiplied by the total number of scoops to arrive at an estimated total for each species.

In 2017, the total number of fishes collected during 22 days of continuous trap operation was 110,181 (189 natives, 109,992 nonnatives; Table 2; Figure 13). For the second consecutive year, the total nonnative fishes decreased. Possible explanations include a loss of open water habitat to encroaching macrophytes reducing in-wetland production, or potentially a smaller seeding crop of nonnative fishes during filling due to a reduction in water volume that entered the wetland. Unlike 2015 and 2016, where Green Sunfish comprised a large portion of fish captured at draining (33% and 25% respectively; Schelly and Breen 2015; Schelly et al. 2016), Green Sunfish only accounted for 2.8% of total captures during the drawdown in 2017. Fathead Minnow was the most abundant nonnative species sampled in 2017 (n=71,145) followed by Brook Stickleback (n=32, 240; Table 2; Figure 13). Interestingly, 14 Yellow Perch were captured during the

Stewart Lake draining in 2017 (Figure 14). We suspect that escapement of fishes from Red Fleet Reservoir, which was recently restocked with this species (Red Fleet Reservoir Advisory Committee 2014) and did not have an exclusionary screen installed at the outlet works in 2017 (T. Hedrick, UDWR, personal comm.), is the likely source of these perch. Additionally, similar size perch and small Walleye were collected from Johnson Bottom in 2017 (T. Jones, GRBFWCO, personal comm.), suggesting this was more of a widespread event. To test this theory, during delivery of flushing flows, crews placed a block net directly in front of the supplemental water pipeline and Yellow Perch were absent. However, absence of Yellow Perch in the supplemental water (diverted from Brush Creek, fed by the reservoir) does not disprove escapement from Red Fleet Reservoir given that the pipeline was not screened during summer months and/or smaller individuals may have been able to pass through our weir structure during filling.

One of the only differences in sampling protocols for 2017 compared to previous years, was the addition of intermittent sampling in the "fish kettle" (see above). We suspected that fish were accumulating in the "kettle" area and not emigrating into the trap, and were also getting pinned under the riverside outlet gate during high volume release periods (Figure 12). To quantify the amount of fish in the "kettle", the same number of net sweeps were performed in the 10' x 10' ft pool as in the outlet trap. Sampling this additional area took place on the first day of draining but was quickly abandoned due to the limited captures. During the early stages of draining, low numbers of fish were emigrating out of the wetland and higher volume release events allowed for sufficient flow to carry fish over the outlet gate and into the trap. Sampling within the "fish kettle" reconvened on 19 October 2017 after observing larger pulses of fish leaving the wetland. In total, 6,128 fish were collected in the "fish kettle" during the draining phase (totals included in Table 2). Although endangered fishes were absent from the "kettle", our efforts showed that fish utilize this area, especially in the latter stages of draining when wetland elevation levels drop, drastically reducing the volume of water exiting the wetland. The "fish kettle" presents multiple problems; more work (not budgeted for) is required to sample to sample this area, it presents new safety concerns, requiring crews to climb into the outlet complex to sample the area, it creates potential for stranding fish in the "kettle" once wetland elevation drops below the level of the riverside outlet gate, and it leaves 1.54 ft of water that cannot be drained out of Stewart Lake. Although BOR made an additional repair to move the safety pins to a lower elevation on 3 November 2017, the riverine outlet gate is yet to be tested during filling and draining phases.

Unfortunately, only two age-0 Razorback Suckers were sampled during Stewart Lake draining in 2017, compared to greater success in previous years (e.g., 2,110 in 2016; Schelly et al. 2016). One razorback was found dead in the trap (135 mm TL), thus leaving only one age-0 Razorback Sucker surviving the entrainment period and returning to the middle Green River (126 mm TL; Figure 15). A possible explanation for the lack of age-0 razorback production in 2017 could have been lower densities of drifting larvae during the time of entrainment, which could be verified when 2017 light trap samples are processed by LFL. Another possibility is the lack of open water habitat, concentrating fish in smaller areas potentially making larvae more susceptible to predation. Finally, due to the increasing submergent vegetation, encroaching cattails and bulrush, fish may

be unable to find their way through the dense vegetation during draining. Despite limited age-0 recruitment of razorbacks in 2017, Stewart Lake did produce a variety of native species including 13 presumptive YOY Bonytail (49-78 TL; pending LFL species verification). Other native species included 12 adult Bonytail (230-319 TL), four YOY Bluehead Suckers, one YOY Flannelmouth Sucker, and the most abundant native species, Speckled Dace (n=157; Table 2).

Task 4: Data entry, analysis and reporting

Recovery Program annual progress report submitted in November 2017.

VIII. Additional noteworthy observations:

- During the draining phase of Stewart Lake in 2017, two adult nonnative Bullfrogs were captured and disposed of. This raises concern because captures along the Green River corridor are rare, and they pose a major predation threat to many species including fish and the native Northern Leopard Frog.

- 14 Yellow Perch were sampled from Stewart Lake in 2017; suspected escapees from Red Fleet Reservoir, but the exact source is unknown. Additionally, this is another concerning capture as the middle Green River has a large assortment of nonnative piscivores and does not need any additions to the system.

IX. Recommendations:

- Cattail and bulrush expansion has reduced open water habitat in Stewart Lake dramatically, putting future fish production at risk. Utah Division opf Wildlife Resources is currently investigating treatment logistics, which will likely entail several controlled burns (funding and personnel to manager the project TBD). Once vegetation is manageable, annual control measures will be required and budgeted for to prevent future rebounds.

- Investigate logistics for dredging the inlet channel to achieve a greater fill in the event that a cattail treatment cannot be implemented by the spring of 2018. Additionally, fabricate and install a newly designed permanent weir panel.

- In 2017, our new trap design incorporated a 1/8” steel plate on one intake panel opposite of the trap door; fish were observed using this dead space. Expanding coverage of the steel plate should be explored to create a larger zero-velocity area. This would allow for greater water volume releases during periods of low emigration, while providing reprieve in the trap during higher volume events.

- Supplemental water delivery has become a standard operating procedure at Stewart Lake. To confirm water delivery, crews must visually inspect the pipeline, adding significant time to our surveys. We recommend installation of a digital flow gauge at the outlet pipes to allow UDWR and other interested

partners to access supplemental water delivery parameters remotely.

XIV. References:

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

Larval Trigger Study Plan Ad Hoc Committee. 2012. Study plan to examine the effects of using larval sucker occurrence in the Green River as a Trigger for Flaming Gorge Dam. Final Report to the Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Red Fleet Reservoir Advisory Committee. 2014. Red Fleet Reservoir fishery management plan. Utah Division of Wildlife Resources. Salt Lake City, UT.

Ruppert, J.B., R.T. Muth, and T.P. Nesler. 1993. Predation on fish larvae by adult red shiner, Yampa and Green rivers, Colorado. *The Southwestern Naturalist* 38(4):397-399.

Schelly, R.C. and M.J. Breen. 2015. Use of Stewart Lake floodplain by larval and adult endangered fishes. Annual Report of Utah Division of Wildlife Resources to the Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Schelly, R.C., J.T. Herdmann, and M.J. Breen. 2014. Use of Stewart Lake floodplain by larval and adult endangered fishes. Annual Report of Utah Division of Wildlife Resources to the Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Schelly, R.C., R.S. Staffeldt, and M.J. Breen. 2016. Use of Stewart Lake floodplain by larval and adult endangered fishes. Annual Report of Utah Division of Wildlife Resources to the Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Skorupski, J.A., Jr., I. Harding, and M.J. Breen. 2013. Use of Stewart Lake floodplain by larval and adult endangered fishes. Annual Report of Utah Division of Wildlife Resources to the Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Speas, D., M. Breen, T. Jones, and R. Schelly. 2017. Updated floodplain wetland priorities for recovery of endangered fish in the middle Green River. Approved memorandum to the Upper Colorado River Endangered Fish Recovery Program Biology Committee. Denver, CO.

Tyus, H.M., and J.F. Saunders, III. 2000. Nonnative fish control and endangered fish recovery: lessons from the Colorado River. *Fisheries* 25(9):17-24.

Table 1. Age-1 Razorback Suckers detected by remote submersible antennas deployed in the channel leading to the Stewart Lake outlet gate during filling (intermittently operated from 28 March-29 June 2017). Data was retrieved on 26 October 2017 from STReaMS (Species Tagging, Research and Monitoring System) at *https://streamsystem.org/*.

134 kHz tag	**Species**	**Year Class**	**Type**	**Last Encounter:Year**	**River**
3DD003BCC91BB	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9277	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94AA	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94BD	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE864A	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8664	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87EC	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE879F	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC92D9	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9372	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9417	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93DF	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94BE	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE85A3	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8782	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9262	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93B0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94AC	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE858A	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE86B5	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC924C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC947F	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE84E0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE84E2	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE878A	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE888C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87BF	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91FA	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC937E	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93C6	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93F9	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8542	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87F0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9178	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9328	Razorback Sucker	2016	Detection	2017	Green River

3DD003BBE870B	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE88A2	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC917C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC921F	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9462	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8518	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE85D8	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8573	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE877D	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9477	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC949F	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE857D	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8715	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87C8	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9194	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91F7	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9358	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9361	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE86DF	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8882	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87C0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC916A	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91E7	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC935E	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94C8	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9498	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8602	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE86D4	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87C7	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9225	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91D1	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9295	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9309	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93E5	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC942D	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87E8	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87B3	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC920C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9290	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93FF	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE85D5	Razorback Sucker	2016	Detection	2017	Green River

3DD003BBE8685	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE876E	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8799	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE87DA	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9175	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91DF	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9243	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC92E2	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91CB	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE85C0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE85C5	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8641	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE86C3	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC91AB	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9200	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC92DD	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC92A0	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9418	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9409	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE84E9	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE859F	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE874E	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9337	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9350	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC93E9	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8678	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8598	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE8770	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC919C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9391	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC940C	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC9444	Razorback Sucker	2016	Detection	2017	Green River
3DD003BCC94D9	Razorback Sucker	2016	Detection	2017	Green River
3DD003BBE866E	Razorback Sucker	2016	Detection	2017	Green River

Table 2. Percent composition of various species and their size ranges collected in 2017 during two sampling phases at Stewart Lake: post-entrainment sampling in the wetland and draining.

	Post-entrainment sampling				Draining			
Species	# Sampled	% Comp.	TL (mm) Mean ± SD	TL (mm) Range	# Sampled	% Comp.	TL (mm) Mean ± SD	TL (mm) Range
Bluehead Sucker	-	-	-	-	4	0.004	52.25 ± 4.1	47-56
Bonytail (Adult)	3	0.732	254 ± 23.5	227-270	12	0.011	270.5 ± 25.8	230-319
Brook Stickleback	137	33.415	54.6 ± 21.7	36-64	34,240	31.076	57.5 ± 12.6	19-86
Common Carp	41	10.000	57.9 ± 20.9	32-145	290	0.263	172.4 ± 35.8	67-282
Creek Chub	1	0.244	65	-	6	0.005	59.6 ± 28.9	98-196
Fathead Minnow	203	49.512	45.1 ± 10.1	20-78	71,145	64.571	54.2 ± 8.5	24-73
Flannelmouth Sucker	-	-	-	-	1	0.001	47	-
Gila sp. (YOY)	-	-	-	-	13	0.012	59.0 ± 8.3	49-78
Green Sunfish	18	4.390	52.8 ± 22.8	28-57	3,089	2.804	62.24 ± 12.1	32-119
Iowa Darter	1	0.244	51	-	326	0.296	51.0 ± 6.7	33-65
Razorback Sucker (Age-0)	-	-	-	-	2	0.002	130.5 ± 6.4	126-135
Red Shiner	1	0.244	52	-	502	0.456	53.3 ± 7.3	37-72
Sand Shiner	-	-	-	-	7	0.006	56.6 ± 19.4	33-58
Speckled Dace	-	-	-	-	157	0.142	48.9 ± 5.6	37-79
White Sucker	5	1.220	61.0 ± 29.3	161-220	373	0.339	90.5 ± 62.0	46-272
Yellow Perch	-	-	-	-	14	0.013	58.3 ± 22.7	78-133
TOTAL	410				110,181			

*Fishes that were subsampled were included in total numbers; TL (mm) calculations only included fish that were measured. Totals also include fish sampled in the “kettle”.

Figure 1. Newly designed Stewart Lake outlet weir with improved structural integrity and focus on large-bodied nonnative fish exclusion.

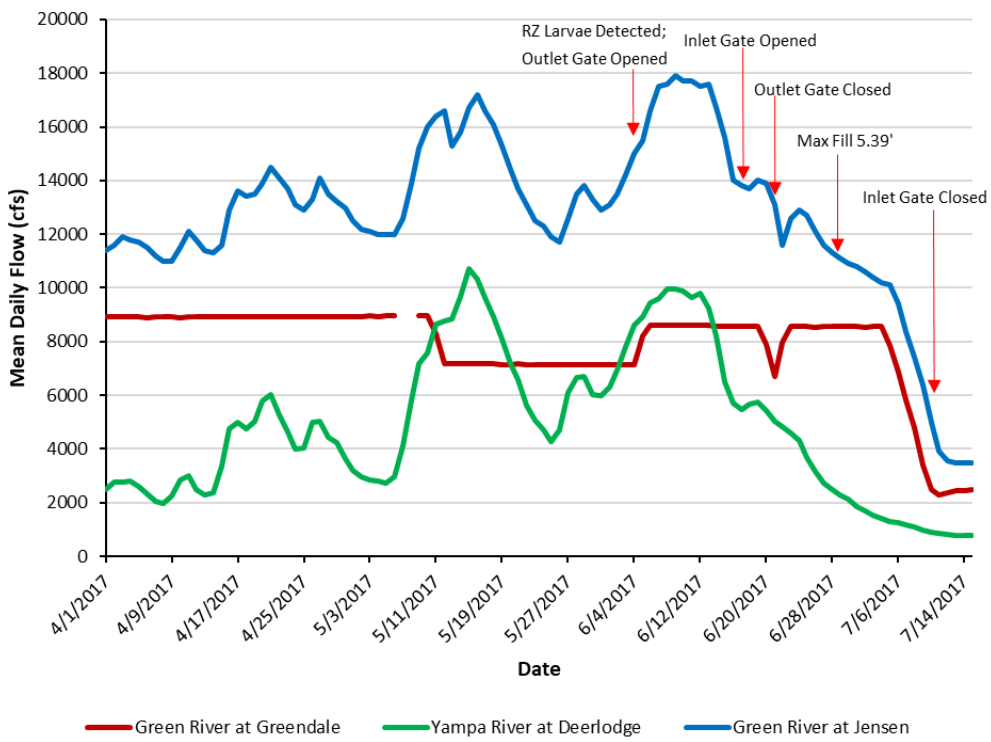

Figure 2. Hydrograph of 2017 spring flows under the Larval Trigger Study Plan, with first detection of larval razorback sucker in Stewart Lake drain and Stewart Lake filling periods highlighted. Flow data originates from USGS gages #09261000 (Jensen, UT), #09260050 (Deerlodge Park, CO), and #09234500 (Greendale, UT). Note that USGS discharge data used to create this figure was provisional.

Figure 3. View of the densely vegetated inlet channel looking towards Stewart Lake wetland.

Figure 4. View of the inlet gate (left), picket weir panel (middle), and the backed up channel leading to the wetland (right) during filling.

Figure 5. View of the dredged outlet channel in Stewart Lake that provides the only remaining open water habitat due to encroachment of cattails, bulrushes and other aquatic macrophytes.

Figure 6. Dense submergent aquatic vegetation in the Stewart Lake outlet channel

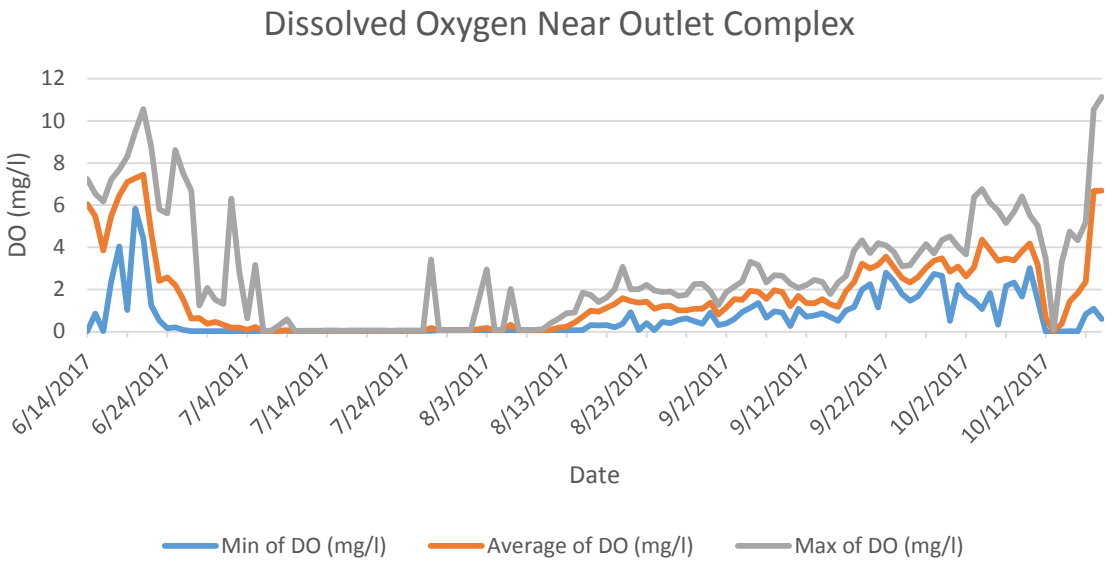

Figure 7. Continuous dissolved oxygen (DO) readings taken near the outlet complex for the duration of the entrainment period.

Figure 8. Newly designed outlet trap (for use in the draining phase) that bolts directly to the new weir wall structure. The out trap features a removable trap door (not shown here), and 1/8" steel plate covering the intake (top right) creating zero velocity habitat within the trap during high volume release events.

Figure 9. Close up of the 1/8” steel plated intake panel displaying the low velocity habitat created during a high volume release event.

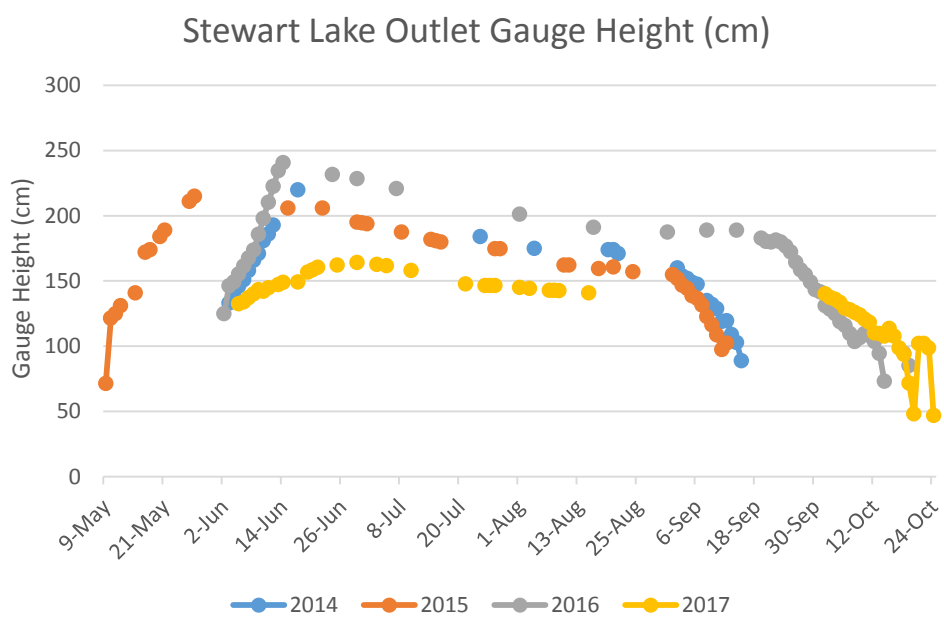

Figure 10. Depth measurements from the gauge at the Stewart Lake outlet structure during the periods of filling, inundation, and draining in 2014, 2015, 2016 and 2017.

Figure 11. Safety pins installed by the Bureau of Reclamation to keep the outlet gate in place during the draining phase.

Figure 12. UDWR personnel standing in the “fish kettle” at the outlet structure with the wetland gate elevated to stop flow (bottom left) and the riverside gate (upper right) in its fixed position with the safety pins that were installed mid-summer by the Bureau of Reclamation in place.

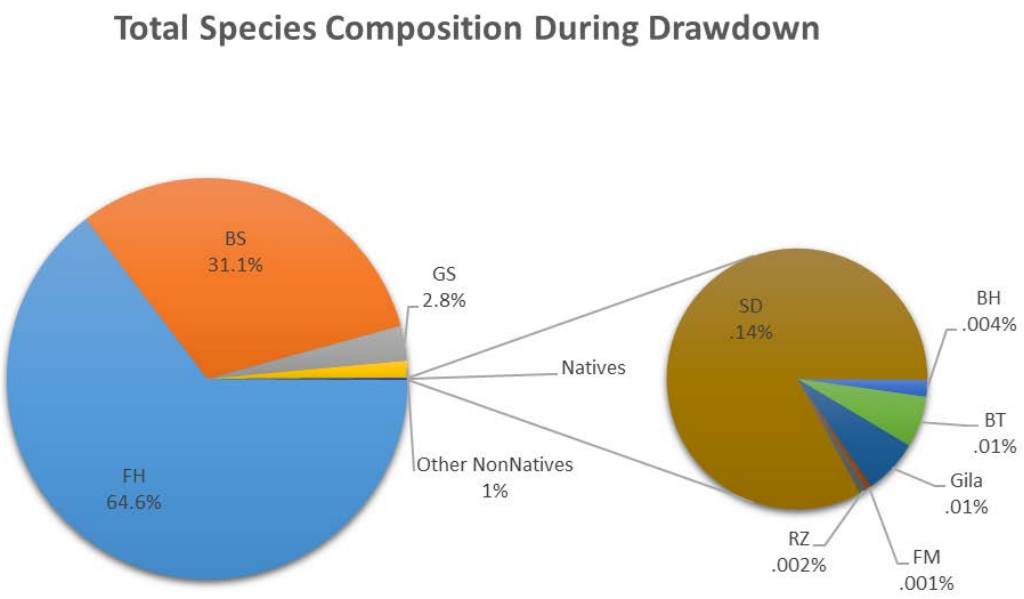

Figure 13. Relative species composition during 2017 Stewart Lake draining for all species (left), with native species detailed in the smaller pie (right).

Figure 14. Yellow Perch captured during the drawdown of Stewart Lake 2017.

Figure 15. Age-0 Razorback Sucker (TL 126 mm) collected during 2017 Stewart Lake draining.