COLORADO RIVER RECOVERY PROGRAM
FY 2019 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 140

I. Project Title: Evaluating effects of non-native predator removal on native fishes in the Yampa River, Colorado

II. Bureau of Reclamation Agreement Number(s): R19AP00058

Project/Grant Period:
Start date (Mo/Day/Yr): 1 Oct. 2018
End date: (Mo/Day/Yr): 30 Sept. 2023
Reporting period end date: 30 Sept. 2019
Is this the final report? Yes _____ No __X___

III. Principal Investigator(s):

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IV. Abstract:

Control actions for several non-native fish predators have been implemented in rivers of the Upper Colorado River Basin. Understanding the response of the native fish community to predator removal is needed to determine if removal programs are having the desired effect. The objective of this project is to document fish community changes in response to predaceous fish removals in a reach of the Yampa River, Colorado. Native species richness increased during the removal period compared to early sampling (2003-2004) conducted in this project, as has native species sampling frequency and abundance, particularly 2008 through 2012. However, frequency in samples was reduced from 2013-2018. The 2018 sampling data has been included in this version of the report, but 2019 data are not yet available because we finished field sampling in the Yampa River in later October and had numerous preserved samples to identify as well which are now nearing completion. Thus, data entry and checking is still ongoing, and we report only preliminary observation and analyses of 2019 data. When it is available, we will modify this report and resubmit it. Data will also be incorporated into a long-term summary report which will be completed in 2020.

V. Study Schedule: Ongoing as needed, agreement extends through September 2023.

VI. Relationship to RIPRAP:

REDUCE NEGATIVE IMPACTS OF NONNATIVE FISHES AND SPORTFISH MANAGEMENT ACTIVITIES (NONNATIVE AND SPORTFISH MANAGEMENT)

Green River Action Plan: Yampa and Little Snake Rivers

III.A.1. Implement Yampa Basin aquatic wildlife management plan to develop nonnative fish control programs in reaches of the Yampa River occupied by endangered fishes. Each control activity will be evaluated for effectiveness and then continued as needed.

Green River Action Plan: Mainstem

III. Reduce negative impacts of nonnative fishes and sportfish management activities (Nonnative and sportfish management)

III.A.2.c Evaluate the effectiveness (e.g., nonnative and native fish response) and develop and implement an integrated, viable active control program.

VII. Accomplishment of FY 2019 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

In 2019, we sampled 123 locations distributed among control (n = 53) and treatment (YOY removal reaches; n = 70) reaches in the Yampa River study area, totals which include many isolated pool samples in each reach. Because we only finished sampling in October this year, data have not been fully summarized but will be presented when available (Researchers Mtg. or updated annual report). However, some reliable observations can be reported at this time. Native fishes were captured in each of the control and treatment reaches in 2019, as well as in isolated pool samples. Native species speckled dace, bluehead sucker, roundtail chub, and mottled sculpin, in order of highest to lowest abundance, were captured but no flannelmouth sucker were noted. Similar to the high flow and cold year in 2011, native fish were relatively abundant in the Yampa River in 2019 and comprised nearly 15% of all fish captured in all reaches and habitat types. Also similar to 2011, smallmouth bass abundance was reduced as that species comprised less than 5% of all fish captured, the lowest total ever. Flows were high and cold into early July in 2019, which likely reduced the length of the reproductive season for bass and reduced water temperatures limited their growth (Figure 1).

Because we did not fully report on 2018 sampling last year because of late October sampling, that is detailed here. In 2018, we sampled control and treatment reaches of Little Yampa Canyon with an effort similar to 2017 and the past. Samples were collected in each reach to document native fish response. A total of 193 samples was collected from July to October, 2018, including 121 from the treatment reach (where YOY smallmouth bass are removed) and 72 from the control reach (no YOY bass removal).

Number of native fish species collected in main channel samples of the Little Yampa Canyon reach of the Yampa River showed a positive response through time in the period 2003-2011, remained relatively abundant in 2012, declined dramatically in 2013 and 2014, increased slightly in 2015 and 2016, and then declined slightly through 2018. In general, native fish comprised 5% or less of all fish captured in sampling, and only in 2011 was it substantially higher at about 16%.

Observations from field sampling in 2018 showed continued low abundance of native

fish. In 2003 only a single native fish, speckled dace Rhinichthys osculus, was captured (n = 4 individuals). In 2004 the number increased to two species, and from 2005-2007, four species were captured. In 2008, six native fishes were collected and in 2009 five, the same number captured in 2010; seven native fishes were collected in 2011, the most ever, and included bluehead, mountain, and flannelmouth sucker, mottled sculpin, speckled dace, roundtail chub, and mountain whitefish. In 2013, five native fishes were collected including bluehead and flannelmouth suckers, roundtail chub, speckled dace, and mottled sculpin, which was the same native species composition as in 2014-2018.

The frequency of presence of native fishes in samples has increased since intensive removal of adult and age-0 bass commenced in 2005 (Figures 2-6). While the total % native fish remains low, the 2008-2012 and 2015-2018 levels represent a five-fold or more increase over 2007 and before, and the 2011 level has not been realized since sampling began. Presence of native fishes in 2012 samples was also high (comparable to 2008-2010), but slightly less than in 2011, declined dramatically in 2013 and 2014, rose substantially in 2015, and declined slightly from 2016 through 2018.

Frequency of roundtail chub Gila robusta in samples has also increased through time up until 2012 or so but then declined. Roundtail chub were present in substantially larger numbers in the treatment reach where age-0 bass are removed compared to the control reach where no age-0 bass are removed (Figure 6), a trend which continues through 2018. However, chub numbers, both young and adults (Project 125 report), in the Little Yampa Canyon reach, are now very low and no young chubs were collected in this study in the control reach in 2018. We interpret abundance trends as a river-wide response of increasing native fish abundance in 2008 through 2012, perhaps because of higher stream flows and reduced water temperatures. Those same conditions promote later smallmouth bass spawning and slower growth (see below), which may inhibit or reduce predation by that species on native fishes. The larger proportion of native fish in samples in the treatment reach compared to the control is thought a response to removal of large numbers of Age-0 smallmouth bass each year. The 2013-2018 decline in roundtail chub is likely due to a high abundance of age-0 and age-1 smallmouth bass from large year-classes produced in 2012 and 2013, and a delayed response by native fishes to bass, declining in 2012 and particularly 2013-2018.

An additional aspect of work in FY-2010 to 2018 was an evaluation of sampling efficiency of our one-pass sampling in specific habitat types. To accomplish that, we sampled in a typical fashion in several locations one or more times. Each time at each site, we sampled with a single pass of electric seine sampling, and then repeated that sampling 1-2 more times to determine removal efficiency of our sampling. In general, in each of the 2010-2018 sampling years, first pass removal constituted about 55-65% of the smallmouth bass present at each site, a relatively high depletion rate. That depletion rate increased to 74% in 2017 and 2018. Repeated visits from late summer into autumn will allow us to understand recolonization dynamics of those habitats through the year. As is customary, we plan to report results of 2019 sampling at the Researchers Meeting in January 2020.

We made good progress on analysis of otoliths of smallmouth bass collected from the Yampa River through 2012, which added to the population dynamics modeling portion of Project 161, the smallmouth bass data synthesis. The goal is to better understand effects of streamflow and water temperature on timing and duration of smallmouth bass spawning and hatching dates, and growth rates, so strategies to disadvantage reproductive success of that species can be formulated. That information was summarized in a final report, along with similar data from the Green River, which will be useful to guide decisions regarding potential modified flows or temperatures from Flaming Gorge Dam (Bestgen and Hill 2016). Those modifications would be designed to reduce reproductive success of smallmouth bass in the Green River downstream of Flaming Gorge Dam.

Results of otolith analysis showed that smallmouth bass in the Yampa River study area first hatched well after spring peak flows declined but the specific calendar date varied from early June to early July across years 2005-2012. A main controlling factor to smallmouth bass reproduction appears to be water temperature, as well as habitat availability. For example, when water temperatures warmed earlier in the lower flow year 2007, smallmouth bass hatching began as early as 4 June. In contrast, first hatching of smallmouth bass in the higher flow year 2008, when water temperatures remained colder later, occurred as late 2 July. Even though timing of hatching varied across years, a consistent environmental cue to spawning appeared to be the regular onset of water temperatures of 16□C or higher. Hatching is also consistent with lower water levels and presumably, availability of low velocity nearshore habitat. Peak hatching in the Yampa River occurred about 2-3 weeks after first bass hatched, although in 2009 the peak was only about 10 days after hatching first started. The duration of the spawning season was relatively brief, usually about 4 weeks in most years. Results of hatching date distributions related to flow and water temperature regimes was presented at the Non-native Fish Workshop in 2009 as well as at the Upper Colorado River Researchers Meeting (2010, 2011, 2012, 2013), the Colorado-Wyoming Chapter of the American Fisheries Society (2009), and the Larval Fish Conference in Santa Fe, New Mexico (2010), and the October 2015 Colorado Plateau researchers meeting (Flagstaff, AZ).

An opportunistic flow spike in the Yampa River, a natural event caused by thunderstorms in summer 2015, allowed us to evaluate effects of that spike on bass reproduction and survival. Yampa River flows more than doubled from ~1,000 cfs to ~2,500 cfs over 3 days and then returned to ~1,000 cfs over 3 additional days during the peak period of smallmouth bass hatching (Figure 7). Those observations also demonstrated the potential effects of a flow spike that could be implemented in the regulated Green River in the future. The 10 July flow spike likely resulted in reduced survival of smallmouth bass larvae produced just before, during, and after that flow spike. The mechanism is not precisely known but may have been a product of turbidity, increased flow velocity, reduced water temperatures, or all three factors, all of which are known to reduce survival of early life stages of smallmouth bass (Bestgen and Hill 2016 provide supporting details). Growth of bass was also reduced not only during that period but well after, likely a result of reduced food availability. We also saw similar reductions in captures of Colorado pikeminnow larvae in the lower Yampa River during that event (Project 22f annual report 2016). This information was included in a recently completed description

of a flow spike study plan that was submitted to the Recovery Program in November 2018 (Bestgen 2018).

This Yampa River scenario is similar to the one that could be produced by flow spikes released from Flaming Gorge Dam, to affect smallmouth bass in the Green River. Although turbidity fluxes would likely be minimal during such events, increased flow velocity may have a similar effect of reducing bass early life stage survival and growth. We were able to document these patterns since 2005 because of long-term collection of young bass samples by our Yampa River field crews. It may also be possible to induce a smaller flow spike via releases from Elkhead Reservoir. Such a spike (maximum release about 550 cfs) would be most effective when Yampa Flows are very low, so that the stage and water velocity increase is maximized. The Elkhead Reservoir release would be increased if paired with a natural storm event, where flow, turbidity, or both were increased.

We have also conducted comprehensive analyses of factors affecting growth rates of Age-0 smallmouth bass in the Yampa River. Specifically, we compared intra-annual and inter-annual patterns of bass growth rates and lengths, and related those patterns to thermal and hydrologic characteristics of the Yampa River in the period 2003-2012, as well as in the Green River upstream and downstream of the Yampa River. Intra-annual cohort growth of smallmouth bass varied from 0.66 mm/day in 2005 to 1.12 mm/day in 2006, both in first cohorts of the year. The shortest bass were from cohort 3 in 2008 (mean TL = 40 mm) and the largest in cohort 1 in 2007 (102 mm TL). Early cohort growth rates were faster than later ones in all years because they had the benefit of the entire warm summer season to grow. Bass growth ceased when water temperatures declined to about 10□C. General linear model analyses showed that age-0 bass growth rates were highest, and length was greater in September, in years when water temperatures were high and spring runoff flows declined early. Conversely, bass growth rates were lower, and length was shorter in September, in years when water temperatures were cool and runoff was prolonged. Bass from isolated pools usually grew more slowly than those from the mainstem Yampa River. Quantifying factors that affect growth and ecology of age-0 smallmouth bass in the Yampa River will assist with population dynamics investigations that support optimizing strategies for bass removal, and aid recovery efforts for native fishes in the Upper Colorado River Basin. Results of bass growth rate analyses were presented three times in 2010 (all by Angela Hill), at the Upper Colorado River Researchers Meeting, the Colorado-Wyoming Chapter of the American Fisheries Society, and the Larval Fish Conference in Santa Fe, New Mexico, and the October 2015 Colorado Plateau researchers meeting (Flagstaff, AZ). This information was also incorporated into a population dynamics model for smallmouth bass developed under Project 161, which allows investigation of year-specific effects on growth and subsequent over-winter survival related to Yampa River flow and water temperature.

We also conducted additional smallmouth bass otolith research in spring 2010-2012. The literature is controversial in regards to the number of daily increments and the timing of their deposition in otoliths of smallmouth bass at hatching and swimup. Because this information is critical to our understanding of hatching time and interpretation of

hatching date distributions, we raised smallmouth bass embryos in constant and fluctuating temperature regimes at 20□C. Embryos were acquired from the Colorado Division of Wildlife Hatchery at Wray, Colorado. Series of bass from each treatment were preserved through ontogeny to resolve the issue of increment deposition timing and clarity. Those analyses have been completed and the Results were published in the North American Journal of Fish Management in 2014 (Hill and Bestgen 2014); the pdf of the reprint was sent to the Program list server in spring 2014 as well. We also used this information to develop a study plan to implement flow spikes from Flaming Gorge Dam to disadvantage reproductive success of smallmouth bass in the Green River. That report is presently under review and will be included in an evaluation of the efficacy of Flaming Gorge Dam flow and water temperature recommendations to assist with recovery of Green River endangered fishes.

White River sampling

We also completed sampling in the White River on four occasions in 2018. That sampling showed continued abundant smallmouth bass. Specific to that effort was sampling conducted before (10 July) and after (21 July) a flush of sediment and water from Kenney Reservoir (19 July) that was designed to reduce or remove algae from water intake structures for the City of Rangely, Colorado. The release was for 90 minutes and at 1,100 ft3/sec. Table 1 shows those results, with no apparent effect (slight increase based on catch per unit effort statistics) of the flushing flow on juvenile (mostly age-0) smallmouth bass.

A series of pictures pre and post flush were also obtained (Alden Vanden Brink, District Manager, Rio Blanco Water Conservancy District (970 675-5055) and are presented in Appendix I. Those images show cleansing effects of the flows. Also posted is a letter from the Rangely Utilities Department (Donald C. Reed) describing the event and the apparent success with regards to algae removal (page 19 of this report).

Lack of apparent success removing age-0 smallmouth bass could be due to many factors including the short flushing time, and the size of bass when the flow began. A 90-minute flow may be insufficient to remove bass, especially when the age-0 bass had already attained mean TL of 37 mm (25-57 mm). Field crews have consistently noticed that susceptibility of young bass to the electric seine is relatively low and their abundance in early July was probably substantially underestimated. Growth of young bass is fast as mean TL of fish increased from 37 mm on 10 July to 50 mm on 24 July, 81 mm on 21 August, and 83 mm by 3 October.

The 1,100 ft3/sec flood wave began at Kenney Reservoir at 8:05 AM 19 July, and passed the downstream Watson, Utah USGS gage with an attenuated peak of 362 ft3/sec on 20 July, at 3:30 AM (Figure 8, about 19.5 hours later).

Also of note during the 21 August sample period was water flow over the spillway. Notable fish captures included 323 young-of-year black crappie (46-75 mm TL), when none were captured in the two previous sampling periods in July. During the 3 October sample, the spillway had stopped flowing and only 3 YOY black crappie were sampled.

The White River was sampled in 2019 on a single day (Table 1 B). Bass abundance, based on catch per unit effort, was slightly lower in 2019, based on that limited sampling.

VIII. Additional noteworthy observations:

IX. Recommendations:

- Present a more complete summary of data regarding the native fish response evaluation at the 2020 Researchers Meeting (if necessary).
- Continue sampling in 2020 and out years, although effort will be reduced because the budget for this project was severely reduced. This important dataset contributes to understanding the relationship of native fish response to predator removal and flow levels in summer in the Yampa River.
- Finish a synthesis of this information that has been collected since 2003.

X. Project Status:

A Cooperative Agreement with the Bureau of Reclamation for this and other projects was negotiated and was in place in October 2018 and extends through 2023.

XI. FY 2019 Budget Status:

A. Funds Provided: $95,245
B. Funds Expended: $78,861
C. Difference: $16,384
D. Percent of the FY 2019 work completed, and projected costs to complete: about 20% of FY19 tasks remain to be completed.
E. Recovery Program funds spent for publication charges: 0

XII. Status of Data Submission (Where applicable):

XIII. Signed:

Principal Investigator: Kevin R. Bestgen

Date: 14 November 2019

REFERENCES

Bestgen, K. R. 2018. Evaluate effects of flow spikes to disrupt reproduction of smallmouth bass in the Green River downstream of Flaming Gorge Dam. Final report to the Upper Colorado River Endangered Fish Recovery Program. Denver, Colorado. Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins. Larval Fish Laboratory Contribution 214. DOI: 10.13140/RG.2.2.33277.61926

Bestgen, K. R., and A. A. Hill. 2016. River regulation affects reproduction, early growth, and suppression strategies for invasive smallmouth bass in the upper Colorado River basin. Final report to the Upper Colorado River Endangered Fish Recovery Program, Project

FR-115, Denver, CO. Department of Fish, Wildlife, and Conservation Biology, Colorado State University, Fort Collins. Larval Fish Laboratory Contribution 187.

Hill, A. A. and K. R. Bestgen. 2014. Otolith daily increment deposition in age-0 smallmouth bass reared in constant and fluctuating water temperatures. North American Journal of Fisheries Management 34:774-779.

APPENDIX:

Table 1. Results for White River smallmouth bass sampling in 2018 and 2019. SMB = smallmouth bass, CSU = Colorado State University. The catch per unit effort data were from electric-seine sampling conducted just downstream of Kenney Reservoir, near Rangely, Colorado. The first two passes in 2018 bracket a flushing flow event (90 minutes, 1,100 ft3/sec) from Kenney Reservoir on 19 July.

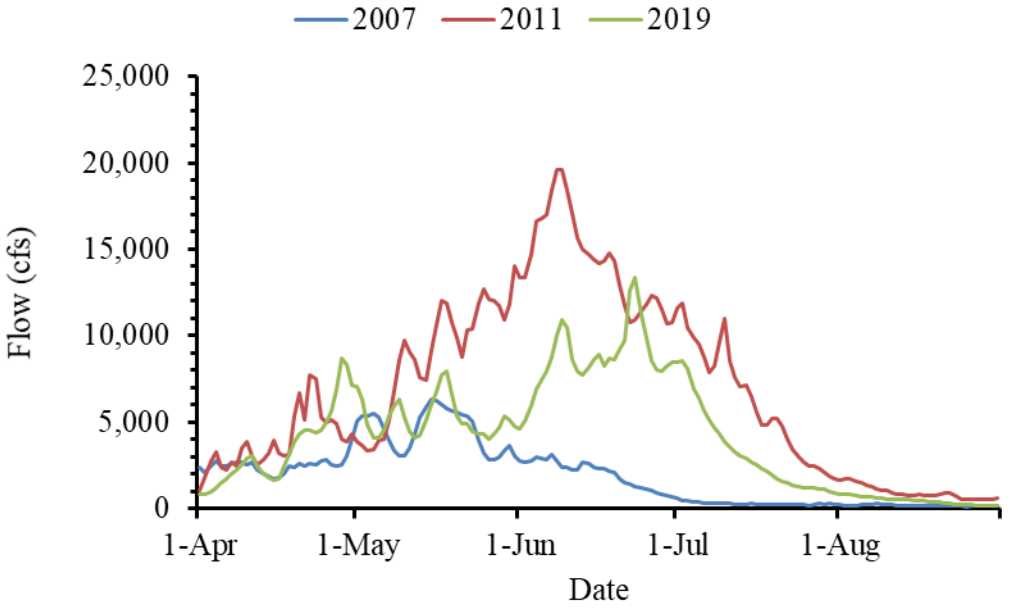
2018

				Number of SMB				CPUE (#fish/hr)			
Pass	Sampling Period	Agency	Effort (hrs)	Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	10-Jul	CSU	1.48	95	76	1	172	64.2	51.4	0.7	116.2
2	24-Jul	CSU	1.29	110	44	3	157	85.3	34.1	2.3	121.7
3	21-Aug	CSU	1.44	98	6	2	106	68.1	4.2	1.4	73.6
4	3-Oct	CSU	1.22	286	15	2	303	234.4	12.3	1.6	248.4
			5.43	589	141	8	738	108.5	26.0	1.5	135.9

2019

				Number of SMB				CPUE (#fish/hr)			
Pass	Sampling Period	Agency	Effort (hrs)	Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	23-Aug	CSU	2.1	185	30	1	216	88.1	14.3	0.5	102.9

A.



B.

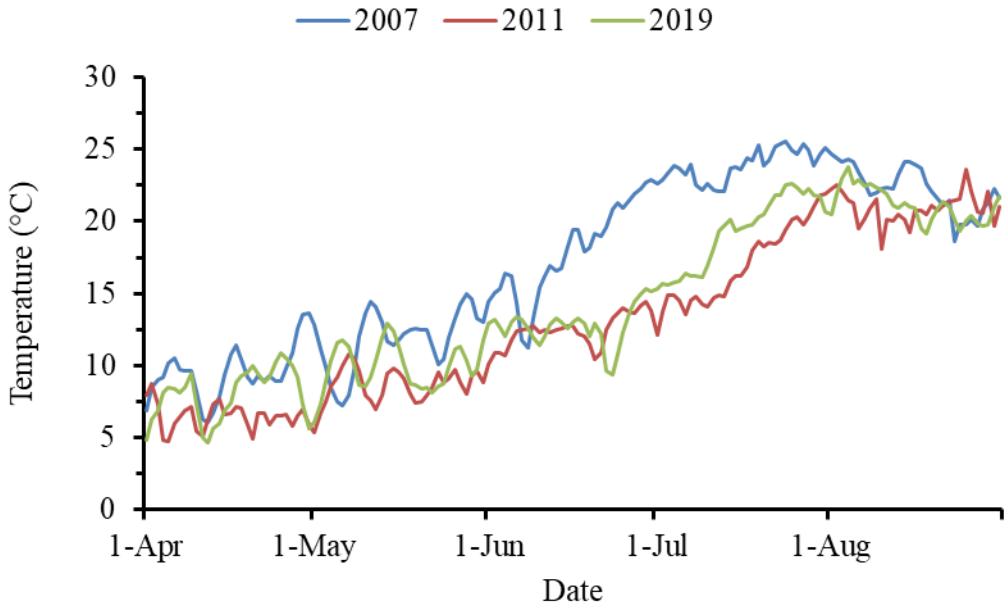
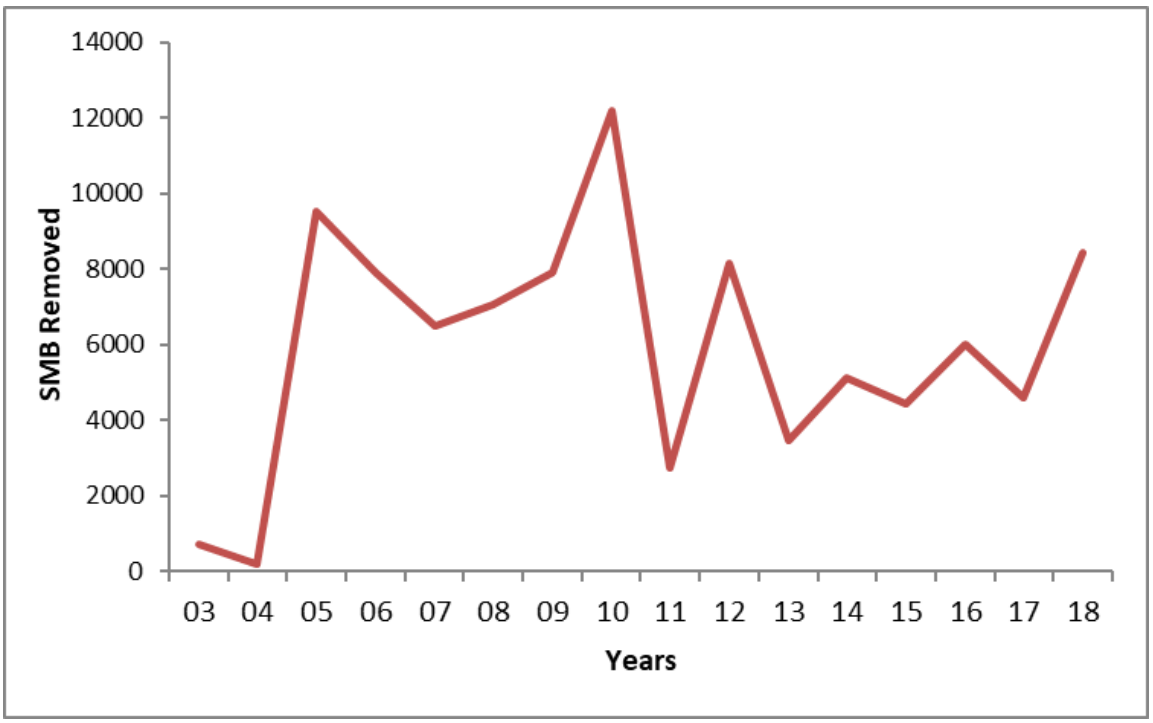


Figure 1. Flow and water temperature regimes for the Yampa River in 2019. A low flow and warm year (2007) and a high flow and cold year (2011) are shown for comparison.

a.



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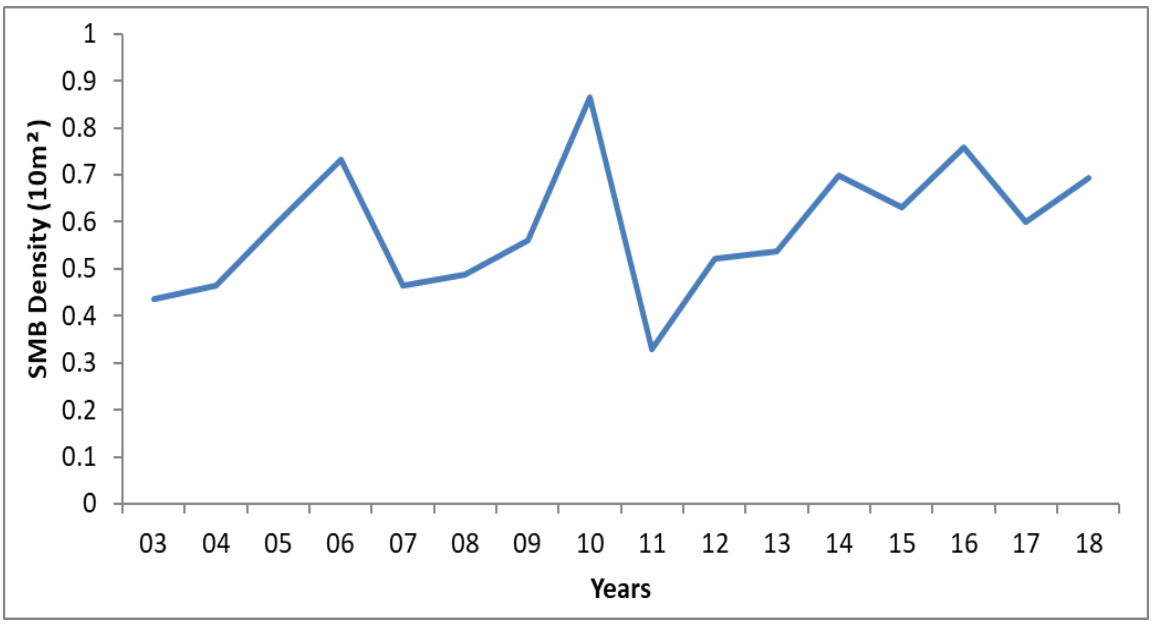

Figure 2. Number of small-bodied smallmouth bass (usually < 100 mm total length) removed from the treatment reach of Little Yampa Canyon, 2003-2018 (panel a) and density of bass captured (panel b).

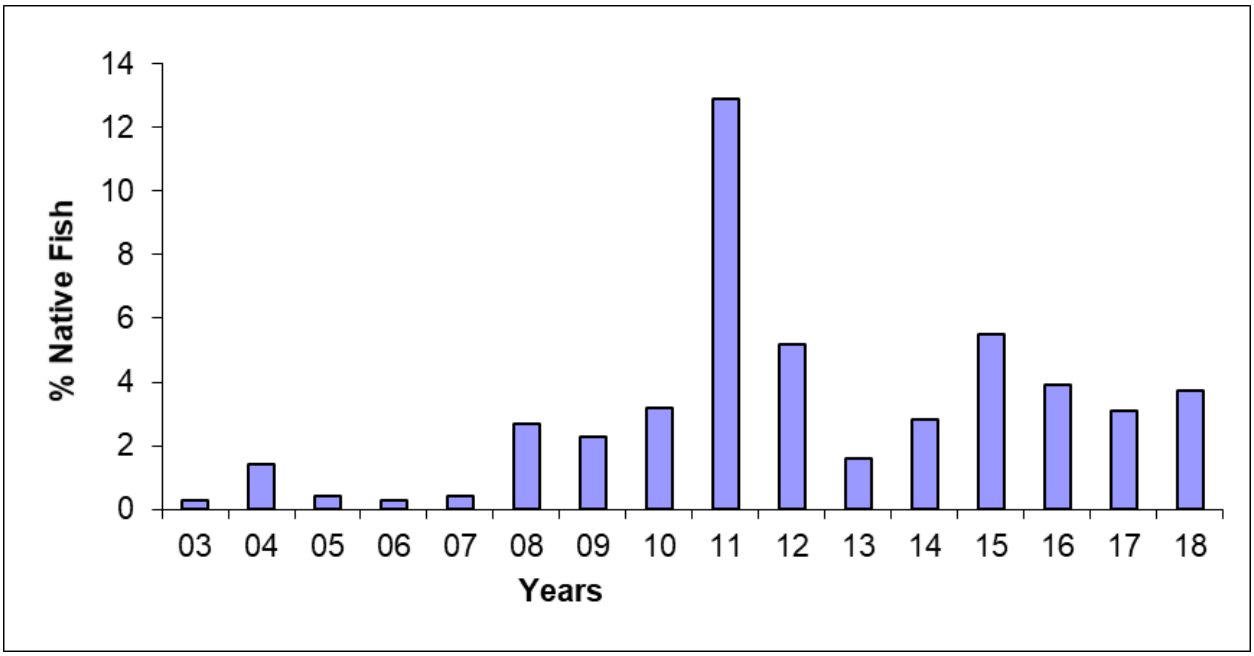

Figure 3. Percent composition of native fishes in the Yampa River, 2003-2018, in samples collected from the main channel in Little Yampa Canyon.

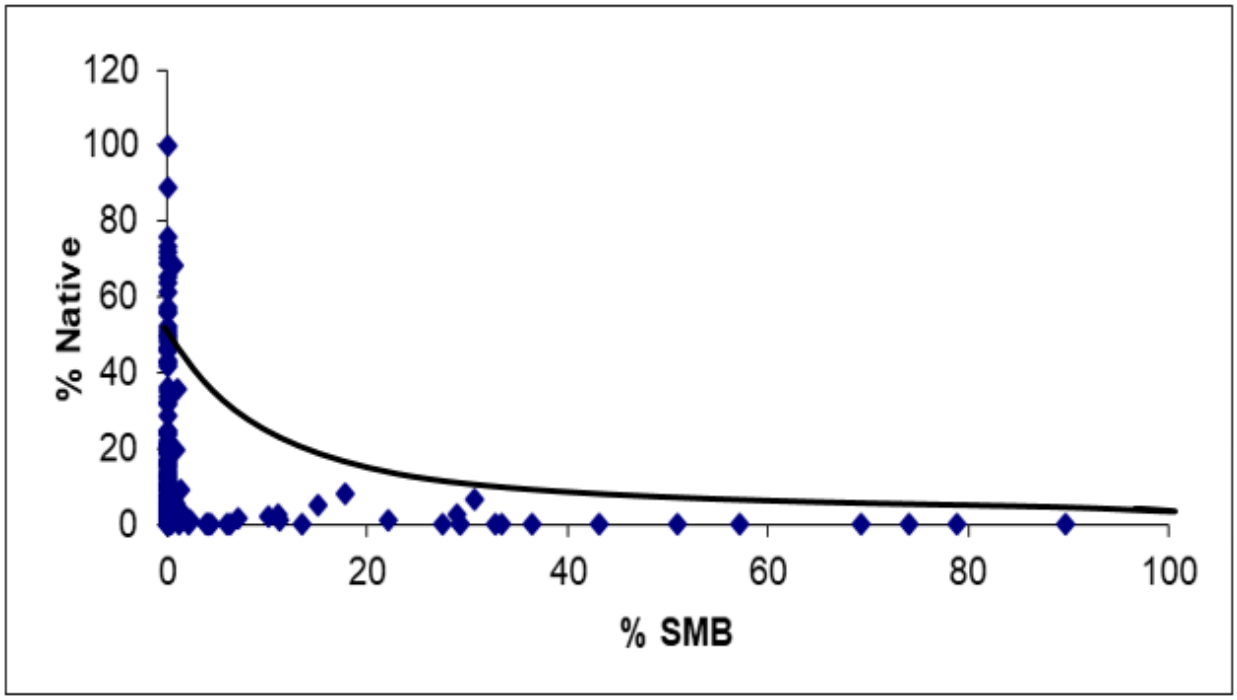

Figure 4. Percent native fishes as a function of percent smallmouth bass in samples collected from isolated pools in the Little Yampa Canyon reach of the Yampa River 2003-2018.

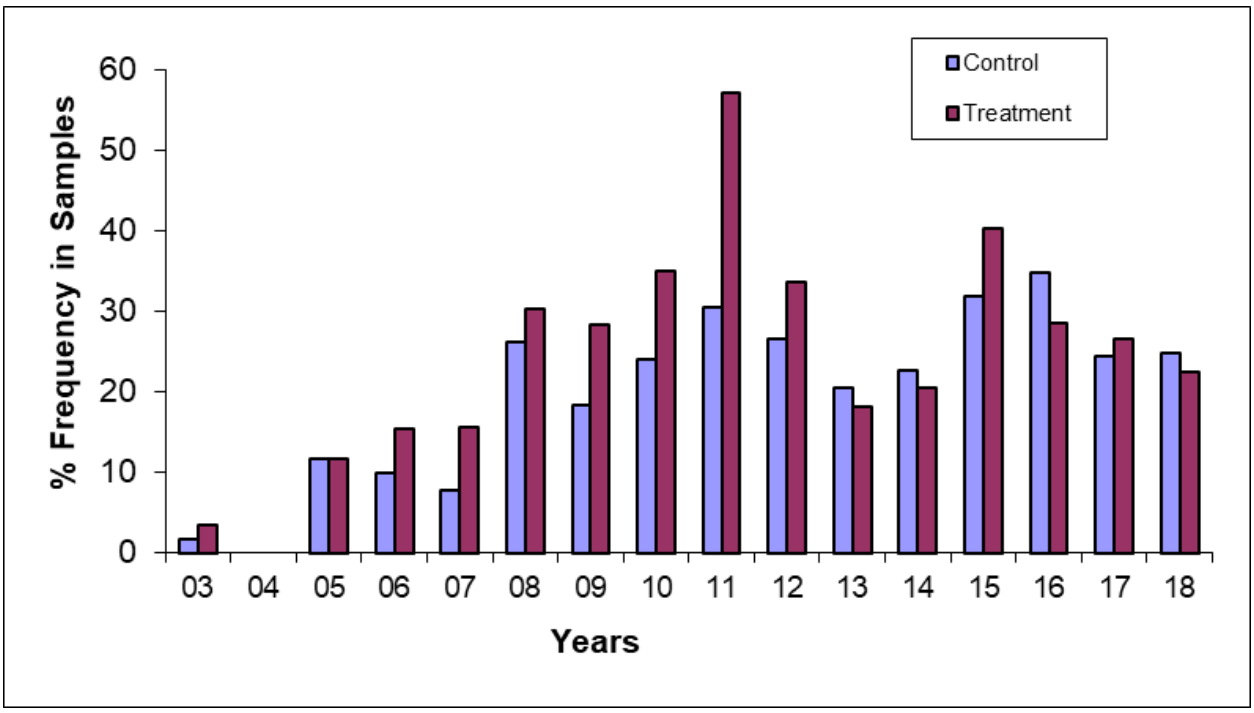

Figure 5. Presence of native fishes (any species) in samples collected in the main channel of the Yampa River in control (no age-0 smallmouth bass removal) and treatment (intensive age-0 smallmouth bass removal) reaches in Little Yampa Canyon, 2003-2018. Removal of young-of-year smallmouth bass began in 2005.

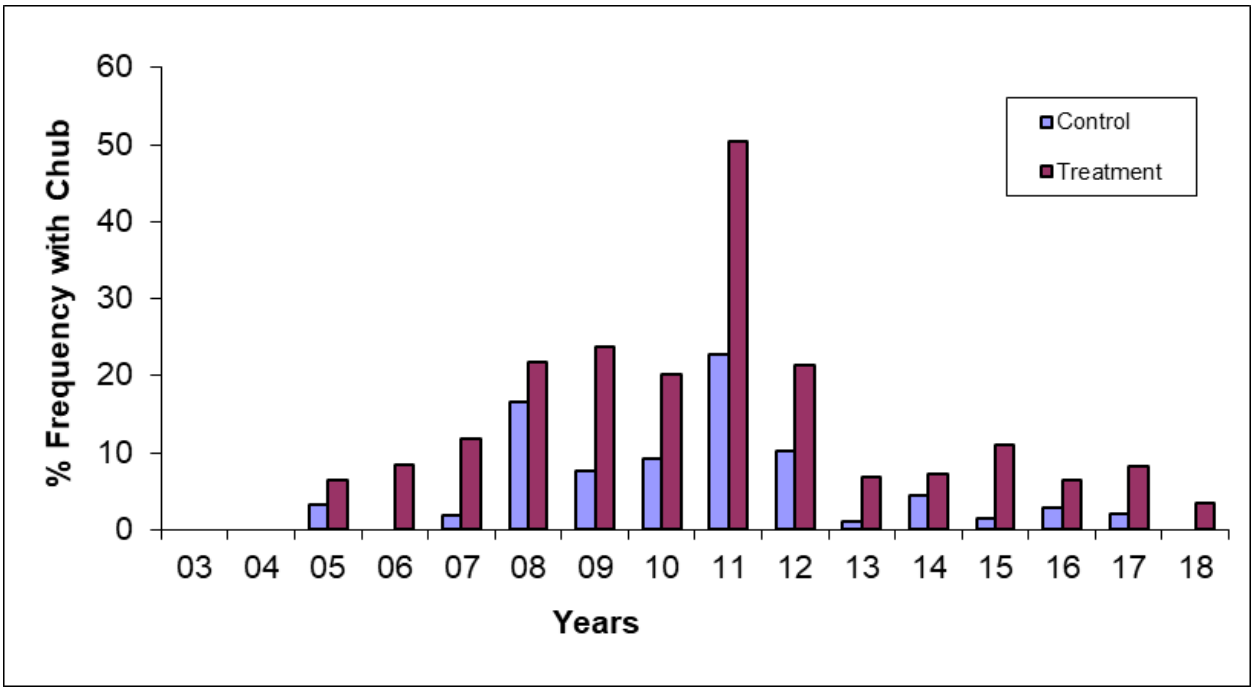

Figure 6. Frequency of roundtail chub in samples collected in the main channel Yampa River in the control (no age-0 smallmouth bass removal) and treatment (intensive age-0 smallmouth bass removal) reaches in Little Yampa Canyon, 2003-2018.

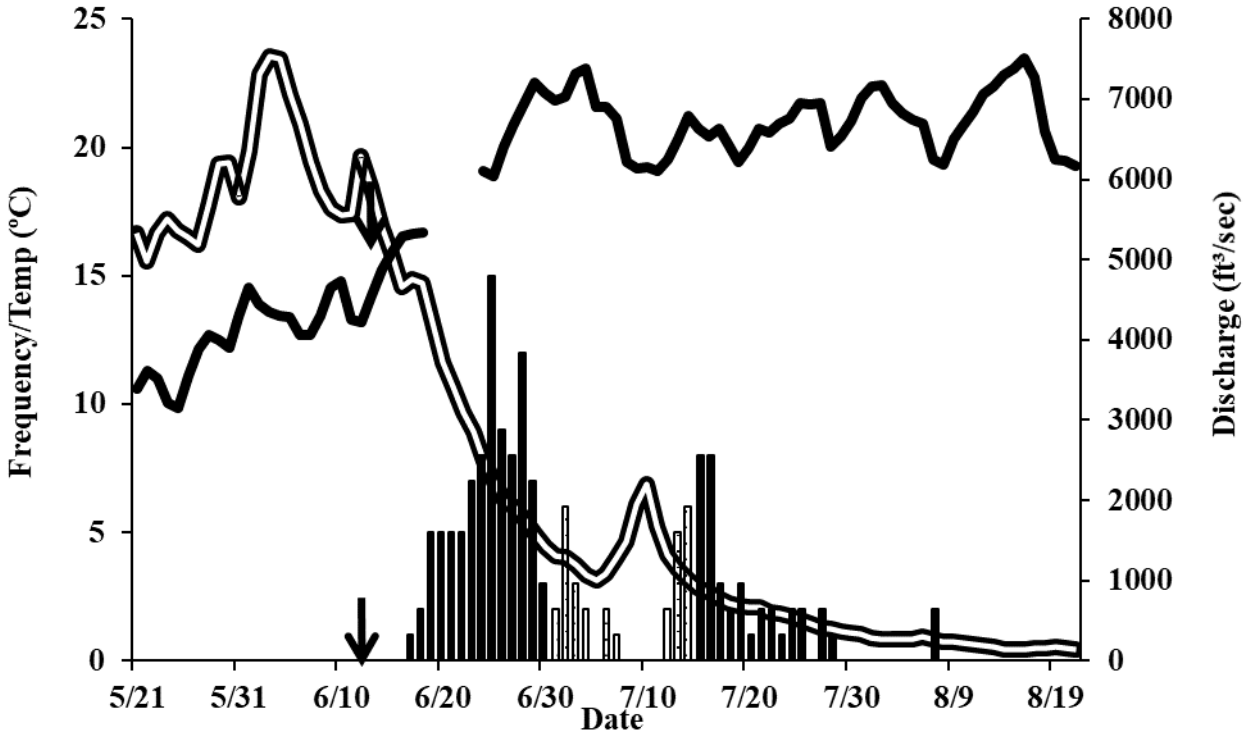

Figure 7. Distribution of hatching dates of smallmouth bass in the Yampa River, Colorado, 2015. The usual pattern of hatching dates results in a mound-shaped distribution. The flow spike on 10 July, and associated turbidity, likely resulted in reduced survival of smallmouth bass larvae produced before, during, and after that spike.

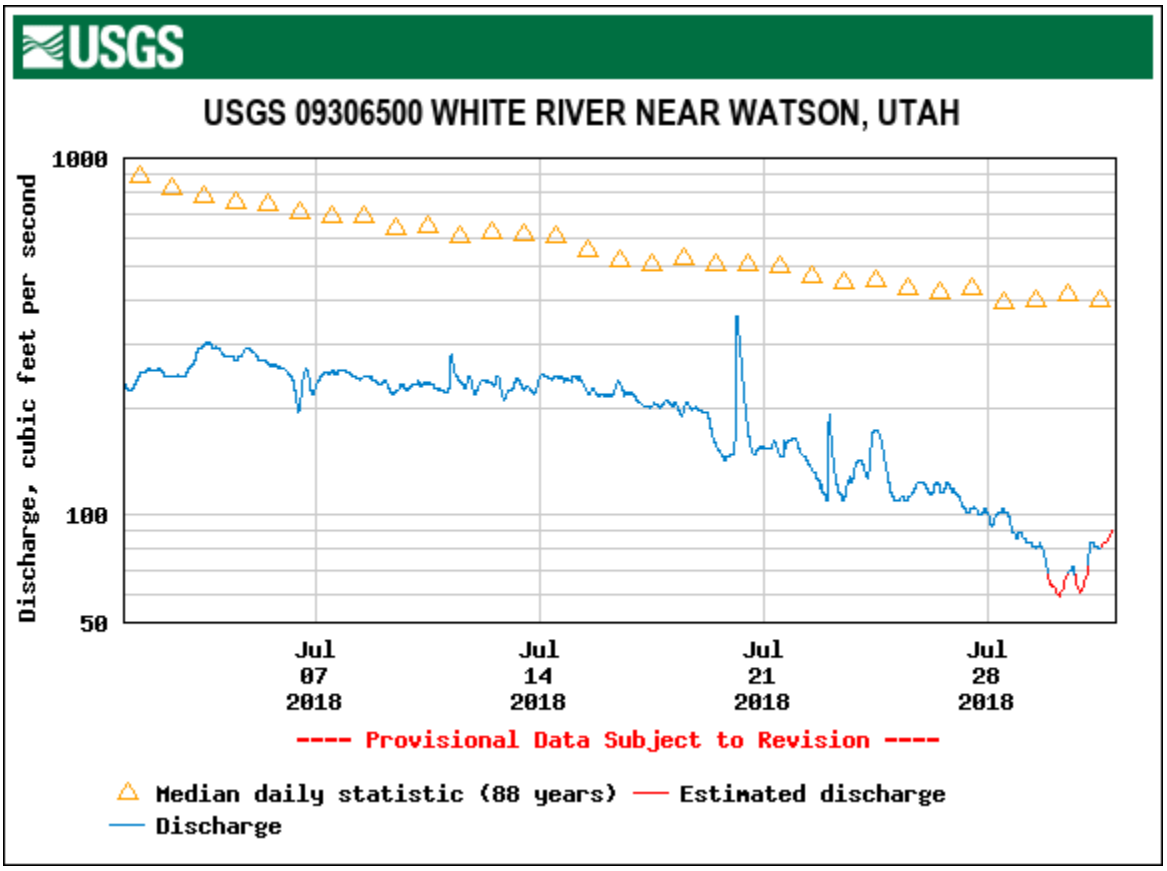

Figure 8. White River discharge in July 2018, showing the attenuated flow peak at 3:30 AM, 20 July (362 ft^3/sec) after release (1,100 ft^3/sec) from upstream Kenney Reservoir at 8:05 AM on 19 July.

Appendix I. Paired pictures of White River algae conditions downstream of Kenney Reservoir, near Rangely, Colorado, before and after a 90 minutes flushing flow of 1,100 ft^3/sec from Kenney Reservoir.

Before

After

Before

After

Before

After

Before

After


Before


After

Before

After

TOWN OF RANGELY – Utilities Department

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Fax: 970-675-8471

Subject: Flushing of the White River.

Date: July 23, 2018

From: Don Reed/Utilities Supervisor

On July 19, 2018 at 8:05 a flushing program was activated by the Water Conservancy District as an experimental application below Taylor Draw Dam. This initiative was proposed by Alden Vanden Brink in hopes of cleaning up the banks of the river that has been an ongoing problem for many years and even more predominate this year that results in clogging of the intake screens. The proposal was to turn on the turbine and reach a flow of 1100 cfs which calculates out at almost ½ million gallons per minute This targeted flow should create a scouring effect, and help remove buildup of aquatic algae, filamentous weed and other vegetation that is clogging the screens. The duration time of the scour will be determined by inflows of Kenny Reservoir. Flush was about 2.5 hours.

In conclusion of the flush it was determined as successful in accomplishing the task, on a scale of 1 to 10 it was rated about a plus 7. The Town Engineer took before and after photos from the Dam to the Water Treatment Plant river intake which clearly shows the results. This initiative should be utilized as a tool in aiding the Water Dept. in reducing the overall cost in screen cleaning, and improving water quality, as well as maintaining the White River.

This Department would like to Thank Mr. Vanden Brink and the Water Conservancy for proposing and executing this program. A sincere congratulation on a job well done. Attached is the Data and observations noted during the flushing program.

Submitted By.

Donald C. Reed

Observation Notes and Data Collection.

Note that river intake screens were cleaned just prior to the start of the program. The river pump station is off-line at this time. A raw water sample was collected. The current level of wet well was 9.21 feet.

A.) Initial observation at 8:05 am taken at outlet of Dam. Shows immediate scouring of vegetation on rocks and structures.
B.) Took about 35 minutes to reach the WTP River Intake Facility. Start to see some debris floating by.
C.) At 9:41am start to observe a lot of vegetation flowing down the river, and river is starting to rise.
D.) At 11:40 am reached peak flow and rivers station wet well level is at 12.28 feet and have a lot of debris floating down that has a lot of newer vegetation.
E.) River flow is slowed down and at 4:08 pm river flow is back to normal.

Lab Sample Results

1.) Raw sample from River at intake structure prior to flushing. PH=7.63 Temp 22.1

Alk=142 NTU=13.9 Fluoride=.09

2.) Raw sample from River intake after flushing. PH=7.91 Temp=21.3 Alk=131 NTU 8.8

Note Jocelyn Mullen took a lot of photos and will provide them upon request.