

I. Project Title: **Nonnative fish control in the middle Green River**

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

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IV. Abstract:

The purpose of this project is to remove nonnative species that pose the greatest threat to recovery of the four endangered fish in the upper Colorado River basin through predation, competition, and hybridization. Nonnative target species include smallmouth bass, walleye, northern pike, and white sucker. Total bass catch rates increased for the first time since 2014, possibly due to a successful 2016 cohort of smallmouth bass spawned in tributary streams. Bass reproduction in the Green River was disrupted for the fourth consecutive year by high spring peak flows and cooler water temperatures unfavorable to bass recruitment, as well as nest disruption in prime spawning habitat in Island Park during the multi-agency spring surge effort. Northern pike and white sucker captures increased, while walleye captures decreased despite an increase in targeted walleye effort.

V. Study Schedule: FY 2004 – FY 2018

VI. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

- III. Reduce negative impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).
- III.A. Reduce negative interactions between nonnative and endangered fishes.
- III.A.2. Identify and implement viable active control measures.

- III.A.2.c. Implement and evaluate the effectiveness of viable active control measures.

GREEN RIVER ACTION PLAN: MAINSTEM

- III. Reduce impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).
 - III.A. Reduce negative impacts to endangered fishes from sportfish management activities.
 - III.A.4. Develop and implement control programs for nonnative fishes in river reaches occupied by the endangered fishes to identify required levels of control. Each control activity will be evaluated for effectiveness, and then continued as needed.
 - III.A.4.a. Northern pike in the middle Green River.
 - III.A.4.b. (3) Smallmouth bass in the middle and lower Green River.
- VII. Accomplishment of FY 2017 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1. Northern pike, white sucker, and walleye removal.

We employed several strategies to reduce impacts of nonnative fish during the spring of 2017. Despite overlap with Colorado pikeminnow population estimates (Project 128), additional effort targeting walleye was simultaneously expended. From 13 March-27 June 2017 a total of 100.99 hrs of electrofishing were expended to target walleye, more than tripling effort in 2016 of 28.09 hrs (Staffeldt et al. 2016). Tributary electrofishing took place from 14 March-20 May 2017 targeting Ashley Creek (river mile [RM] 299.0), Stewart Lake drain (RM 299.2), Brush Creek (RM 304.6), Cliff Creek (RM 302.8), and Escalante Ranch outlet (RM 304.8) comprising 33.94 hrs of effort, an increase from 2016 (16.5 hrs; Staffeldt et al. 2016). Fyke netting in backwaters and tributaries took place from 13 March-20 May 2017 with a total of 134 overnight sets, an increase from 2016 (76 overnight sets; Staffeldt et al. 2016). Additionally, higher flows allowed for access to five side channels/backwaters at: RM 299.1, 299.9, 301.0, 303.3, and 304.4.

Northern Pike – Northern pike captures increased in 2017, with a total of 71 individuals removed from the middle Green River: 25 during fyke netting, 17 during tributary electrofishing, 16 during smallmouth bass removal, nine during targeted walleye removal, and four during Colorado pikeminnow population estimates (Table 1). With increased effort during spring tributary and backwater sampling in 2017, total northern pike captures were higher than in 2015 (n=38) and 2016 (n=45) (Schelly et al. 2015; Staffeldt et al. 2016), but well below higher catches in 2013 and 2014 of 177 and 114, respectively (Skorupski et al. 2013; Schelly et al. 2014). Size distribution was skewed towards larger individuals with 65 adults (≥ 300 mm total length [TL]; 92% of catch), 63 piscivores (≥ 375 mm TL; 89% of catch), and six juveniles (< 300 mm TL; 8% of catch). Fyke netting and electrofishing in tributaries and backwaters continues to be a more effective removal method than main channel electrofishing (Table 1).

Walleye – Total walleye captures decreased more than 50% in 2017 (n=65), despite more than tripling our efforts. Total captures are down from 135, 147, and 149 removed in 2016, 2015, and 2014, respectively (Schelly et al. 2014, 2015; Staffeldt et al. 2016). Seventy-five percent of walleye removed in 2017 were captured during dedicated spring walleye sampling and Colorado pikeminnow population estimates (n=49; Table 2). Although no clear walleye spawning aggregations were observed in 2017, 21 ripe males were removed; we did not remove any ripe females in 2017. Of the 21 ripe males, 12 were captured in Dinosaur National Monument between RM 319.3-310.8, near or at the spawning bar discovered in 2015 (Schelly et al. 2015). Combined catch-per-unit-effort (CPUE) for this reach was 0.54 fish/hr compared to 0.17 fish/hr for all spring electrofishing (walleye and Colorado pikeminnow sampling). The remainder of the 2017 walleye catch included nine individuals removed during smallmouth bass removal, one during tributary electrofishing, and six during fyke netting (Table 2). Although unclear, with fewer walleye captures overall and lack of ripe females removed, it is possible that prolonged higher than average spring flows (Figure 1) limited our effectiveness in 2017.

In response to an increase in walleye catch rates below the confluence of the White River (RM 246.1) observed in 2016 (Staffeldt et al. 2016), 60 hrs of electrofishing effort was expended in 2017 between RM 245.8-215.8. Nine walleye were captured in this area (CPUE = 0.15 fish/hr), similar to the combined spring CPUE of 0.17 fish/hr (see above).

In 2017, walleye size distribution was skewed towards large adults with all but two fish in the piscivore size class (≥ 375 mm TL). Two walleye under 300 mm TL were captured during smallmouth bass removal in 2017 (RM 213.8, 208 mm TL; RM 248.8, 241 mm TL). Eyeballs were extracted from these two individuals and shipped to the U.S. Fish and Wildlife Service La Crosse Fish Health Center for ploidy analysis. Results indicated that both fish were diploid (J. Bailey, personal communication). An additional walleye (248 mm TL) was captured on 19 June 2017 on the Duchesne River during state-funded three species population surveys (Michaud et al. 2017). Captures of juvenile walleye in the middle Green River have been rare; however, collection of juvenile and/or age-0 fish did occur in 2009 (Monroe and Hedrick 2009), 2012 (Skorupski and Breen 2012) and 2013 (Harding et al. 2013). Including the two juveniles mentioned above, otoliths were extracted from a total of 41 individual walleye in 2017 for future strontium isotope analysis.

White Sucker – In 2017, white sucker captures were higher than in 2016, 1,738 vs. 649, respectively (Staffeldt et al. 2016). Historically, targeting tributaries and backwaters for white suckers has produced high catch rates (Skorupski et al. 2013). Electrofishing in tributaries and backwaters in 2017 produced a CPUE of 10.5 fish/hr, compared to 0.5 and 3.6 fish/hr for spring main channel electrofishing and smallmouth bass removal, respectively (Table 3). Combining all sampling methods, an additional 33 white x flannelmouth sucker hybrids (mean TL = 337 mm, range = 180-337 mm) were captured along with one white x bluehead sucker hybrid (TL = 383 mm; Table 4).

White sucker size distribution was skewed towards smaller individuals in 2017 (mean TL = 152 mm, range = 55-550 mm). In southwestern Missouri, white suckers become mature around 275 mm (Wakefield and Beckman 2005). Because of this, our goal for removing

white suckers is to keep the average total length of the white sucker population less than 275 mm TL. In 2017, only 4% of the white suckers removed (n=67) were \geq 275 mm TL.

The Duck Lakes in Brown's Park were identified in 2014 as a potential source population for white sucker (Schelly et al. 2014), and follow up sampling took place in the fall of 2015 to better understand the scope of the problem (Schelly et al. 2015). Based on 2015 sampling, additional surveys were not necessary. However, we have moved forward with engineer consultation (FY 2017 UDWR funds) for wetland renovations, where we have selected the better of two design alternatives, to eliminate fish escapement in the future. The wetland renovation has been slated for two phases of construction (first phase funded by FY 2018 Watershed Restoration Initiative funds; phase two funding TBD) to begin in the spring of 2018 with hope of completion by the end of the 2018 field season. Draw-down and treatment of these ponds will be required concurrently with this renovation (funding TBD).

Task 2. Smallmouth bass removal.

Targeted smallmouth bass removal occurred from 26 June-29 September 2017. Two full electrofishing passes were implemented in the middle Green River from Split Mountain boat ramp (RM 319.3) to Tabyago Riffle (RM 206.8). The first full pass was performed on 7-18 July 2017, and the second on 14-28 August 2017. Data from these passes were used to identify areas with the highest catch rates, and guide subsequent electrofishing efforts. Additionally, and for a fourth consecutive year, multi-agency crews (UDWR-Vernal, UDWR-Moab, and the Green River Basin Fish and Wildlife Conservation Office [GRBFWCO]) implemented the spring "surge" effort to disturb smallmouth bass spawning during the period of optimal water temperatures in Island Park (RM 333.9 to 327.6); UDWR-Vernal contributed 10.41 hrs of effort. A summary of collaborative efforts in Island Park is described in the Project #123a annual report.

Between Split Mountain boat ramp (RM 319.3) and Tabyago Riffle (RM 206.8), including captures in Island Park, 3,985 smallmouth bass were removed during targeted removal. Including smallmouth bass removed during Colorado pikeminnow population estimate sampling (n=75), walleye removal (n=89), tributary electrofishing (n=1), and fyke netting (n=1), a total of 4,151 bass were removed in 2017. This represents an 88% increase in total bass captures over 2016 (n=2,204; Staffeldt et al. 2016). Additionally, GRBFWCO removed 24 smallmouth bass between the White River confluence (RM 246.1) and Tabyago Riffle during Colorado pikeminnow sampling (T. Jones, personal communication).

Catch rate – A combined CPUE of 11.68 fish/hr during targeted smallmouth bass removal (including Island Park) is compared to previous years in Table 5 and represents the highest CPUE since 2014. A multi-year comparison of catch rates parsed into sized classes is summarized in Figure 2. With a prolonged high spring peak flow (Figure 1) and cooler water temperatures (Figure 3) due to Flaming Gorge Dam releases, conditions may have disfavored smallmouth bass reproduction in 2017 (e.g., Bestgen and Hill 2016). This may help explain the absence of a mid-season explosion of age-0 smallmouth bass (e.g., Skorupski et al. 2013), for the fourth consecutive season (Schelly et al. 2014, 2015; Staffeldt et al. 2016). However, there was an 81% increase in CPUE from 2016 to 2017

(6.45 vs. 11.68 fish/hr; Table 5). Catch rates rose beginning in the Ouray National Wildlife Refuge in section N (RM 255.8-250.8), increasing in the downstream direction, and culminating with the highest CPUE in sections Q and R (RM 240.8-230.8; Figure 4). Considering the geographic relationship to the confluence of the White and Duchesne rivers, our data may suggest that source habitats with differing hydrologic conditions could play a role in the distribution of smallmouth bass in the Green River in 2017. For example, smallmouth bass removal data from the White River showed a substantial increase of sub-adult bass in 2017 (2016 n=384; 2017 n=1,461) downstream from the Colorado/Utah border (Smith et al. 2016, 2017). Additionally, 185 smallmouth bass (mean TL = 222 mm; range = 61-400 mm) were collected during five days of boat electrofishing on the lower 15 miles of the Duchesne River conducted in 2017 for state-funded three species population surveys (Michaud et al. 2017). Furthermore, a similar concentration of juvenile and sub-adult bass was encountered in 2011, beginning near the confluence of the Duchesne River, which was suggested as a source population (Skorupski and Breen 2011).

Catch rates by month were low and stable from March to June, with an increase in sub-adults in July and August, and a larger increase across size classes in September (Figure 5). The increase in CPUE during the month of September could be an artifact of targeting concentration areas determined by previous full pass sampling and an increased susceptibility by our gear as juveniles reached larger sizes later in the year. In 2017, 28% of the total smallmouth bass electrofishing effort was expended in the highest catch rate sections P, Q, R and S; in September, 44% of our electrofishing effort targeted the same four sections (Table 6; Figure 4).

Population size structure – Figure 6 displays the size distribution of smallmouth bass captured in the middle Green River in 2017, which is compared with previous year classes in Figure 7. Smallmouth bass < 100 mm TL constituted the most abundant size class of the 2017 catch, just slightly higher than the next three larger size classes of 100-125 mm, 126-150 mm, and 151-175 mm (Figure 6). A decrease in the percentage of smallmouth bass > 175 mm TL was observed in 2017 compared to the past three years (Figure 7), suggesting that strong year classes from 2012 and 2013 (Skorupski and Breen 2012; Skorupski et al. 2013) have been exploited or succumbed to natural mortality. Of the total 2017 smallmouth bass catch, 3.5% (n=144) were in the piscivore size class (\geq 325 mm TL), a slight decrease from 2016 (3.9%; Staffeldt et al. 2016), but a slight increase from 2015 (2.4%; Schelly et al. 2015). In the last three weeks of bass removal in 2017 (7-28 September), 1,918 smallmouth bass were removed; 529 individuals were < 100 mm TL (27.5%; presumably age-0 fish) with a range of 50-99 mm TL (mean = 80 mm). Captures of bass < 100 mm TL increased compared to the last three weeks of 2016 sampling (n=128, 21.6% of catch; Staffeldt et al. 2016).

Movement – Currently there are no mark-recapture studies conducted by Vernal UDWR. Three floy-tagged smallmouth bass were captured in 2017; all three tags were deployed by GRBFWCO. One bass, tagged in lower Whirlpool Canyon on 17 June 2015 (TL = 180 mm), was recaptured at RM 314.5 and had grown to 281 mm TL; another fish tagged in Island/Rainbow Park on 16 July 2016 (TL = 282 mm) was recaptured at RM 327.8, having grown to 320 mm TL; and a fish tagged on 6 August 2011 (TL = 351 mm) was

recaptured at RM 280.8 and had grown to 412 mm. A more detailed analysis of growth and movement associated with these tagged fish is described in Project #123a annual report.

Task 3. Data entry, analysis, and reporting

Recovery Program annual progress report submitted in November 2017.

VIII. Additional noteworthy observations:

Ancillary captures – Table 4 lists additional nonnative species removed during all sampling efforts in the middle Green River. Most notably, 2017 sampling saw the addition of two white crappie (190 and 164 mm TL), which were preserved in ethanol to maintain the ability for genetic confirmation given that this is a newly emerging invasive threat in the upper Colorado River basin. Additionally, 11 juvenile kokanee and three lake trout were captured in the middle Green River in 2017, and while survival of these salmonids through the summer is unlikely, it does highlight an ongoing risk of nonnative fish escapement from Flaming Gorge Reservoir.

Predation on endangered fishes – Multiple identifiable endangered fish and/or PIT tags were recovered from the stomachs of nonnative predatory fishes in 2017, once again confirming high levels of predation on native fishes by these voracious nonnative predators. One smallmouth bass (356 mm TL) contained a tagged bonytail. Found in northern pike stomachs were two unknown tags, one bonytail, and two juvenile razorback suckers; one untagged, and one tagged at Stewart Lake in 2016 (Schelly et al 2016). Walleye stomachs yielded tags from a 2016 Stewart Lake razorback sucker (Schelly et al 2016), two bonytail, and two unidentified fish.

Juvenile walleye – As mentioned above, the addition of juvenile walleye captures is noteworthy due to a lack of documented in-river recruitment and few previous captures of juveniles. The source of these fish is currently unknown; however, several possibilities deserve exploration. In 2017, juvenile walleye and yellow perch were captured in Johnson Bottom (Jones et al. 2017) and yellow perch were captured in Stewart Lake (Staffeldt et al. 2017). Both of these wetlands are located downstream of Red Fleet Reservoir, which was not screened in 2017 (T. Hedrick, UDWR, personal communication). However, Red Fleet Reservoir was successfully treated in 2015 to remove illegally introduced walleye and subsequently stocked with > 99% triploid walleye (Red Fleet Reservoir Advisory Committee 2014). Ploidy analysis of both juvenile walleye captured in the middle Green River indicated diploidy (J. Bailey, personal communication), suggesting in-river reproduction or escapement from a reservoir other than Red Fleet. Of the two juvenile walleye captured in 2017, one was below the Duchesne River confluence and the other just upstream. Likewise, an age-0 walleye was collected from a backwater 1.5 miles upstream of the Duchesne River during fall young-of-year surveys in 2013 (Harding et al. 2013). These observations in addition to juvenile walleye captures on the lower Duchesne River in 2017 (Michaud et al. 2017) and previously in 2009 (Breen and Hedrick 2010), suggest the Duchesne River as a possible source. Furthermore, fish escapement from Starvation Reservoir has previously

been documented (Brunson et al. 2007) and emigration to the Green River was suggested by otolith microchemistry (Johnson et al. 2014). A temporary fish screen has since been installed on Starvation Reservoir, but in-river reproduction by walleye that remain in the lower Duchesne River is not out of the question.

IX. Recommendations:

- With promising results suggesting local smallmouth bass population suppression after multiple years of using two full passes to direct intensive fishing efforts at hotspots, we recommend a continuation of this approach in 2018.
- A large population of white suckers persists in Duck Lakes (Parson's Unit Waterfowl Management Area) in Brown's Park, potentially serving as a source population for the middle Green River. Work to address this problem will continue in 2018.
- Continue targeting riffles where walleye have been observed spawning whenever personnel and equipment are available. More specifically, this effort will be more substantial in years when we are not conducting population estimates for Colorado pikeminnow under project #128; Walleye specific removal efforts will still occur during pikeminnow years to a lesser extent. In 2016, a concentration of Walleye was discovered between the White River confluence and Sand Wash. An attempt to exploit this concentration occurred in 2017, but catch rates in this reach were similar to spring sampling of the middle Green River as a whole. However, 2017 may be an anomaly based on abnormal flow conditions, possibly affecting the timing of walleye spawning migrations, thus we still recommend monitoring this area during spring sampling in 2018.

X. Project Status: On track and ongoing.

XI. FY 2017 Budget Status

- A. Funds Provided: \$252,831
- B. Funds Expended: \$252,831
- C. Difference: \$0
- D. Percent of the FY 2017 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 by January 2018.

XIII. Signed: Richard R. Staffeldt 11/6/2017
Principal Investigator Date

XIV. References.

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Table 1. – NORTHERN PIKE. Total abundance, catch-per-unit-effort (CPUE; electrofishing (fish/hr) and fyke-netting (fish/overnight set)), and total length (mm) means and ranges for four projects during 2017. Spring main channel (MC) sampling included captures during dedicated walleye removal and Colorado pikeminnow population estimates.

Project	Abundance	Electrofishing CPUE	Fyke CPUE	Mean TL	Range TL
Spring Tributary Sampling	42	0.501	0.187	618.2	405-925
Spring MC Sampling	13	0.046	-	600.1	235-815
Smallmouth Bass Removal	16	0.047	-	433.0	176-675

Table 2. – WALLEYE. Total abundance, catch-per-unit-effort (CPUE; electrofishing (fish/hr) and fyke-netting (fish/overnight set)), and total length (mm) means and ranges for four projects during 2017. Spring main channel (MC) sampling included captures during dedicated walleye removal and Colorado pikeminnow population estimates.

Project	Abundance	Electrofishing CPUE	Fyke CPUE	Mean TL	Range TL
Spring Tributary Sampling	7	0.029	0.045	575.4	494-627
Spring MC Sampling	49	0.174	-	524.8	451-671
Smallmouth Bass Removal	9	0.026	-	495.1	208-638

Table 3. – WHITE SUCKER. Total abundance, catch-per-unit-effort (CPUE; electrofishing (fish/hr) and fyke-netting (fish/overnight set)), total length (mm) means and ranges for four projects in 2017. Spring main channel (MC) sampling included captures during dedicated walleye removal and Colorado pikeminnow population estimates.

Project	Abundance	Electrofishing CPUE	Fyke CPUE	Mean TL	Range TL
Spring Tributary Sampling	379	10.548	0.157	178.7	55-550
Spring MC Sampling	144	0.510	-	206.4	84-550
Smallmouth Bass Removal	1,215	3.561	-	143.2	60-428

Table 4. — Additional nonnative species removed during all sampling efforts in the middle Green River in 2017.

Species	Abundance
Black bullhead	10
Black crappie	85
Brown trout	80
Channel catfish	1
Green sunfish	812
Gizzard shad	20
Kokanee	11
Largemouth bass	2
Lake trout	3
Rainbow trout	41
White x bluehead sucker hybrid	1
White Crappie	2
White x flannelmouth sucker hybrid	33

Table 5. — Smallmouth bass catch-per-unit-effort (CPUE; fish/hr) from 2004 – 2017.

Year	CPUE (fish/hr)
2004	9.33
2005	4.02
2005	4.71
2007	26.04
2008	8.56
2009	7.96
2010	9.60
2011	7.40
2012	34.10
2013	48.60
2014	16.97
2015	6.55
2016	6.45
2017	11.68

Table 6. — 2017 electrofishing effort totals for 5-mile sections of the middle Green River during walleye (WE; 13 March-27 June) and smallmouth bass (SM) removal (26 June-29 September). Sections include Island Park (IP), and the entire reach between Split Mountain boat ramp (A) to Tabyago Riffle (W).

Section	River Miles	WE Targeted Effort (hrs)	SM Targeted Effort (hrs)
IP	334-328	-	10.41
A	319-316	7.85	12.41
B	316-311	10.40	19.96
C	311-306	2.51	5.55
D	306-301	1.61	6.86
E	301-296	0.08	5.86
F	296-291	-	15.19
G	291-286	-	14.51
H	286-281	-	16.05
I	281-276	-	18.23
J	276-271	-	14.19
K	271-266	-	10.90
L	266-261	-	8.33
M	261-256	-	15.74
N	256-251	6.54	17.41
O	251-246	11.82	12.21
P	246-241	12.08	27.83
Q	241-236	8.35	22.45
R	236-231	10.66	21.34
S	231-226	10.41	23.77
T	226-221	10.57	16.77
U	221-216	8.11	14.41
V	216-211	-	8.06
W	211-207	-	2.74
Total		100.99 hrs	341.18 hrs



USGS 09261000 GREEN RIVER NEAR JENSEN, UT

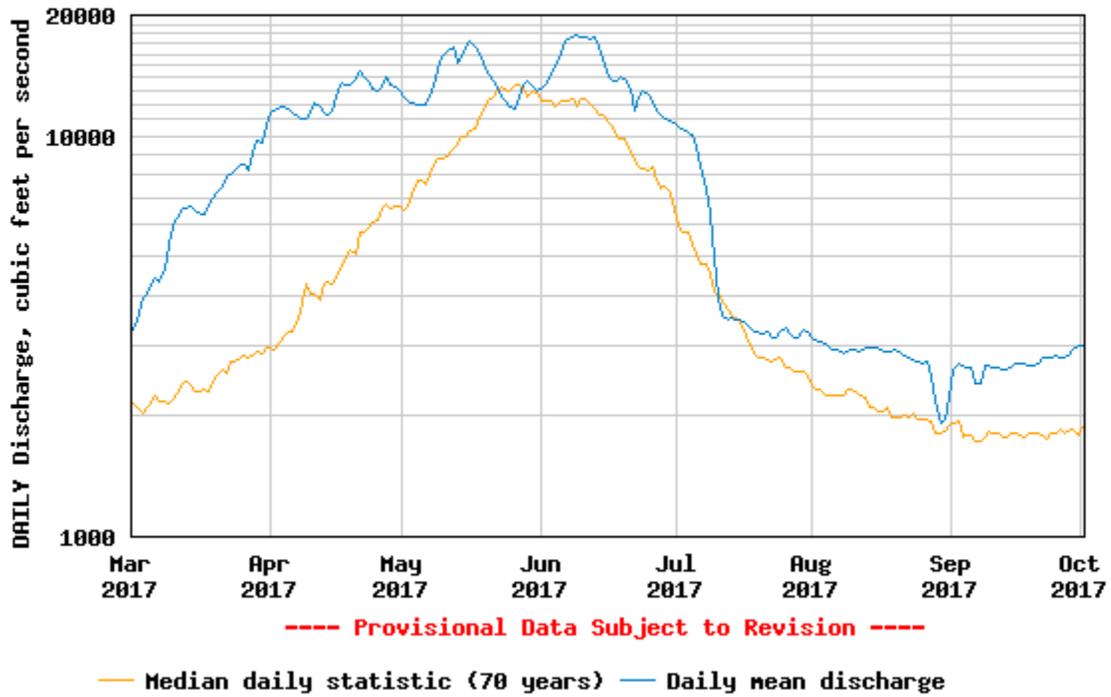


Figure 1. Green River hydrograph at Jensen, Utah from 1 March—1 October 2017.

Year to Year SMB Electrofishing CPUE Comparison

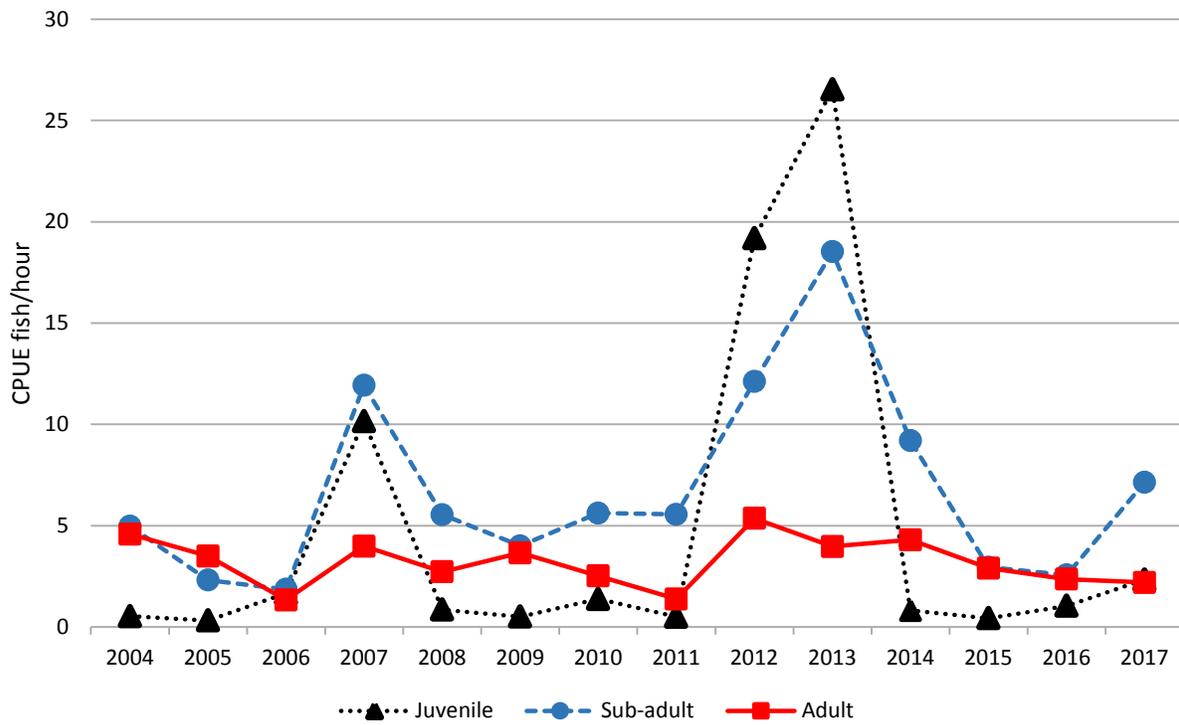


Figure 2. Catch-per-unit-effort (fish/hour) of juvenile (<100 mm TL), sub-adult (100-199 mm TL), and adult (≥ 200 mm TL) smallmouth bass in the middle Green River 2004-2017, during targeted smallmouth bass removal.



USGS 09261000 GREEN RIVER NEAR JENSEN, UT

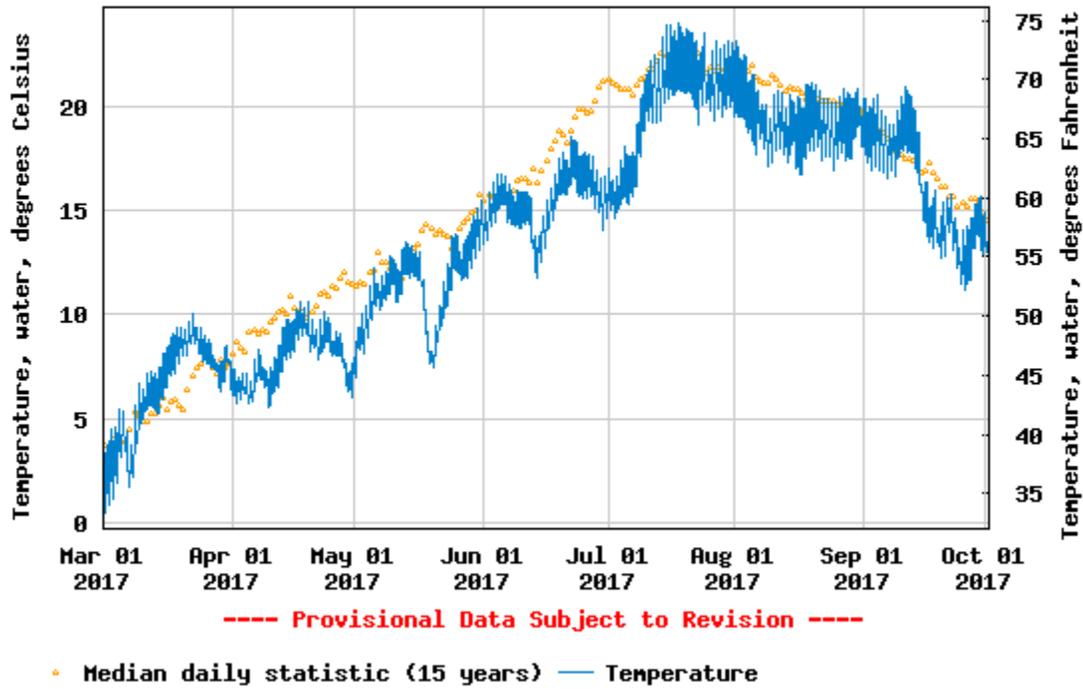


Figure 3. Green River temperatures at Jensen, Utah from 1 March—1 October 2017.

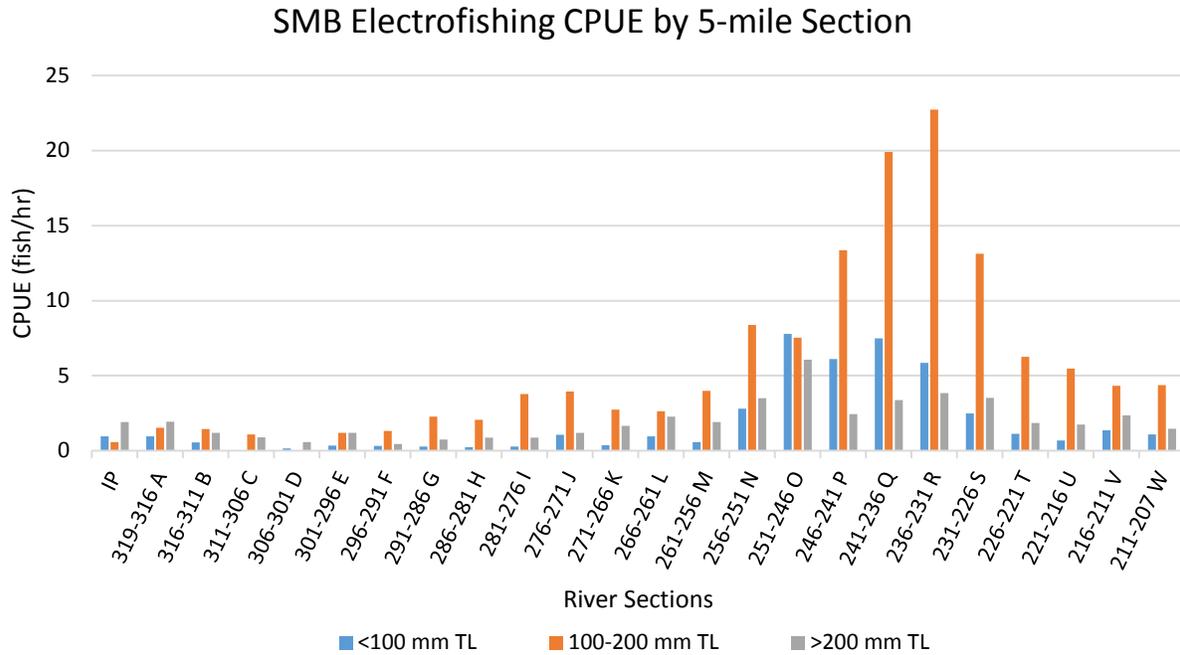


Figure 4.—Smallmouth bass juvenile (< 100 mm TL), sub-adult (100-200 mm TL), and adult (> 200 mm TL) catch rates for Island Park (IP) and from Split Mountain boat ramp (A) to Tabyago Riffle (W) in the middle Green River, 26 June – 29 September 2017.

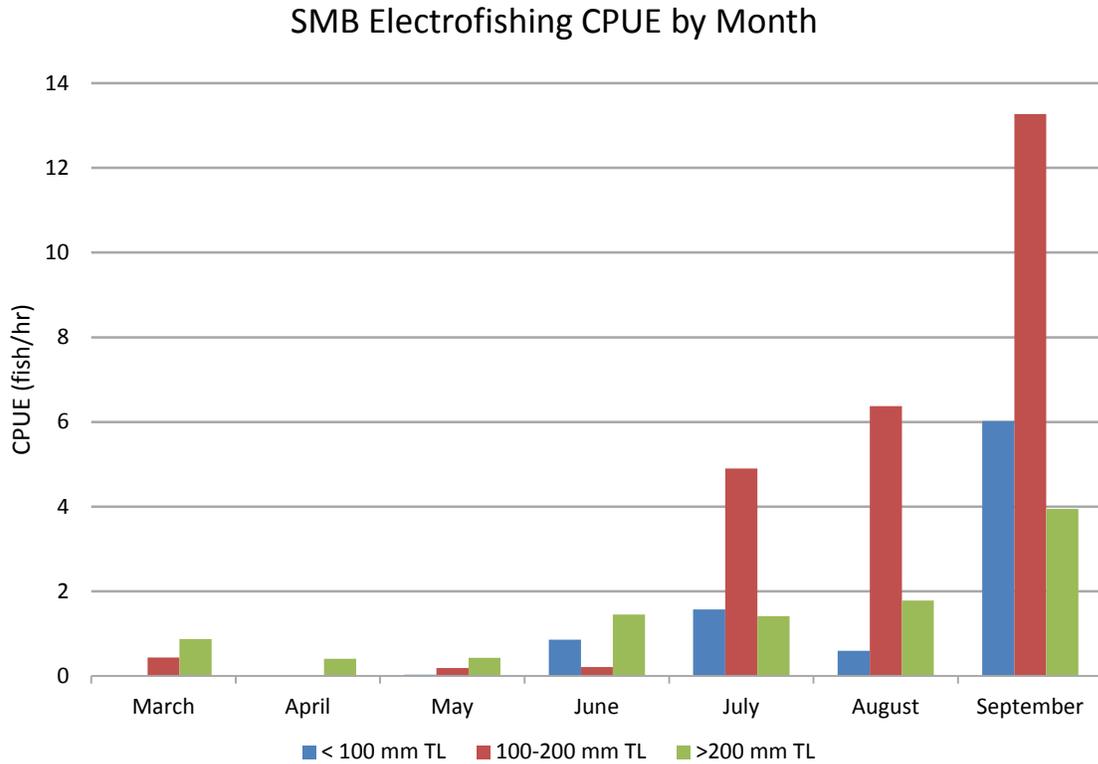


Figure 5. –Smallmouth bass juvenile (< 100 mm TL), sub-adult (100-200 mm TL), and adult (> 200 mm TL) catch rates by month in the middle Green River in 2017. Catch rates in March, April, May and early June correspond to sampling that specifically targeted Colorado pikeminnow and walleye (spring fyke netting and tributary electrofishing excluded for data consistency); rates from 26 June – 29 September 2017 correspond to sampling that targeted smallmouth bass.

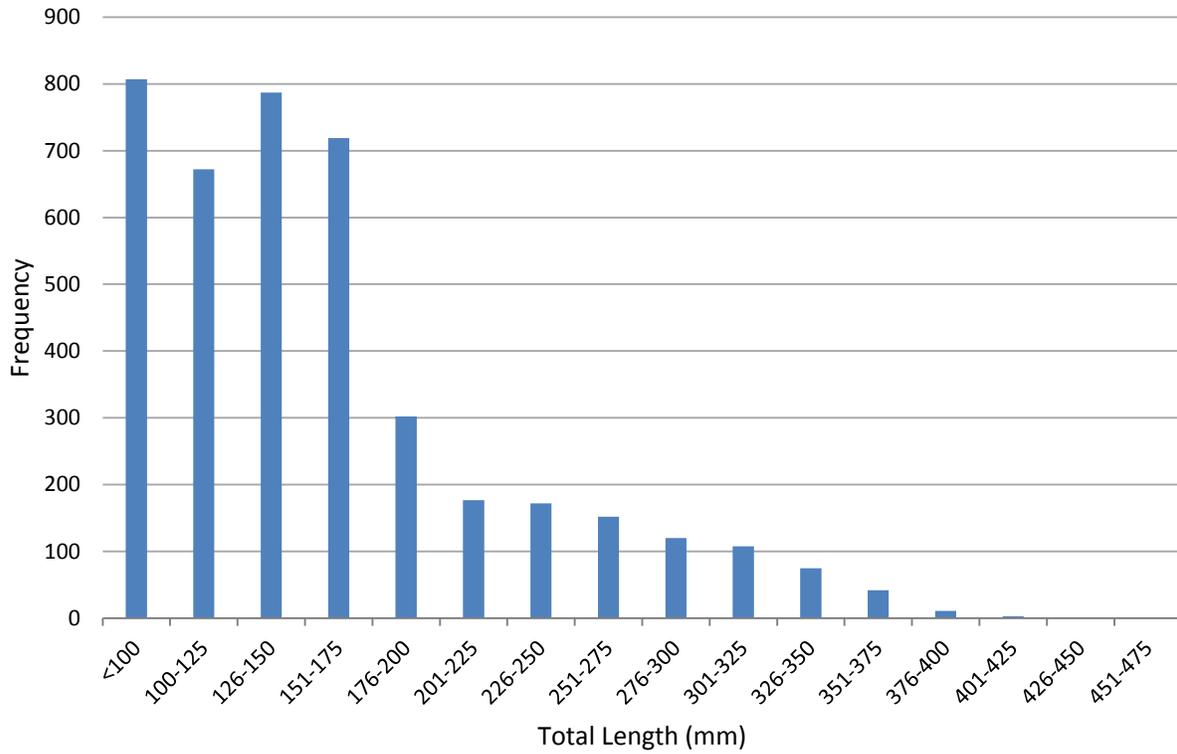


Figure 6. —Size distribution of smallmouth bass electrofishing captures in the middle Green River (includes Colorado pikeminnow population estimates, walleye and smallmouth bass sampling periods).

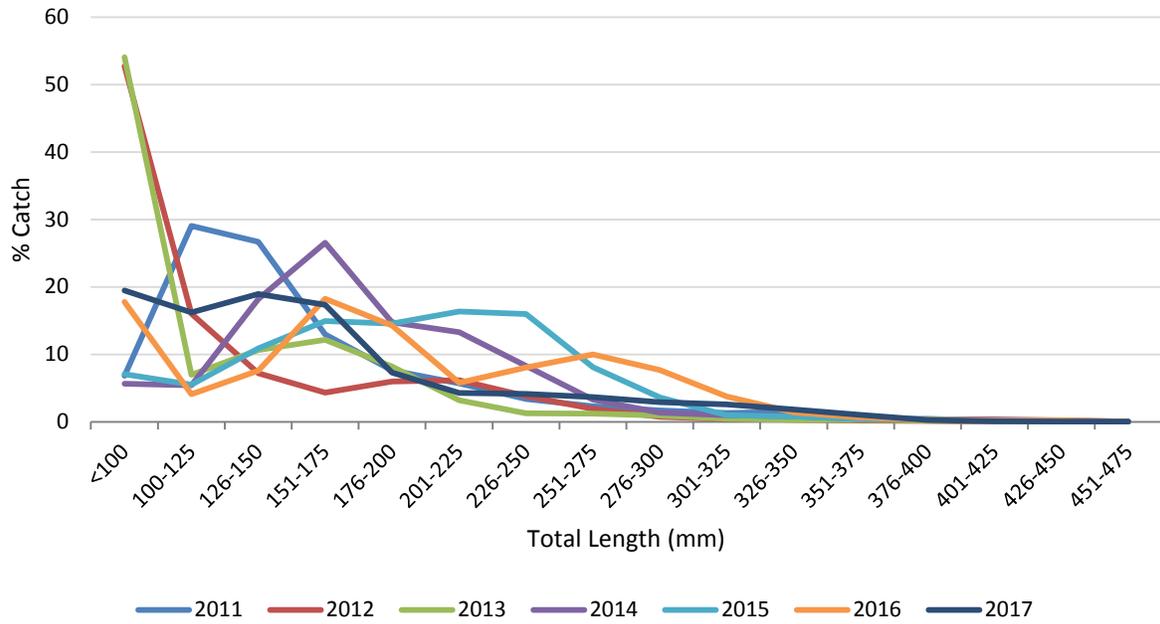


Figure 7. — Smallmouth bass size-class frequency comparisons across years from 2011 – 2017 in the middle Green River.