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

Bureau of Reclamation Agreement Number:
R19AP00058

Project/Grant Period:
Start date: 10/01/2018
End date: 09/30/2023
Reporting period end date: 09/30/2020
Is this the final report? Yes _____ No _X_

Principal Investigator:
John Hawkins Senior Research Associate
Larval Fish Laboratory
Dept. Fish, Wildlife, and Conservation Biology
1474 Campus Mail
Colorado State University
Fort Collins, CO 80521
Phone: (970) 491-2777
Fax: (970) 491-5091
Email: John.Hawkins@ColoState.EDU

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. Due to COVID-19 travel restrictions in Colorado, we were unable to travel and conduct sampling in April and May. We began sampling in June and due to COVID-19 distancing protocols we reduced our crew size to four people. Boat electrofishing to remove Smallmouth Bass in the middle Yampa River occurred on up to five occasions (passes) in six reaches from June to mid-July using two electrofishing Jon-boats or rafts that sampled both shorelines. Smallmouth Bass ≥ 100 mm were marked and released on one occasion in Little Yampa Canyon (RM 124.0-100.0) to estimate their abundance, evaluate how the population responds to removal, and monitor fish movement and growth. Using mark-recapture methods, we estimated 304 adult Smallmouth Bass (47—707, 95% CI; CV=68%) and 1,183 sub-adult Smallmouth Bass (118—2,476, 95% CI; CV=56%) inhabited Little Yampa Canyon in 2020. Even with occasional strong year classes, the adult population of Smallmouth Bass in Little Yampa Canyon remains low compared to almost all prior years. Based on abundance estimates, density in Little Yampa Canyon was 13 adult and 49 sub-adult Smallmouth Bass per mile.

Using boat electrofishing, we removed 2,026 bass from six reaches of the middle Yampa River. We removed an additional 313 bass by angling and 7,701 bass using an electric seine from July into October. We also removed Northern Pike *Esox lucius* from the middle Yampa River study area and those data were provided to Colorado Parks and Wildlife (CPW) biologists who reported the results in the Annual Report for Project # 98a.
Another task (98c) was to remove adult Northern Pike in the spring during their spawning period from the reach between Steamboat Springs and Hayden (RM 194.2—170.6), identify and prioritize spawning areas, and later to capture young pike to confirm reproduction and to estimate spawning dates. No adult pike removal occurred in

2020 due to COVID-19 travel restrictions. After travel restrictions were lifted, we sampled backwaters between Steamboat and Hayden with a 4-m seine in June and July and captured 116 Young-of-Year Northern Pike. We will use otoliths from those fish to count their age in days since hatching and estimate their incubation period and fertilization (spawning) date.

Study Schedule:
2003-Ongoing

Relationship to RIPRAP:
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.1 Prevent nonnative fish introduction; reduce invasion and recruitment.
III.B.1.c. (1) Implement remedial measures to reduce pike reproduction in Yampa River.
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 (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 in Yampa River designated critical habitat. (YS J-1).

Accomplishment of FY 2020 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:
Initial findings and preliminary results for 2020 are provided in the attached Appendix and are subject to change as data are further analyzed. Shortcomings to work due to COVID-19 travel restrictions and distancing protocols:

Task 1	Data, reporting, meetings. Completed
Task 2	Field preparation. Completed
Task 3	Steamboat pike removal. Field work not done
Task 4a	Early spring, middle Yampa bass and pike removal. Field work not done
Task 4b	Middle Yampa bass and pike removal. Completed with reduced field staff
Task 5	Bass Surge removal. Completed with reduced field staff
Task 6	Young-of-year pike sampling. Completed
Task 7	Young-of year bass removal. Completed
Task 8	Equipment preparation, data entry and analysis. Completed

Additional noteworthy observations: See attached report for preliminary results.

Recommendations:
Recommendations for middle Yampa Smallmouth Bass removal
• Continue using Little Yampa Canyon as a monitoring site with annual mark-recapture studies of Smallmouth Bass abundance.
• Continue intensive Smallmouth Bass nest disruption (The Surge) focusing on major production in areas in Craig, South Beach, Little Yampa Canyon, Lower Juniper, and Upper Maybell.

Recommendations for upper Yampa River Northern Pike removal
• Continue to focus Northern Pike removal in backwaters using raft electrofishing.
• Define spawning period from daily increments by aging YOY pike otoliths.
• Collect attribute data for spawning areas.

Project Status:
On track, ongoing, complete, etc.

FY 2020 Budget Status
Funds Provided: $481,856
CSU: $439,790
FWS-Vernal: $25,479
FWS-Grd Jct : $16,587
Funds Expended: $378,593
Difference: -$103,263- unspent money due to COVID-19 restrictions on travel.
Percent of the FY 2020 work completed, and projected costs to complete: 76.5%
A total of $103,263 (23.5%) was unspent due to COVID-19 travel restrictions at the start of field season and other constraints on travel and housing while sampling.

Tasks with unspent funds due to COVID-19 travel restrictions:
Task 3: Steamboat pike removal- Field work not done. Travel and supplies unspent.
Task 4a: Spring middle Yampa Bass and pike removal. Travel and supplies unspent. Biologist and Technicians salaries unspent.
Task 4b: Middle Yampa SMB and Pike removal. Completed with reduced staff. Supplies and Technician salaries unspent.
Task 5: Yampa Surge. Completed with reduced staff. Supplies and Technician salaries unspent.
Task 7. YOY bass removal. Completed with reduced staff. Biologists salary unspent.
Unspent amounts by Category:

Materials and Supplies	$16,530
Permanent Salaries	$21,448
Temporary Salaries	$32,225
Travel	$17,680
Indirect Costs	$15,380
Total	$103,263

Recovery Program funds spent for publication charges: -none-

Status of Data Submission
Endangered fish capture data and other database records of field collections will be submitted by January 30, 2021.

Signed:
John Hawkins
Principal Investigator
Date: 11/20/20

Appendices:
Annual Performance Progress Reports (3)
Preliminary Results of Smallmouth Bass removal in the middle Yampa River, 2020

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)
BUREAU OF RECLAMATION AGREEMENT NUMBER: R20PG00024
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
U.S. Fish and Wildlife Service
Grand Junction FWCO
445 West Gunnison Ave., Suite 140
Grand Junction, Colorado 81501
Phone: (970) 628-7204
Fax (970) 628-7217
Email: travis_francis@fws.gov

Project/Grant Period:
Start date: 10/01/2019
End date: 09/30/2024
Reporting period end date: 09/30/2020
Is this the final report? Yes _____ No X

Performance:
We were tasked with providing a 3-person field crew for eight 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 2020 smallmouth bass "Surge" effort was targeted to remove smallmouth bass as the Yampa River neared base flows. We did not complete this work in 2020. Due to COVID-19 restrictions we were not able to hire as many seasonal Biological Technicians as planned. With the Upper Colorado River Endangered Fish Recovery Programs approval, we had to make the difficult decision to prioritize projects on the Colorado and Gunnison rivers with the remaining staff available.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R20PG00024

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 125

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

Bureau of Reclamation Agreement Number:
R20PG00024

Project/Grant Period:
Start date: 10/01/2019
End date: 09/30/2024
Reporting period end date: 09/30/2020
Is this the final report? Yes _____ No X

Performance:
U.S. Fish and Wildlife Service Green River Basin FWCO contributed personnel and equipment for two weeks in July to assist with the 2020 Yampa River Surge. All data were submitted to the CSU Larval Fish Lab, who will compile, analyze, and report the results.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R19AP00058

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 125/98c

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

Principal Investigator:
John Hawkins
Larval Fish Laboratory
Dept. of Fish, Wildlife, and Conservation Biology
Colorado State University
Ft Collins, Colorado 80523
970-491-2777/ fax 970-491-5091
john.hawkins@colostate.edu

Bureau of Reclamation Agreement Number:
R19AP00058

Project/Grant Period:
Start date: 10/01/2018
End date: 09/30/2023
Reporting period end date: 09/30/2020
Is this the final report? Yes _____ No _X_

Performance:
Due to COVID-19 travel restrictions in April and May we were unable to travel and did not complete tasks 3 and 4a. We were still able to complete all other tasks. We conducted one marking pass followed by four removal passes in Little Yampa Canyon. We obtained an estimate of the number of Smallmouth Bass in Little Yampa Canyon. We coordinated Surge sampling with USFWS. We assisted Colorado Parks and Wildlife in removal of nonnative fishes in South Beach, Lower Juniper, and Upper Maybell reaches. Large numbers of invasive nonnative predators were removed from Critical Habitat on multiple occasions from June through October.

We captured Young-of-Year (YOY) pike from backwaters on the Yampa River between Steamboat Springs and Hayden, Colorado to confirm spawning locations and timing. We produced an annual report on activities in 2020 and will present data at meetings in 2020 and 2021

Preliminary results of the removal of Smallmouth Bass from the middle Yampa River, 2020.
Hawkins, John (CSU), Donald Tuttle III (CSU), Kyle Dick (CSU), Christian Smith (FWS), Cameron Walford (CSU) and Tory Eyre (CPW).

Methods-Middle Yampa SMB removal

Study Site

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 river sampled by Colorado Parks and Wildlife (CPW) and Colorado State University-Larval Fish Laboratory (CSU). Two additional study areas included a 16.5-mile section between Hayden and Craig, Colorado and Juniper Canyon sampled by U.S. Fish and Wildlife Service (FWS) during Smallmouth Bass spawning. Data for Smallmouth Bass captured by those agencies in 2019 are summarized in this report.

Study reaches in the middle Yampa River.

Reach	Agency	RM	Area sampled (miles)
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
Juniper Canyon	FWS	88.7 – 91	2.3
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

Sampling Methods

Fish sampling occurred with boat electrofishing on up to five occasions (passes) during runoff from June through July, typically using two electrofishing boats or rafts sampling both shorelines continuously downstream. In prior years, we allocated more effort (increased passes) in reaches with abundant Smallmouth Bass spawning habitat, specifically Craig, South Beach, Little Yampa Canyon, Lower Juniper, and Upper Maybell. Due to COVID-19, travel restrictions and constraints, sampling was greatly reduced by us and other agencies in 2020. We were able to complete one pass in South Beach, Lower Juniper, and Upper Maybell. No removal occurred in Lower Maybell, Sunbeam, or Lily Park in 2020. Sample passes in Little Yampa Canyon, our monitoring reach, were reduced by half, compared to 2019, partly due to travel restrictions and partly due to less snowpack and flows that declined below 1000 cfs earlier in 2020. We removed and euthanized Smallmouth Bass from all reaches on all sampling occasions except during one pass in Little Yampa Canyon when bass were marked and released to estimate abundance, movement, and growth. On the marking pass, Smallmouth Bass >100-mm total length were marked with a numbered, purple, Floy-tag and released.

Smallmouth Bass were assigned to life stages based on their total length: juvenile (< 100 mm), sub-adult (100–199 mm), and adult (>200-mm). Smallmouth Bass 325-mm and larger, which is a size that is the highest predatory threat to native fishes, were considered piscivores of concern. In each reach, we estimated catch rates (# fish captured/hour) for each pass. In our monitoring site, Little Yampa Canyon, we also estimated abundance and compared results with previous years. Annual length frequency histograms tracked strong or weak year classes of Smallmouth Bass over time.

Concurrent with Smallmouth Bass sampling, in all reaches we removed other invasive nonnative species including Northern Pike, White Sucker *Catostomus commersonii*, white sucker hybrids, Centrarchids, Black Bullhead *Ameiurus mela*s, and Creek Chub *Semotilus atromaculatus*. We measured lengths and released alive all native fishes, trout, and Channel Catfish *Ictalurus punctatus*. Fish community structure and composition are reported for Little Yampa Canyon. Northern Pike data were provided to CPW and were reported in the annual report for Project # 98a.

Spawning disruption (The Surge)

In 2020, we completed the 11th year of an intensive removal program (The Surge) that targeted spawning Smallmouth Bass within the Craig, South Beach, Little Yampa Canyon, Lower Juniper, and Upper Maybell reaches. These reaches have high concentrations of spawning Smallmouth Bass and are easily accessible by boat. The goal was to remove large numbers of adult bass and reduce reproductive success by capturing or displacing adult fish during nest building, spawning, or nest guarding. Field crews and equipment from FWS-Vernal, Utah Fish and Wildlife Conservation Office assisted with Surge sampling. During the Surge, as flows declined towards base flow, we maximized catch rates by focusing on reaches with known spawning habitat where spawning bass were highly susceptible to capture. Targeted spawning areas included braided river sections, backwaters, scour holes, or shallow pools below debris fans. We defined the start of spawning and Surge removal when minimum daily water temperatures remained above 16°C at the USGS Maybell Gage (09251000) and in 2020, this began on June 20th. Smallmouth Bass were removed in target reaches during the Surge on up to three occasions from June 23rd through July 12th using Jon-boat and raft electrofishers.

Young-of-Year (YOY) Smallmouth Bass removal

After bass spawning ended, we sampled from July 30th through October 8th with an electric seine, standard seine, or backpack electrofisher to determine Smallmouth Bass spawning success and remove small-bodied, primarily YOY, Smallmouth Bass from a 12-mile Treatment reach in Little Yampa Canyon (RM 100-112).

Results-Middle Yampa SMB removal

Water year details

The 2020 spring run-off began in late April, duration of the peak was short, and flows declined rapidly starting in early June. Water temperatures reached were suitable for Smallmouth Bass spawning (16°C) on June 20th, about 20 days earlier than in 2019.

Fish removal effort

In 2020, we sampled a total of 211.5 hours with boat and raft electrofishing in June and July. Most of that effort occurred at our monitoring site, Little Yampa Canyon (131.5 hours; Table 1). Electrofishing effort in each reach was lower than typical in 2020 due to a delayed start and fewer sample occasions in each reach. Three reaches, Lily Park, Sunbeam, and Lower Maybell were not sampled in 2020. Additional sampling effort with other gear in Little Yampa Canyon included 69 person-hours of hook-and-line-fishing and 39.1 hours of e-seine electrofishing during six sample passes from July through October (Table 2). E-seine effort was higher than in 2019, because 2020 e-seine sampling started earlier due to early low flows.

Smallmouth Bass Catch Rates- boat electrofishing

We captured 2,026 Smallmouth Bass from six reaches of the Yampa River with boat electrofishing. We marked and released 93 of those fish in Little Yampa Canyon of which 20 were recaptured and euthanized, leaving 73 tagged fish at large. All other Smallmouth Bass were euthanized. The number of Smallmouth Bass captured in

2020 was much lower than the number captured in previous years by boat electrofishing due to reduced sampling time and effort. We captured only four large, piscivore-sized Smallmouth Bass (> 325 mm TL) and they comprised 0.2% of the total electrofishing catch. Catch rates support that our removal efforts are highly effective at reducing these larger, highly predatory sizes (Breton et al. 2014). We first reported the number of piscivore-sized Smallmouth Bass in 2013 and in the first two years they comprised 2% of the catch. The following two years they comprised 1% of the catch and since 2017 they have comprised less than 0.5% of the catch, suggesting that the number of larger-sized Smallmouth Bass have declined due to their high capture probability with boat electrofishing (Breton et al 2014).

Smallmouth Bass occupied all six reaches sampled in 2020 and catch rates reflected a combination of fish density in each reach and environmental conditions on any given pass. At our monitoring reach, Little Yampa Canyon, catch rates of sub-adult slightly declined and adult catch rate remained similar to those observed in 2019 (Figure 1).

Catch rates (CPUE) for Smallmouth Bass of all sizes captured by boat electrofishing were highest in Juniper Canyon, (39.8 fish/ hr) and Upper Maybell (26.2 fish/hr), followed by Lower Juniper, (16.5 fish/hr; Table 1, Figure 2). High catch rates were driven by abundant sub-adult Smallmouth Bass in those reaches (Table 1; Figure 2). Adult catch rates were highest at Upper Maybell (6.7 fish/hr) and Lower Juniper (6.4 fish/hr); otherwise, adult catch rates were 0.4—2 fish/hr in other reaches. Sub-adult catch rates were highest at Juniper Canyon (35.7 fish/hr) and Upper Maybell (19.2 fish/hr). Sub-adult catch rates in other reaches ranged 4—9 fish/hr; Table 1; Figure 2). Juvenile Smallmouth Bass catch rates were highest in Juniper Canyon (2.3 fish/hr); juvenile catch rates in all other reaches were less than 1 fish/hr. The distribution pattern of juveniles, sub-adults, and adults, expressed as the number of fish caught per mile, is shown in Figure 3.

When Smallmouth Bass spawn, electrofishing is highly effective because Smallmouth Bass spawn in water depths were they are vulnerable to capture, they congregate in those areas, and they return to those areas if displaced. By removing spawning fish from active spawning sites we open that habitat to new spawners who are available for capture on our next pass. During the Surge, we waited 2-5 days between removal passes to allow areas to refill with new fish and then resampled each area to remove another wave of spawners. Removal during the Surge in prior years has included additional personnel from other agencies that significantly increased sampling effort. In 2020, Surge effort in the Craig and Little Yampa Canyon reaches was similar to past years, but in South Beach, Little Yampa Canyon, Lower Juniper, and Upper Maybell reaches, there was significantly less effort than in the past.

After spawning, Smallmouth Bass were captured with raft electrofishing in backwaters created with declining flows and along outer bends with boulder or rubble cover. Sub-adult bass were easily trapped and captured by raft electrofishing in these short, deep, clear backwaters where they were attracted to abundant, small, forage fishes and capture rates for sub-adult Smallmouth Bass doubled in 2020 when the technique was used on the fifth pass in Little Yampa Canyon (Table 1).

We usually track year-class strength of Smallmouth Bass produced in the previous year by monitoring the number of age-1 juveniles (<100 mm) captured by boat electrofishing in early spring. Unfortunately, our ability to monitor the 2019 cohort was limited by low catch for all life stages of smallmouth bass in 2020 due to significantly reduced sampling effort (Table 1; Figure 4).

Smallmouth Bass Catch Rates-electric seine, backpack electrofisher, and angling

From July into October, when flows were too low to use large electrofishing boats, we shifted to techniques and gear that targeted smaller-sized, primarily YOY Smallmouth Bass. In 2020, we sampled for 39.1 hours with an

electric seine or backpack electrofisher in the 12-mile study reach of Little Yampa Canyon (RM 100-112). Catch rates for YOY (juvenile) Smallmouth Bass caught by those gear were 191.5 fish/hr (Table 2). This was almost four times higher than the 65.5 juvenile fish/hr captured with similar gear in 2019, suggesting a strong year class in 2020 due to early spawning compared to later spawning in 2019.

We sampled opportunistically with hook and line angling for additional removal of Smallmouth Bass from July through September. Angling effort totaled 69 person-hours and removed 313 Smallmouth Bass for a catch rate of 4.5 fish/hr (Table 2).

Smallmouth Bass abundance

We marked 73 sub-adult and 20 adult Smallmouth Bass on Pass 2 in Little Yampa Canyon (Table 1). Using a Lincoln-Petersen model, we estimated 304 adult Smallmouth Bass (47—707, 95% CI; CV=68%) inhabited Little Yampa Canyon in 2020 (Table 3; Figure 5). We estimated 1,183 sub-adult Smallmouth Bass (118—2,476, 95% CI; CV=56%) inhabited Little Yampa Canyon in 2020. Point estimates of adult abundance was similar to that in 2019 and sub-adult abundance was lower than in 2019. In 2020, wide confidence intervals and high coefficients of variation for both life stages were a result of low catch rates during both the mark and the recapture pass. Only one adult and two sub-adult fish were recaptured during the recapture pass. Even with occasional strong year classes, the adult population of Smallmouth Bass in Little Yampa Canyon remains low compared to almost all prior years (Figure 5).

Fish Community Sampling

We monitored fish community structure by capturing all fish encountered by boat electrofishing on all sampling occasions in Little Yampa Canyon. Nonnative fish dominated the fish community, comprising 96% of all fish collected with nonnative Smallmouth Bass and White Sucker being the most abundant species collected (Table 4). Fewer Northern Pike were captured in 2020 (64 fish) compared to 294 captured in 2019, but this was partly due to less effort in 2020. We captured only one Roundtail Chub *Gila robusta* and no Colorado Pikeminnow in Little Yampa Canyon in 2020. We caught 21 Bluehead Sucker *Catostomus discobolus* and nine Flannelmouth sucker *Catostomus latipinnis*, in Little Yampa Canyon; 14 of the Bluehead and three of the Flannelmouth were recaptured, PIT-tagged fish, stocked by CPW.

Observations on the repair of floodplain habitat changes in 2019--2020

In 2019, during peak runoff, the river breached the bank and captured a gravel pit at river mile 142.8, near Craig, Colorado. River flow was redirected through the gravel pit and created a new backwater by breaching an adjoining gravel pit. This backwater had abundant aquatic vegetation suitable for Northern Pike spawning. An adjacent, 1-mile-long, river channel was abandoned by the river and formed a large, well-connected backwater suitable for Smallmouth Bass spawning. Restoration work conducted by the land owner in 2020 successfully rebuilt the bank to disconnect the gravel pit and reroute the river back to its original channel.

General Observations 2020

- Sampling did not occur in April and May due to Statewide COVID-19 travel restrictions. We began sampling on June 2, six weeks later than originally planned.
- Smallmouth Bass spawning started June 20, about 20 days earlier than in 2019, allowing for a long summer growth period for YOY. Later catch rates for YOY Smallmouth Bass suggest a strong year class was produced in 2020.

- Numbers of adult Smallmouth Bass remain relatively low even with occasional productive year classes due to high catch rates for larger adult sizes and intensive river wide removal in past years.
- Colorado Pikeminnow and Roundtail Chub were extremely rare in the sampled reaches.

Recommendations for Middle Yampa Smallmouth Bass

- Continue using Little Yampa Canyon as a monitoring site with annual mark-recapture studies of Smallmouth Bass abundance.
- Continue intensive Smallmouth Bass nest disruption (The Surge) focusing on major production in areas in Craig, South Beach, Little Yampa Canyon, Lower Juniper, and Upper Maybell.

Acknowledgements

We thank CSU field crew which included Trent Moore and Jed Perkins. We thank the Vernal, Utah FWS field crew (FWS-FWCO) and Jenn Logan and crew (CPW) for field assistance.

References

Breton, A., D. Winkelman, J. Hawkins, and K. Bestgen. 2014. Population trends of smallmouth bass in the upper Colorado River Basin with an evaluation of removal effects. Project 161 Final Report to Upper Colorado River Endangered Fish Recovery Program, U.S. Fish and Wildlife Service. Larval Fish Laboratory Contribution 169.

Hawkins. J. 2008. Evaluation of smallmouth bass and Northern Pike management in the middle Yampa River. Project 125. 2008 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins, J. C. Walford, and A. Hill. 2009a. Smallmouth bass control in the middle Yampa River, 2003-2007. Contribution 154 of the Larval Fish Laboratory, Colorado State University. Final Report for the Upper Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, B. Wright., J. Logan, and A. Hill. 2009b. Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2009 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, and B. Wright. 2010 Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2010 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, and B. Wright. 2011 Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2011 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, and K. Battige. 2012 Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2012 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, and K. Battige 2013 Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2013 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Hawkins. J., C. Walford, and K. Battige. 2014 Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Project 125. 2014 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Hawkins. J., C. Walford, K. Battige, and C. Noble. 2015. Evaluation of smallmouth bass and northern pike management in the middle Yampa River: Preliminary results of the removal of smallmouth bass from the middle Yampa River and Northern Pike from the upper Yampa River. Project 125. 2015 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Hawkins. J., C. Walford, and C. Noble. 2016. Evaluation of smallmouth bass and northern pike management in the middle Yampa River: Preliminary results of the removal of smallmouth bass from the middle Yampa River and Northern Pike from the upper Yampa River. Project 125. 2016 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Hawkins. J., C. Walford, D. Tuttle III, and T. Eyre. 2017. Evaluation of smallmouth bass and northern pike management in the middle Yampa River: Preliminary results of the removal of smallmouth bass from the middle Yampa River and Northern Pike from the upper Yampa River. Project 125. 2017 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Hawkins. J., C. Walford, D. Tuttle III, and T. Eyre. 2018. Evaluation of smallmouth bass and northern pike management in the middle Yampa River: Preliminary results of the removal of smallmouth bass from the middle Yampa River and Northern Pike from the upper Yampa River. Project 125. 2018 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Hawkins. J., C. Walford, D. Tuttle III, Kyle Dick, and T. Eyre. 2019. Evaluation of smallmouth bass and northern pike management in the middle Yampa River: Preliminary results of the removal of smallmouth bass from the middle Yampa River and Northern Pike from the upper Yampa River. Project 125. 2019 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service

Wright, B. 2009. Middle Yampa River northern pike removal and evaluation: Smallmouth Bass evaluation and limited removal. Project 98a. 2008 Annual Report to the Colorado River Endangered Fish Recovery Program, U. S. Fish and Wildlife Service.

Table 1—Number and catch per hour (CPUE) for Smallmouth Bass captured by boat electrofishing in the middle Yampa River, 2020. Life stages based on length: juvenile (<100 mm), sub-adult (100-199 mm), and adult (≥200 mm).

Craig				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1-Surge	FWS	Jun 23-25	21.6	9	40	5	54	0.4	1.9	0.2	2.5
2-Surge	FWS	Jul 7-8	10.1	12	81	9	102	1.2	8.0	0.9	10.1
3-Surge	FWS	Jul 9-10	9.7	17	59	3	79	1.7	6.1	0.3	8.1
Total			41.5	38	180	17	235	0.9	4.3	0.4	5.7

South Beach				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1-Surge	LFL	Jun 23-24	13.5	4	77	27	108	0.3	5.7	2.0	8.0
Total			13.5	4	77	27	108	0.3	5.7	2.0	8.0

Little Yampa Canyon				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1	LFL	Jun 2-4	19.5	7	99	31	137	0.4	5.1	1.6	7.0
2-Mark	LFL	Jun 9-12	32.2	21	74	20	115	0.7	2.3	0.6	3.6
3-Recap	LFL	Jun 13-16	25.4	4	57	33	94	0.2	2.2	1.3	3.7
4-Surge	LFL	Jun 27-30	27.7	13	213	122	348	0.5	7.7	4.4	12.6
5-Surge	LFL	Jul 9-12	26.8	55	328	18	401	2.1	12.2	0.7	15.0
Total			131.5	100	771	224	1095	0.8	5.9	1.7	8.3

Lower Juniper				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1-Surge	LFL	Jun 25-26	11.8	8	111	76	195	0.7	9.4	6.4	16.5
Total			11.8	8	111	76	195	0.7	9.4	6.4	16.5

Table 1-continued

Juniper Canyon				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1-Surge	FWS	Jun 26	3.4	8	122	6	136	2.3	35.7	1.8	39.8
Total			3.4	8	122	6	136	2.3	35.7	1.8	39.8

Upper Maybell				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1	CPW	Jun 16	6.7	2	102	33	137	0.3	15.3	5.0	20.6
2-Surge	FWS	Jun 26	3.1	1	86	33	120	0.3	27.4	10.5	38.2
Total			9.8	3	188	66	257	0.3	19.2	6.7	26.2
Grand Total			211.5	161	1499	416	2026	0.8	6.9	2.0	9.6

Table 2—Number and catch per hour (CPUE) for Smallmouth Bass captured by e-seine and backpack electrofishing or angling in the middle Yampa River, 2020. Life stages based on length: juvenile (<100 mm), sub-adult (100-199 mm), and adult (≥200 mm).

E-Seine and backpack				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	EL Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1	LFL	7/30-8/08	3.12	333	1	1	335	106.7	0.3	0.3	107.4
2	LFL	8/13-8/18	8.28	1451	30	5	1486	175.2	3.6	0.6	179.5
3	LFL	8/25- 9/01	8.28	1023	9	8	1040	123.6	1.1	1.0	125.6
4	LFL	9/10-9/13	5.89	1127	36	1	1164	191.3	6.1	0.2	197.6
5	LFL	9/22-9/28	6.68	1225	38		1263	183.4	5.7	0.0	189.1
6	LFL	10/06-10/08	6.86	2330	74	9	2413	339.7	10.8	1.3	351.7
Total			39.11	7489	188	24	7701	191.5	4.8	0.6	196.9

Angling				Number of Fish				CPUE (# fish/hr)			
Pass	Agency	Dates	Hrs	Juv	Sub-Adult	Adult	Total	Juv	Sub-Adult	Adult	Total
1	LFL	Jul 30-Aug 1	14	--	27	11	38	--	1.9	0.8	2.7
2	LFL	Aug 13-14	11.3	--	28	38	66	--	2.5	3.4	5.8
3	LFL	Aug 25-Sep1	25	1	58	92	151	0.04	2.3	3.7	6.0
4	LFL	Sep 11-13	8	1	10	10	21	0.1	1.3	1.3	2.6
5	LFL	Sep 22-27	10.7	1	8	28	37	0.1	0.7	2.6	3.5
Total			69	3	131	179	313	0.2	1.9	2.6	4.5

Table 3—Abundance estimates for sub-adult (100-199 mm) and adult (≥200 mm) Smallmouth Bass in 24-mile-long Little Yampa Canyon, Yampa River, 2020. Abundance estimated using with a Lincoln-Petersen estimator with Chapman's correction. SE = Standard Error. CV= Coefficient of Variation.

Life Stage	Abundance	95% CI	SE	CV	Density # fish/mile
Sub-adult	1,183	73—2,476	659.7	56%	49
Adult	304	20—707	206.1	68%	13

Table 4—Number and relative abundance of each species captured by boat electrofishing in Little Yampa Canyon, Yampa River, Colorado, 2020. Released bass were marked with Floy tags and released for estimating abundance, movement, and growth.

	Number of fish			Relative Abundance
Little Yampa Canyon	Removed	Released	Total	(%)
nonnative species				
Smallmouth Bass	1004	91	1095	21.8
Northern Pike	64	--	64	1.3
White Sucker	3501	1	3502	69.8
White X Flannelmouth Sucker	3	--	3	0.1
White X Bluehead Sucker	2	--	2	0.0
Creek Chub	36	--	36	0.7
Green Sunfish	53	--	53	1.1
Rainbow Trout	--	15	15	0.3
Cutthroat Trout	--	1	1	0.02
Brown Trout	--	24	24	0.5
Black Bullhead	7	--	7	0.1
Total nonnatives	4670	132	4802	95.7
native species				
Bluehead Sucker	--	21	21	0.4
Flannelmouth Sucker	--	9	9	0.2
Mountain Whitefish	11	162	173	3.4
Mottled Sculpin	--	11	11	0.2
Roundtail Chub	--	1	1	0.02
Total native	11	204	215	4.29
Total number of fish	4681	336	5017	100

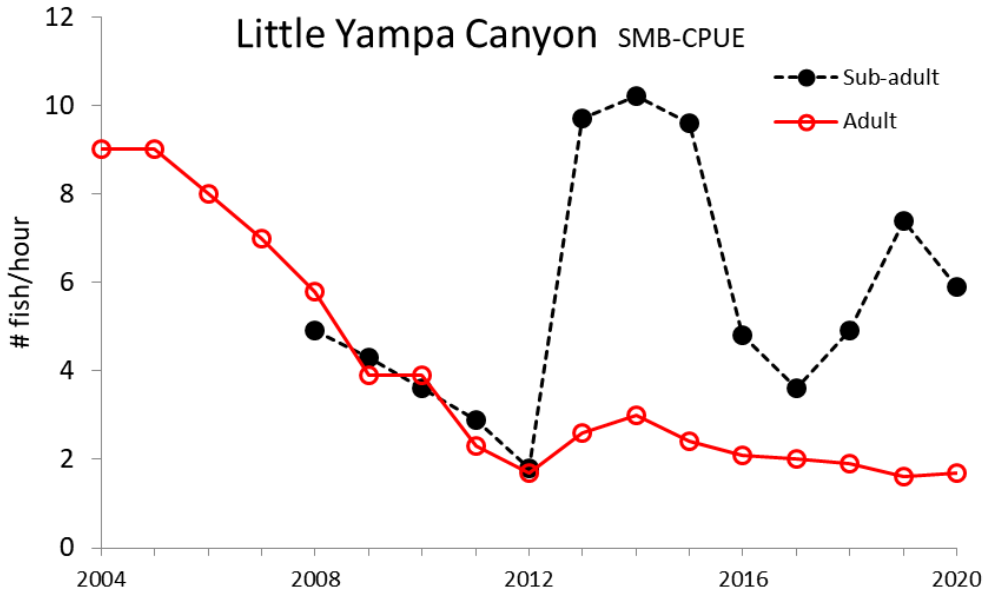

Figure 1—Number of sub-adult (100-199 mm) and adult (≥200 mm) Smallmouth Bass captured per hour of boat electrofishing in two reaches of the Yampa River, 2004-2020.

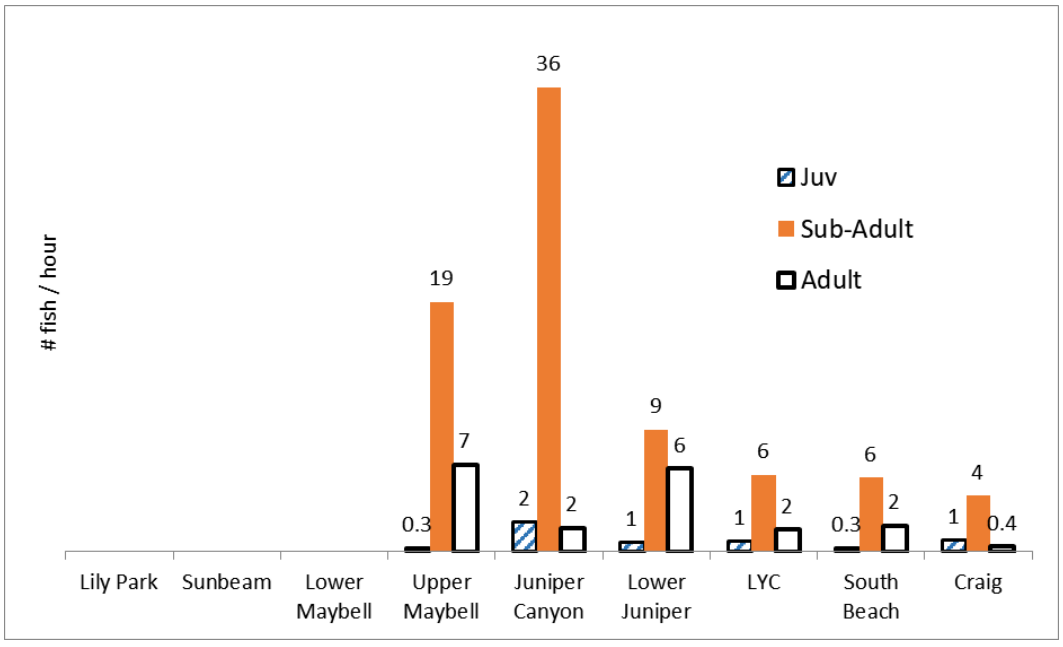

Figure 2—Catch per unit effort for Smallmouth Bass captured by boat electrofishing in study reaches arranged longitudinally from downstream (left) to upstream (right) in the Yampa River, 2020.

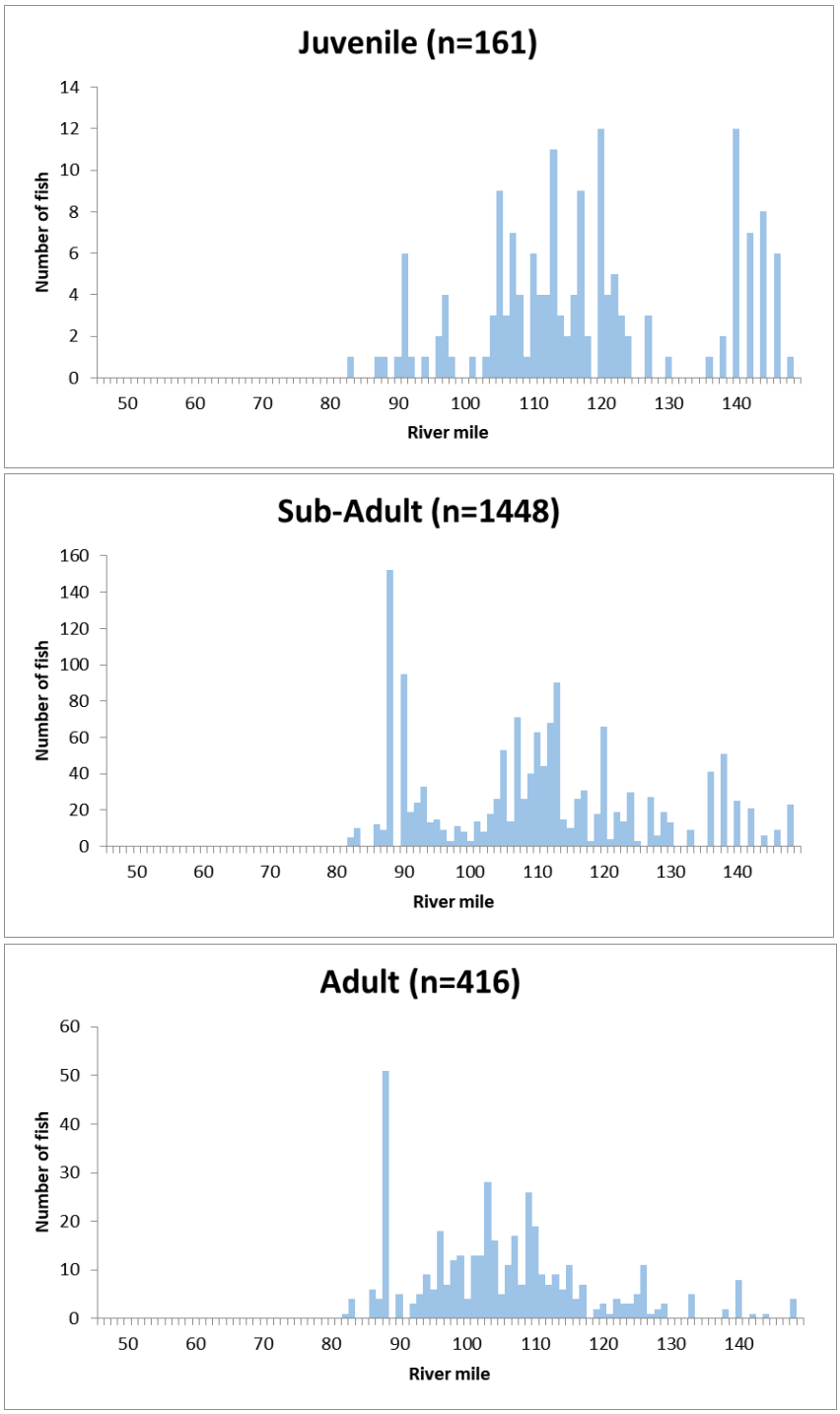

Figure 3—Number of Smallmouth Bass captured with boat electrofishing per mile in the middle Yampa River, 2020. Note that the y-axis scale varies by life stage.

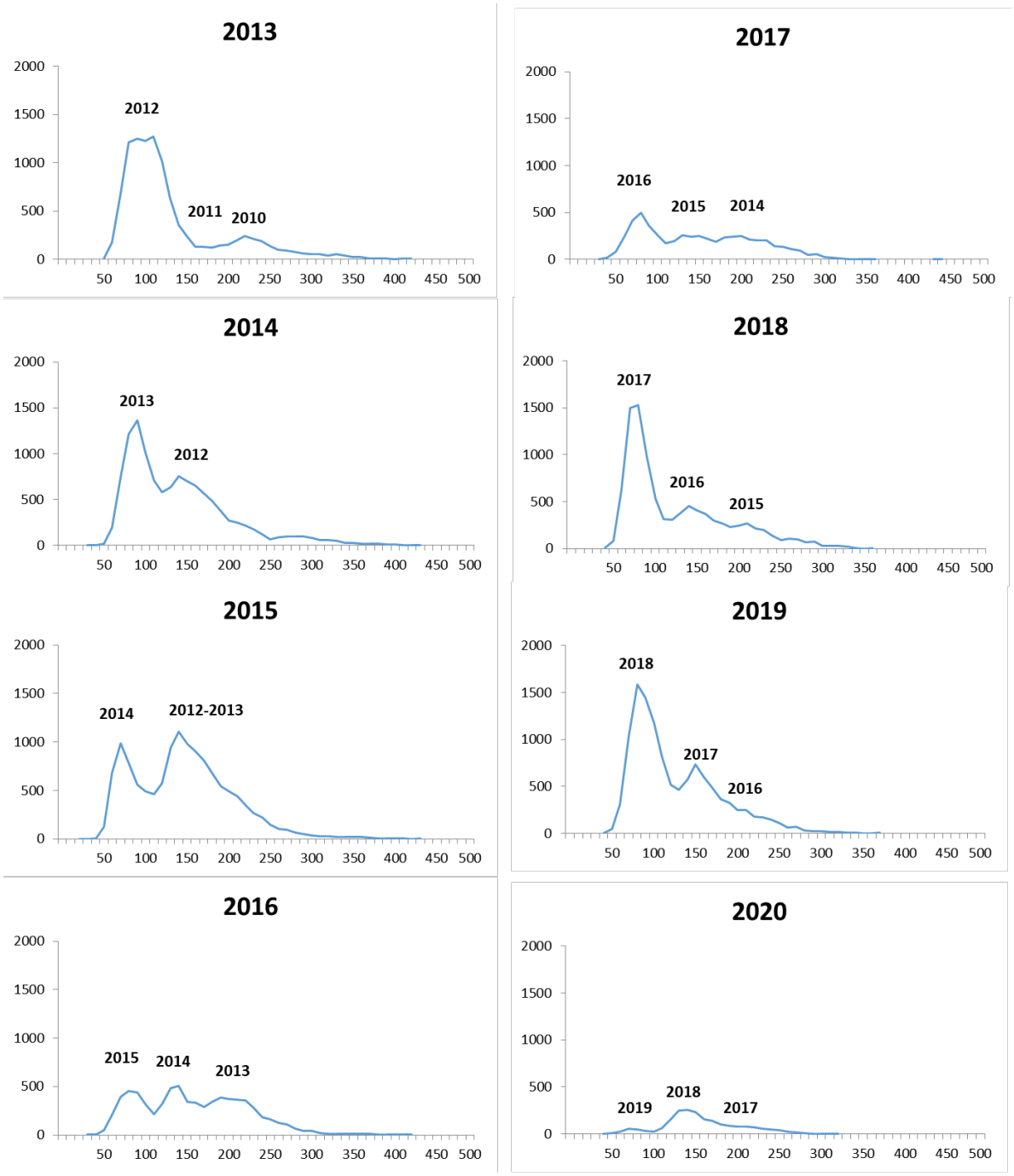

Figure 4—Annual length-frequency of Smallmouth Bass captured with boat electrofishing in all reaches of the middle Yampa River, 2013-2020. Estimated year classes in each graph show year-class strength for the prior three years.

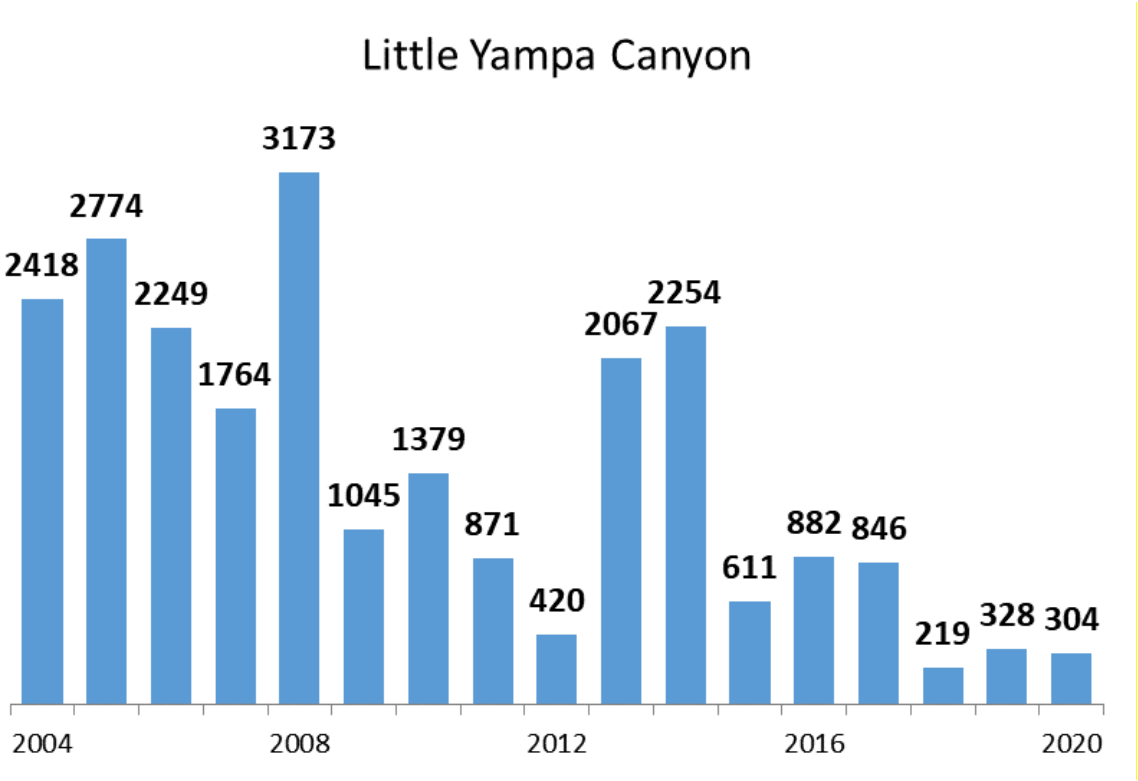

Figure 5---Estimated abundance of adult Smallmouth Bass (≥ 200 mm) in Little Yampa Canyon, Yampa River, 2004—2020. Abundance estimated with a modified Lincoln-Peterson estimator.