

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

II. Principal Investigator(s):

Joseph A. Skorupski Jr. / Matthew J. Breen
Utah Division of Wildlife Resources
Northeast Region
152 East 100 North
Vernal, Utah 84078
Phone: (435) 781-5315; fax: (435) 789-8343
E-mail: jskorupski@utah.gov
mattbreen@utah.gov

III. Project Summary:

The Upper Colorado River Endangered Fish Recovery Program and its partners, have determined that control of specific nonnative fish in the upper Colorado River basin is essential to the recovery of the four endangered fish species: Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*Gila elegans*). This determination has been documented specifically for Colorado pikeminnow, razorback sucker, and bonytail in nursery habitats and in the mainstem middle Green River in Section 4.3.2 of each species' Recovery Goals document (USFWS 2002). Smallmouth bass, northern pike and white sucker (including hybridized forms) are the three nonnative species of greatest concern.

Smallmouth bass (*Micropterus dolomieu*) abundance has dramatically increased in the Green River since 2000. As a result, the Biology Committee recommended implementing mechanical removal measures of smallmouth bass in the upper Colorado River basin. Six years of removal (2004-2011), and annual Nonnative Fish Control Workshops have added to the knowledge base of the effort required to remove smallmouth bass from the Green River. During the December 2006 workshop, participants discussed the importance of increasing the removal effort and discussed the need for a dramatic increase to be able to adequately suppress the middle Green River smallmouth bass population.

Northern pike (*Esox lucius*) are rated as one of the six nonnative species of greatest concern to the success of endangered species populations due to competition and predation (Hawkins and Nesler 1991). Northern pike became established in the Yampa River in the early 1980's. A control program for northern pike in the Yampa River was initiated in 1999 and removal of northern pike in the middle Green River was initiated in 2001. Based on trends in catch rates over subsequent years, removal efforts have been

successful at reducing the number of northern pike and maintaining this reduced level in the middle Green River.

White sucker (*Catostomus commersonii*) and white sucker hybrid removal was incorporated into this project in 2008. The species is problematic due to its ability to hybridize (McDonald et al. 2008) and compete with native catostomids for resources. In southwestern Missouri, white suckers mature around 275 mm (Wakefield and Beckman 2005). Because of this, our goal for removing white suckers is to keep the average total length (TL) of the white sucker population less than 275 mm. This may not address their ability to compete with native suckers; however, it should limit their ability to hybridize with native catostomids.

The purpose of this project is to minimize the expansion of all predatory nonnative fishes, especially smallmouth bass, in the Green River. Our objectives were to: 1) conduct one tagging pass and eleven removal passes for smallmouth bass in the middle Green River from Split Mountain boat ramp (river mile [RM] 319.3) to Tabyago Riffle (RM 206.7), 2) maintain low occurrence of adult northern pike in the middle Green River, 3) maintain low densities and smaller size classes of white sucker in the middle Green River, 4) determine efficiency of smallmouth bass, northern pike removal and white sucker efforts, 5) calculate an annual population estimate of smallmouth bass in the middle Green River, and 6) identify the means and levels of smallmouth bass and northern pike control necessary to minimize the threat of predation/competition on endangered and other native fishes.

IV. Study Schedule: Initial year - FY 2011; Final year - FY 2011

V. 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.

VI. Accomplishment of FY 2011 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

We electroshocked concentration areas during spring for northern pike and white sucker; however fyke nets could not be utilized due to high flow conditions. During 2011 sampling, 57 northern pike and 317 white suckers were removed from Island Park to Tabyago Riffle and selected tributaries. White sucker mean TL was 230 mm and 40% were mature, suggesting we are maintaining individuals below 275 mm, but a large proportion of captures were reproductively mature.

Eleven of the 12 scheduled smallmouth bass removal passes were conducted from Split Mountain Boat Ramp to Tabyago Riffle. Due to adverse weather conditions and poor catch rates, pass 11 was not completed (~45 miles not sampled) and sampling was not attempted for pass 12. The sampling season was delayed by prolonged high flows (Figure 1), requiring us to sample well into October and deal with colder temperatures. We completed mark-recapture population estimates, although limited returns resulted in large variations in the estimates. Regardless, trends in the population estimates and relative abundances suggest a large sub-adult size class that is primarily located below the Duchesne River confluence.

Task 1. Capture and remove northern pike and white sucker

Overall, northern pike captures were low; 25, 11 and 21 individuals were captured during smallmouth bass removal, spring tributary sampling and spring main channel sampling, respectively (Table 1 and Figure 2). The majority of individuals were found in Stewart Lake Drain, Ashley Creek, Cliff Creek and in the main channel above river mile 298 (Figure 2). Only eight individuals were found below this point during the smallmouth bass removal. Results indicate we are maintaining a good level of control on the northern pike population in the Middle Green.

Additional nonnatives captured were kokanee, largemouth bass, and yellow perch, which have not been reported in this reach (Table 1 and Figure 2). This is likely an anomaly, due to high flows, but should be monitored for similar occurrences or an increase in numbers.

During spring tributary sampling, white suckers were predominantly found in Ashley Creek and Stewart Lake Drain (Figure 2). Greater abundances also coincide with spring main channel sampling (Figure 2), where individuals are likely congregating in upper reaches (river miles 334-327 and 319-298) for spawning. In addition, it appears that sampling time determines which habitat white suckers were located in during early spring. Sampling overlapped for tributaries and the main channel for a number of dates. Trends suggest that the majority of individuals were found in tributaries from 11-18 April

2011 (Figure 3). Numbers were greatly reduced during other dates; however, during overlapping dates (tributaries vs. main channel) a large number of white sucker were removed in the main channel (Figure 3). Island Park to Rainbow Park and Split Mountain Boat Ramp to Redwash and were sampled on 25 April 2011 and 4 May 2011. Low abundances were observed during the same dates in tributaries (Figure 3). This demonstrates a movement of white suckers between the main channel and tributaries above Redwash (RM 298). The largest and greatest proportion of mature and ripe white suckers were sampled during early spring (Table 2). Although the average length during all projects was < 275 mm, a large number of mature individuals were sampled, suggesting a greater sampling effort is needed during spring to sufficiently remove mature white suckers. From Whirlpool to Split Mountain Boat Ramp, hybridization rates were low (Table 3). Less than one percent of captured suckers were hybridized, demonstrating a low rate of introgression.

Task 2. Twelve smallmouth bass collecting passes from Split Mountain boat ramp to Tabyago Riffle

Population estimates. — Smallmouth bass were marked with red Floy tags on the third pass to calculate Lincoln-Peterson population estimates with the Chapman correction. We estimated 10,204 (90.5 bass/mile) and 2,159 (19.2 bass/mile) sub-adult (100-199 mm TL) and adult (>200 mm TL) bass, respectively for the entire reach (Table 4 and 5). However, we estimated 1,000 sub-adults and 623 adults from Split Mountain to the Duchesne River confluence, whereas the Duchesne River confluence to Tabyago section estimate yielded 13,649 sub-adults and 494 adults (Table 4). A separate estimate demonstrates a larger population of sub-adults below the Duchesne River confluence (Figure 4). Age class estimates were adjusted for growth (sub-adults = 0.69 mm/day; adults = 0.60 mm/day), based on recaptured individuals (Table 6). The number of recaptured fish during the population estimate was low representing exploitation rates ranging from 8-13% for all estimates of sub-adult and adult smallmouth bass (Table 4). Exploitation rates in 2011 were lower than previous years signifying smallmouth bass were not adequately removed throughout the field season (Table 7).

The 2011 population estimate compared to previous years increased in sub-adults, whereas adult numbers were stable (Figure 5); however, 2008-2009 sampling did not occur below the Duchesne River, thus sub-adult populations above the Duchesne River decreased when comparing the split population estimate (Figure 4) to the 2008 and 2009 estimates. What is apparent is the sub-adult population has increased since 2010 and a large proportion of the individuals are found below the Duchesne River. Catch rates by sample reach show a similar pattern of high concentrations of sub-adult fish below the Duchesne River; the Duchesne River confluence is located at river mile 248 (Figure 6).

Catch rates. — Smallmouth bass catch rates were low in the beginning of the season, increased dramatically after the first pass, and remained high until a decline in pass nine and 10 (Figure 7). Catch-per-unit-effort (CPUE) was high for pass 11, but as stated earlier, about 45 miles were not sampled (Figure 7). River miles 291 – 248 were

excluded during pass 11, which happened to be in an area where CPUE was low for the other 10 passes, likely explaining the observed increase in CPUE (Figure 6). This demonstrates that even late in the season high CPUE can be accomplished if certain areas are sampled. Thus, there is a need to focus on concentration areas to maximize time in the field. CPUE in 2011 decreased compared to previous years, but this does not necessarily suggest a decline in the population (Table 8). It is likely that low CPUE above the Duchesne River reduced our overall catch rate. This is not an extraneous descriptor of abundance, but rather highlights the importance of distributing effort where smallmouth bass are known to occur (see Figure 6). The population estimates, distribution of smallmouth throughout individual sample reaches, and CPUE in pass 11, provide multiple lines of evidence that removal efforts should and can be effectively utilized.

Population size structure. — Length frequencies of bass captured in 2011 represent a positively skewed distribution, with the majority of individuals caught in the 100-150 mm range (Figure 8). This pattern was consistent when percent catch of size classes are separated by month (Figure 9). The majority of fish are less than 200 mm for all months (Figure 9). In 2011, size structure was dominated by 100-150 mm individuals compared to previous years (Figure 10). These are likely age one fish that could recruit into larger size classes resulting in changes in population size structure in the future.

Movement. — A total of 27 marked fish were recaptured in 2011, three of which were tagged prior to 2011 (two in 2010, one in 2007), and one tagged by the Fish and Wildlife Service (FWS) above Split Mountain boat ramp. Of the 23 recaptured from 2011, 15 were sub-adults and 8 were adults. Forty-seven percent of sub-adults moved downstream, 13% moved upstream and 40% were caught within the same five mile section. Twenty-five percent of adults moved downstream, 13% moved upstream and 63% did not move out of the five mile section of capture. On average, 2011 sub-adults grew 0.69 mm/day and adults grew 0.60 mm/day. One of the 2010 recaptures did not exhibit movement, whereas the other moved upstream; information was not available for the 2007 individual. Growth was 86 and 177 mm, for 2010 (averaged) and 2007 fish, respectively. In addition, three tagged fish were recaptured by FWS above Split Mountain Boat Ramp.

Task 3. Data entry, analysis, and reporting

Recovery Program annual progress report (November 2011)

VII. Recommendations:

- Conduct eight smallmouth bass removal passes as suggested by our FY 2012-13 scope of work, but adjust effort accordingly to maximize catch rates. We recommend four complete passes from Split Mountain boat ramp to Tabyago Riffle and four passes that will focus on concentration areas (i.e., double effort below the Duchesne River confluence to Tabyago Riffle; 4 passes become 8).

This will allow us to continue monitoring the entire reach on a temporal basis, while increasing our efficiency in capturing smallmouth bass where they are most abundant. Conduct reach-wide population estimate, marking fish during the third pass to maximize the capture of spawning individuals. Determination of the first pass will be based on previous flows, temperatures and catch rates (Figure 7).

- In accordance with a new reach-specific sampling regime, conduct successive mark-recapture passes (in addition to the reach-wide population estimate) from the Duchesne River confluence to Tabyago Riffle to provide a more robust estimate where smallmouth bass were most abundant. Reducing our time between mark-recapture passes (i.e. two passes in one week) will account for the population estimate assumption of equal vulnerability to capture in the recapture period.
- Verify Duchesne River as source population of smallmouth bass to the Green River. Smallmouth bass sub-adult populations increase substantially below the Duchesne River confluence. Locating and removing a source population would improve the overall smallmouth bass removal efficiency.
- Continue northern pike and white sucker removal during early spring when fish are concentrated in spawning areas. Low northern pike numbers are being maintained, therefore equivalent effort should continue. A large portion of white suckers removed were mature (40%), suggesting additional effort is needed to adequately reduce the chance for hybridization. More mature white suckers are present in the upper reaches of the study area in early spring. We recommend increasing effort during this period of time, which will accomplish three objectives: (1) remove more mature white suckers, (2) provide information on maturity of white suckers in the Green River and ripeness of fish throughout time, (3) gain a better understanding of temporal movement during the spawning season and (4) incorporate additional mainstem sampling during early spring to try to capture fish staging for spawning. Understanding their movement patterns and life history will help us concentrate and increase efforts where needed.

VIII. Project Status: On track and ongoing

IX. FY 2011 Budget Status

- A. Funds Provided: \$205,734
- B. Funds Expended: \$205,734
- C. Difference: \$ 0
- D. Percent of the FY 2011 work completed, and projected costs to complete: 100%
- E. Recovery Program funds spent for publication charges: \$0

X. Status of Data Submission: FY2011 data is formatted, QA/QC and will be submitted to the USFWS by January 2012. FY2010 data was submitted to USFWS in December 2011.

XI. Signed: Joseph A. Skorupski Jr. 11/8/11
Principal Investigator Date

XII. Literature Cited

Hawkins, J.A. and T.P. Nesler. 1991. Nonnative fishes of the upper Colorado River Basin: an issue paper. Final Report of Colorado State University Larval Fish Laboratory to the Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

McDonald, D.B., T.L. Parchman, M.R. Bower, W.A. Hubert, and F.J. Rahel. 2008. An introduced and a native vertebrate hybridize to form a genetic bridge to a second native species. Proceedings of the National Academy of the Sciences of the USA 105:10837–10842.

U.S. Fish and Wildlife Service (USFWS). 2002. Colorado pikeminnow (*Ptychocheilus lucius*) recovery goals: amendment and supplement to the humpback chub recovery plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

U.S. Fish and Wildlife Service (USFWS). 2002. Razorback sucker (*Xyrauchen texanus*) recovery goals: amendment and supplement to the humpback chub recovery plan.

U.S. Fish and Wildlife Service (USFWS). 2002. Bonytail (*Gila elegans*) recovery goals: amendment and supplement to the humpback chub recovery plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

Wakefield, C.K. and D.W. Beckman. 2005. Life history attributes of white sucker (*Catostomus commersonii*) in Lake Taneycomo and associated tributaries in southwestern Missouri. The Southwestern Naturalist 50:423-434.

TABLE 1. — Additional nonnatives removed during smallmouth bass removal in the middle Green River in 2011.

Species	Abundance
Black crappie	3
Bluehead x white sucker	1
Brown Trout	29
Green Sunfish	48
Largemouth bass	2
Northern pike	25
Rainbow trout	4
Walleye	40
White sucker	176
Flannelmouth x white sucker	1
Yellow perch	1

TABLE 2. — Total abundance, mean total length (TL), range of lengths (TL), percent mature and percent ripe white suckers removed for three projects in 2011.

Project	Abundance	Mean TL	Range TL	% Mature	% Ripe
Smallmouth bass removal	176	225	92-383	40	0.6
Spring main channel sampling	73	227	105-410	37	4.1
Spring tributaries sampling	68	237	87-375	45	2.9

TABLE 3. — Total abundance and percent composition of catostomids collected from Echo Park to Split Mountain boat ramp in 2011.

Species	Abundance	% Composition
Bluehead sucker	221	48.0
Flannelmouth sucker	222	48.3
White sucker	15	3.3
Flannelmouth x white sucker	2	0.4

TABLE 4. — Smallmouth bass population estimates and exploitation rates in the middle Green River.

Size Class	Estimate	Captured (pass 3)	Recaptured (pass 4-11)	95% CI	SE	Exploitation (%)
Split Mountain - Tabyago Riffle						
Sub-adult	10,204	194	15	2832 - 17575	3761	8
Adult	2,159	79	8	-760 - 5078	1489	10
Split Mt. - Duchesne River						
Sub-adult	1000	90	7	257 - 1742	379	8
Adult	623	47	4	-199 - 1445	419	9
Duchesne River - Tabyago						
Sub-adult	13649	104	8	-1591 - 28888	7775	8
Adult	494	32	4	-159 - 1147	333	13

TABLE 5. — Number of sub-adult (100 – 199 mm) and adult (>200 mm) smallmouth bass per river mile from 2004 – 2011. Population estimates were not conducted for 2005 and 2006.

Year	Sub-adult	Adult
2004	130	138
2007	282.2	23.4
2008	66	25
2009	47	27
2010	86.6	26.6
2011	90.5	19.2

TABLE 6. — Total smallmouth bass caught and recaptured during 2011. Fish caught in pass 3 were tagged and returned, whereas all other passes were removed.

Pass	Caught	Recapture
1	29	NA
2	326	NA
3	332	NA
4	449	5
5	221	0
6	282	4
7	410	3
8	326	7
9	196	2
10	85	1
11	222	1

TABLE 7. — Smallmouth bass tagged and recaptured from 2004-2011, with total exploitation rates provided.

Year	Tagged	Recaps	Exploitation
2004	295	47	15.9
2005	315	0	0.0
2006	98	1	1.0
2007	122	22	18.0
2008	91	16	17.6
2009	265	45	17.0
2010	413	46	11.1
2011	273	23	8.4

TABLE 8. — Smallmouth bass total catch rates (fish/hour) from 2004 – 2011.

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

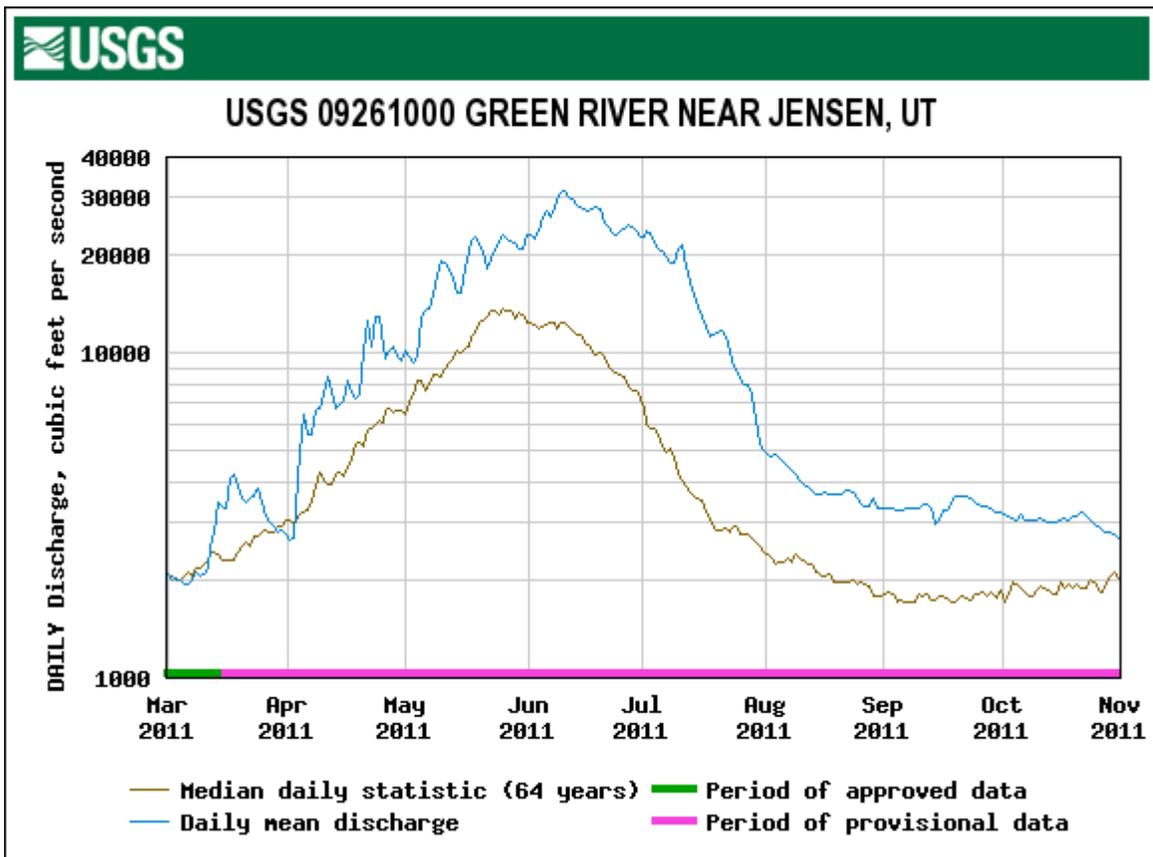


FIGURE 1. — Mean daily discharge of the Green River near Jensen, Utah from March to October 2011.

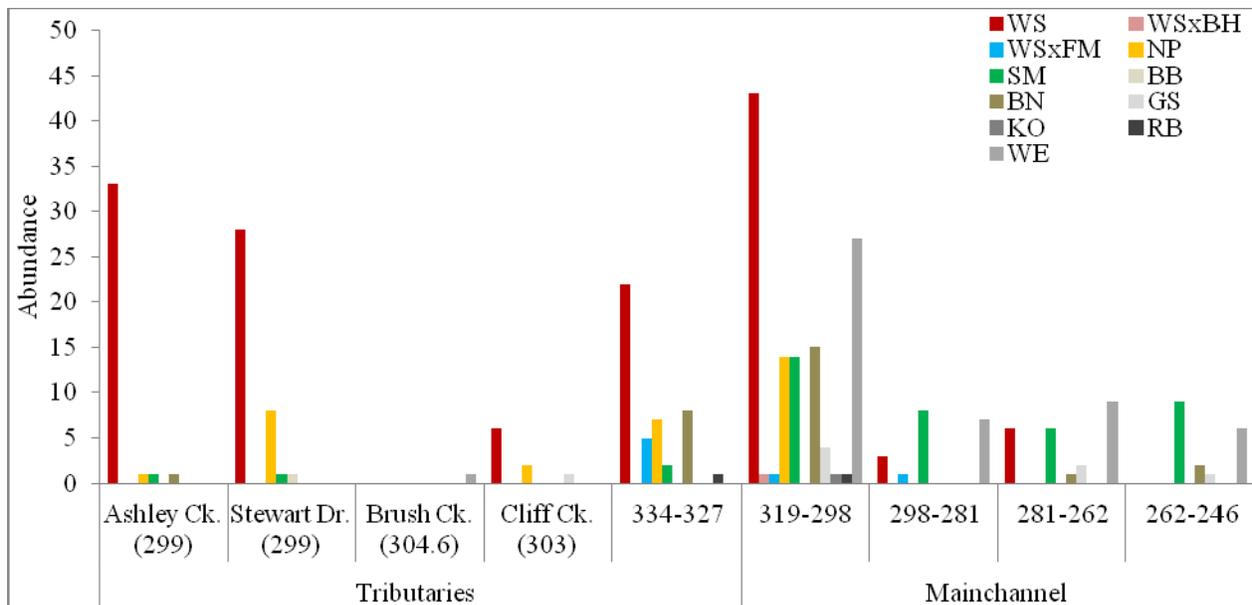


FIGURE 2. — Nonnatives removed during early spring sampling in tributaries (by location and river mile) and the main channel (river miles) of the middle Green River. Species include: white sucker (WS), white sucker x bluehead sucker (WSxBH), white sucker x flannemouth sucker (WSxFM), northern pike (NP), smallmouth bass (SM), black bullhead (BB), brown trout (BN), green sunfish (GS), kokanee (KO), rainbow trout (RB), walleye (WE).

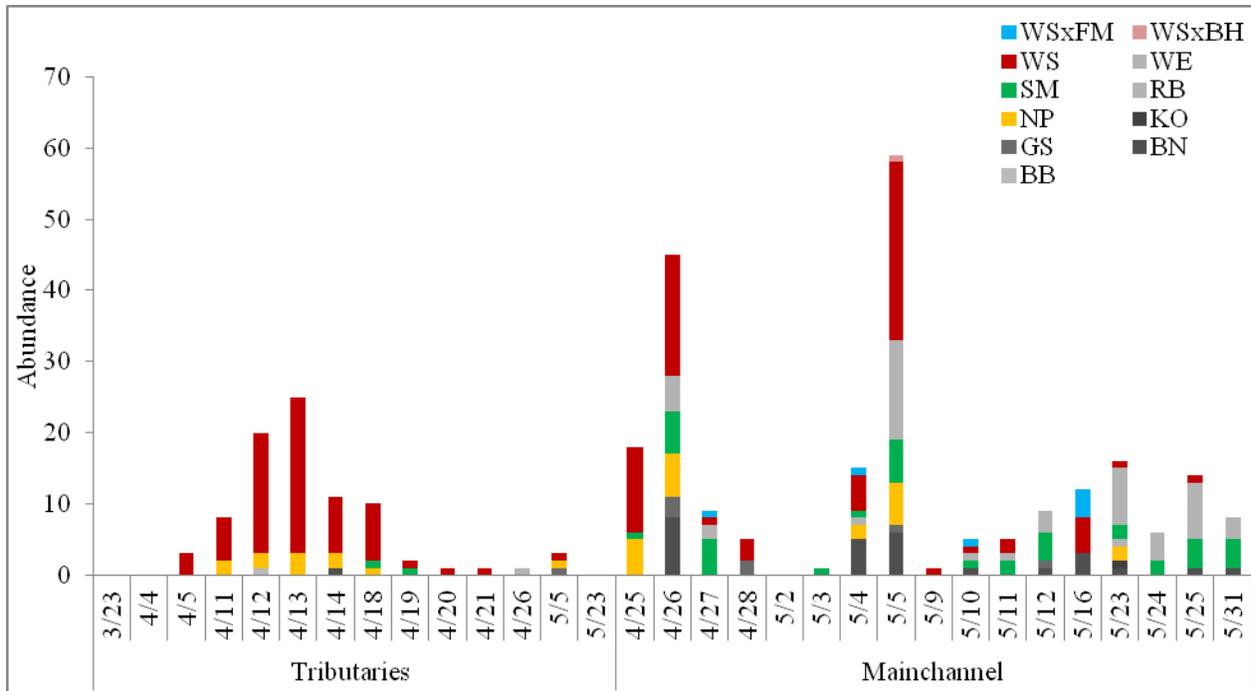


FIGURE 3. — Nonnatives removed during early spring sampling in tributaries and the main channel of the middle Green River in 2011, by date. Species include: white sucker (WS), white sucker x bluehead sucker (WSxBH), white sucker x flannemouth sucker (WSxFM), northern pike (NP), smallmouth bass (SM), black bullhead (BB), brown trout (BN), green sunfish (GS), kokanee (KO), rainbow trout (RB), walleye (WE).

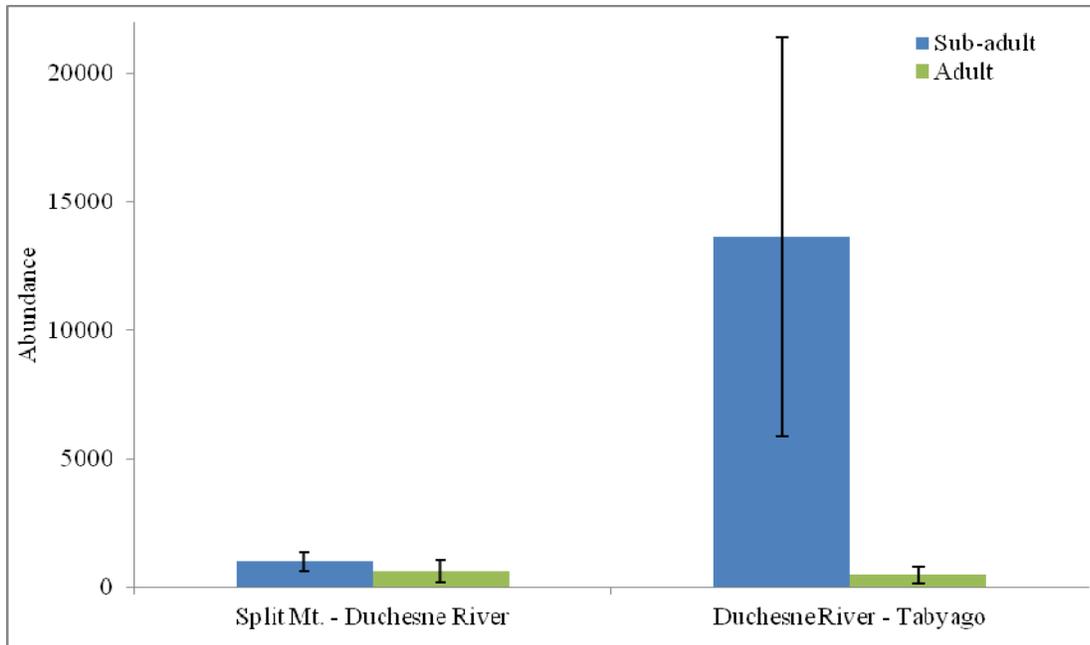


FIGURE 4. — Smallmouth bass sub-adult and adult population estimates and standard errors (SE) in the middle Green River from Split Mountain Boat Ramp – Duchesne River and Duchesne River – Tabyago Riffle in 2011.

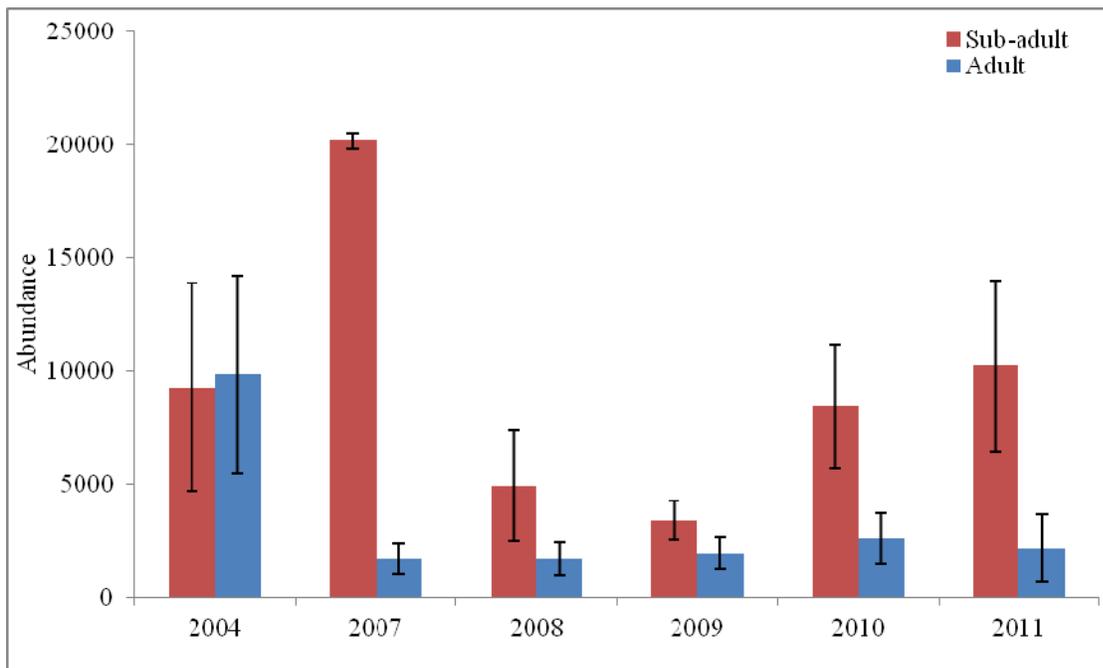


FIGURE 5. — Smallmouth bass sub-adult and adult population estimates and standard errors (SE) in the middle Green River. Split Mountain Boat Ramp to Tabyago Riffle for 2010 and 2011; Split Mountain Boat Ramp to Sand Wash in 2004; Split Mountain Boat Ramp to Duchesne River 2007, 2008 and 2009. Population estimates were not conducted in 2005 and 2006.

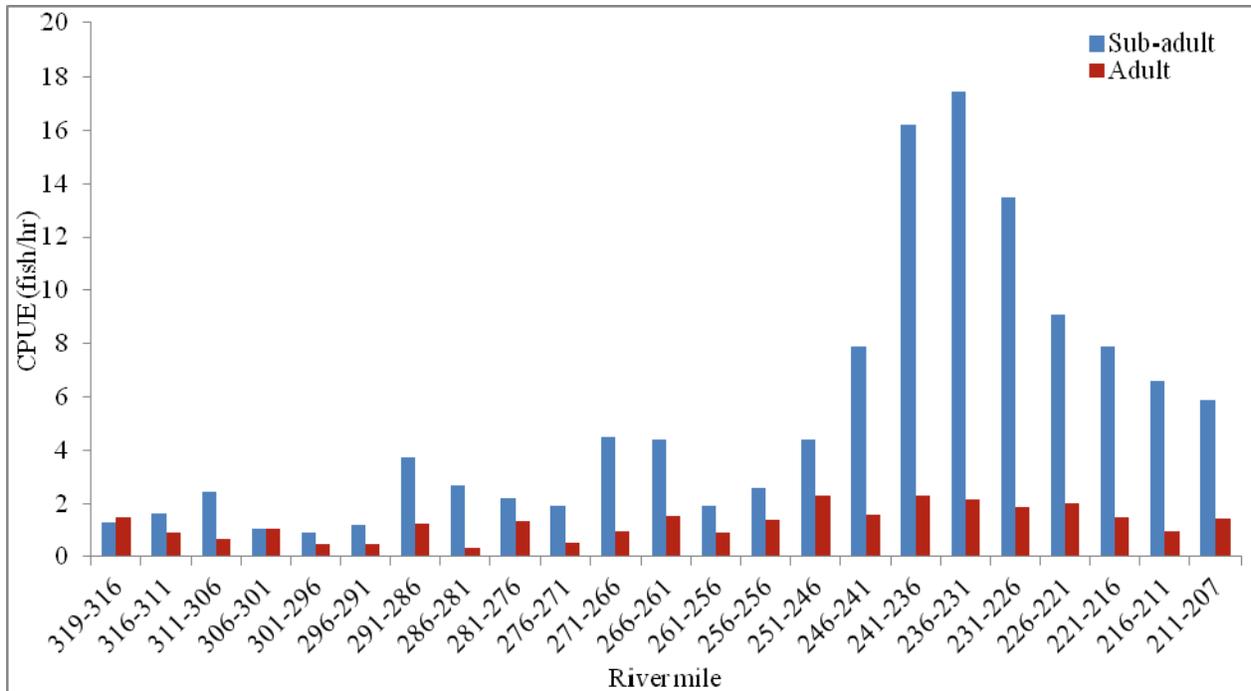


FIGURE 6. — Smallmouth bass sub-adult and adult catch rates separated by sample reach in the middle Green River in 2011 from Split Mountain Boat Ramp to Tabyago Riffle.

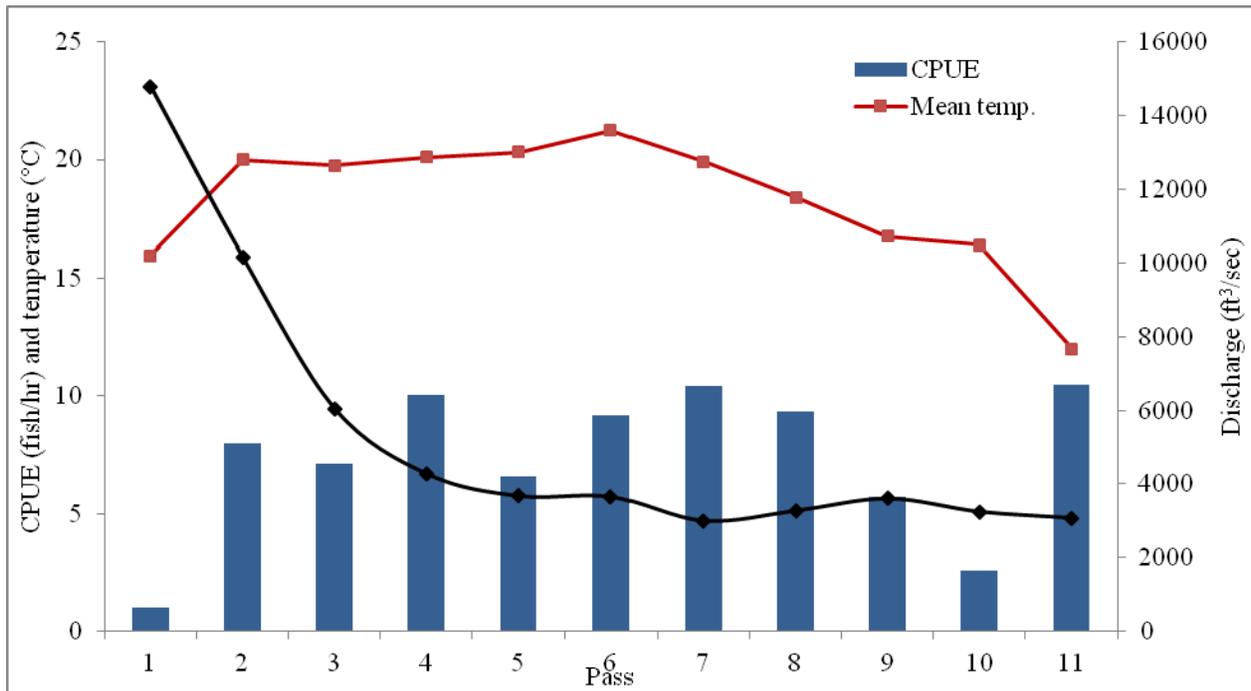


FIGURE 7. — Smallmouth bass catch rates in the middle Green River by pass with mean discharge and mean temperature for each pass in 2011.

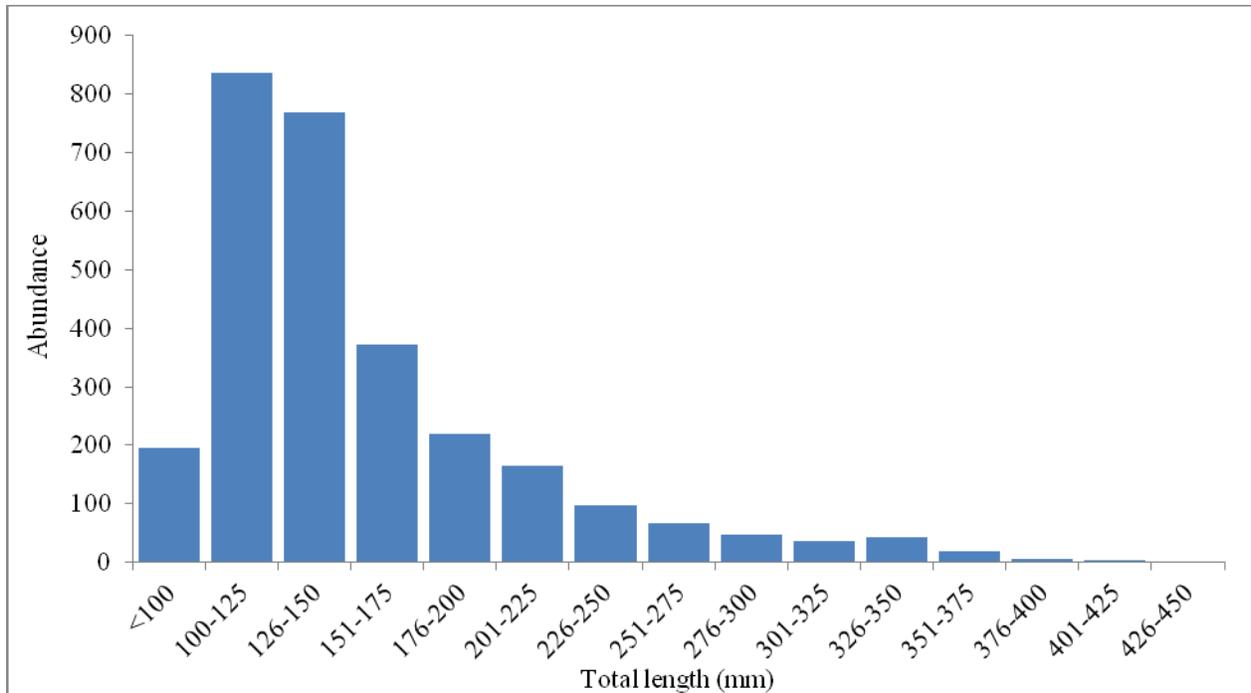


FIGURE 8. — Length frequency of smallmouth bass captured in the middle Green River in 2011.

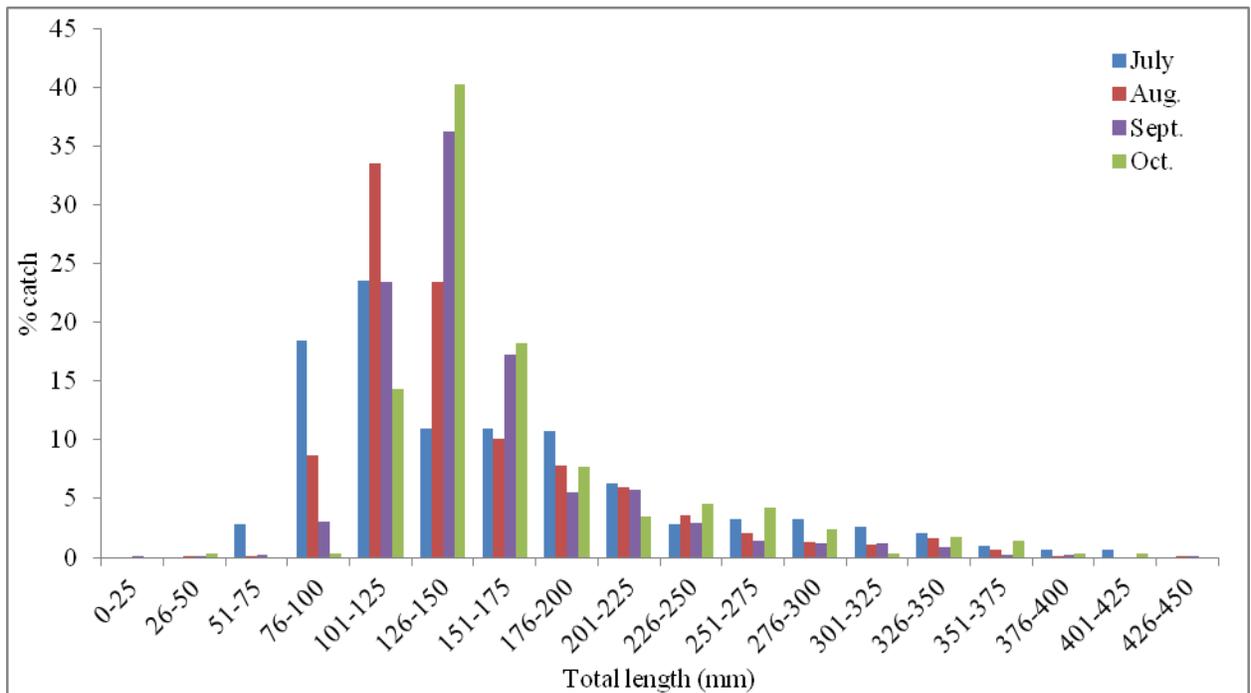


FIGURE 9. — Length frequency of smallmouth bass captured in the middle Green River in 2011 during each month of the field season.

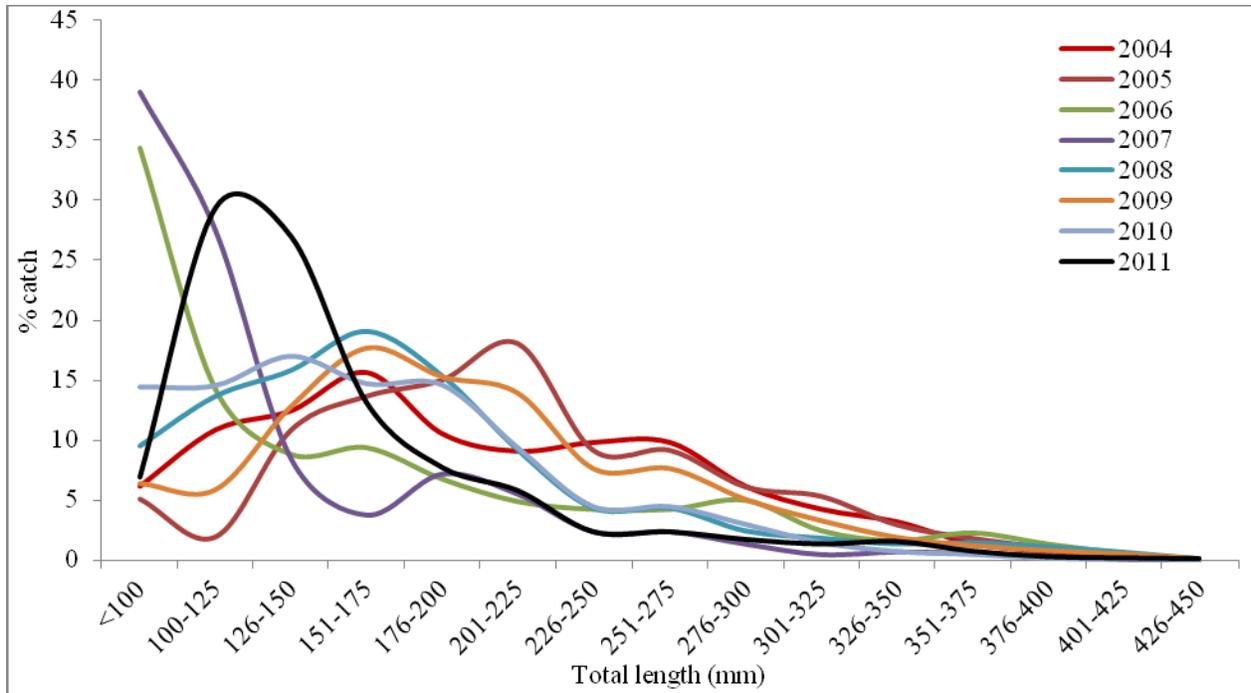


FIGURE 10. — Length frequency of smallmouth bass captured in the middle Green River from 2004 – 2011.