

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: 09/30/2016
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 continue to decline likely due to three consecutive years of higher 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. Walleye and Northern Pike captures remained relatively steady, and there was a decline in White Sucker captures in 2016.

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 2016 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1. Northern Pike, White Sucker, Walleye, & Island Park Smallmouth Bass removal.

To maximize effectiveness and efficiency, we implemented a diverse set of techniques to remove problematic nonnative fish at a variety of locations under Task 1. Although we conducted Colorado Pikeminnow population estimates (Project #128) in spring 2016, we also removed Walleye during this time of the year. We continued targeting of Walleye during early season sampling for the third consecutive year from 12 April-8 June 2016. Walleye removal consisted of only a fraction of the effort (28.09 hrs) compared to the previous two years (Schelly et al. 2014; Schelly et al. 2015), mainly because availability of personnel and equipment is much reduced while working on Project #128. Tributary electrofishing took place from 11 April-6 June 2016 targeting Stewart Lake drain, Ashley Creek, Brush Creek and Cliff Creek, comprising 16.5 hrs of effort. Fyke netting in backwaters and tributaries took place from 23 March-10 May 2016 with a total of 76 overnight sets at the same locations mentioned above. In addition to these localities, higher flows allowed access to five additional backwaters located at: RM 299.1, 299.8, 300.2, 301.8, and 304.8. For a third 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; UDWR-Vernal contributed 9.12 hrs of effort. Additionally, the middle Green River Smallmouth Bass targeting phase took place from 28 June-10 October 2016, comprising 310.86 hrs of effort. This was over 100 hrs less effort than was applied in 2015 (417.74 hrs) because a prolonged spring runoff delayed the onset of favorable conditions for targeting Smallmouth Bass, reducing the duration of the Smallmouth Bass phase by approximately one month (Figure 1).

Task 1 Results

Northern Pike – Northern Pike captures increased slightly in 2016, with a total of 45 individuals removed from the middle Green River: 24 during fyke netting, eight during Colorado Pikeminnow population estimates, six during Smallmouth Bass removal, four during tributary electrofishing, and three during spring Walleye removal (Table 1). Total Northern Pike captures this year was similar to 2015 (38 total), but well below higher catch rates observed in 2014 (Schelly et al. 2015; Schelly et al. 2014). Size distribution continues to be skewed towards larger individuals with 40 out of 45 fish (89%) in the piscivore size class (≥ 450 mm TL). Fyke netting and electrofishing in tributaries and backwaters continues to be a more effective removal method than main channel electrofishing.

Walleye – Total Walleye captures decreased slightly in 2016 (135 removed), compared to 147 and 149 removed in 2015 and 2014, respectively (Schelly et al. 2015, Schelly et al. 2014). Dedicated spring Walleye removal efforts were reduced in 2016 due to efforts focused on Colorado Pikeminnow population estimates. Greater than 70% of the Walleye removed in 2016 were captured during spring Walleye targeting and Colorado Pikeminnow population estimates (Table 2); additionally three of the 135 Walleye were captured in Island Park, an area that would not normally be sampled for Walleye in the absence of Pikeminnow population estimate sampling. In addition, with the discovery of Walleye spawning aggregations over riffle habitats in Dinosaur National Monument downstream of Split Mountain (Schelly et al. 2015), we conducted experimental passes in 2016 through Split Mountain Canyon (RM 327.5 – 319.3), which contains similar habitats. This area was sampled using cataraft electrofishing equipment on two separate days, only resulting in one captured Walleye. Given limited capture efficiency in this reach for Walleye on two occasions, the additional two days originally slated for removal at this location was shifted to assist GRBFWCO with a fourth pass of Colorado Pikeminnow population estimates (see below). The remainder of the 2016 Walleye catch included 28 individuals removed during Smallmouth Bass sampling and 10 during spring tributary sampling. In terms of catch-per-unit effort (CPUE), spring main channel electrofishing yielded the highest catch rates, (CPUE = 0.71 fish/hr). In 2016, the Walleye size distribution was skewed towards large adults with all 135 Walleye in the piscivore size class (≥ 375 mm TL).

While conducting a fourth pass for Colorado Pikeminnow population estimates, we removed 17 Walleye (of the 135 total removed) from the White River confluence to Sand Wash (RM 246.1 to 215.5). Interestingly, Walleye were more abundant in this reach (CPUE = 1.03/hr vs. 0.36/hr for all other sampling locations) and larger on average (mean TL = 542.3 mm) than Walleye removed upstream (mean TL = 521.5 mm), warranting further investigation of Walleye captured in this reach during the previous three Colorado Pikeminnow passes in 2016. Combining all three passes, 25 (potentially 26, but capture location is uncertain for one fish) of 53 total Walleye (47.2%) were removed from this reach (T. Jones, personal communication), suggesting that we should target this area for Walleye removal in the absence of sampling for Project #128.

White Sucker – Spring White Sucker sampling in tributaries and backwaters has historically produced high catch rates (Skorupski et al. 2013), but in 2016 White Sucker catch rates were lower (Table 3). Only 649 White Suckers were removed in 2016 compared to 657 and 2,851 in 2015 and 2014, respectively (Schelly et al. 2014; Schelly et al. 2015). Of the White Suckers removed, 34 were identified as hybrids with Flannelmouth or Blueheads (Table 4), compared to 29 in 2015 (Schelly et al. 2015).

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 in 2016. However, we have moved forward with engineer consultation (UDWR funds) for wetland renovations, including two design alternatives, to eliminate fish escapement in the future. Treatment of these ponds will be required prior to renovation (hopeful for 2018; funding TBD).

Island Park Smallmouth Bass Surge – A third year of collaborative surge electrofishing was directed at spawning Smallmouth Bass in Island Park, timed to coincide with the advent of 16°C water temperatures, with UDWR-Vernal contributing 9.12 hrs of effort from 30 June-11 July 2016. UDWR-Vernal was only able to contribute two days of removal effort due to a late onset of 16°C water temperatures from a prolonged spring peak, and rapidly dropping flows that didn't allow for Jon boat operation (Figure 1). Results from our Island Park surge sampling are included with our dedicated Smallmouth Bass removal data in Task 2 (below); a summary of collaborative efforts is described in the Project #123a annual report.

Task 2. Smallmouth Bass removal from Split Mountain boat ramp to Tabyago Riffle.

Two full electrofishing passes targeting Smallmouth Bass were implemented in the middle Green River from Split Mountain boat ramp (RM 319.3) to Tabyago Riffle (RM 206.8) during the 2016 season (28 June-7 October) to identify concentration areas for targeted electrofishing. .

Task 2 Results

The combined annual CPUE of 6.45 fish/hr is compared with previous years in Table 5; 2016 represented the lowest CPUE since 2006 and the third lowest value on record. As mentioned above, two full passes, the first completed piecemeal between 28 June-21 July 2016, and the second completed between 29 August-9 September 2016, were used to direct subsequent fishing efforts on stretches with the highest catch rates (see Table 6 and Figure 2). During the Smallmouth Bass targeting phase, 2,003 bass were removed. Including the additional Smallmouth Bass captured during Colorado Pikeminnow population sampling (n=144), Walleye sampling (n=38), tributary electrofishing (n=13), and fyke-netting (n=6), a total of 2,204 Smallmouth Bass were removed in 2016, approximately 1,000 fewer individuals than were captured in 2015 (n=3,257; Schelly et al. 2015). Additionally, GRBFWCO removed 47 Smallmouth Bass between the White

River and the Sand Wash boat ramp during Colorado Pikeminnow population estimate passes that were not included in the total Smallmouth Bass removed.

Catch rate.— Figures 2 and 3 display Smallmouth Bass CPUE values for three different size classes across five-mile sections and across months, respectively. With a prolonged high spring peak flow that created increased turbidity in the early spring (Figure 4), combined with late arrival of base flows, conditions may have disfavored Smallmouth Bass reproduction in 2016 (e.g., Bestgen and Hill 2016). This may help explain the absence of the mid-season explosion of age-0 Smallmouth Bass (Skorupski et al. 2013), for the third consecutive season (Schelly et al. 2014; Schelly et al. 2015). In 2016, there was an overall decrease in Smallmouth Bass CPUE. By reach, CPUE was highest in sections O, P, Q, R, and S, between Ouray National Wildlife Refuge and Sand Wash (Figure 2). Catch rates by month were stable from April to June, with a slight uptick in July and August, and were highest in September and October, specifically for sub-adults (100-200 mm TL) in sections P, Q and R (Figure 3). Additionally, juvenile Smallmouth Bass (<100 mm TL) captures increased in September and October (Figure 3). This may be an artifact of late onset base flows (Figure 1), creating a shorter growing season, thus preventing growth into a catchable size until later in the season. Nevertheless, elevated CPUE was observed late season, despite an increase in turbidity due to monsoonal storm events (Figure 4).

Population size structure. – Figure 5 displays the size distribution of Smallmouth Bass captured in the middle Green River in 2016, which is compared with previous year classes in Figure 6. Smallmouth Bass <100 mm TL constituted a major component of the 2016 catch, representing the second most abundant size class behind 151-175 mm bass (Figure 5). Two other size classes comprised the bulk of remaining captures in 2016; 176-200 and 251-275 mm bass represented the third and fourth most abundant size classes, respectively. Only 3.9 % of the Smallmouth Bass removed (86 individuals) were in the piscivore size class (≥ 325 mm TL), a slight increase from 2015 (2.4%; Schelly et al. 2015). In the last three weeks of the 2016 field season (20 September-7 October), 593 Smallmouth Bass were removed; 128 individuals were < 100 mm TL (21.6%; presumably age-0 fish) with a range of 52 -99 mm TL (mean = 80 mm). There were no captures of fish < 50 mm using Jon boat electrofishing sampling, even though modifications were made to our nets creating a smaller mesh size designed to target smaller fish. However, during ISMP sampling (Project #138) that took place from 12 September-22 September 2016, 42 Smallmouth Bass were captured in primary, secondary, and tertiary backwaters with a 4.6 m beach seine (Breen et al. 2016). Of those 42 individuals, 52% (22) were under 50 mm TL with a range of 35-89 mm TL (mean = 53 mm; unpublished data). This suggests that age-0 fish are present at this time and their absence during 123b sampling could be an artifact of gear bias or habitats sampled.

Movement. – Currently there are no mark-recapture studies being conducted by Vernal UDWR. One floy-tagged Smallmouth Bass was captured in 2016; a GRBFWCO tag deployed on 18 June 2015 in Split Mountain Canyon between Entry Rock and Hatch Beach (RM 326.7 to 322.9). This particular Smallmouth Bass was a mature, ripe male that was recaptured on 5 May 2016 in section B (RM 315.8-310.8), having grown 31

mm. One floy-tagged Northern Pike was captured in 2016; this fish was originally tagged on 6 May 2012 in the Yampa River at Lily Park (RM 51.5), and was recaptured in section B of the middle Green River (RM 315.8-310.8) on 29 August 2016 having grown 376 mm.

Task 3. Data entry, analysis, and reporting

Recovery Program annual progress report submitted in December 2016.

VIII. Additional noteworthy observations:

Ancillary captures. — Table 4 lists additional nonnative species removed during Smallmouth Bass electrofishing. In general, additional nonnative captures slightly increased in 2016 compared to 2015, with the exception of Green Sunfish; 768 and 1,504 in 2016 and 2015 respectively (Schelly et al. 2015). Additionally, one Burbot was removed above the Sand Wash boat ramp (RM 220.8-215.5), likely originating from the population in Flaming Gorge Reservoir. This potentially raises concerns, as the middle Green River already contains numerous piscivorous nonnatives. However this individual Burbot was in poor condition (495 mm TL, 571 g) at the time of capture, hopefully suggesting that survivorship is adversely affected with warmer water temperatures observed the farther downstream this species travels.

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 2017.
- 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. Further sampling of these ponds is unnecessary at this time; however, we recommend continuing to work towards a structural redesign of the complex to eliminate fish escapement into the Green River, which would require a rotenone treatment prior to construction.
- Continued targeting of 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.
- Based on experimental passes in Split Mountain Canyon that yielded limited returns, we do not recommend expending additional effort targeting Walleye in this reach.

- In 2016, during a fourth Colorado Pikeminnow Population estimate pass to assist GRBFWCO, a concentration of Walleye was removed between the White River confluence and Sand Wash. Moreover, further analysis determined that approximately 50% of the Walleye removed by GRBFWCO during pikeminnow passes 1-3 were removed from this same reach. We recommend conducting Walleye-specific removal efforts in this reach during spring sampling (efforts will be more extensive in Project #128 off years). Specifically, with limited personnel and equipment available during years we conduct Project #128, our spring walleye targeting will only focus on the reach mentioned above and the Split Mountain spawning riffles in Dinosaur National Monument.

X. Project Status: On track and ongoing.

XI. FY 2016 Budget Status

- A. Funds Provided: \$253,861
- B. Funds Expended: \$253,861
- C. Difference: \$0
- D. Percent of the FY 2016 work completed, and projected costs to complete: 100%
- E. Recovery Program funds spent for publication charges: \$0

XII. Status of Data Submission (Where applicable):

We will submit our data to the Recovery Program database manager in December 2016.

XIII. Signed: Richard R. Staffeldt 12/2/16
Principal Investigator Date

XIV. References.

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 submitted 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 187.

Breen, M.J., R.C. Schelly, and C.M. Michaud. 2016. Annual fall monitoring of young of year Colorado pikeminnow and small-bodied native fishes. Annual report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Schelly, R.C., Staffeldt, R.R., and M.J. Breen. 2015. Nonnative fish control in the middle Green River. Annual Report of Utah Division of Wildlife Resources to Upper

Colorado River Endangered Fish Recovery Program. Denver, CO.

Schelly, R.C., Boehm, A.M., and M.J. Breen. 2014. Nonnative fish control in the middle Green River. Annual Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Skorupski, J.A., Kiefer, B.P., and M.J. Breen. 2013. Nonnative fish control in the middle Green River. Annual Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

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 2016 (spring main channel sampling included captures during dedicated Walleye removal and Colorado Pikeminnow population estimates).

Project	Abundance	ELECTRO. CPUE	FYKE CPUE	Mean TL	Range TL
Spring Tributary Sampling	28	0.243	0.315	615.1	403-850
Spring Main Channel Sampling	11	0.080	-	615.9	524-764
Smallmouth Bass Removal	6	0.019	-	612.0	454-738

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 2016 (spring main channel sampling included captures during dedicated Walleye removal and Colorado Pikeminnow population estimates).

Project	Abundance	ELECTRO. CPUE	FYKE CPUE	Mean TL	Range TL
Spring Tributary Sampling	10	0.243	0.079	532.6	379-656
Spring Main Channel Sampling	97	0.709	-	521.7	392-650
Smallmouth Bass Removal	28	0.091	-	531.6	421-647

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, and biological data for four projects in 2016 (spring main channel sampling included captures during dedicated Walleye removal and Colorado Pikeminnow population estimates).

Project	Abundance	ELECTRO. CPUE	FYKE CPUE	Mean TL	Range TL
Spring Tributary Sampling	74	2.310	0.474	210.4	55-385
Spring Main Channel Sampling	80	0.584	-	249.2	85-600
Smallmouth Bass Removal	495	1.592	-	179.8	51-475

Table 4. — Totals for additional nonnative species removed during Smallmouth Bass removal electrofishing efforts in the middle Green River in 2016.

Species	Abundance
Black Bullhead	7
Black Crappie	21
Bluehead x White Sucker*	9
Brown Trout	27
Burbot	1
Flannelmouth x White Sucker*	25
Green Sunfish	768
Largemouth Bass	1
Rainbow Trout	2
Yellow Perch	2

* hybrids are included in white sucker counts provided in text

Table 5. — Smallmouth Bass catch-per-unit-effort (CPUE; fish/hr) from 2004 – 2016.

Year	CPUE (fish/hr)
2004	9.33
2005	4.02
2006	4.71
2007	26.04
2008	8.56
2009	7.96
2010	9.6
2011	7.4
2012	34.1
2013	48.6
2014	16.97
2015	6.55
2016	6.45

Table 6. — 2016 electrofishing effort totals for 5-mile sections of the middle Green River during Walleye (12 April-7 June) and Smallmouth Bass removal (28 June-7 October). Sections include Island Park (IP) and Split Mountain Canyon (SMC) in Dinosaur National Monument, and the entire reach between Split Mountain boat ramp (A) to Tabyago Riffle (W).

SECTION	RIVER MILES	WE	SMB
		HRS EFFORT	HRS EFFORT
IP	334-328	–	9.12
SMC	328-319	6.81	–
A	319-316	6.90	15.02
B	316-311	4.15	28.96
C	311-306	0.68	9.76
D	306-301	6.33	9.23
E	301-296	3.21	9.60
F	296-291	–	13.46
G	291-286	–	5.18
H	286-281	–	10.51
I	281-276	–	10.18
J	276-271	–	10.27
K	271-266	–	13.01
L	266-261	–	14.67
M	261-256	–	24.01
N	256-256	–	12.96
O	251-246	–	4.60
P	246-241	–	20.54
Q	241-236	–	15.72
R	236-231	–	19.42
S	231-226	–	14.01
T	226-221	–	16.75
U	221-216	–	8.31
V	216-211	–	8.86
W	211-207	–	6.67
TOTAL		28.09 HRS	310.86 HRS

USGS 09261000 GREEN RIVER NEAR JENSEN, UT

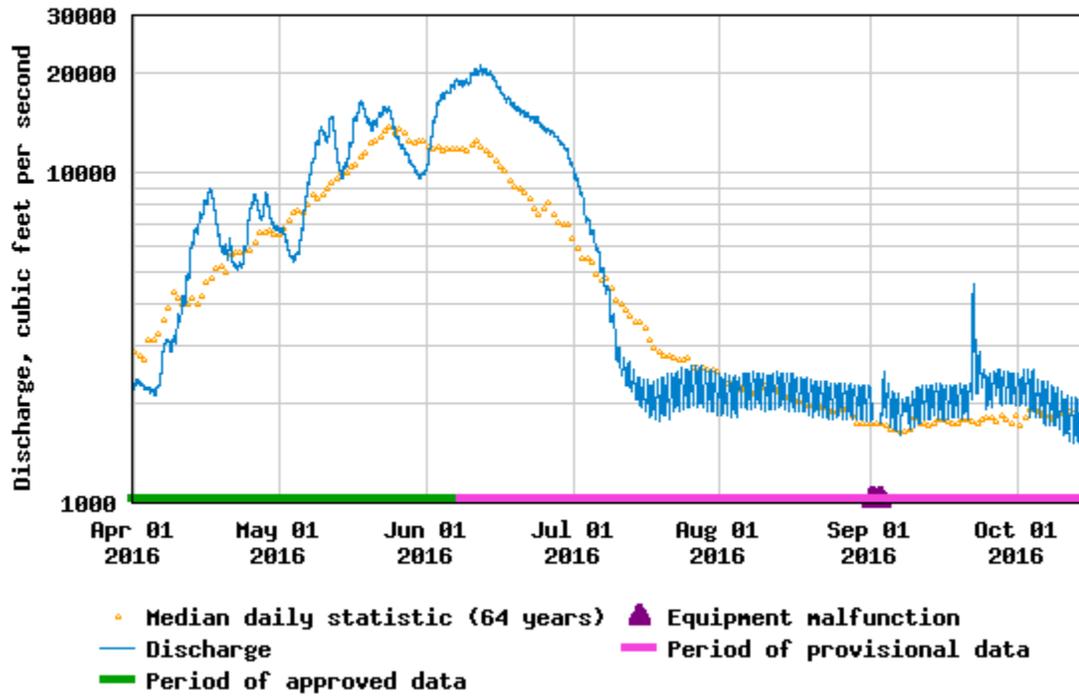


Figure 1. Green River hydrograph at Jensen, Utah, for 1 April – 15 October 2016.

SMB Electrofishing CPUE by 5-mile Section

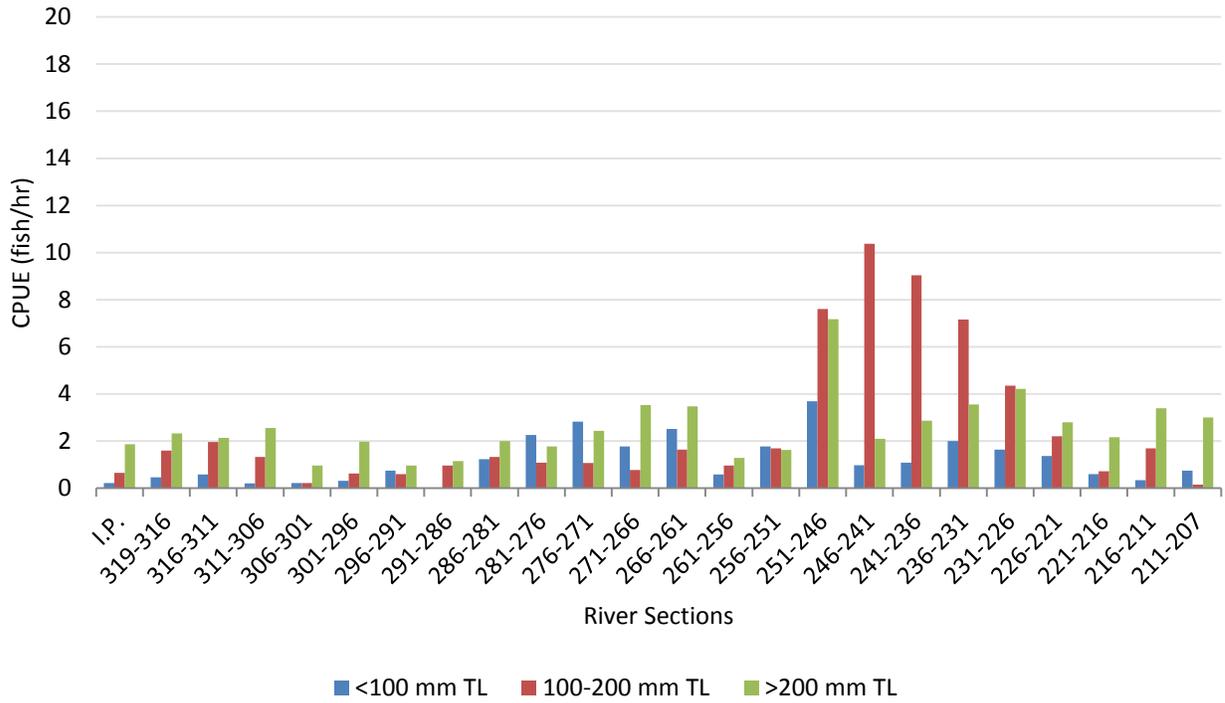


Figure 2. — 2016 Smallmouth Bass juvenile (<100 mm TL), sub-adult (100-200 mm TL), and adult (>200 mm TL) catch rates for Island Park (I.P.) and from Split Mountain boat ramp to Tabyago Riffle in the middle Green River, 28 June - 7 October.

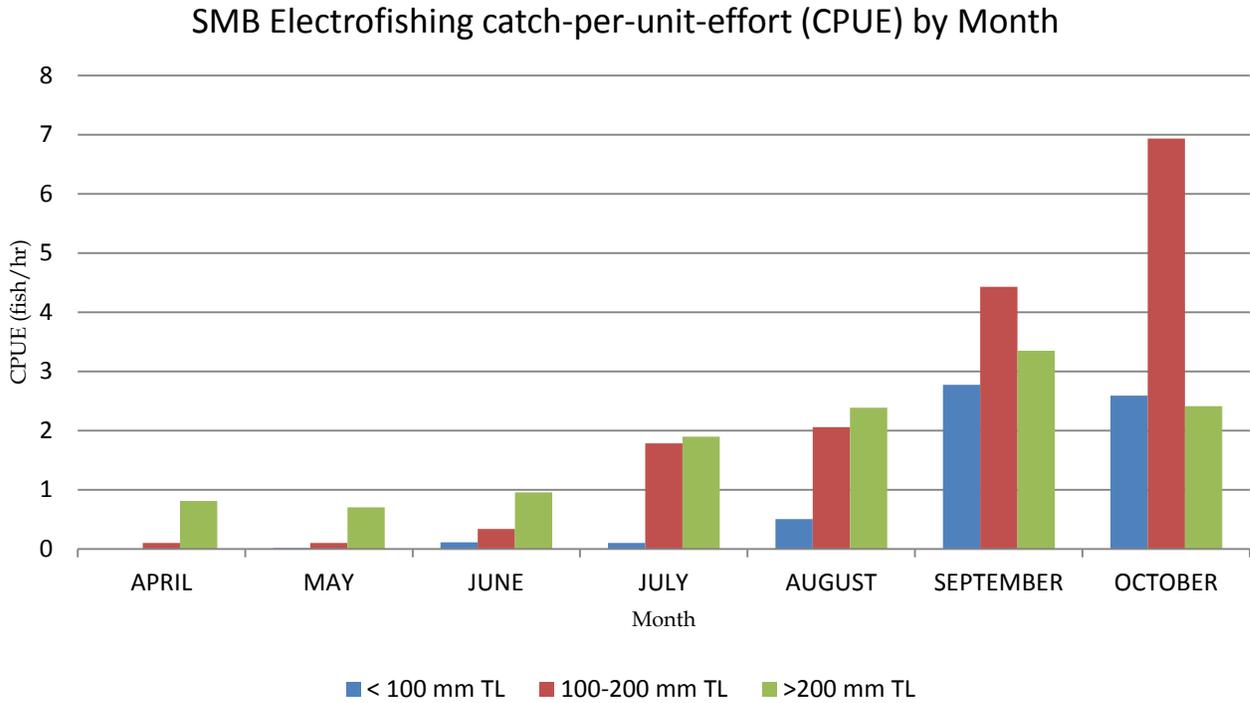


Figure 3. — 2016 Smallmouth Bass juvenile (<100 mm TL), sub-adult (100-200 mm TL), and adult (>200 mm TL) catch rates by month in the middle Green River. Catch rates in April, May and early June correspond to sampling that specifically targeted Colorado Pikeminnow and Walleye; rates from 28 June – 7 October correspond to sampling that targeted Smallmouth Bass.

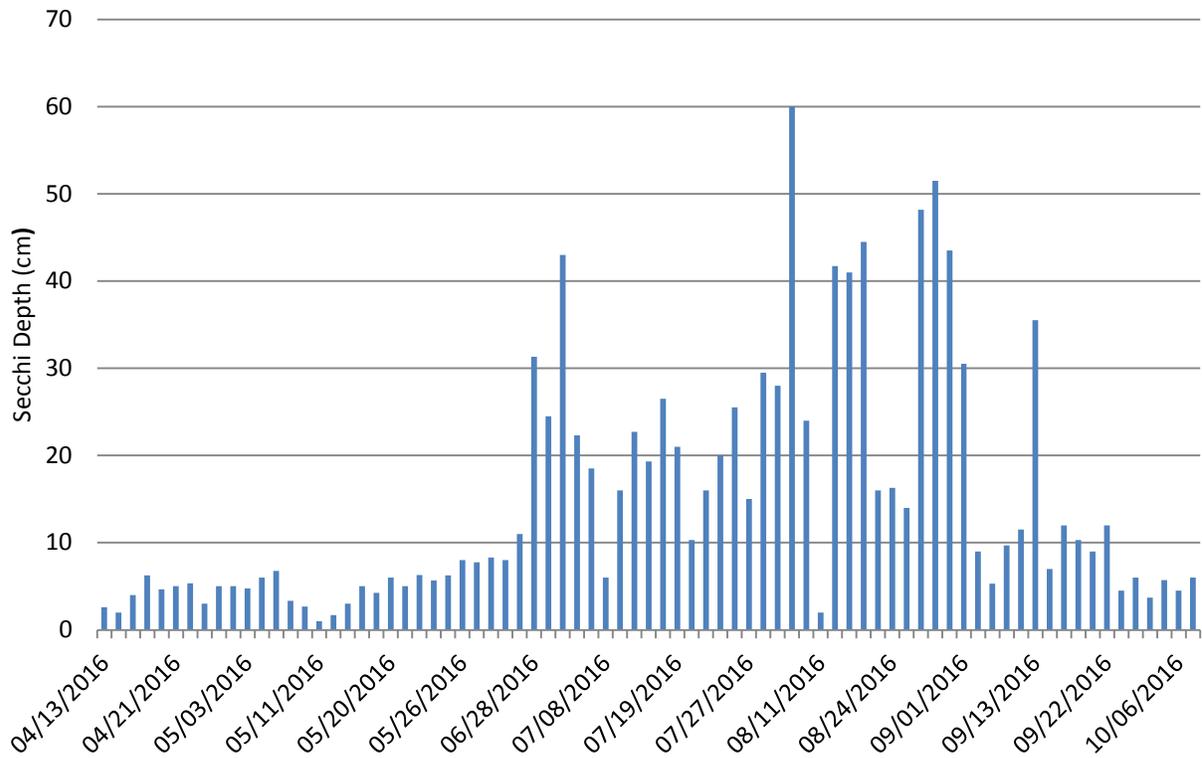


Figure 4. Water clarity, expressed as daily average Secchi depths (cm), in the middle Green River from 13 April to 7 October 2016.

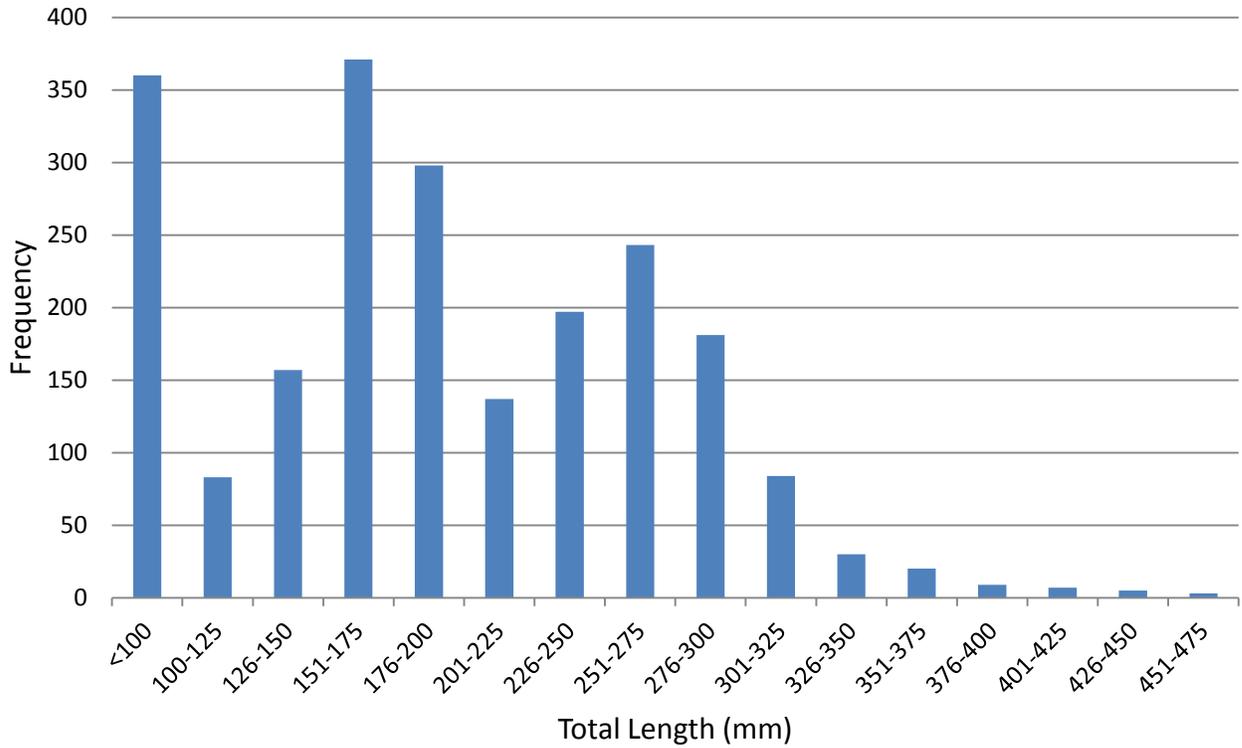


Figure 5. — 2016 size distribution of Smallmouth Bass electrofishing captures in the middle Green River (includes Colorado Pikeminnow population estimates, Walleye and Smallmouth Bass sampling periods).

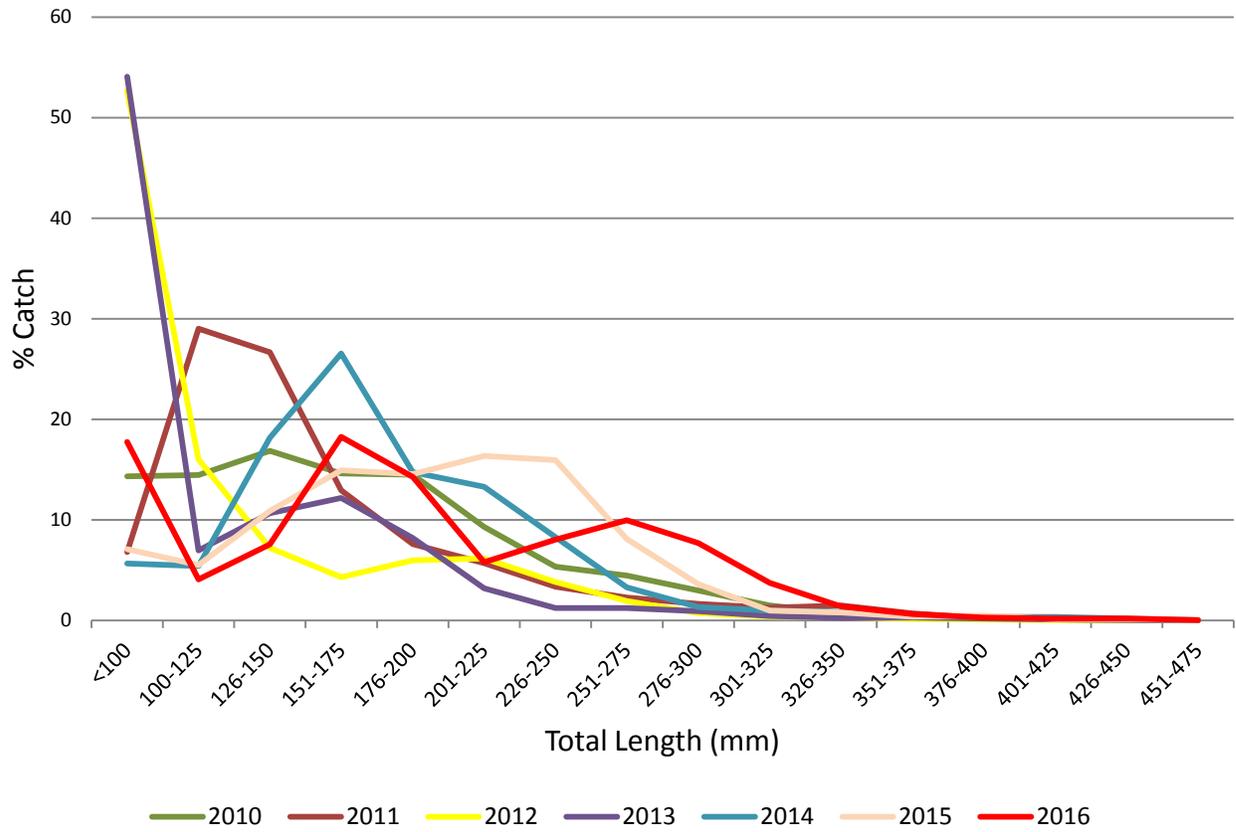


Figure 6. — Smallmouth Bass size-class frequency comparisons across years from 2010-2016 in the middle Green River.