

I. Project Title: **Evaluation of Smallmouth Bass and Northern Pike management in the middle Yampa River.**

II. Bureau of Reclamation Agreement Number: R14AP00001
Performance Progress Reports (PPR) attached for CSU and FWS.

Project/Grant Period: Start date: 10/01/2008
End date: 09/30/2018
Reporting period end date: 10/14/2016
Is this the final report? Yes _____ No x

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IV. Abstract:
This study was an evaluation of whether Smallmouth Bass *Micropterus dolomieu* numbers can be controlled through active removal from reaches of the Yampa River that are critical habitat for Colorado Pikeminnow *Ptychocheilus lucius*. The study area included 103.5 miles of the middle Yampa River from near Craig, Colorado (River Mile, RM 151.0) to Dinosaur National Monument (RM 47.5) and was divided into eight reaches. Boat electrofishing occurred on up to eight occasions (passes) from April through July using two electrofishing jon-boats or rafts that sampled both shorelines. Smallmouth Bass ≥ 100 mm were marked and released on one occasion in one reach (Little Yampa Canyon) to estimate their abundance, to evaluate how the population responds to removal, and to monitor fish movement and growth. Using mark-recapture methods, we estimated 882 adult Smallmouth Bass (391—1347, 95% CI; CV=28%) inhabited Little Yampa Canyon in 2016. We estimated that 2,653 sub-adult Smallmouth Bass (619—4,687, 95% CI; CV=39%) inhabited Little Yampa Canyon in 2016. Density in Little Yampa Canyon was 37 adult and 111 sub-adult Smallmouth Bass per mile. In addition to electrofishing, we removed small, primarily Age-0 Smallmouth Bass using an electric seine from August through October, in the lower 12 miles of Little Yampa Canyon. In total, we captured 13,702 Smallmouth Bass by all gears combined in all sampled reaches, including 7,670 juveniles (<100 mm), 3,736 sub-adults (100-199 mm), and 2,296 adults (≥ 200 mm) in all reaches.

We also removed all Northern Pike from the middle Yampa River study area. Data for Northern Pike were provided to Colorado Division of Wildlife (CPW) biologists and those results are reported in Project # 98a. A final task was to remove adult Northern Pike from the reach between Steamboat Springs and Hayden, (RM 194.2—170.6) identify spawning areas, and capture young pike to confirm reproduction. We did not

mark pike in 2016 due to rapidly rising flows, therefore; no estimate was calculated for their abundance. We removed 157 Northern Pike from the upper Yampa River on three sampling occasions using raft electrofishing.

- V. Study Schedule: *Initial year-2003 Final year- on going.*
- VI. Relationship to RIPRAP:¹: *Version: April 22, 2014*
Green River Action Plan: Yampa and Little Snake rivers
 - III Reduce negative impacts of nonnative fishes and sport fish management activities
(nonnative and sport fish management).
 - III.B Implement CPW Yampa Basin aquatic wildlife management plan and the Recovery Program’s Yampa River Nonnative Fish Control Strategy. Each control activity will be evaluated for effectiveness and then continued as needed. See also III.A.2.c.1&2 under General Recovery Program Support Action Plan.
 - III.B.1 Prevent nonnative fish introduction; reduce invasion and recruitment.
 - III.B.1.c Remove Northern Pike and Smallmouth Bass above Craig, CO (YS C-3).
 - III.B.1.D. Target spawning areas (YS C-4)
 - III.B.1.D.1 Northern Pike
 - III.B.1.D.2 Smallmouth Bass
 - III.B.2. Control nonnative fishes via mechanical removal.
 - III.B.2.a. Estimate nonnative abundance, status, trends & distribution (YS I-3).
 - III.B.2.c. Identify and evaluate gear types and methods to control nonnative fishes (YS I-5)
 - III.B.2.d. Remove and translocate Northern Pike from the Yampa River. See Hawkins et al 2005. (YS J-1).
 - III.B.2.d. Remove (*formerly* “and translocate”) Northern Pike from the Yampa River. See Hawkins *et al.* 2005. (YS J-1).
 - III.B.2.e. Remove (*formerly* "and translocate") Smallmouth Bass. (YS J-1).
- VII. Accomplishment of FY 2016 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:
Initial findings and preliminary results for 2016 are provided in the attached Appendices, but are subject to change as data are further analyzed. For comparison with previous results see Hawkins *et al.* 2008; 2009a; 2009b; 2010; 2011; 2012; 2013, 2014, 2015 and Wright 2009.
- VIII. Additional noteworthy observations: See attached report of preliminary results.

¹ See RIPRAP at www.coloradoriverrecovery.org/documents-publications/foundational-documents/RIPRAP/RIPRAPApril2014Z.pdf

IX. Recommendations:

Recommendations for Middle Yampa Smallmouth Bass

- Continue mark-recapture to estimate Smallmouth Bass abundance in Little Yampa Canyon.
- Continue Smallmouth Bass removal.
- Continue intensive Smallmouth Bass nest disruption (The Surge) focusing on major production areas, especially in Little Yampa Canyon, South Beach, Lower Juniper, and Upper Maybell.
- Reallocate effort to insure removal during the spawning period in Upper Maybell.
- Continue using raft EL into the base flow period to increase removal of sub-adult bass.

Recommendations for Upper Yampa River Northern Pike

- Continue to focus Northern Pike removal in backwaters using raft electrofishing.
- Increase the use of gill and fyke nets in backwaters as appropriate.
- Postpone mark-recapture of Northern Pike for abundance until 2018.
- Continue collection of YOY pike and aging otoliths to identify the spawning period.
- Re-establish the boundaries of the study area to exclude raft EL in the section of river through Steamboat Springs for safety and logistical reasons.

X. Project Status: on track and ongoing

XI. FY 2016 Budget Status

A. Funds Provided:	\$404,567
CSU:	\$364,825
FWS-Vernal:	\$23,614
FWS-Grand Junction:	\$16,128
B. Funds Expended:	\$404,567
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:	none

XII. Status of Data Submission (Where applicable): Endangered fish capture data and other database records of field collections will be submitted by early 2017.

XIII. Signed: John Hawkins 11/14/16
Principal Investigator Date

APPENDICES:

Annual Performance Progress Reports (3)

A: Preliminary Results of Smallmouth Bass removal in the middle Yampa River, 2016

B: Preliminary results of Northern Pike removal in the upper Yampa River, 2016.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R14AP00001

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: FR-125

Project Title: **Evaluation of Smallmouth Bass and Northern Pike management in the middle Yampa River.**

Principal Investigator: John Hawkins.

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Project/Grant Period: Start date (Mo/Day/Yr): 1 Oct. 2008
 End date: (Mo/Day/Yr): 30 Sept. 2018
 Reporting period end date: 14 Nov. 2016
 Is this the final report? Yes _____ No X

Performance: The Larval Fish Laboratory completed all tasks and objectives of the Smallmouth Bass portion of this work. We obtained an estimate of the number of Smallmouth Bass in Little Yampa Canyon. We coordinated mark-recapture and Surge sampling with CPW and USFWS. We conducted one marking pass in Little Yampa Canyon and eight and six multiple removal passes in Little Yampa Canyon and Lily Park study reaches, respectively. We removed large numbers of invasive nonnative predators from Critical Habitat on multiple occasions from April through October.

Due to unexpected high flows, we removed all pike encountered on the first pass in the Steamboat to Hayden reach instead of marking and releasing them. For this reason, we did not estimate abundance of pike in that reach. We conducted three removal passes for Northern Pike between Steamboat Springs and Highway 40 Bridge and sampled for YOY pike to confirm spawning locations. We produced an annual report on activities and will present data at workshops and meetings in January 2017.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R15PG00083

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 125

Project Title: Middle Yampa Smallmouth Bass and Northern Pike removal

Principal Investigator: Chris Smith and Tildon Jones
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Project/Grant Period: Start date (Mo/Day/Yr): 10/01/2014
 End date: (Mo/Day/Yr): 9/30/2019
 Reporting period end date (Mo/Day/Yr): 09/30/2016
 Is this the final report? Yes No

Performance: USFWS completed its portion of task 4, “conduct Smallmouth Bass removal and spawning disruption during the spawning period.” We performed two weeks of electrofishing in order to remove Smallmouth Bass adults in spawning habitats. Data has been submitted to the project lead at CSU, who will be responsible for data analysis and reporting.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R15PG00083

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 125

Project Title: **Evaluation of Smallmouth Bass and Northern Pike Management in the Middle Yampa River (Surge)**

Principal Investigator: Travis Francis, Fish Biologist
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Project/Grant Period: Start date (Mo/Day/Yr): 10/1/2014
End date: (Mo/Day/Yr): 9/30/2019
Reporting period end date (Mo/Day/Yr): 9/30/2016
Is this the final report? Yes _____ No X

Performance:

We were tasked with providing a 3-person field crew for 8 days (total of 24 man days) with administrative support to assist crews from the CSU – Larval Fish Laboratory sometime from mid-June to mid-July. The 2016 Smallmouth Bass “Surge” effort was targeted to remove Smallmouth Bass as the Yampa River neared base flows. From July 5-8, we provided two jet-powered, hard-bottomed, electrofishing boats and a 3-person crew for 6 days (12 man days). Then from July 11-15, we provided two electrofishing rafts and a 3-person crew for 6 days (15 man days).

Appendix A:

Preliminary results of the removal of Smallmouth Bass from the middle Yampa River, 2016.

Hawkins, J. (CSU), C. Walford, (CSU), and C. Noble, (CPW).

Methods-Middle Yampa SMB removal

The study area was primarily within a 103.5-mile reach of the middle Yampa River, between Craig, Colorado (river mile; RM 151.0) and Dinosaur National Monument boundary (RM 47.5) and consisted of eight reaches totaling 96.1 miles of sampled waters. These reaches were sampled by Colorado Parks and Wildlife (CPW) and Colorado State University-Larval Fish Laboratory (CSU). It also includes a 16.5-mile section of the Hayden to Craig reach sampled during the Surge by US Fish and Wildlife Service (FWS). Smallmouth Bass data collected by those agencies are summarized in this report.

Location of study reaches in the middle Yama River.

<u>Reach</u>	<u>Agency</u>	<u>RM</u>	<u>Area sampled (miles)</u>
Lily Park	CSU	47.5 -- 55.5	8.0
Sunbeam	CPW	60.6 -- 71.0	10.4
Lower Maybell	CPW	71.0 -- 79.2	8.2
Upper Maybell	CPW	79.2 – 88.7	9.5
Lower Juniper	CPW	91.0 – 100.0	9.0
Little Yampa Canyon	CSU	100.0 – 124.0	24.0
South Beach	CPW	124.0 – 134.5	10.5
Hayden-Craig	FWS	134.5-151.0	16.5

Fish sampling occurred with boat electrofishing on up to eight occasions (passes) at each reach during runoff from April through July, typically using two electrofishing boats sampling both shorelines continuously downstream. Reaches with higher catch rates received greater effort through more passes. Smallmouth Bass were removed from all reaches except on one pass in Little Yampa Canyon when they were marked and released, primarily to track abundance, but also to monitor movement and growth. On that marking pass, Smallmouth Bass ≥ 100 -mm total length were marked with a numbered Floy tag and released. On all other passes in Little Yampa Canyon and in other reaches Smallmouth Bass were removed and euthanized upon capture. The primary CSU study sites were Little Yampa Canyon and Lily Park, where all species of fish were captured and measured on all sample occasions to describe and monitor fish community structure and composition.

Smallmouth Bass were grouped into life stages based on their length: juvenile (< 100 mm), sub-adult (100–199 mm), and adult (≥ 200 -mm). Another grouping was created for large piscivorous Smallmouth Bass (≥ 325 -mm) that are considered the highest predatory threat to prey.

We removed other invasive nonnative species including Northern Pike, White Sucker, white sucker hybrids, centrarchids, bullhead, Creek Chub, and Common Carp. Northern Pike data were reported by CPW in their annual report for Project # 98a.

Spawning disruption (The Surge)

In 2016, we completed the seventh year of an intensive removal program (The Surge) which targeted spawning bass with the goal of removing large numbers of adult bass and reducing reproductive success by disrupting nest building, spawning, and nest guarding. Increased effort during the Surge was obtained by assembling field crews and equipment from CSU, CPW, and FWS (Vernal and Grand Junction field stations) to increase removal effort in known spawning areas. As flows declined towards base flow, we optimized our catch rates by focusing on reaches with known spawning habitat. Targeted areas typically included braided areas, backwaters, scour holes, debris fans, and outer bends with complex rubble or boulder structure. Water temperatures of 16°C initiate Smallmouth Bass spawning and in 2016 that began on June 20th. Surge removal occurred from June 20th through July 29th, in Craig, South Beach, Little Yampa Canyon, and Lower Juniper reaches. Fish were removed in target reaches every 2-5 days and some sites were visited up to four times. We shifted from larger Jon boats during runoff to electrofishing rafts as flows declined to levels too low for safe Jon boat navigation (approximately 750 cfs).

Age-0 Smallmouth Bass removal

After bass spawning ended, we shifted to sampling with an electric seine and removed Age-0 and Age-1 Smallmouth Bass in the lower 12-miles of Little Yampa Canyon from August through October. Removal of Age-0 fish did not occur in other reaches or in the upper 12 miles of LYC because it is a Control reach for Project 140 (“Evaluating the effects of nonnative predator fish removal on the native fishes in the Yampa River”). In addition, we sampled the small-bodied fish community with seines and backpack electrofisher every 5-miles from Craig to lower Cross Mountain Canyon (RM 145—55.5) to determine the distribution of the small-bodied fish community, including Smallmouth Bass.

Results-Middle Yampa SMB removal

Smallmouth Bass abundance and exploitation

Using a Lincoln-Petersen model, we estimated 882 adult Smallmouth Bass (391—1347, 95% CI; CV=28%) inhabited Little Yampa Canyon in 2016 (Table 1; Figure 1). We estimated that 2,653 sub-adult Smallmouth Bass (619—4,687, 95% CI; CV=39%) inhabited Little Yampa Canyon in 2016 (Table 1). Density in Little Yampa Canyon was 37 adult and 111 sub-adult Smallmouth Bass per mile. High CVs indicated that abundance estimates for both life stages were imprecise likely due to low capture probability on the recapture pass. Of 68 marked and released adults, 46% (n=31) were recaptured and removed in 2016. Of the 90 sub-adult Smallmouth Bass marked, 14% (n=13) were recaptured and removed in 2016. Some of these recaptures occurred after the recapture pass and were not used in the Lincoln-Petersen estimate. Abundance of adult Smallmouth Bass was among the four lowest measured over the past 13 years (Figure 1). While slightly higher than the 611 observed in 2015, the population in Little Yampa Canyon has greatly declined from the strong year class produced in 2012 that reached adult size in 2014 when 2,254 adults were present in the reach (Figure 1).

Exploitation Rates

We used the number of fish removed by boat electrofishing on all passes divided by the abundance estimate to obtain the exploitation rate of Smallmouth Bass in Little Yampa Canyon. We removed 47% (n=1,249) of the sub-adult and 62% (n=547) of the adult Smallmouth Bass from Little Yampa Canyon in 2016 (Table 1).

Fish removal effort

In 2016, we sampled a total of 577.4 hours with boat and raft electrofishing from April through July. Most of that effort occurred in Little Yampa Canyon (257.9 hrs). Other sites with high effort included Lily Park (71.7 hrs), and the other two Surge reaches: South Beach (75.2 hrs) and Lower Juniper (58.3 hrs; Table 2). The other four reaches had much lower effort devoted to removing Smallmouth Bass. In Craig, only Surge passes were reported here; several passes prior to the Surge were reported in the FWS Annual report for Project 98b. Effort in Sunbeam was low because Smallmouth Bass habitat is poor there. However; more effort should be expended in the Lower Maybell and especially Upper Maybell, a known spawning location (Table 2). Total effort for each gear type in 2016 was very similar to that of the prior two years.

Captures by gear type

We captured 13,702 Smallmouth Bass by all gears of which 13,544 were removed and 158 were marked and released. This included 7,249 Smallmouth Bass captured by electrofishing boats, 196 captured by angling, and 6,257 captured by electric seine (Tables 2 and 3). We marked and released less than 1% (n=158) of all Smallmouth Bass captured.

Large piscivores (≥ 325 mm TL) comprised one percent of all Smallmouth Bass captured by boat electrofishing (75 of the 7,249 Smallmouth Bass captured). Piscivores were captured most frequently in South Beach (2.8% of the catch) followed by Little Yampa Canyon and Sunbeam (1.4% of the catch). Large piscivores comprised 0.4-0.8% of the catch in Lower Juniper, Upper Maybell, Lower Maybell, and Lily Park and none were captured in the Craig reach.

During the Surge we increased our effort significantly within a short period of time in known spawning reaches (Craig, South Beach, Little Yampa Canyon, and Lower Juniper). Surge sampling was highly effective because Smallmouth Bass are very territorial and during spawning typically remain near their nests in shallow water where they are highly susceptible to the electrofishing gear. By removing spawning fish from active spawning sites we open habitat to new spawners who are then available for capture on our next pass. When possible we allowed 2-5 days between removal passes for these areas to refill with new fish and then resampled them to remove another wave of spawners. Sampling during spawning was an effective method for obtaining high catch rates of adult bass and disrupting the production of new bass.

At base flow, bass were readily captured with raft electrofishing in backwaters and in outer bends with boulder or rubble cover. Groups of sub-adult and small adult Smallmouth Bass were captured in short, deep backwaters where they were apparently preying on abundant small fishes. In 2016, 46% of all sub-adult bass captured in Little Yampa Canyon were captured on one pass (Surge Pass 8) using raft electrofishing (Table 2). Similar results were observed in 2015 when 41% of all sub-adult bass were captured on the last pass. We recommend the continued use of electrofishing rafts to exploit this behavior to remove sub-adult Smallmouth Bass.

Catch Rates

Smallmouth Bass occupy all reaches of the middle Yampa River and catch rates reflect a combination of fish density and sampling conditions on any given pass. Boat electrofishing catch rates for adult Smallmouth Bass (≥ 200 mm) captured on all sample passes were highest in Lily Park (12 fish/hr) and upper Maybell (5.2 fish/hr), followed by Craig (3.5 fish/hr), South Beach (3.5 fish/hr), Lower Maybell (3.2 fish/hr), Lower Juniper (3.1 fish/hr), Little Yampa Canyon (2.1 fish/hr), and Sunbeam (0.7 fish/hr; Table 2; Figures 2 and 3). Lily Park has a high catch rate because bass densities are high there and because bass in that reach are highly

vulnerable to capture. Adult bass catch rates in Little Yampa Canyon have declined over time and are now fairly low most likely because the reach receives the highest removal effort of any reach (Figure 2). In 2016, we electrofished 11 hours per mile in Little Yampa Canyon (257.9 hours/24 miles; Table 2). Compare this to Upper Maybell where we electrofished only 2.4 hours per mile. More effort should be spent in Upper Maybell, an area with high catch rates and known spawning.

Highest catch rates for sub-adult bass were in Lily Park (15.3 fish/hr), Craig (14.4 fish/hr), and Maybell (9.1 fish/hr; Table 2; Figure 3). Catch rates for sub-adult bass declined in both Lily Park and Little Yampa Canyon from 2015 to 2016 (Figure 2).

Juvenile Smallmouth Bass (<100 mm) catch rate was highest in Craig (7.6 fish/hr) followed by Lower Juniper (3.8 fish/hr) and Lily Park (3.2 fish/hr; Table 2; Figure 3). There is little spawning habitat in Lily Park, so high juvenile abundance there reflects reproduction and dispersal from other reaches. Of the 4,555 juvenile Smallmouth Bass (≤ 100 mm) captured after September 20th by electric seine, a subsample of 955 was measured for total length and 16% of those fish were <50 mm.

Catch rates of juvenile Smallmouth Bass declined by half from 2015 to 2016 (Figure 2). Juvenile bass captured by our boat electrofishing in the spring of 2016 were primarily 1-year-old fish hatched the previous year. An event that likely reduced the number of juvenile Smallmouth Bass in 2016 was a flow spike that occurred in July 2015 during the spawning period. In 2015, flow spikes resulted in several environmental events that likely reduced spawning success of Smallmouth Bass. These flow spikes were caused by widespread storms in the Yampa Basin and were recorded at several gages including the Upper Yampa at Steamboat Springs gage (USGS 09239500), Elk River near Milner gage (USGS 09242500), and the Little Snake River near Lily gage (USGS 09260000). Over three-days, flow doubled in Little Yampa Canyon from 1270 cfs on July 7th to 2200 cfs on July 10th as measured at the Maybell Gage (USGS Gage 09251000). We observed that increased flows breached some previously still backwaters resulting in increased water velocities over spawning sites. If velocities increased high enough over nests it would displace emergent larvae and encourage nesting adults to abandon nests. Not all spawning backwaters breached during the spike event and since velocities at spawning sites were not measured we do not know the extent of harm caused solely from increased flow. Another aspect of the spike flow which could have further affected nesting behavior was a decrease in maximum daily water temperatures which declined 4^oC from 24^oC to 20^oC at Maybell.

Rainstorms on July 6th caused flash floods in Little Yampa Canyon (RM 120.5 and 126) that resulted in a modest flow increase but primarily affected spawning by depositing fine sediment in low-velocity areas along shore margins and in backwaters. This sediment was deposited for at least 30 miles downstream and likely disrupted both active and future nesting activities in that area by suffocating eggs, disorienting emergent larvae, and displacing spawning adults.

In addition to suspended sediments, dissolved load increased turbidity and reduced water clarity for several days. Some backwaters remained turbid for days after water in the main channel had cleared. Prior to the flash flood, on June 29th and 30th, Secchi-tube depths in Little Yampa Canyon were 55-58 cm and on July 7th the day after the flash flood, the water was orange colored and Secchi depth declined to 2 cm. Over the next three days, as flows continued to rise, water clarity improved slightly with Secchi depths between 10 and 15 cm in Little Yampa Canyon;

comparatively, on the same day 10 miles upstream of the flash flood, Secchi depth was 35 cm. Water clarity in the river improved by July 11th, 4 days later, when Secchi depth returned to near pre-event levels (35-40 cm) in Little Yampa Canyon. Extremely low water clarity like we observed would increase crayfish predation on active nests and hinder male spawning displays and their ability to attract a mate.

In conclusion, these environmental events had a potentially large effect on nesting bass in 2015; but which one of these flow spike components (flow, temperature, sediment, or turbidity) had the greatest effect on bass spawning is unknown and deserves further study. Novel techniques for recreating these events could provide a useful tool for managing the Smallmouth Bass.

Spawning observations

Spawning started around June 20 and continued into late July based on adequate habitat, water temperatures, capture of ripe males in spawning habitat, and ripe females. Smallmouth Bass were observed or captured over nesting-type habitat in all Surge reaches.

Fish Community Sampling

During nonnative fish removal sampling, we also collected and measured all fish species on all sampling occasions in Little Yampa Canyon and Lily Park. Nonnative fish still dominate the fish community, comprising 98% of all fish collected in Little Yampa Canyon, about the same as in 2015 (Table 4). Smallmouth Bass and white suckers were the most abundant fishes collected. At Lily Park, nonnative fish comprised 62% of the fish collected and native fish appear to be holding their own comprising 38% of fish captured (Table 5). The difference in Little Yampa Canyon and Lily Park is that native species comprise less than 1% each in Little Yampa Canyon while in Lily Park native species persist even in the presence of high densities of Smallmouth Bass (Table 5). Flannelmouth sucker and bluehead sucker comprise the majority of native fish captured in Lily Park. We captured two Colorado pikeminnow in Little Yampa Canyon and five in Lily Park by electrofishing.

In 2015, CPW stocked PIT tagged bluehead sucker in Milk Creek which has a confluence with the Yampa River at RM 119.2. We recaptured 222 of those PIT tagged fish in 2015 and 12 in 2016. Lengths ranged from 199-290 mm. Fish were recaptured as far as 66.7 miles downstream and 26.8 miles upstream from Milk Creek.

Northern Pike: Statistics for Northern Pike that we captured were reported by CPW in their annual report. Of note is the strong cohort of Northern Pike observed in 2016 as Age-1 fish between 300 and 450 mm TL. These fish were produced in 2015 and were between 75 and 250 mm TL when captured in 2015 as YOY (Figure 5).

Recommendations for Middle Yampa Smallmouth Bass

- Continue mark-recapture to estimate Smallmouth Bass abundance in Little Yampa Canyon.
- Continue Smallmouth Bass removal.
- Continue intensive Smallmouth Bass nest disruption (The Surge) focusing on major production areas, especially in Little Yampa Canyon, South Beach, Lower Juniper, and Upper Maybell.
- Reallocate effort to insure removal during the spawning period in Upper Maybell.
- Continue using raft EL into the base flow period to increase removal of sub-adult bass.

Acknowledgements

We thank the field crews that assisted with collections. CSU field crew included: Carli Baum, Kyle Dick, Drew Ebner, Robert Garza, Kalli Jimmie, Lance Ostrom, and Don Tuttle. We thank CPW crews led by Cory Noble and FWS crews led by Travis Francis and Christopher Smith. We thank Kevin McAbee and Kallie Jimmie for reviewing this report.

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Table 1--- Abundance estimates for sub-adult (100-199 mm) and adult (≥ 200 mm) Smallmouth Bass in 24-mile long Little Yampa Canyon, Yampa River, 2016. Abundance was estimated using a Lincoln-Petersen estimator. SE = Standard Error. CV= Coefficient of Variation. Exploitation rate is based on the number of Smallmouth Bass removed by boat electrofishing after the marking passes were completed.

Life Stage	Abundance	lower – upper 95% CI	SE	CV %	Density #fish/mile	# removed	% removed
Sub-adult	2653	619—4687	2034.1	39	111	1249	47%
Adult	882	391—1347	166.8	28	37	547	62%

Table 2—CPUE (Catch per unit effort) for Smallmouth Bass captured by boat electrofishing in the middle Yampa River, 2016. Catch rates for E-Seine, and angling are included for Little Yampa Canyon. Life stages were based on length: juvenile (<100 mm), sub-adult (100-199 mm), and adult (≥200 mm).

Hayden-Craig				Number of fish				CPUE (# fish/hr)			
Pass	Sampling Period	Agency	Effort (Hrs)	Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1-Surge	Jul 12-13	FWS	14.9	57	176	52	285	3.8	11.8	3.5	19.2
2-Surge	Jul 15	FWS	4.4	89	103	15	207	20.1	23.2	3.4	46.7
Total			19.3	146	279	67	492	7.6	14.4	3.5	25.5

South Beach				Number of fish				CPUE (# fish/hr)			
Pass	Sampling Period	Agency	Effort (Hrs)	Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 19	CPW	8.3	1	3	6	10	0.1	0.4	0.7	1.2
2	Apr 25	CPW	10.3	1	2	10	13	0.1	0.2	1.0	1.3
3	May 3	CPW	3.5	3	1	4	8	0.9	0.3	1.1	2.3
4	May 18	CPW	10.6		11	27	38	0.0	1.0	2.5	3.6
5-Surge	Jun 16	CPW	8.8	1	9	17	27	0.1	1.0	1.9	3.1
6-Surge	Jun 30	CSU,FWS	6.0	11	20	60	91	1.8	3.3	10.0	15.1
7-Surge	Jul 6-7	CSU,FWS	12.7	44	105	78	227	3.5	8.3	6.1	17.8
8-Surge	Jul 12-15	CSU,FWS	14.9	142	139	61	342	9.5	9.3	4.1	23.0
Total			75.2	203	290	263	756	2.7	3.9	3.5	10.1

Little Yampa Canyon-EL Boat				Number of fish				CPUE (# fish/hr)			
Pass	Sampling Period	Agency	Effort (Hrs)	Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 20-26	CSU	40.1	1	18	47	66	0.0	0.4	1.2	1.6
2-Mark	May 4-10	CSU	34.8	15	90	68	173	0.4	2.6	2.0	5.0
3-Recap.	May17-24	CSU	50.0	32	174	127	333	0.6	3.5	2.5	6.7
4	Jun 3-19	CSU	46.9	106	62	54	222	2.3	1.3	1.2	4.7
5-Surge	Jun29-Jul 1	CSU	12.9	63	105	83	251	4.9	8.2	6.4	19.5
6-Surge	Jul 6-8	CSU	16.2	104	85	100	289	6.4	5.2	6.2	17.8
7-Surge	Jul 12-16	CSU,FWS	31.6	115	144	42	301	3.6	4.6	1.3	9.5
8-Surge	Jul 26-29	CSU	25.5	243	571	26	840	9.5	22.4	1.0	32.9
Total			257.9	679	1249	547	2475	2.6	4.8	2.1	9.6

Table 2-cont.

Little Yampa Canyon-E-Seine

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	July30-31	CSU	1.1	53	6	6	65	47.5	5.4	5.4	58.2
2	Aug9-11	CSU	2.4	344	25	13	382	141	10.2	5.3	156.6
3	Sep 7-9	CSU	4.2	1160	16	1	1177	276	3.8	0.2	280.5
4	Sep 20-27	CSU	9.9	3341	57	1	3399	338	5.8	0.1	344.0
5	Oct 6-11	CSU	4.9	830	12	1	843	168	2.4	0.2	170.5
6*	Oct 18-24	CSU	3.7	384	7	-	391	103	1.9	-	104.6
Total			26.3	6112	123	22	6257	232	4.7	0.8	237.8

*Pass 6 E-Seine sampling included Isolated Pools where few bass occur.

Little Yampa Canyon-Angling

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
7-Surge	July 14-16	CSU	16.5		33	12	45		2.0	0.7	2.7
1	July30-Aug1	CSU	12.5	1	40	18	59	0.01	3.2	1.4	4.7
2	Aug14-15	CSU	29		10	35	45		0.3	1.2	1.6
3	Sep9-10	CSU	21		24	23	47		1.1	1.1	2.2
Total			79.0	1	107	88	196	0.01	1.4	1.1	2.5

Lower Juniper

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 20	CPW	6.2	13	5	3	21	2.1	0.8	0.5	3.4
2	May 4	CPW	9.1	6	11	5	22	0.7	1.2	0.5	2.4
3-Surge	Jun 9-17	CPW	6.4	4	9	19	32	0.6	1.4	3.0	5.0
4-Surge	Jun 20-21	CSU,FWS	13.3	18	28	20	66	1.4	2.1	1.5	5.0
5-Surge	Jul 1	CSU	3.7	26	16	22	64	6.9	4.3	5.9	17.1
6-Surge	Jul 6-7	CSU	12.1	85	109	85	279	7.0	9.0	7.0	23.1
7-Surge	Jul 12-14	CSU	7.6	67	59	29	155	8.9	7.8	3.8	20.5
Total			58.3	219	237	183	639	3.8	4.1	3.1	11.0

Upper Maybell

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 27-28	CPW	12.3	9	37	60	106	0.7	3.0	4.9	8.6
2	Jun 15	CPW	10.3	18	169	58	245	1.8	16.5	5.6	23.9
Total			22.6	27	206	118	351	1.2	9.1	5.2	15.6

Table 2—cont.

Lower Maybell

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 21	CPW	8.8	8	9	16	33	0.9	1.0	1.8	3.7
2	May 5	CPW	9.6	12	34	34	80	1.2	3.5	3.5	8.3
3	May 19	CPW	10.1	12	44	41	97	1.2	4.4	4.1	9.6
4	Jun 3	CPW	8.7	4	28	33	65	0.5	3.2	3.8	7.4
Total			37.3	36	115	124	275	1.0	3.1	3.3	7.4

Sunbeam

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	Apr 26	CPW	9.1	2	1	6	9	0.2	0.1	0.7	1.0
2	Jun 1	CPW	10.6	10	18	10	38	0.9	1.7	0.9	3.6
3	Jun 14	CPW	15.4	6	13	8	27	0.4	0.8	0.5	1.8
Total			35.1	18	32	24	74	0.5	0.9	0.7	2.1

Lily Park

Pass	Sampling Period	Agency	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
				Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
1	May 6-7	CSU	13.3	33	102	161	296	2.5	7.7	12.1	22.3
2	May 19-20	CSU	15.5	23	246	219	488	1.5	15.9	14.1	31.5
3	Jun 1-2	CSU	11.6	21	202	159	382	1.8	17.5	13.8	33.1
4	Jun 6-7	CSU	13.8	13	217	156	386	0.9	15.7	11.3	28.0
5	Jun 14-15	CSU	11.8	27	157	88	272	2.3	13.3	7.5	23.0
6	Jun 28	CSU	5.8	112	174	77	363	19.3	29.9	13.2	62.4
Total			71.7	229	1098	860	2187	3.2	15.3	12.0	30.5

Totals by Gear Type

Gear	Sampling Period	Effort (Hrs)	Number of fish				CPUE (# fish/hr)			
			Juv	Sub-adult	Adult	All sizes	Juv	Sub-adult	Adult	All sizes
EL-Boat	Apr-Jul	577.4	1557	3506	2186	7249	2.7	6.1	3.8	12.6
Angling	July-Sept	79	1	107	88	196	0.01	1.4	1.1	2.5
E-Seine	July-Oct	26.3	6112	123	22	6257	232	4.7	0.8	237.8
Grand Total			7670	3736	2296	13702				

Table 3— Number of Smallmouth Bass captured by boat electrofishing during large-bodied fish sampling in the middle Yampa River, spring, 2016. Includes 158 Smallmouth Bass marked and released in Little Yampa Canyon for abundance estimation.

Reach	Electrofishing boat
Craig	492
South Beach	756
Little Yampa Canyon	2475
Lower Juniper	639
Upper Maybell	351
Lower Maybell	275
Sunbeam	74
Lily Park	2187
Total	7249

Table 4— Number and relative abundance of fish captured by boat electrofishing in Little Yampa Canyon, Yampa River, 2016.

	Removed	Released	Total	Relative Abundance %	Table 5--
<i>nonnative species</i>					-
Smallmouth Bass	2362	158	2520	34.1	Number
Northern Pike	215	-	215	2.9	and
White Sucker	4027	1	4028	54.6	relative
White x Flannelmouth Sucker	21	-	21	0.3	abundance
White x Bluehead Sucker	17	-	17	0.2	of
Creek Chub	196	-	196	2.7	fish
Green Sunfish	98	-	98	1.3	captured
Rainbow Trout	2	48	50	0.7	by
Brown Trout	-	42	42	0.6	boat
Black Bullhead	19	-	19	0.3	electro
Black Crappie	4	-	4	0.1	fishing
Bluegill	2	-	2	0.03	in
Channel Catfish	-	4	4	0.1	Lily
Common Carp	3	-	3	0.04	Park
Brook Stickleback	1	-	1	0.01	,
Redside Shiner	-	1	1	0.01	Yampa
<i>native species</i>					River,
Bluehead Sucker	-	47	47	0.6	Colorado
Flannelmouth Sucker	-	16	16	0.2	201
Speckled Dace	-	37	37	0.5	6.
Mountain Whitefish	1	32	33	0.5	
Mottled Sculpin	2	17	19	0.3	
Roundtail Chub	-	6	6	0.1	
Colorado Pikeminnow	-	2	2	0.03	
Cutthroat Trout	-	1	1	0.01	
Total number of fish	6970	412	7382	100%	

	Removed	Released	Total	Relative Abundance %
<i>nonnative species</i>				
Smallmouth Bass	2187	-	2187	46.4
Northern Pike	75	-	75	1.6
White Sucker	576	-	576	12.2
White x Flannelmouth Sucker	11	-	11	0.2
White x Bluehead Sucker	3	-	3	0.1
White x Bluehead x Flannelmouth Sucker	2	-	2	0.04
Creek Chub	2	-	2	0.04
Green Sunfish	6	-	6	0.1
Rainbow Trout	-	2	2	0.04
Brown Trout	1	5	6	0.1
Black Bullhead	2	-	2	0.04
Black Crappie	1	-	1	0.02
Channel Catfish	-	19	19	0.40
Common Carp	33	-	33	0.7
Red Shiner	-	5	5	0.1
<i>native species</i>				
Bluehead Sucker	1	172	173	3.7
Flannelmouth Sucker	7	1526	1533	32.5
Bluehead x Flannelmouth Sucker	-	3	3	0.1
Speckled Dace	-	1	1	0.02
Mottled Sculpin	-	4	4	0.1
Roundtail Chub	-	64	64	1.4
Colorado Pikeminnow	-	5	5	0.1
Total number	2907	1806	4713	100%

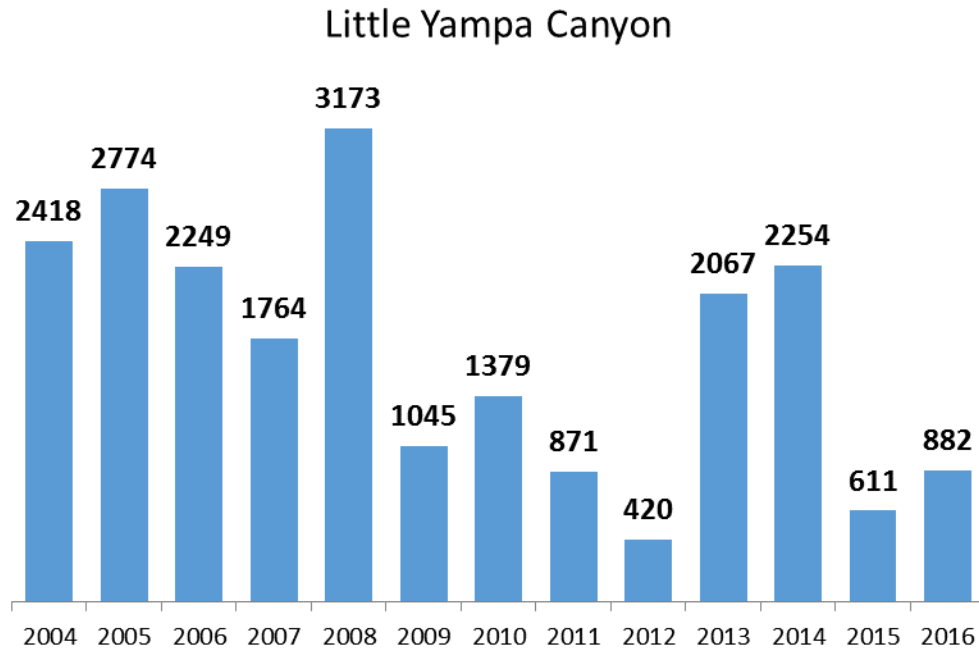


Figure 1---Estimated abundance of adult Smallmouth Bass (≥ 200 mm) in Little Yampa Canyon, Yampa River, 2004—2016. Abundance estimated with a modified Lincoln-Peterson estimator.

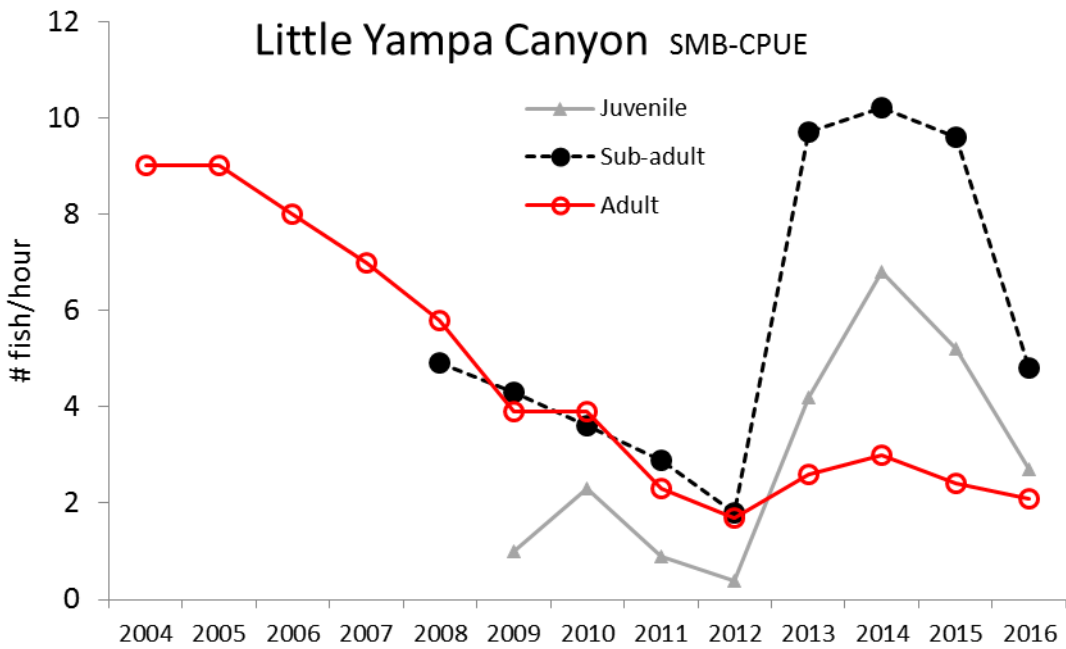
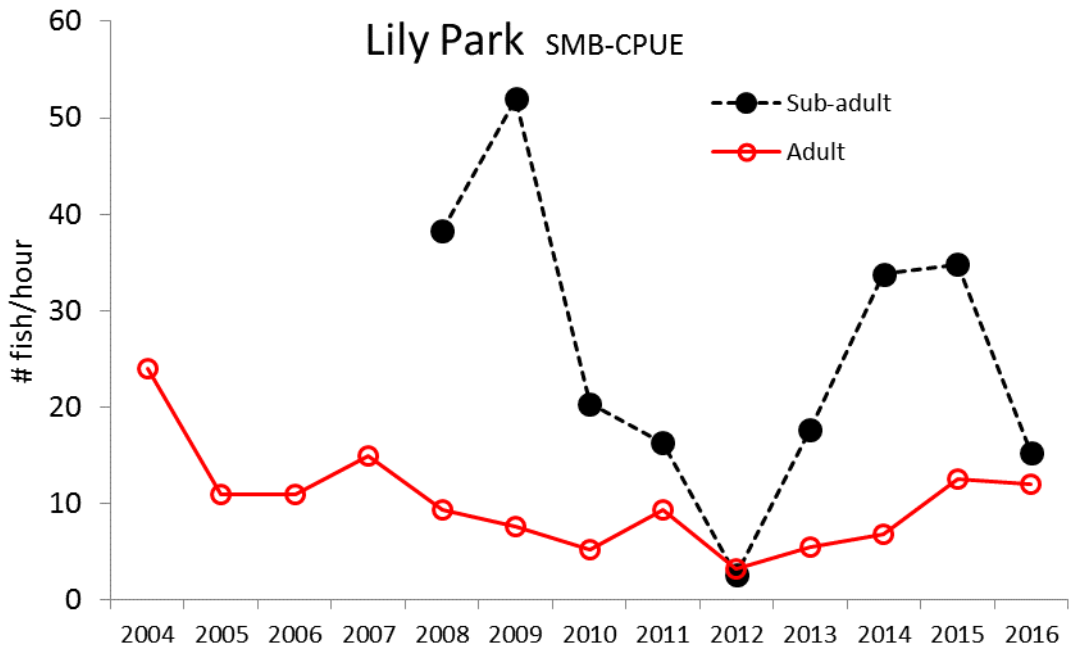


Figure 2—Number of juveniles (<100 mm, LYC only), sub-adult (100-199 mm), and adult (≥200 mm) Smallmouth Bass captured per hour of boat electrofishing in two reaches of the Yampa River, 2004-2016.

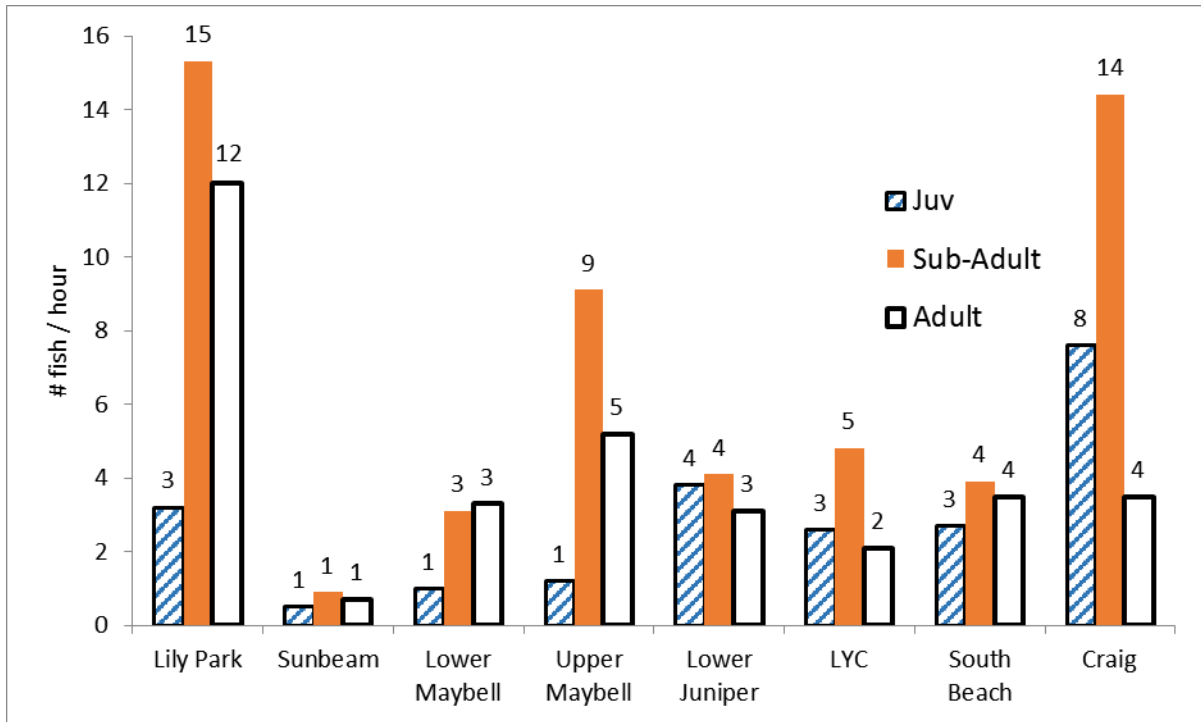


Figure 3—Catch per unit effort along a longitudinal gradient of the middle Yampa River, 2016.

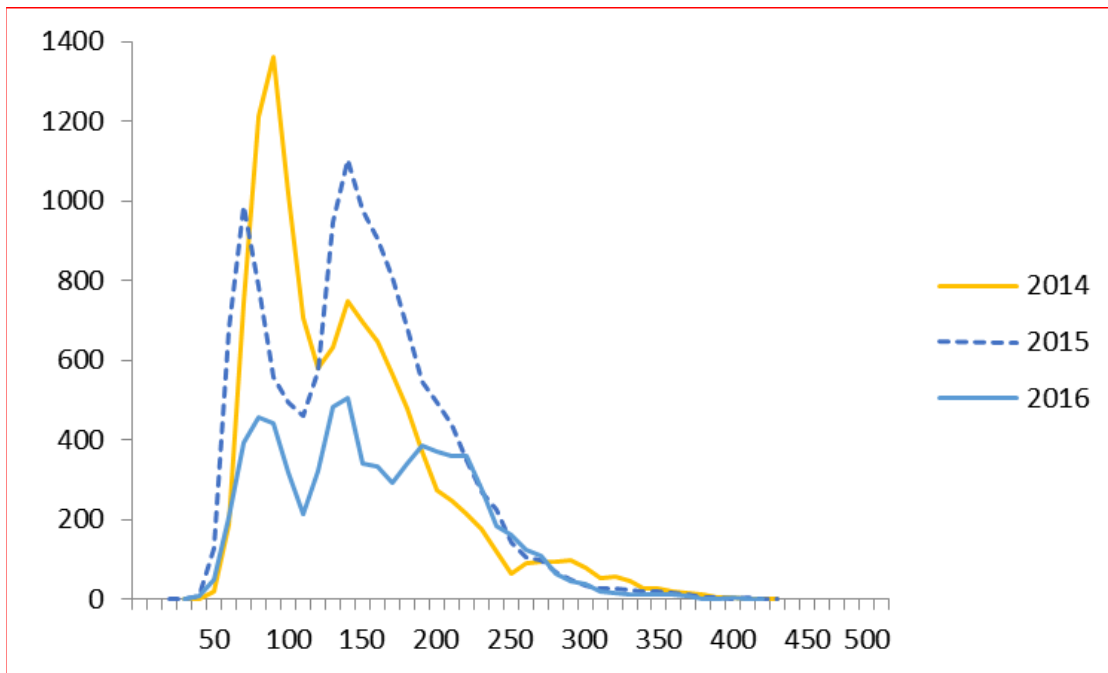


Figure 4—Length frequency of Smallmouth Bass captured by boat electrofishing, trammel nets, and fyke nets in all reaches of the middle Yampa River, 2014--2016.

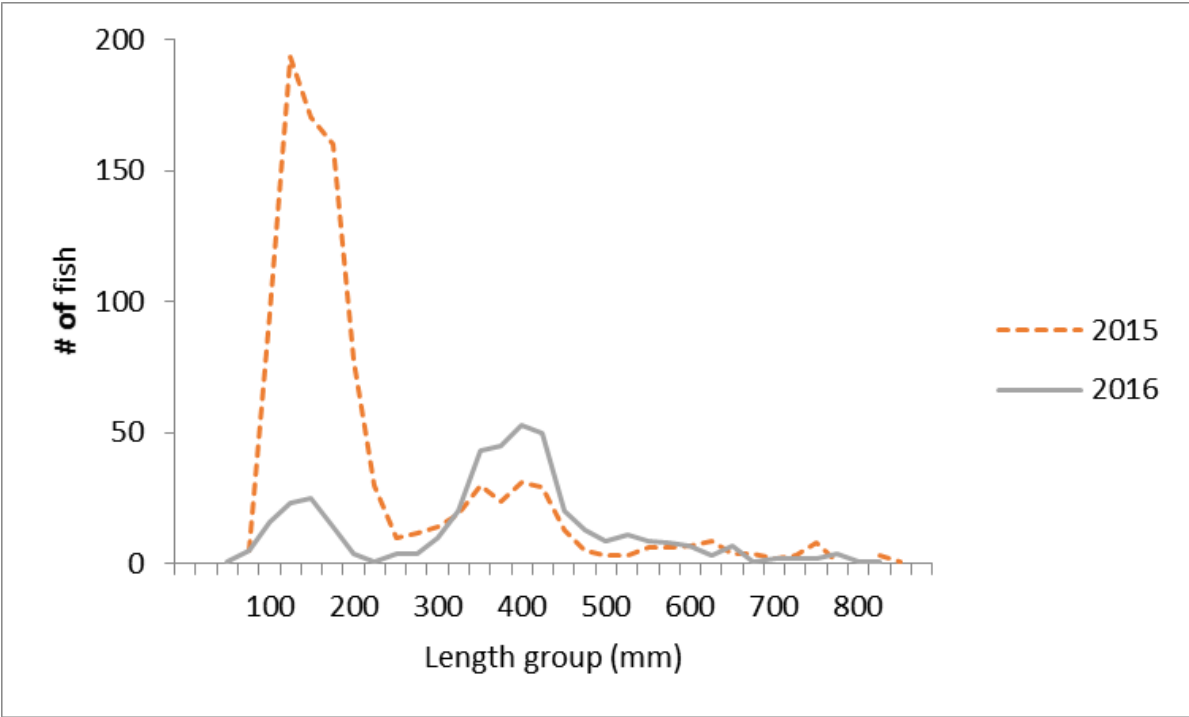


Figure 5 Length-frequency of Northern Pike captured in the middle Yampa River by CSU, 2015 and 2016. Includes pike captured in Little Yampa Canyon, Lily Park, and during the Surge in Craig, South Beach, and Lower Juniper. Length group increments are 25 mm.

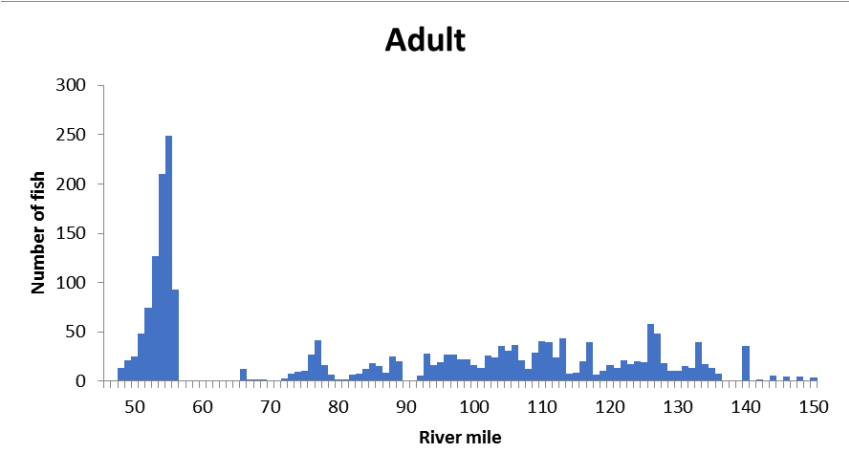
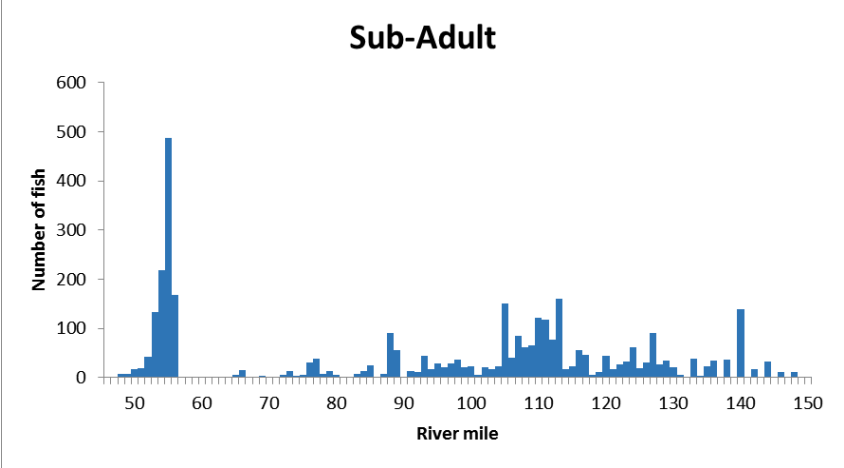
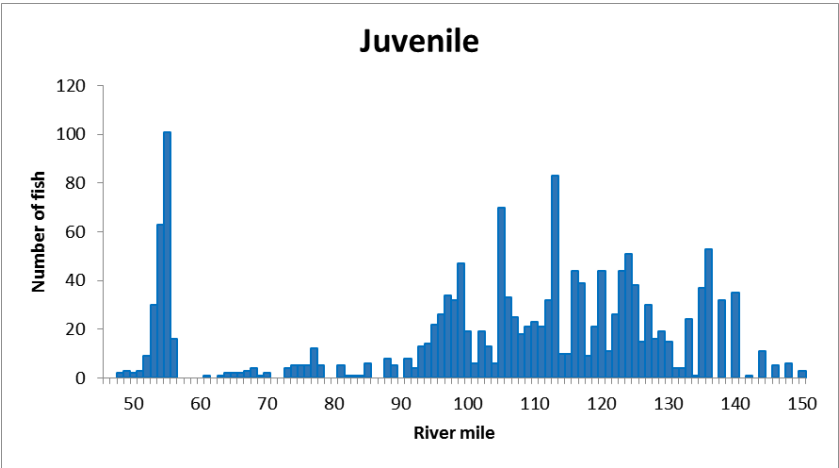


Figure 6—Number of Smallmouth Bass captured per mile in the middle Yampa River, 2016.

Appendix B:

Preliminary results of the removal of Northern Pike from the upper Yampa River, 2016.

Hawkins, John and Donald Tuttle III

Methods-Upper Yampa NP removal

Northern Pike occupy and have reproducing populations in the Yampa River and in several reservoirs within the basin. They are being actively removed from most of these locations by Colorado Parks and Wildlife (CPW) and the Colorado River Endangered Fish Program. Northern Pike are removed from the river downstream of Highway 40 Bridge near Hayden to the confluence with the Green River under Recovery Program projects 98a, 98b, 110, and 125 to benefit endangered fishes in Critical Habitat. Pike are currently removed by CPW from Catamount Reservoir and in the Yampa River from Catamount to Steamboat Springs to prevent their dispersal downstream and to benefit local trout and Mountain Whitefish fisheries. This study describes results of pike removal from the reach between Steamboat Springs and Highway 40 bridge near Hayden. In 2004 and 2005, Northern Pike in the Steamboat to Hayden reach were captured, Floy tagged, and released on two and three occasions, respectively; to estimate their abundance, monitor movement, and evaluate growth (Finney and Atkinson 2004; 2005). That study partitioned the reach into upper, middle, and lower sections. Our study was within that same reach but did not include their 5-mile-long upper section. Pike in that section were removed by CPW. Our study area was between Tree Haus Bridge in Steamboat Springs and Highway 40 Bridge at the Hayden Power Plant water intake (RM 194.2-170.6). In 2016, all raft electrofishing occurred downstream of the KOA campground (RM 189.3). The section from Tree Haus Bridge to KOA campground contains little apparent pike habitat and was avoided due to safety concerns of the many low bridges and concern for safety of public boaters through the popular white water kayaking sections through town.

Our goal each year is to sample in April before runoff to obtain an estimate of the number of Northern Pike that occupy the study reach from Steamboat to Hayden and then resample the reach and remove Northern Pike to evaluate the effectiveness of removal. All Northern Pike were euthanized with an overdose of the FDA approved fish anesthetic MS-222.

CPW provided rafts that we converted to use with ETS electrofishing gear. Northern Pike were captured in backwaters which we often blocked with gill or trammel nets. We also used a backpack electrofisher and gill nets in selected backwaters from May through July to catch adult and young-of-year (YOY) Northern Pike. YOY were collected to confirm whether or not spawning had occurred in the reach and to obtain otoliths for estimating hatch dates. Young-of-year pike were collected and are being aged to determine spawning dates for 2016. Identifying the spawning period and the associated environmental conditions in a given year will help us identify the dates of spawning and increase future efficiency in catching adult Northern Pike and disrupting spawning.

Almost all of the study site reach was located within private property. Although electrofishing can occur on the water without touching land, gaining access to launch or take-out boats, set nets, or stop and process fish requires landowner permission. In 2016 and previous years, cooperation and permission was granted by a strong majority of landowners who understood the benefit of removing pike to their local trout and whitefish fisheries.

Results-Upper Yampa NP removal

Start of 2016 sampling was delayed due cold early April weather that delayed the start of runoff and resulted in heavy spring snows that also prevented access to our launch sites. Local and mountain snow melted rapidly for a period in mid-April and caused a high, early runoff peak measured at Steamboat Springs (USGS Gage 09239500; Figure 1). At the time we were concerned that if we completed the marking pass and released tagged pike, we might not complete our recapture and removal passes due to rapidly rising runoff flows. Our concern was that high flows would prevent safe passage under bridges. Therefore, we decided not to mark pike on the first pass in 2016. The early peak subsided enough for us to complete three removal passes between April 19th and May 5th.

In 2016, we sampled between 3 to 10 miles per day, traveling shorter distances in sections with more backwaters. We primarily sampled backwaters to reduce our interactions with trout typically found in the mainstream and increase our sampling effort in backwaters where pike are concentrated and highly vulnerable to capture.

Raft electrofishing effort totaled 20.3 hours between April 19 and May 5th. Most effort occurred in backwaters and less than 2 hours of electrofishing effort occurred in the river channel. We sampled 54 individual backwaters at least once, including 17 sampled at least twice, and 11 sampled on all three passes.

We captured, euthanized with MS-222, and removed 157 Northern Pike with raft electrofishing, and most (130) were large piscivores (≥ 450 mm) which are considered the greatest threat as predators (Table 1). Their mean length was 588 mm, minimum length was 240 mm, and maximum length was 1026 mm (Figure 2). We squeezed all pike captured to determine sex and sexual condition based on the expression of gametes and 149 were also dissected to examine gamete condition and stomach contents; 71 were females, 83 were males, and three were frozen for later examination.

Spawning was confirmed with capture of ripe fish, often males and females in the same backwater. A large percentage of male pike were ripe during the entire sampling period from April 19 through May 5. Female pike were ripe between April 21 through May 5th (Table 2). The peak of spawning was April 27th based on the highest percent of females that were ripe that day, although very ripe females spawning eggs were captured on April 21, 22, 28 and May 3 and 5. Generally there were pike in both ripe and unripe condition during the entire sampling period between April 22 and May 5.

We observed, but seldom landed, other species including brown trout, rainbow trout, mountain whitefish, mottled sculpin, and white sucker. Prey removed from stomachs of Northern Pike included frogs and a variety of fish that included speckled dace, redbreast shiner, mottled sculpin, creek chub, brook stickleback, white sucker, brown trout, and mountain whitefish. Size of fish consumed ranged from small 60 mm minnows to a 310 mm brown trout. Adult white sucker, brown trout, and mountain whitefish ranged 213-310 mm in size and were between 33 and 37% of the length of the pike that ate them. For example, we removed a 310 mm (12 inch) brown trout from an 830 mm (33 inch) Northern Pike meaning the pike ate prey 37% of its length.

Recommendations for Upper Yampa River Northern pike

- Continue to focus Northern Pike removal in backwaters using raft electrofishing.
- Increase the use of gill and fyke nets in backwaters as appropriate.

- Postpone mark-recapture of Northern Pike for abundance until 2018.
- Continue collection of YOY pike and aging otoliths to identify the spawning period.
- Re-establish the boundaries of the study area to exclude raft EL in the section of river through Steamboat Springs for safety and logistical reasons.

Acknowledgements

We thank the CSU field crew that assisted with collections including: Carli Baum, Kyle Dick, Drew Ebner, Kallie Jimmie, Ed Kluender, and Lance Ostrom. Pike otoliths were aged by Kyle Dick and Carli Baum. We also thank CPW personnel in the Steamboat Springs office including Billy Atkinson, Jim Haskins (AWM), and Justin Pollock (DWM) and Yampa Valley landowners who graciously allowed access on private property during sampling. We thank Kevin McAbee and Kallie Jimmie for reviewing this report.

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Table 1--Number of Northern Pike captured and removed from Steamboat Springs to Hayden in the upper Yampa River, 2016. Life stages were based on total length: juvenile (juv.; <300 mm) and adult (\geq 300 mm).

Spring sampling				Number of fish			CPUE (# fish/hr)		
Pass	Sampling Period	Sampling Gear	Effort (Hrs)	Juv.	Adult	All sizes	Juv.	Adult	All sizes
1	Apr 19-22	Raft EL	6.9		55	55		8.0	8.0
2	Apr 26-28	Raft EL	6.3		52	52		8.3	8.3
3	May 3-5	Raft EL	7.1	1	49	50	0.1	6.9	7.0
Total			20.3	1	156	157	0.05	7.7	7.7

Table 2—Percent of ripe male and female Northern Pike captured each day in the Yampa River, 2016. Number of fish captured each day in parentheses.

	4/19	4/20	4/21	4/22	4/26	4/27	4/28	5/3	5/4	5/5
% ripe males	92%	33%	100%	100%	60%	100%	93%	89%	100%	100%
# males	(12)	(3)	(8)	(7)	(5)	(5)	(14)	(9)	(12)	(8)
% ripe females	0%	--	33%	25%	25%	63%	33%	29%	0%	13%
# females	(5)		(15)	(4)	(4)	(8)	(15)	(7)	(5)	(8)
Water temp ©	4.5	4.4	4.7	6.7	4.1			5.6	5.8	
Flow (cfs)	854	834	923	1070	1290	1170	1040	907	1030	1250

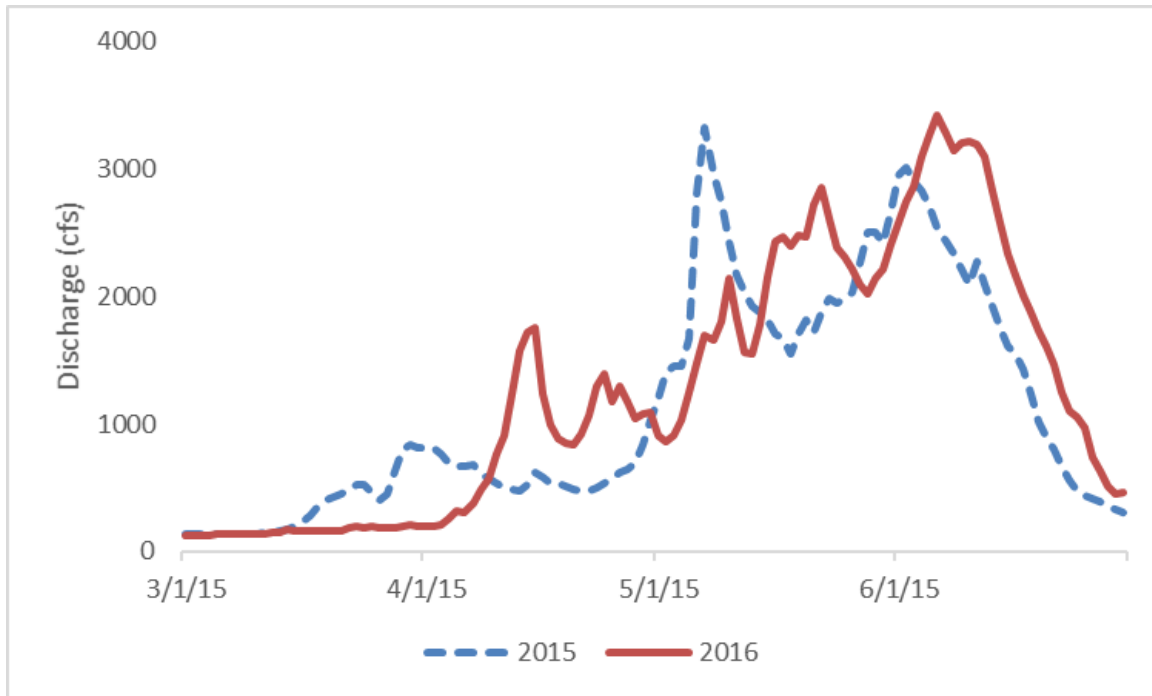


Figure 1- Steamboat gage (USGS# 09239500) discharge, 2015 and 2016.

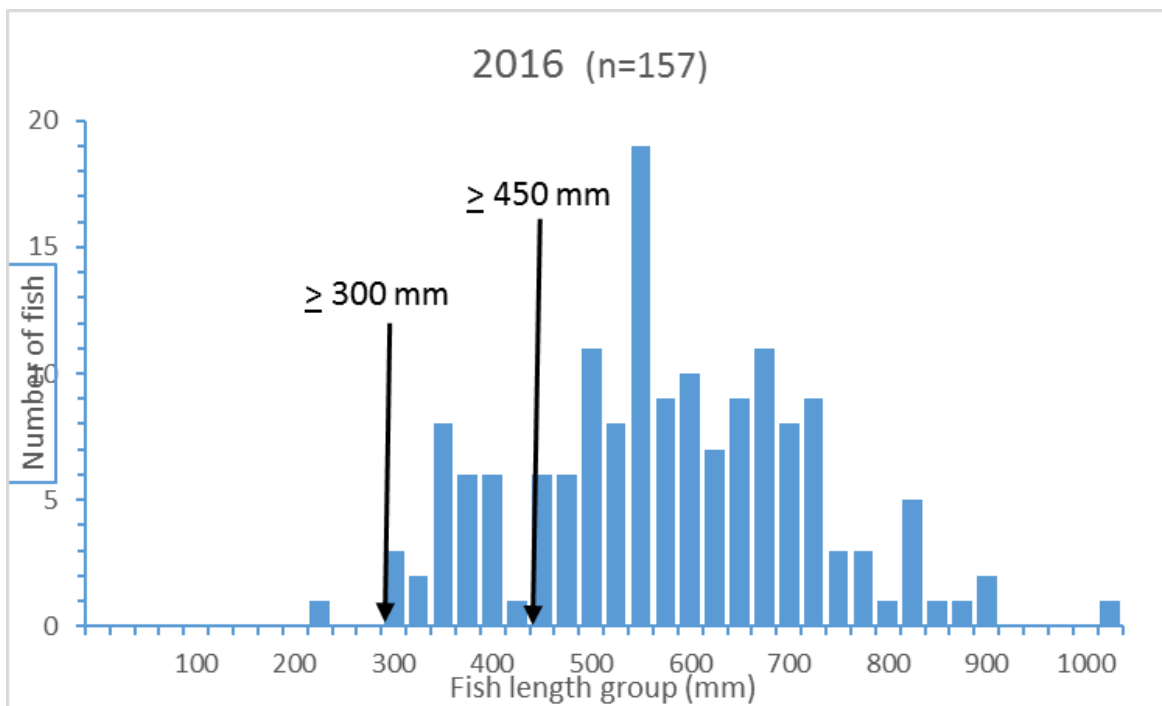


Figure 2-- Length frequency of Northern Pike captures in the upper Yampa River, 2016. Vertical arrows indicate the starting size for adult fish (≥ 300 mm total length; TL) and piscivores (≥ 450 mm TL).