

COLORADO RIVER RECOVERY PROGRAM
FY 2019 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 123b, 123d, 126a

I. Project Title: Evaluation of walleye removal in the Upper Colorado River Basin

II. Bureau of Reclamation Agreement Number(s):
USFWS Grand Junction: R15PG400083
USFWS Vernal: R13PG40020
UDWR Moab: R19AP00059
UDWR Vernal: R19AP00059

Project/Grant Period: Start date (Mo/Day/Yr): 10/01/2018
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Is this the final report? Yes _____ No X

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IV. Abstract:

Green River Sub-basin: Researchers removed 229 walleye during 2019. We encountered 84% of these individuals downstream of the Tusher diversion facility. Nearly all walleye were captured using boat mounted electrofishing gear; however, a single individual was captured in a trammel net. Targeted efforts on the Lower Green River achieved the highest CPUE in the basin with catch rates in excess of 3.4 fish/hour (up from 1.66 fish/hour in 2018). Targeted efforts on the Middle Green River yielded substantially lower catch rates (0.15 fish/hour). Consistent with past years, catch rates were higher in the spring than summer within the Green River Sub-basin. Overall, the size structure and distribution supports the assumption that the lotic walleye population is not able to consistently recruit at this time and is therefore supported by escapement from, primarily, the Lake Powell reservoir population.

Colorado River Sub-basin: In 2019, field crews removed a total of 237 adult walleye throughout the upper Colorado River sub-basin in both targeted removal projects and as part of other projects. Targeted efforts to remove walleye included three complete passes in the summer and fall from Bighorn Camp (lower Westwater Canyon; RM114.0) to Potash, UT (RM47.2) and one pass in the fall from Bighorn Camp to Fish Ford (RM105.8). UDWR Moab also completed two spring mini passes and one fall mini pass in lower Westwater Canyon (RM116.2-111.0). Walleye removal was also performed as part of Project 127 (Colorado pikeminnow abundance estimate), which completed four full passes in the lower reach from Bighorn Camp (lower Westwater Canyon; RM114.0) to the confluence of the Green River (RM0.0). Logistical problems resulting from personnel issues in the spring led to reduced work in FY19 for project 126a. Total effort expended in FY19 was 300.8 hours electrofishing in the spring and 192.19 hours in the late summer and early fall. Our 2019 fall catch rates increased to 0.46 fish/hr from 0.40 fish/hr, in 2018. Our 2019 spring catch rates increased to 0.47 fish/hr from 0.36 fish/hr, in 2018. One walleye was collected during project 127 in the Grand Valley, this is the first capture of a walleye in this reach since 2012 (n=6). UDWR Moab did one exploratory trip on the lower Dolores River (RM9.0-0.0), the 7th May, for a total of 2.1 hours electrofishing and did not collect any walleye.

V. Study Schedule: 2014-ongoing.

VI. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

III. Reduce negative impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).

III.A. Reduce negative interactions between nonnative and endangered fishes.

III.A.2. Identify and implement viable active control measures.

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.

COLORADO RIVER ACTION PLAN: MAINSTEM

- III. Reduce 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. Develop basinwide aquatic management plan to reduce nonnative fish impacts while providing sportfishing opportunities.

VII. Accomplishment of FY 2019 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Initial findings and preliminary results for 2019 are provided in the attached report, but are subject to change as data are further analyzed.

VIII. Additional noteworthy observations: See attached report

IX. Recommendations:

Basin Wide

- Analyze historic data on walleye distributions throughout the Upper Colorado River Basin and compile a comprehensive technical report. This report would summarize past walleye distribution throughout the upper Colorado River Basin and present status of this invasive species. The goal of this effort is to locate critical gaps in our knowledge while providing a more robust source of data to inform future management decisions.

Colorado River Sub-basin

- Continue targeted walleye removal as a component of Projects 126a and 123d.
- Increased effort to maximize exploitation may warrant further consideration.

Green River Sub-basin

- Continue walleye removal as a component of existing projects, especially Project 128: Abundance estimates for Colorado pikeminnow in the Green River.
- Continue targeted walleye removal as a component of Projects 123b and 123d particularly in years when Project 128 is not occurring.
- Maintain spatial and temporal flexibility in the application of effort across all nonnative removal projects. This will allow investigators to reallocate effort to areas containing high densities of problematic nonnative fish species.

Lower Green River

- Additional effort should be applied between Tusher Diversion and Green River State Park (RM 128-120) as this segment has the highest catch rates for walleye in the reach. Removal should be conducted seasonally, justified by noteworthy catch rates.

Desolation and Gray Canyons

- Although catch rates do not currently warrant targeted removal in this reach,

continued removal of walleye under existing projects, especially 128 and 123a, is justified.

Middle Green River

- Continue walleye-specific removal efforts between the White River confluence and Sand Wash during spring sampling, with more extensive efforts in Project #128 off years. In years we conduct Project #128, our spring walleye targeting will only focus on the reach mentioned above and the Split Mountain spawning riffles in Dinosaur National Monument.

Upper Green, Yampa and White Rivers

- Targeted walleye removal efforts are not warranted at this time. Continue the removal of walleye as ancillary captures through ongoing sampling efforts.

Duchesne River

- We recommend conducting walleye-specific removal efforts in the Lower Duchesne River during spring peak flows, which is the only time that passage by electrofishing boats/rafts is possible in this system. The Ute Indian Tribe expressed interest in conducting a nonnative removal project in the Duchesne River in the future, otherwise UDWR can only sample this reach on an opportunistic basis as state funds and tribal access allow.

X. Project Status: on track and ongoing

XI. FY 2019 Budget Status

See annual reports for Projects 123a, 123b, 123d and 126a for budget descriptions.

XII. Status of Data Submission:

Data are compiled and will be submitted to the database manager by January 2020.

XIII. Signed:

Christopher Michaud and Travis Francis 11/19/2019

Principal Investigator

Date

APPENDIX:

A. Preliminary results of walleye removal in the Upper Colorado River Basin.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R15PG00083

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 126a

Project Title: Removal of Non-native Fish in the Upper Colorado River between Grand Valley Water User's Dam [Government Highline Diversion Dam] near Palisade, Colorado, and Potash, Utah.

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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): 9/30/2018
Is this the final report? Yes _____ No X

Performance:

GJ FWCO was tasked with completing 4 full passes of targeted walleye removal from Cisco to Potash, UT. During the fall (2019) 3 full passes were completed in the reach from Bighorn Camp (Lower Westwater Canyon; RM 114.0) to Potash, UT (RM 47.2). An additional one day of effort (two e-fish boats per day) was applied to the reach from Bighorn Camp to Fish Ford. A total of 88 adult walleye were removed. For additional details pertaining to other non-native fishes removed please see annual report for project 126a.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: -
#R19AP00059

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 123b

Project Title: Nonnative fish control in the middle Green River

Principal Investigator:

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Project/Grant Period: Start date (Mo/Day/Yr): 10/01/2018
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Performance:

All walleye removal effort for the middle Green River described in this report occurred under the Upper Colorado River Recovery Program's Project #123b, which also includes mechanical removal efforts for other species not mentioned here (northern pike, white sucker, and smallmouth bass). All work was completed under Tasks 1 & 3 of the Project #123b scope of work. Electrofishing effort to target walleye in the middle Green River totaled 105.3 hrs. Additionally, UDWR Vernal conducted 13.9 hrs. of electrofishing below Tusher Diversion under Recovery Program Project #123d.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R19AP00059
UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 123d

Project Title: Walleye control in the Lower Green and Colorado Rivers

Principal Investigator:

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Project/Grant Period:

Start date (Mo/Day/Yr): 10/01/2018
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Reporting period end date: 9/30/2019
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Performance: All work was completed under Tasks 1, 2 and 3 of the FY19 123d scope of work.

Walleye removal in the Green River Sub-basin

Utah Division of Wildlife Resources completed 43.4 hours of electrofishing effort, targeting walleye on the lower Green River between 28 February 2019 and 16 October 2019. All effort was focused on high value walleye habitat downstream of the Tusher diversion (RMI 128.3 - 114.5). A total of 151 walleye were removed from the Green River (CPUE = 3.51 fish/hour) in 2019. See Table 1 for ancillary captures.

Walleye removal in the Colorado River Sub-basin

Utah Division of Wildlife Resources crews completed 6.6 hours of targeted walleye removal on the Colorado River between Big Hole and Cisco boat ramp (RMI 116.6 - 111) in 2019. Sampling took place between 7 March 2019 and 8 October 2019. UDWR removed one walleye during the sampling period (CPUE = 0.14 fish/hour). UDWR also completed 2.1 hours of sampling between RMI 9 - 0 on the Lower Dolores River on 7 May 2019. No walleye were encountered. See Table 1 for ancillary encounters.

Table 1. Targeted and ancillary captures within the Green and Colorado River Sub-basins during Project 123d (UDWR-Moab) in 2019.

Reach	Common name	Number	Fish/hour
Lower Colorado	bluegill	1	0.14
	bonytail	3	0.43
	Colorado pikeminnow	1	0.14
	green sunfish	1	0.14
	roundtail chub	4	0.57
	razorback sucker	1	0.14
	smallmouth bass	12	1.71
	walleye	1	0.14
	white sucker	5	0.71
Lower Dolores	bonytail	4	2.00
	roundtail chub	4	2.00
	smallmouth bass	1	0.50
Lower Green	black bullhead	8	0.19
	black crappie	3	0.07
	bonytail	3	0.07
	Colorado pikeminnow	10	0.23
	grass carp	4	0.09
	green sunfish	8	0.19
	largemouth bass	51	1.19
	northern pike	2	0.05
	razorback sucker	5	0.12
	smallmouth bass	5	0.12
	walleye	151	3.51
white sucker	9	0.21	

Appendix A:

Preliminary results of the removal of walleye from the Upper Colorado River Basin, 2019.

Michaud C. & M. Partlow (UDWR), T. Francis, T Jones & C. Smith (USFWS), & E. Kluender (CSU).

Background

The introduction, establishment, and proliferation of nonnative fishes is considered the primary threat to the recovery of four Colorado River large bodied endangered fishes: Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*). Warm water game fish, primarily stocked in reservoirs for recreational purposes and then establishing in downstream river reaches, are thought to have the greatest adverse effect on endangered native fishes. Of those species, large bodied predators are considered the most problematic, specifically smallmouth bass, northern pike, and walleye.

Walleye (*Sander vitreus*) are a large bodied, highly piscivorous fish native to the Mississippi and several coastal northeastern drainages (Etnier and Starnes 1993). This species is often potadromous, residing mainly in lakes and reservoirs and making seasonal spawning migrations into rivers during early spring. Spawning occurs just post ice-off when temperatures reach 6–11°C over gravel or cobble substrates (Paragamian, 1989; McMahon and Terrell 1984). Adult walleye pose a particularly high threat to native species recovery in the upper Colorado and Green River Sub-basins because of their overlapping niche (with Colorado pikeminnow) and their high predatory threat (with all native fishes). This was demonstrated by the discovery of three juvenile Colorado pikeminnow (2014 (n=2), 2015 (n=1)) and seven bonytail (2014 (n=1); 2015 (n=3), 2016 (n=3)) in the stomachs of walleye (Francis et al. 2015). In fact, abundance estimates for Colorado pikeminnow have declined in the Upper Colorado River basin since walleye numbers have increased in both sub-basins.

There is scant evidence of the initial introduction of walleye into the Upper Colorado River Basin (Figure 1). In their 1966 publication: Glen Canyon Reservoir Post Impoundment Investigation, Roderick Stone and Kent Miller reference a stocking report noting the introduction of walleye into Strawberry reservoir in the 1950s. This impoundment, located on the Strawberry River, a tributary of the Green River, was a likely early source population of walleye in the Upper Colorado River basin. By 1962, walleye were encountered on the Green River within Dinosaur National Monument (Azevedo 1962) and on the Colorado River in the nascent waters of Lake Powell (Stone and Miller, 1966). Between both state sanctioned and illegal introductions, walleye populations had been established in ten reservoirs in the Upper Colorado River basin by 1990. Then, in 1998, gizzard shad (*Dorosoma cepedianum*) were accidentally stocked into Morgan Lake in the San Juan River basin. Gizzard shad are a preferred prey species for walleye and are known to support robust walleye populations; as such, gizzard shad are used by fishery managers to bolster walleye condition and populations where they are desired. Gizzard shad escaped Morgan Lake and colonized Lake Powell by 2000. Annual gill net surveys, provided by George Blommer (UDWR; Figure 2), in Lake Powell provide evidence that the walleye population in Lake Powell responded as expected and has grown substantially over the past 15 years. By the mid 2000s gizzard shad populations had expanded upstream, invading both the Green and Colorado Rivers (Figure 3). Between 1962 and 2006 walleye were encountered in the Colorado River and its tributaries; however, numbers remained relatively low.

Researchers noted a dramatic increase in walleye encounters, first on the Green River in 2007 then on the Colorado River in 2010 (Figure 4). Therefore, a dominant hypothesis is that the introduction and expansion of gizzard shad in the Colorado and Green River Sub-basins has led to increased walleye numbers in endangered fish habitats.

Research efforts have shown that walleye reach various portions of endangered fish habitat through escapement from multiple reservoirs in the Colorado and Green River Sub-basins. Researchers used chemical fingerprinting (strontium isotopes laser ablated from otoliths), to identify three reservoir sources of walleye (Red Fleet and Starvation in the Green River Sub-basin and Rifle Gap in the Colorado River Sub-basin) as well as in river reproduction (Green River) from samples collected through 2008 (Johnson et al, 2014). In response to this escapement, both the states of Utah and Colorado have been proactive in containing these sources through various means. Colorado Parks and Wildlife installed a downstream screen on Rifle Gap Reservoir in 2013 and is managing against the fertile walleye population. Utah Division of Wildlife Resources (UDWR) chemically treated Red Fleet Reservoir in 2015 and replaced fertile walleye with a sterile population. UDWR also installed a downstream screen on Starvation Reservoir in 2015. Therefore, all of the major upstream sources of walleye have been contained since 2015.

Ongoing Research

Unfortunately, all of the tissues analyzed by Johnson et al. (2014) were collected before large numbers of walleye were discovered in the Lower Green and Colorado Rivers. Therefore questions remained as to the source of the increased abundance of riverine walleye, especially in light of the increasing walleye population in Lake Powell. In 2015, U.S. Fish and Wildlife Service funded the U.S. Geological Survey to analyze more recent otoliths collected from these reaches and both McPhee Reservoir and Lake Powell which could be potential source populations. The preliminary results of this study may be found here: <https://doi.org/10.5066/P9ECFI2O>.

In-river Mechanical Removal Efforts

Green River Sub-basin

Walleye encounters on the Green River began increasing in 2007 and, although they have leveled off in recent years, encounters remain at noteworthy levels. Historically, both the Middle and Lower Green River yielded higher catch rates and a greater number of encounters than other reaches within the sub-basin. However, during the past two years CPUE has increased on the Lower Green and declined on the Middle Green. Managers consider both reaches critically important for Colorado pikeminnow recovery because they serve as nursery habitat for younger age classes. Survival of young age classes is important to preserve recruitment into the adult population. Beginning in 2014, the Upper Colorado River Endangered Fish Recovery Program added a targeted walleye removal element to Projects 123a and 123b within the Lower and Middle Green River. In 2017, targeted walleye removal under project 123a was assigned a separate scope of work. This effort is now directed under project 123d. These targeted walleye efforts have thus far been successful in that they consistently yield higher catch rates than do other projects operating within these reaches. Also, they provide a spring removal effort in years in which Colorado pikeminnow abundance estimate sampling does not take place and additional effort in sub-reaches containing high value walleye habitat.

Colorado River Sub-basin

After a two year (2011 and 2012) hiatus from sampling the lower 112 miles of the upper Colorado River sub-basin, our 2013 catch of walleye significantly increased during our springtime Colorado pikeminnow sampling from 46 individuals in 2010 to 268 in 2013 (Figure 4). In response, walleye specific removal began during the summer and fall. Experimental removal in 2013 provided evidence that summer efforts provided minimal success as walleye were most likely occupying a thermal niche that placed them in deeper habitat than our gear could effectively reach. It was also documented that our best success during the fall occurred in the reach from Cottonwood Wash (RM 112.3) to Potash (RM 47.2). Beginning in 2014, in years when Colorado pikeminnow abundance estimate work is occurring during the spring, all targeted walleye removal work will occur in the fall. During years when Colorado pikeminnow estimate work is not occurring, targeted walleye removal work will be split between the spring and fall. The first of a two year break from Colorado pikeminnow sampling began in 2016 and was extended through 2018 because of personnel (seasonal employee hiring) issues due to an internal reorganization of Human Resources on an agency-wide scale. In 2019, project 127, Colorado pikeminnow abundance estimate work, began a new three year cycle on the Colorado River. Field crews for project 127 completed four full passes from Bighorn Camp (Lower Westwater Canyon; RM 114) to the confluence of the Green River (RM 0.0). Targeted efforts to remove walleye included three complete passes in the summer and fall from Bighorn Camp (lower Westwater Canyon; RM 114.0) to Potash, UT (RM 47.2; summer and fall work began 20 August and concluded 9 October). The reach in lower Westwater Canyon (Bighorn Camp to Cisco) was added to this work in response to 2016 findings of many non-native piscivores in this reach. In 2019, Projects 126a and 123d completed two spring and two fall mini reaches in lower Westwater Canyon outside of the full passes completed.

Study Area

For the purpose of this study, the “Green River Sub-basin” has been broken down into eight reaches (Table 1, Figure 1). Reaches are designated based on geologic or habitat transitions or commonly used access points and do not necessarily reflect the starting and stopping points of individual projects. Consequently, figures contained in this report may differ from those published in individual annual reports. During 2019 the majority of targeted walleye removal occurred on three relatively small sub-reaches within the main-stem Green River – a twenty-mile reach near Jensen, Utah, a forty-mile reach near Ouray, Utah and a thirty-mile reach near Green River, Utah (Table 2).

Walleye are targeted in the upper Colorado River from lower Westwater Canyon to the confluence with the Green River, although effort has been broken down into four reaches where walleye are currently encountered. The four reaches are: 1. lower Westwater Canyon (RM 116) to Dewey Bridge (RM 94.6), 2. Dewey Bridge to Takeout Beach (RM 74.2; Professor Valley), 3. Takeout Beach to Potash (RM 47.2), and 4. Potash to the confluence of the Green River (RM 0.0).

Ancillary captures within Cataract Canyon are treated separately and follow results from the Colorado River Sub-basin. Recovery program collaborators expend little effort within this reach. Project 130: Population monitoring of humpback and bonytail chub in Cataract Canyon is the

only ongoing study within this reach.

Methods

Data from all reaches was collected using electrofishing gear mounted on a variety of watercraft with the exception of a small trammel netting effort Desolation and Cataract Canyons during 2019. Aluminum jonboats, rafts and cataracts were all employed on different river reaches. Data from three types of projects are summarized in this report: targeted walleye removal projects (123d, 123b and 126a), projects targeting smallmouth bass and northern pike (123a, 123b, 126a, 125, 98c, 110 and 167) and endangered fish monitoring projects (127, 129 and 130). Detailed methodologies are located in the annual reports for each project.

Results and Discussion

Green River Sub-basin

During 2019, researchers encountered walleye throughout the Green River Sub-basin. However, similar to 2017 and 2018, we encountered no walleye within the White River or the Yampa River upstream of the Lower Yampa Canyon reach. Because these reaches have consistently lacked walleye encounters, effort accrued within them was omitted from this analysis. Field crews removed 229 walleye through 937 hours of electrofishing within the sub-basin. Basin-wide catch rates were 0.25 fish/hour, up from 2018 (0.17 fish/hour). Sampling within the sub-basin began on 28 February 2019 and continued through 16 October 2019.

Similar to past years, catch rates on the Green River were highest within a 30-mile sub-reach immediately downstream of the Tusher Diversion Dam (RMI 128), which we previously identified as spawning habitat. Similar to 2018, two spawning sites on the Middle Green River showed little difference in CPUE when compared to the remainder of the reach (Figure 5).

Targeted walleye removal on the Lower Green River produced the highest catch rates in the sub-basin during 2019 (Table 3, Figures 5 and 6). The success of targeted efforts at effectively removing walleye stems from a number of factors. First, sampling is concentrated within sub-reaches that have yielded high catch rates for walleye in the past. Second, researchers maintain the flexibility to modify timing and location of sampling as well as sampling methods with the goal of maximizing walleye captures. Third, we focus our efforts during spring, a time when catch-rates are consistently higher in the Green River Sub-basin (Figure 7). Fourth, the Tusher Diversion Dam at river mile 128 has become an obstacle to upstream passage during years when debris blocks the fish ladder, concentrating walleye within its tail waters. This year was the first of two consecutive “off” years for Project 128 (Abundance Estimates for Colorado pikeminnow in the Green River Basin), consequently, there is a notable reduction in electrofishing effort within the Green River Sub-basin when compared to the previous three years.

While the number of walleye encountered in the sub-basin fell by 25%, catch rates rose substantially in targeted efforts during 2019. Increases in walleye catch rates within the Lower Green River are driving this trend.

Lower Green River

Researchers with the Utah Division of Wildlife Resources Moab Field Station (UDWR-Moab)

and Northern Regional Office (UDWR-Vernal) completed 57 hours of electrofishing effort on the Lower Green River in 2019 (Table 3). Sampling began on 28 February 2018 and concluded on 16 October 2019. Crews removed 196 walleye through targeted efforts (Figure 8). Overall catch on the Lower Green River remained stable between 2018 and 2019. Catch rates, however, increased substantially. During 2018, within the Tusher diversion sub-reach we achieved overall CPUE of 1.48 fish/hour and targeted CPUE of 1.66 fish/hour while during 2019 researchers achieved catch rates of 3.42 fish/hour.

Desolation and Gray Canyons

UDWR-Moab began sampling in Desolation and Gray Canyons (RM 206.5-128) on 20 June and finished on 21 August 2019 under Project 123a. Crews completed 116.6 hours of electrofishing effort, encountering two walleye and yielding a CPUE of 0.02 walleye/hour (Table 4, Figures 5, 6 and 8). One additional walleye was encountered during Project 129: Humpback chub population estimates in Desolation/Gray Canyons. Because this fish was captured in a trammel net it was omitted from CPUE calculations. Both the number of fish encountered and catch rates in Desolation and Gray Canyons were down slightly compared to 2018.

Middle Green River

UDWR-Vernal completed 347.6 hours of electrofishing effort in the Middle Green River in 2019. Researchers removed 23 walleye from this reach between 19 March and 2 October 2019 yielding a catch rate of 0.07 walleye/hour (Table 5, Figures 5, 6 and 8).

Crews completed 103.6 hours of targeted effort under project 123b, in the Middle Green River between 19 March and 30 May 2019. Sixteen walleye were removed, yielding a CPUE of 0.15 fish/hr. Most of the targeted effort was applied between Split Mountain boat ramp and Spring Hollow (RM 319.3-295.8) and between Wyasket Bottom and Sand Wash boat ramps (RM 255.8-215.8). These sub-reaches have produced substantial walleye captures in the past and are therefore the focus of targeted walleye efforts under Project 123b. An additional seven walleye were encountered in the Middle Green River during 244.1 hours of targeted smallmouth bass removal and tributary electrofishing under Project 123b (Table 5).

Upper Green River

Sampling in the Upper Green River began on 09 April and concluded on 26 September 2019. Consistent with past years, catch rates for walleye in the Upper Green River were the lowest recorded on the Green River (0.01 walleye per hour). Researchers with USFWS-Vernal, UDWR-Moab and Vernal and Colorado State University (CSU) removed a total of four walleye over 272.6 hours of effort (Table 6, Figures 5, 6 and 8).

Yampa River

Sampling in Lower Yampa Canyon began on 11 June and concluded on 19 July 2019 under Project 110. Researchers encountered three walleye on the Yampa River (Figure 8). Electrofishing effort (Project 110) within the Lower Yampa Canyon totaled 142.5 hours, yielding a CPUE of 0.02 walleye per hour (Table 7, Figures 5 and 6). Additional effort was completed in Middle and Upper Yampa River (Projects 125, 98c), however no walleye were encountered and this effort was excluded from CPUE calculations for the Green River Basin.

White River

Crews from USFWS-Vernal, UDWR-Vernal and CPW encountered no walleye on the White River in 2019. Effort from the White River was excluded from CPUE calculations for the Green River Sub-basin.

Duchesne River

UDWR-Vernal was unable to access the Duchesne River during 2019.

Size Structure

Mean total length for walleye removed in 2019 was 463 mm, lengths ranged from 310 mm to 692 mm (Figure 9). Mean total length in the Lower Green (449 mm) differed significantly from the Green River Sub-basin upstream of the Tusher diversion structure (561 mm) based on a Wilcoxon rank sum test with continuity correction ($W = 434.5$, $p < 0.05$). Overall, this size structure and distribution supports the assumption that the lotic walleye population is not able to consistently recruit at this time and is therefore supported by escapement from, primarily, the Lake Powell reservoir population.

Spawning Observations

Eighty three walleye in spawning condition (36% of the total catch) were encountered in the Green River between 20 March and 8 May 2019. The majority of these fish were male (89%). Aggregations of ripe fish were noted in three discrete sub-reaches of the Green River, consistent with previous years. These sub-reaches include the uppermost section of the Middle Green River (RM 320 – 300), the confluence of the Green and White Rivers (RM 250 – 220) and an area immediately downstream of the Tusher Diversion on the Lower Green River (RM 128-100). Successful walleye reproduction has been documented in the Green River. In 2014, two larval walleye were identified within light trap samples taken from the Lower Green River (Howard, 2014). However, the notable lack of recruit sized walleye supports the assumption that this species has not been able to consistently reproduce and recruit successfully within the Green River Sub-basin.

Upper Colorado River Sub-basin:

From 2016 through 2019, two offices have cooperated to conduct targeted walleye removal in the upper Colorado River. Colorado pikeminnow population estimate work (project 127) did not occur from 2016 through 2018; therefore, efforts were roughly half of the total electrofishing effort expended in 2015 and 2019 when Colorado pikeminnow sampling was conducted (Figure 10). The Grand Junction Fish and Wildlife Conservation Office (GJ FWCO) completed four full passes, in the spring 2019, from Bighorn Camp (lower Westwater Canyon; RM114.0) to the confluence of the Green River (RM 0.0) for a total of 297.5 hours of electrofishing effort during project 127. GJ FWCO completed three full walleye removal passes in the summer and fall, 2019, in all three reaches (Bighorn Camp to Dewey Bridge {RM114.0 to RM94.6}, Dewey Bridge to Takeout Beach {RM94.6 to RM74.2}, Takeout Beach to Potash {RM74.2 to RM47.2}) for a total of 184.02 hours of electrofishing effort during project 126a (Colorado River non-native fish removal). One additional mini pass from Bighorn Camp (RM114.0) to RM109.7 upstream of Fish Ford (RM105.8) was conducted during the fall for a total of 4.97 hours of electrofishing effort. Beginning in 2015, UDWR Moab provided additional removal effort in the Upper Colorado River sub-basin. Their efforts are targeted to specific walleye areas, and are thus shorter in duration and length than GJ FWCO. In 2019, UDWR Moab contributed 6.58 hours of

electrofishing effort. In 2019, UDWR Moab conducted an experimental trip in the lower Dolores River (RM9.0-0.0) for an additional 2.1 hours of electrofishing and did not collect any walleye.

In 2019, 236 adult walleye were removed with a mean total length of 483 mm and lengths ranging from 341-683 mm (Figure 11). One additional 475 mm walleye was removed from the Grand Valley, the first occurrence since 2012 when 6 were collected in this reach. Two of the adult walleye collected were captured in trammel nets during scare and snare efforts for Project 127. The remaining 234 were collected by use of electrofishing boats. Our 2019 walleye spring electrofishing catch rate (0.47 fish/hr) was similar to our summer/fall catch rate (0.46 fish/hr). These were an increase when compared to our 2018 spring catch rate (0.37 fish/hr) and summer/fall 2018 catch rate (0.40 fish/hr). Walleye catch rates varied amongst reaches when comparing the spring and fall (Table 8, Figure 12). Anecdotal evidence suggests that higher magnitude flows from monsoonal inputs may increase walleye captures, as they may take refuge closer to shore where electrofishing is more effective. The 2019 fall hydrograph didn't receive the large monsoonal pulses experienced in fall 2014, 2015, and 2017; however, was consistently higher than mean discharge keeping the water more turbid throughout the fall and catch rates (in general) were up (Figure 13).

Most walleye collected since 2014 have been dissected to determine gonadal development, sex and diet of the fish occupying the Upper Colorado River. All walleye have been scanned with a PIT tag reader to determine predation of endangered fishes. Five adult walleye collected, in 2019, were ripe. One female and two males were identified ripe the 8th through 10th of April, in Canyonlands (RM16.5 to 41). Two ripe females were collected the 23rd May in Professor Valley near White's Rapid (RM 78). All of these results can be found in Table 8. In 2016, while UDWR Moab and Grand Junction FWCO were doing their annual razorback sucker monitoring in the Colorado River arm of Lake Powell fifty walleye were PIT tagged. Expectations were to tag many more fish; however, the site closest to the river/lake mixing zone became covered in high water debris and made it impractical to sample with trammel nets early during the season. This work was completed in hopes to determine if fish in the lower sections of the Upper Colorado and Green Rivers were originating in Lake Powell. Fortunately, UDWR out of Wahweap continued tagging more Colorado arm of Lake Powell walleye in 2017.

In 2018, UDWR out of Wahweap and Salt Lake City sonic tagged walleye collected in Lake Powell. This project is possible in conjunction with a Bureau of Reclamation funded project to monitor razorback sucker use of Lake Powell. Sonic tags have been surgically implanted into razorback sucker collected in the San Juan and Colorado Arms of Lake Powell since 2011. Submersible Ultrasonic Receivers are placed throughout Lake Powell and in upstream rivers that can detect these tags from up to three kilometers away. This is an attempt to better understand the phenology of razorback sucker, and now, walleye throughout the Colorado River Basin.

Cataract Canyon:

Utah Division of Wildlife Resources removed three walleye from the Colorado River within Cataract Canyon in 2019. These were ancillary captures while engaged in Project 130: Humpback chub monitoring in Cataract Canyon. Two walleye were captured in trammel nets and one while angling. All captures were made between river mile -4.5 and -33.

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Table 1: Location of study reaches in the Upper Colorado River Basin.

River	Reach	Projects	Agency	River miles	Length (miles)
Green River	Upper Green	123a, FR-115, 128	CSU, UDWR, USFWS	380 - 319.3	60.7
	Middle Green	123b, 128	UDWR, USFWS	319.3 - 206.5	112.8
	Desolation	123a, 128	UDWR, USFWS	206.5 - 128	78.5
	Lower Green	123a, 128	UDWR	128 - 0	128
Yampa River	Middle Yampa	125, 98c	CPW, CSU, USFWS	189.2 - 46	143.2
	Lower Yampa	110	USFWS	46 - 0	46
Duchesne River	Lower Duchesne	123b	UDWR	15 - 0	15
White River	White River	167, 128	CPW, UDWR, USFWS	104 - 0	104
Colorado River	Lower Colorado	127, 126a	UDWR, USFWS	116 - 0	116
	Cataract Canyon	130	UDWR	-4.5 - -10	5.5

Table 2: Locations of targeted walleye removal projects.

<i>Project</i>	<i>River</i>	<i>Reach</i>	<i>River miles</i>	<i>Length (miles)</i>
123b	Green River	Middle Green	319.3 - 295.8	23.5
		Middle Green	255.8 - 215.8	40
	Duchesne River	Lower Duchesne	15 - 0	15
123d	Green River	Lower Green	128 - 97	31
126a	Colorado River	Lower Colorado	116 - 47.2	68.8

Table 3. Walleye captures on the Lower Green River (RM 128-0) under Projects 123b and 123d are targeted captures.

<i>Lower Green River</i>	<i>Effort (hr)</i>	<i>Number of walleye</i>	<i>CPUE (fish/hr)</i>
123b	13.90	45	3.24
123d	43.40	151	3.48
Total	57.30	196	3.42

Table 4. Walleye captures on the Green River within Desolation and Gray Canyons (RM 206.5-128). All captures are ancillary captures under existing projects.

<i>Desolation</i>	<i>Effort (hr)</i>	<i>Number of walleye</i>	<i>CPUE (fish/hr)</i>
123a	116.60	2	0.02

Table 5. Walleye captures on the Middle Green River (RM 319.3-206.5). Captures under Project 123b are ancillary captures. Captures under 123b(t) are targeted removal efforts.

<i>Middle Green River</i>	<i>Effort (hr)</i>	<i>Number of walleye</i>	<i>CPUE (fish/hr)</i>
123b	244.10	7	0.03
123b(t)	103.60	16	0.15
Total	347.70	23	0.07

Table 6. Walleye captures on the Upper Green River (RM 380-319.3). 123b(t) denotes a targeted effort, all other captures are ancillary captures under existing projects.

<i>Upper Green River</i>	<i>Effort (hr)</i>	<i>Number of walleye</i>	<i>CPUE (fish/hr)</i>
123a	212.80	2	0.01
123b	8.80	1	0.11
123b(t)	1.70	0	0.00
FR-115	49.30	1	0.02
Total	272.60	4	0.01

Table 7. Walleye captures on the Lower Yampa River (RM 46-0). All captures are ancillary captures under existing projects.

<i>Lower Yampa River</i>	<i>Effort (hr)</i>	<i>Number of walleye</i>	<i>CPUE (fish/hr)</i>
110	142.50	3	0.02

Table 8. Catch/effort (CPE, fish/hr) comparison by year for four different length classes (total length) of walleye (< 200mm = age-0; 200-299 mm = juveniles; 200-374mm = adults, > 375 = piscivore) for the Upper Colorado River Sub-basin's four reaches. Catch/effort data is partitioned by season. Note: spring collections occur by two methods; electrofishing and backwater scare and snare with trammel nets, catch/effort is reported only for electrofishing.

River Section	Length Class (mm)		Walleye													
			Time Period													
			Fall 2019	Spring 2019	Fall 2018	Spring 2018	Fall 2017	Spring 2017	Fall 2016	Spring 2016	Fall 2015	Spring 2015	Fall 2014	Spring 2014	Fall 2013	Spring 2013 No Effort Key Punched
Lower Westwater Canyon to Dewey Bridge	< 200	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	200-299	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	300-374	No. of fish	1 E-fish	0	3 E-fish	0	4 E-fish	0	1 E-fish	0	0	0	1 E-fish	0	0	0
		E-fish C/E	0.02		0.03		0.04		0.02				0.02			
	> 375	No. of fish	30 E-fish	2 E-fish	44 E-fish	14 E-fish	67 E-fish	0	7 E-fish	4 E-fish	30 E-fish	18 E-fish	64 E-fish	(5 total) 4 E-fish	19 E-fish	20
		E-fish C/E	0.45	0.05	0.5	0.41	0.71		0.13	0.14	0.46	0.46	1.32	0.1	0.62	NA
Dewey Bridge to Takeout Beach (Professor Valley)	< 200	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	200-299	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	300-374	No. of fish	9 E-fish	0	1 E-fish	0	1 E-fish	0	0	0	3 E-fish	0	0	0		0
		E-fish C/E	0.18		0.03		0.03				0.04					
	> 375	No. of fish	27 E-fish	15 E-fish	2 E-fish	9 E-fish	9 E-fish	0	7 E-fish	8 E-fish	25 E-fish	18 E-fish	8 E-fish	(19 total) 18 E-fish	3 E-fish	67
		E-fish C/E	0.55	0.21	0.06	0.6	0.31		0.16	0.24	0.34	0.28	0.44	0.29	0.18	NA
Takeout Beach to Potash, UT	< 200	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	200-299	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		E-fish C/E														
	300-374	No. of fish	0	1 E-fish	0	0	5 E-fish	0	0	2 E-fish	2 E-fish	0	0	1 E-fish	0	0
		E-fish C/E		0.01			0.14			0.04	0.02			0.02		
	> 375	No. of fish	22 E-fish	64 E-fish	1 E-fish	2 E-fish	14 E-fish	16 E-fish	4 E-fish	23 E-fish	15 E-fish	(18 total) 14 E-fish	34 E-fish	(45 total) 39 E-fish	1 E-fish	94
		E-fish C/E	0.29	0.91	0.27	0.1	0.39	0.32	0.14	0.44	0.18	0.22	0.35	0.74	0.04	NA
Potash, UT to the confluence of the Green River	< 200	No. of fish	No sample	0	No sample	0	No sample	0								
		E-fish C/E														
	200-299	No. of fish	No sample	0	No sample	No sample	0	No sample	1							
		E-fish C/E														
	300-374	No. of fish	No sample	0	No sample	1 E-fish	No sample	0	No sample	2						
		E-fish C/E										0.01				
	> 375	No. of fish	No sample	(65 total) 63 E-fish (5 w/o effort)	No sample	(28 total) 26 E-fish	No sample	(39 total) 31 E-fish	No sample	84						
		E-fish C/E		0.77								0.23		0.35		

Table 9. Walleye dissection results from the Colorado River 2014-2019.

Year	2014	2015	2016	2017	2018	2019
# WE removed	216	158	56	116	76	237
# WE dissected	70	156	53	113	60	236
# gender identified	70	104	39	103	49	205
% Male	53	38	28	48	53	40
% Female	47	62	72	52	47	60
# WE empty stomachs	28	102	34	80	44	130
# WE unidentifiable fish remains in stomach	34	24	6	14	10	60
# WE with NNF in stomachs	6	21	3	13	4	31
# WE with T&E fish in stomachs	2	4	3	0	0	0
# WE with other native fishes in stomachs	0	4	7	6	1	14
# WE with mammals or crustaceans in stomach	0	1	0	0	0	1
# WE with aquatic vegetation in stomach	0	0	0	0	1	0
% positively identified stomach contents native	25	28	77	32	20	33
% positively identified stomach contents non-native	75	72	23	68	80	67

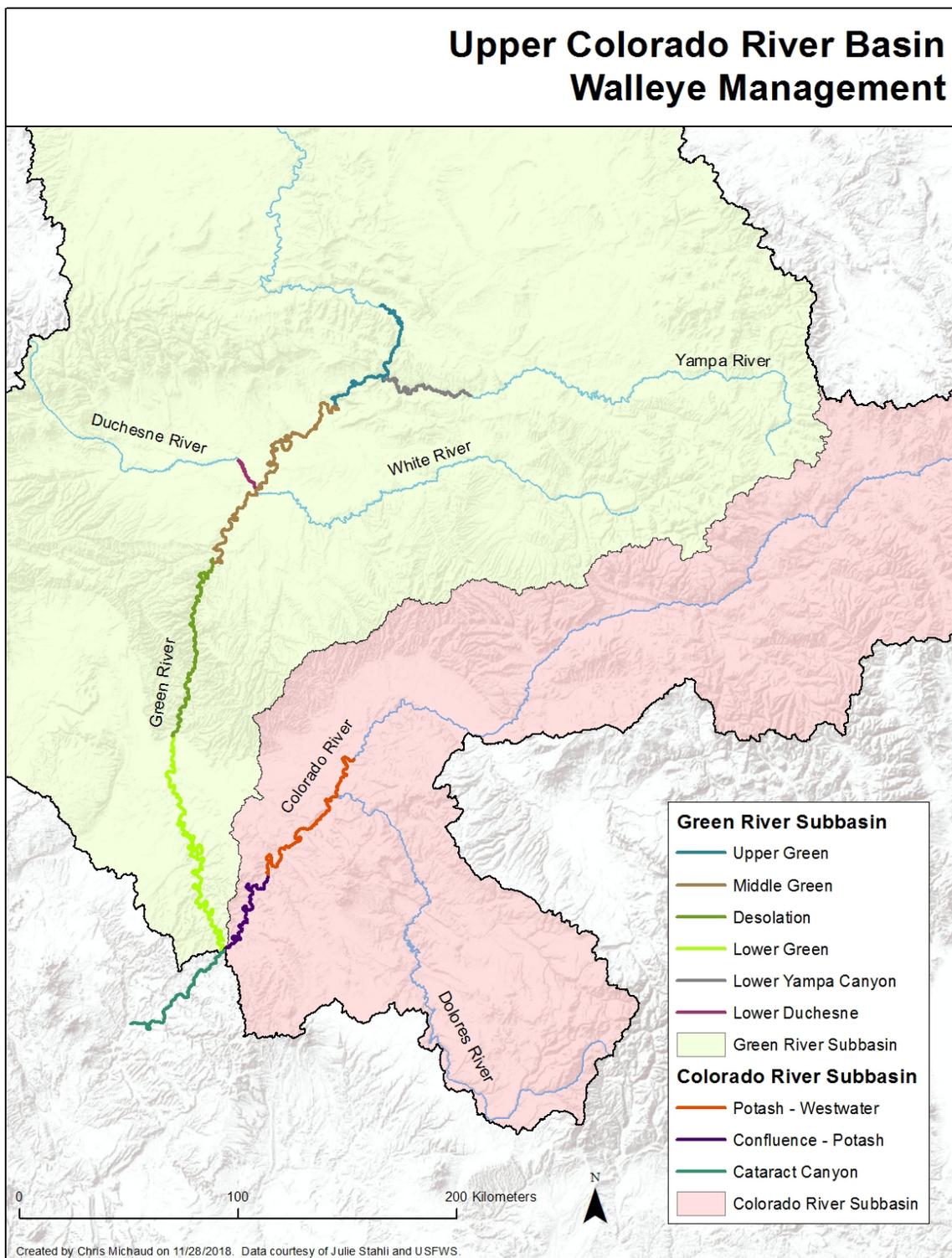


Figure 1. Green River Sub-basin (green highlight) and Colorado River Sub-basin (pink highlight) map with each of the associated removal reaches notated. Both sub-basins combined are referred to as the “Upper Colorado River Basin”.

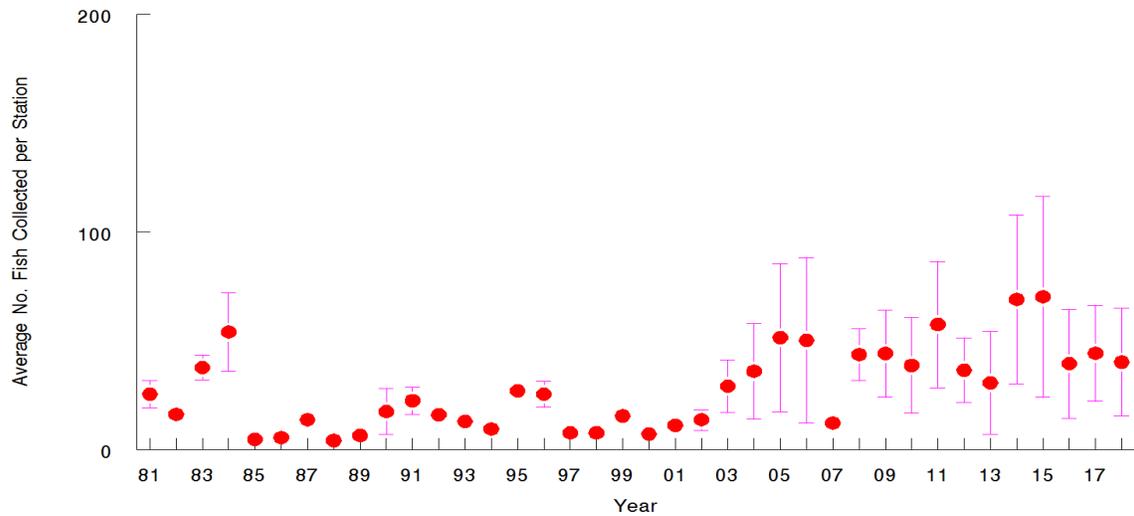
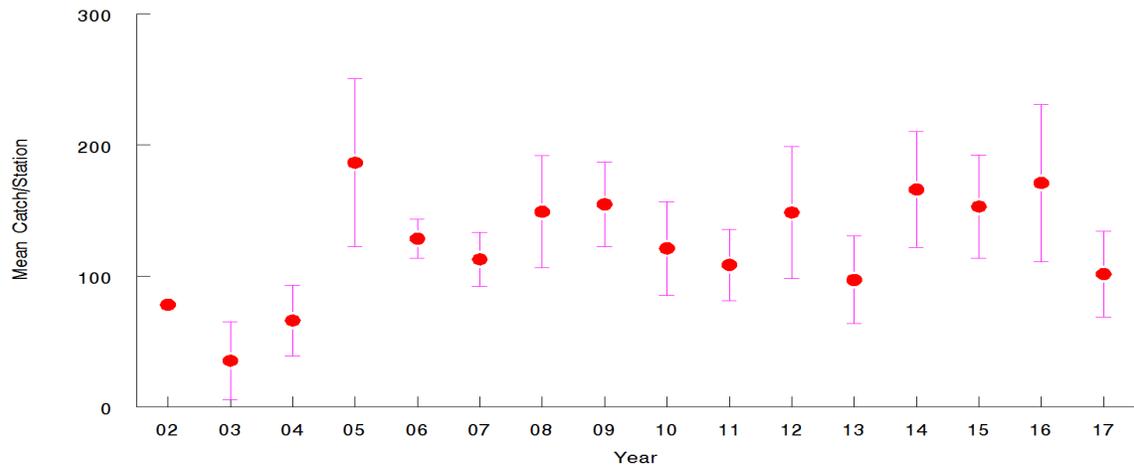


Figure 2. Upper graph: Mean catch/station of gizzard shad from the annual gill-netting survey with SE, Lake Powell, UT. 2002-2017. Lower graph: Average catch of walleye per station from the fall gill-net survey with SE, Lake Powell, UT. 1981-2018. Provided courtesy of George Blommer, UDWR Wahweap.

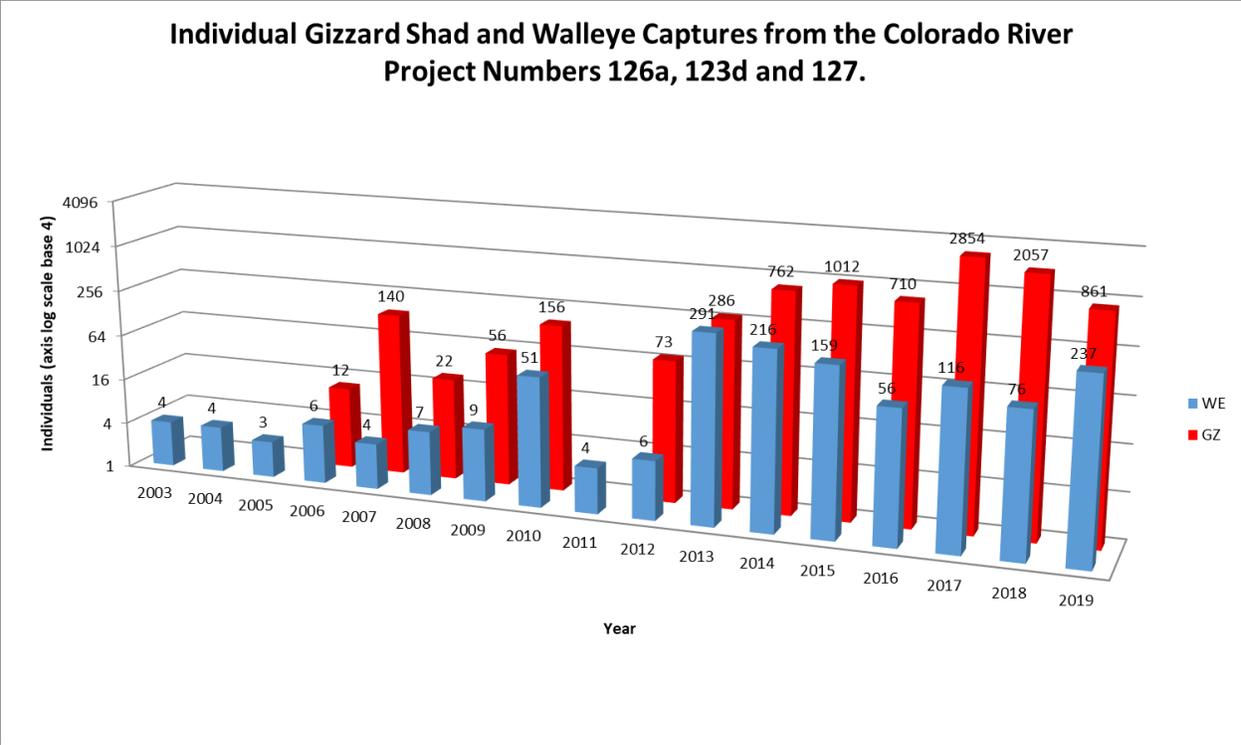


Figure 3. Individual gizzard shad and walleye captures from the Upper Colorado River; 2003-2019. Note: captures are not standardized for effort.

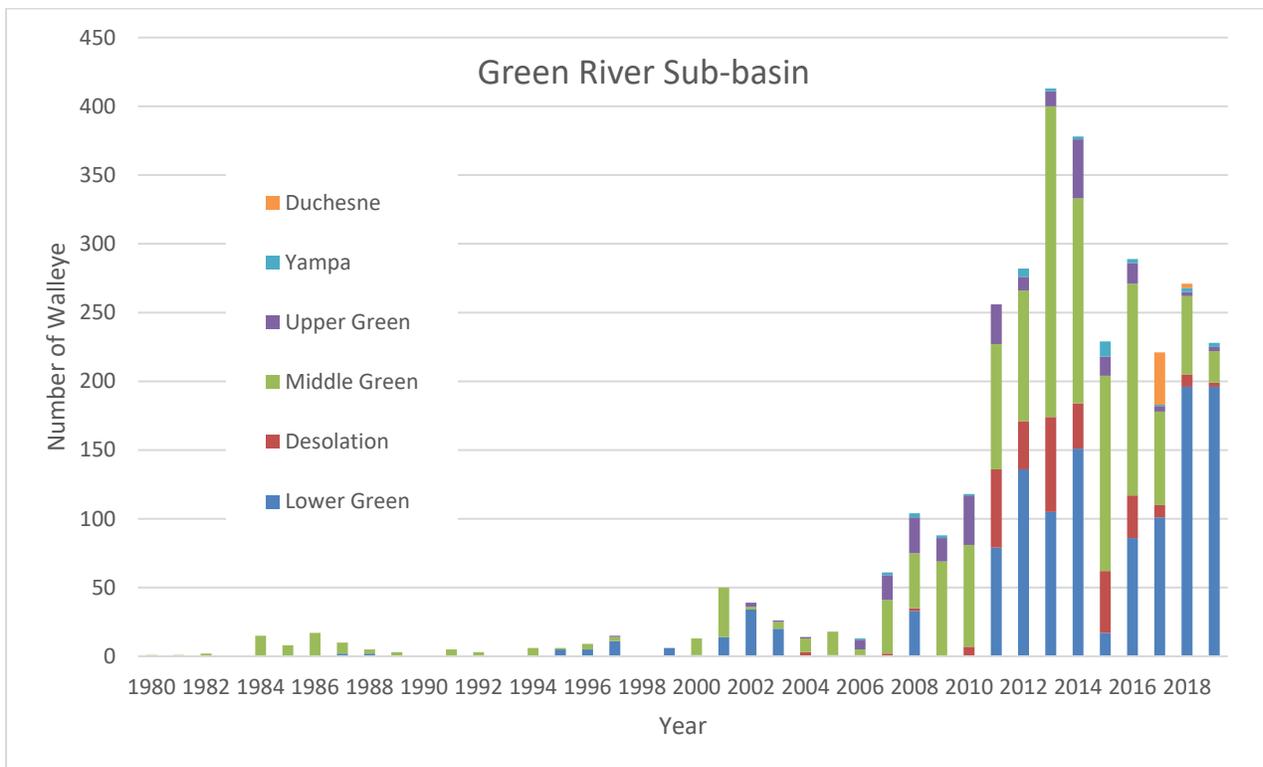
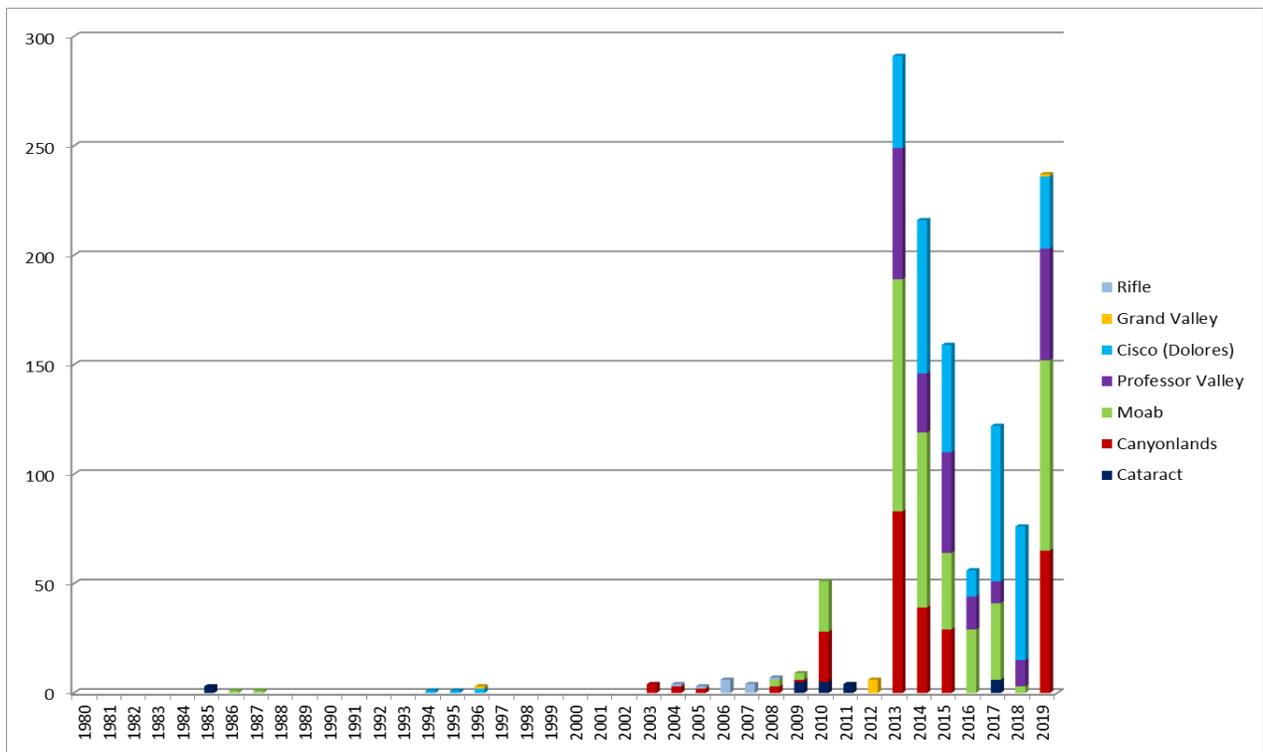


Figure 4. Annual captures of walleye in the Colorado (top graph) and Green River (bottom graph) Sub-basins. Note: captures are not standardized for effort.

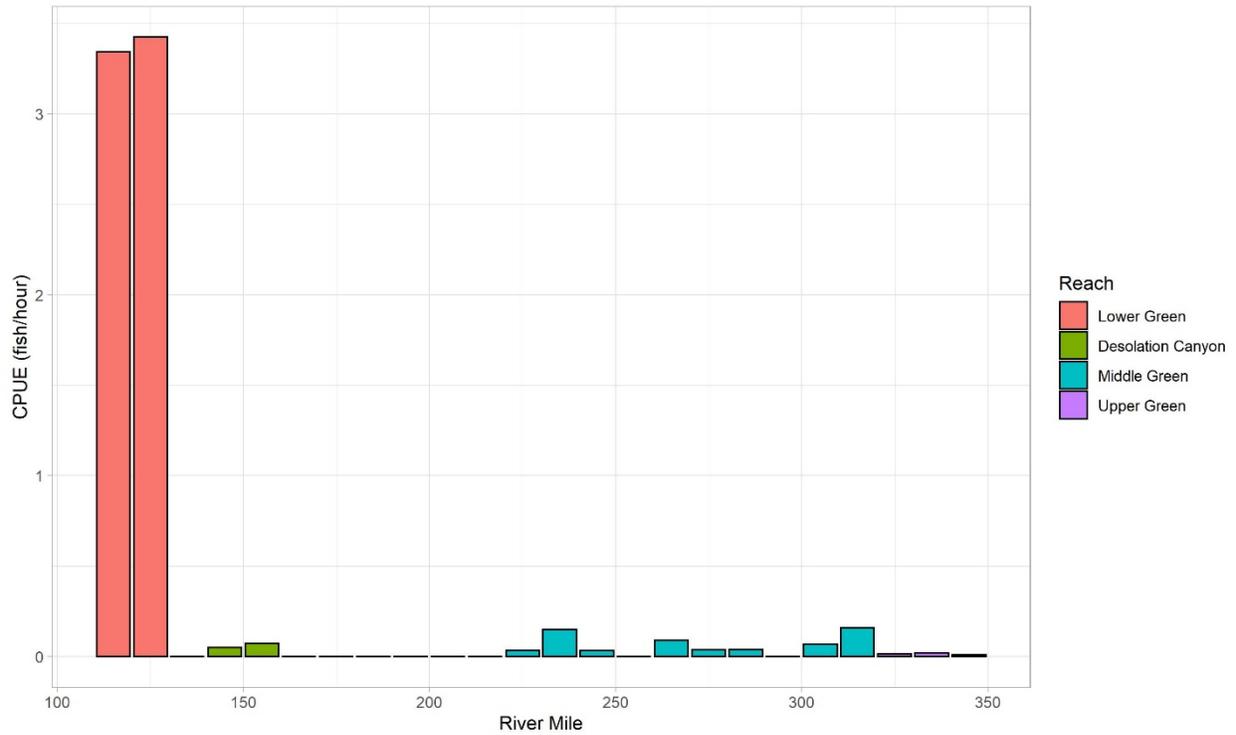


Figure 5. Catch-per-unit-effort for walleye on the Green River, 2019.

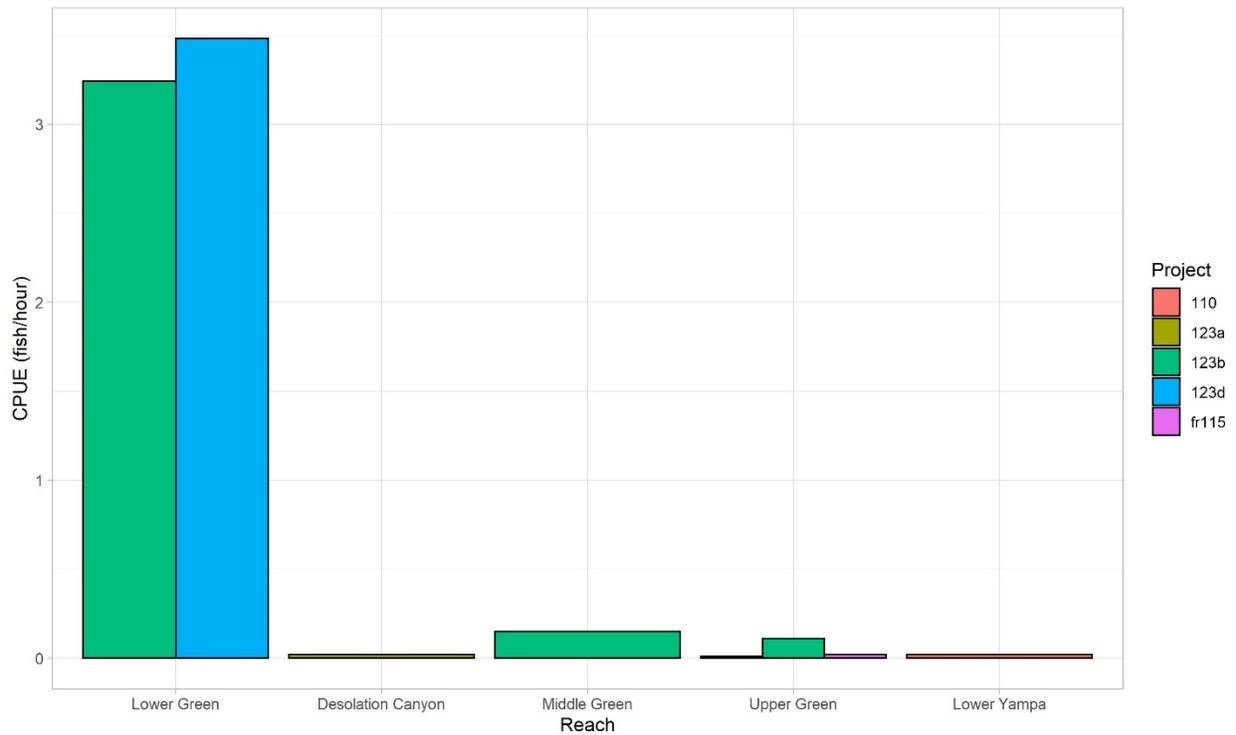


Figure 6. Catch per unit effort by project and reach in the Green River Sub-basin during 2019.

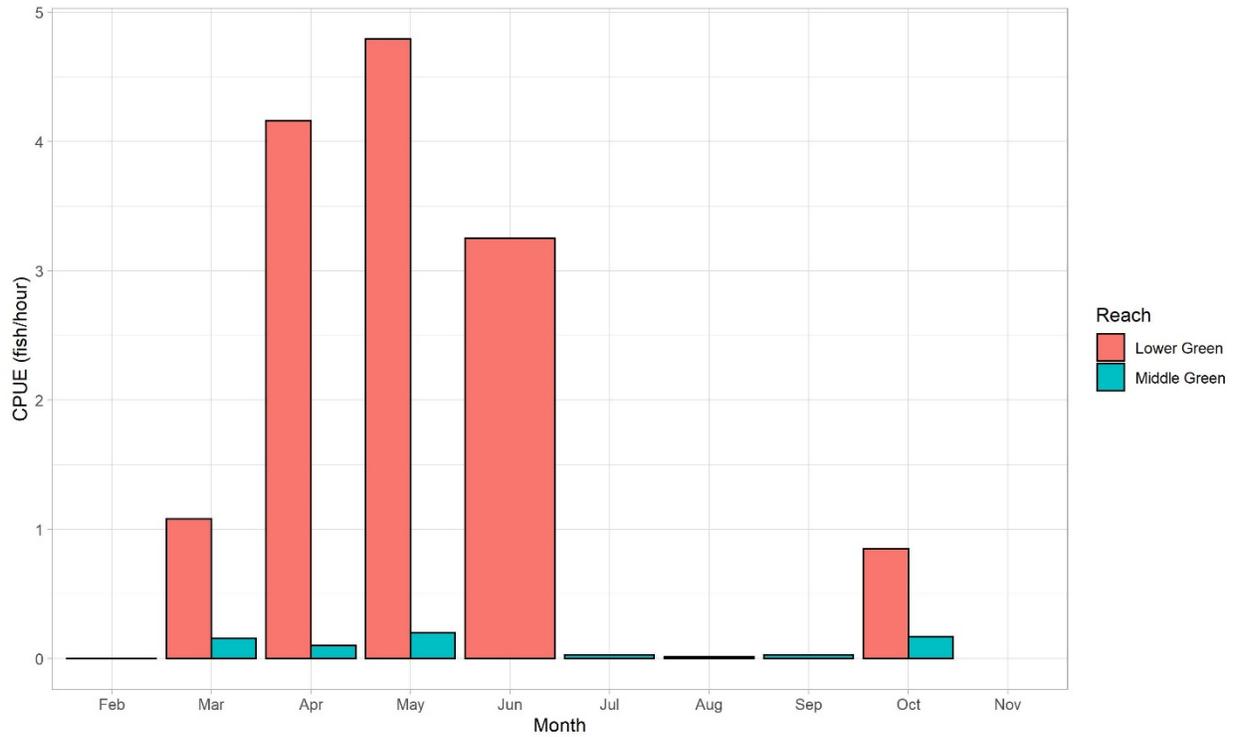


Figure 7. Temporal differences in catch rates during 2019.

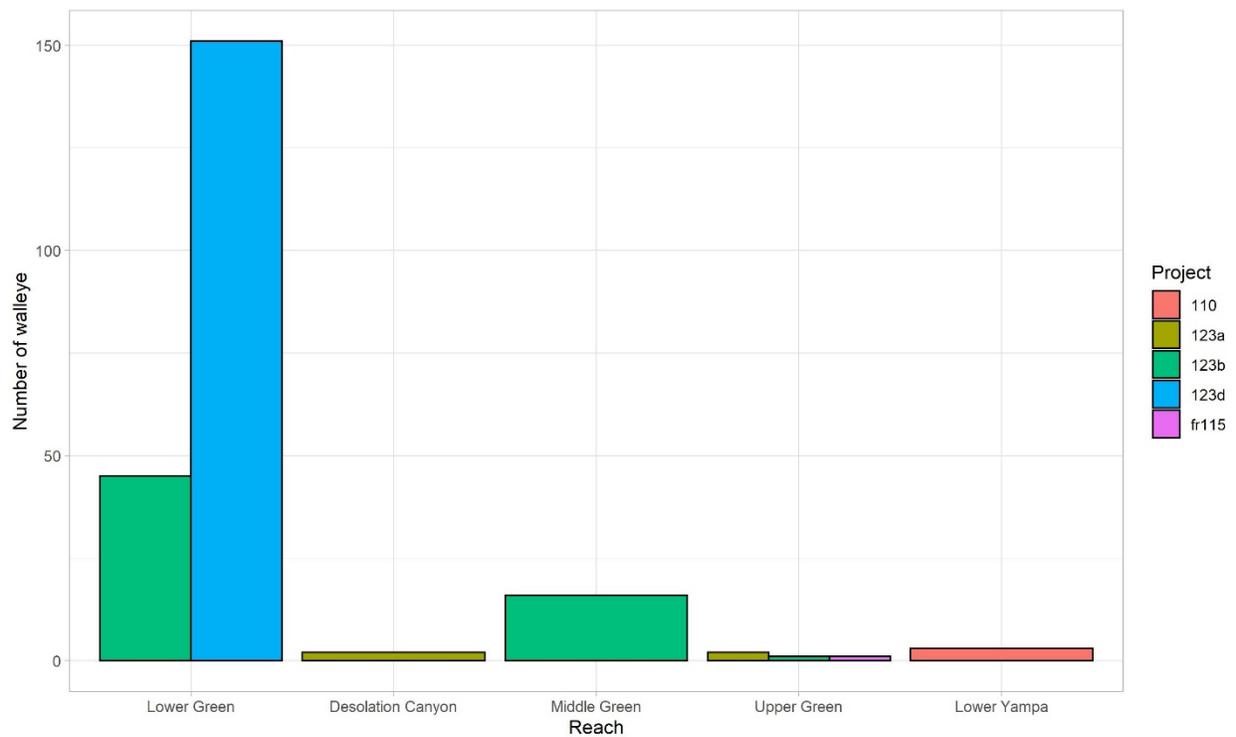


Figure 8. Number of walleye removed by reach and project in the Green River Sub-basin during 2019.

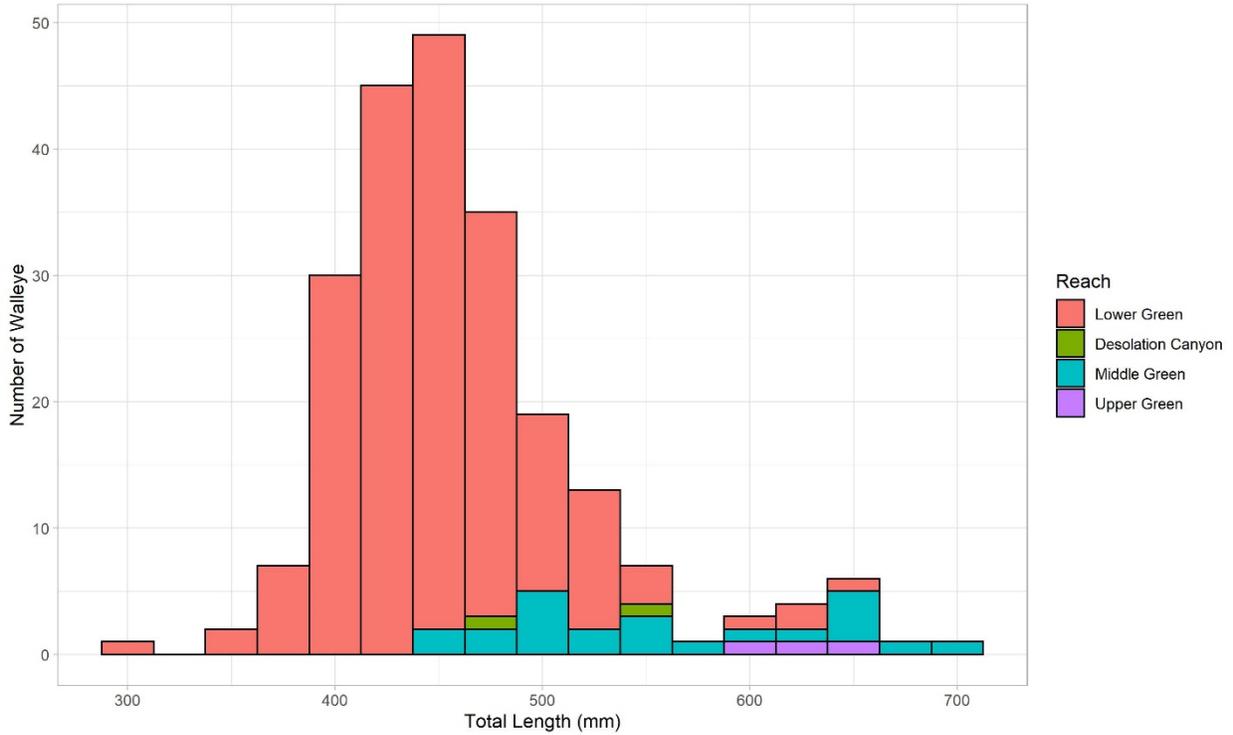


Figure 9. Length frequency histogram for walleye encountered in the Green River Sub-basin during 2019.

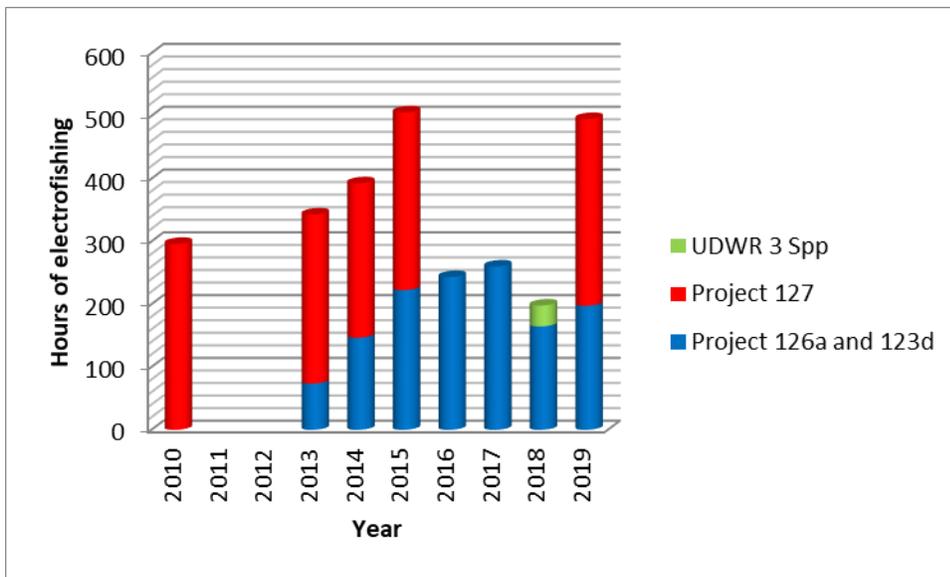
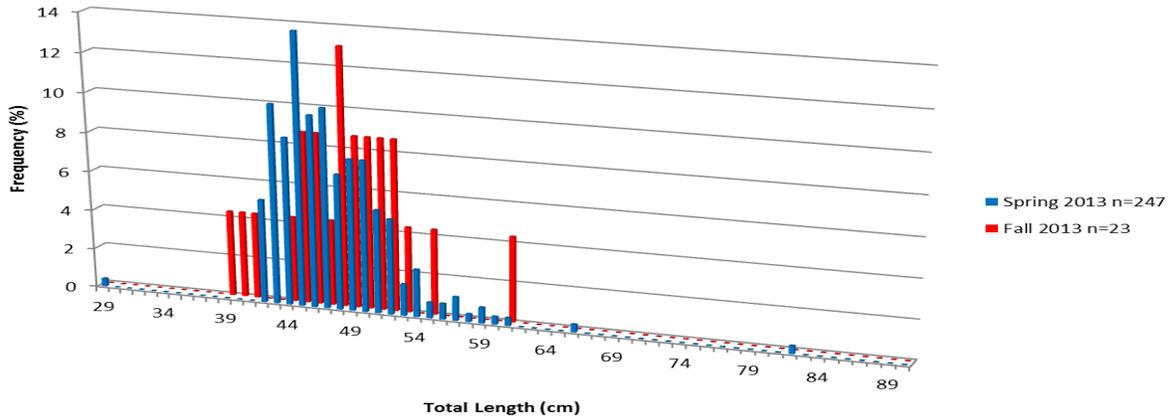
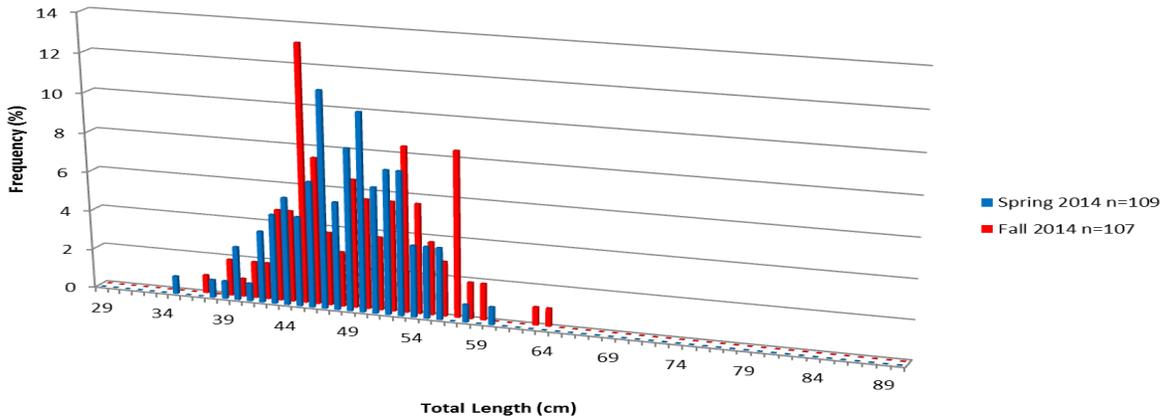


Figure 10. Total electrofishing effort expended from 2010-2019 by Colorado pikeminnow abundance estimate work (Project 127) and non-native fish removal projects (Projects 126a and 123d) in the lower 116 miles of the Upper Colorado river Sub-basin.

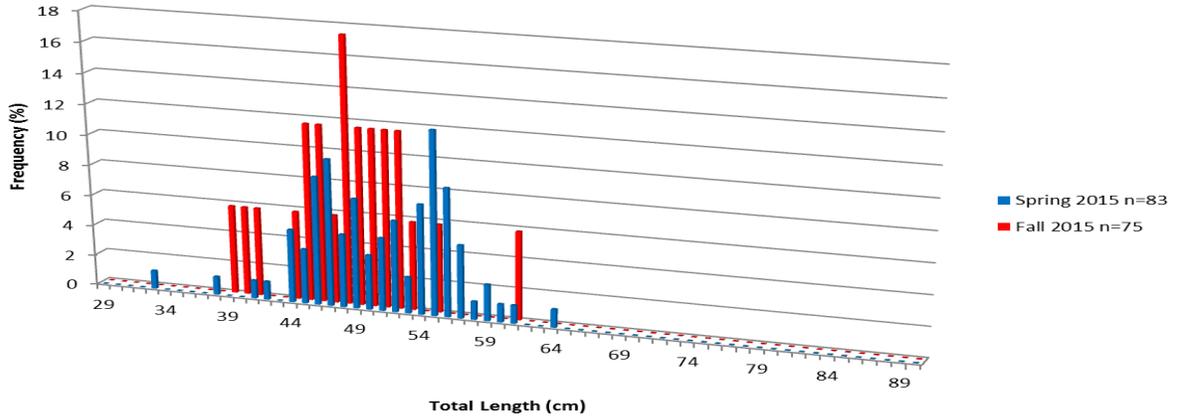
WE Length Frequency 2013 n=270



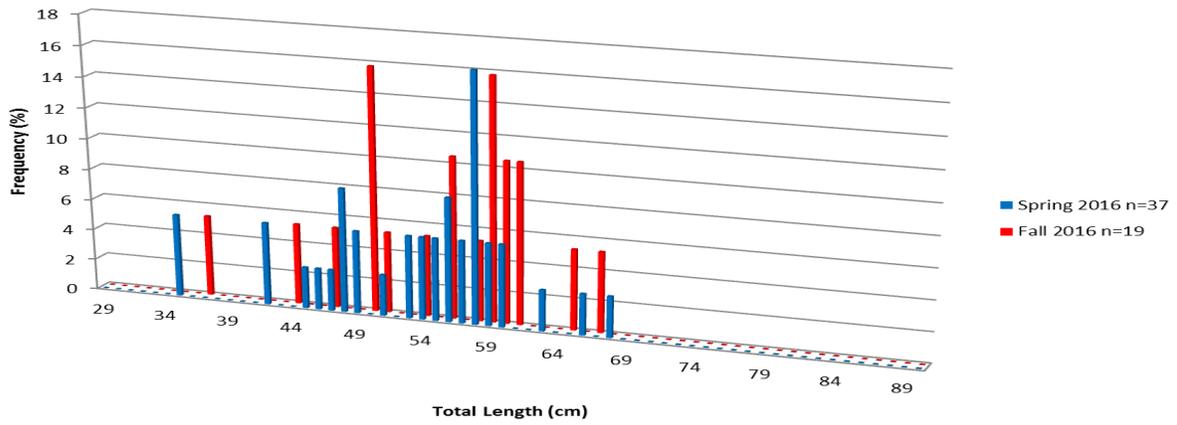
WE Length Frequency 2014 n=216



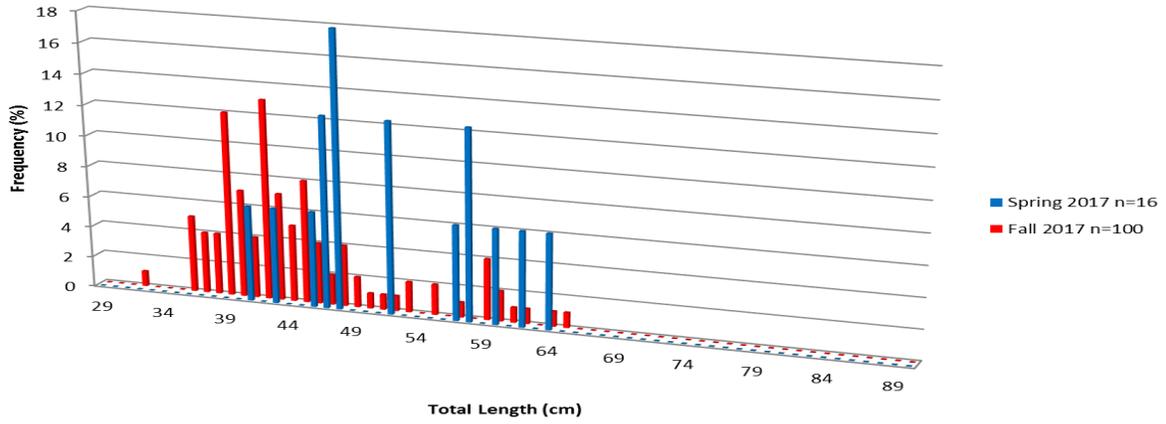
WE Length Frequency 2015
n=158



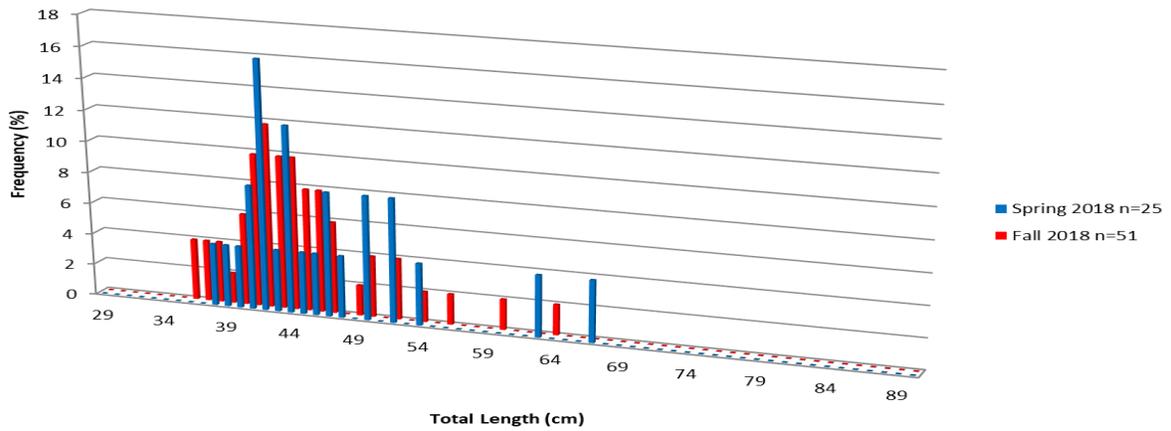
WE Length Frequency 2016
n=56



WE Length Frequency 2017
n=116



WE Length Frequency 2018
n=76



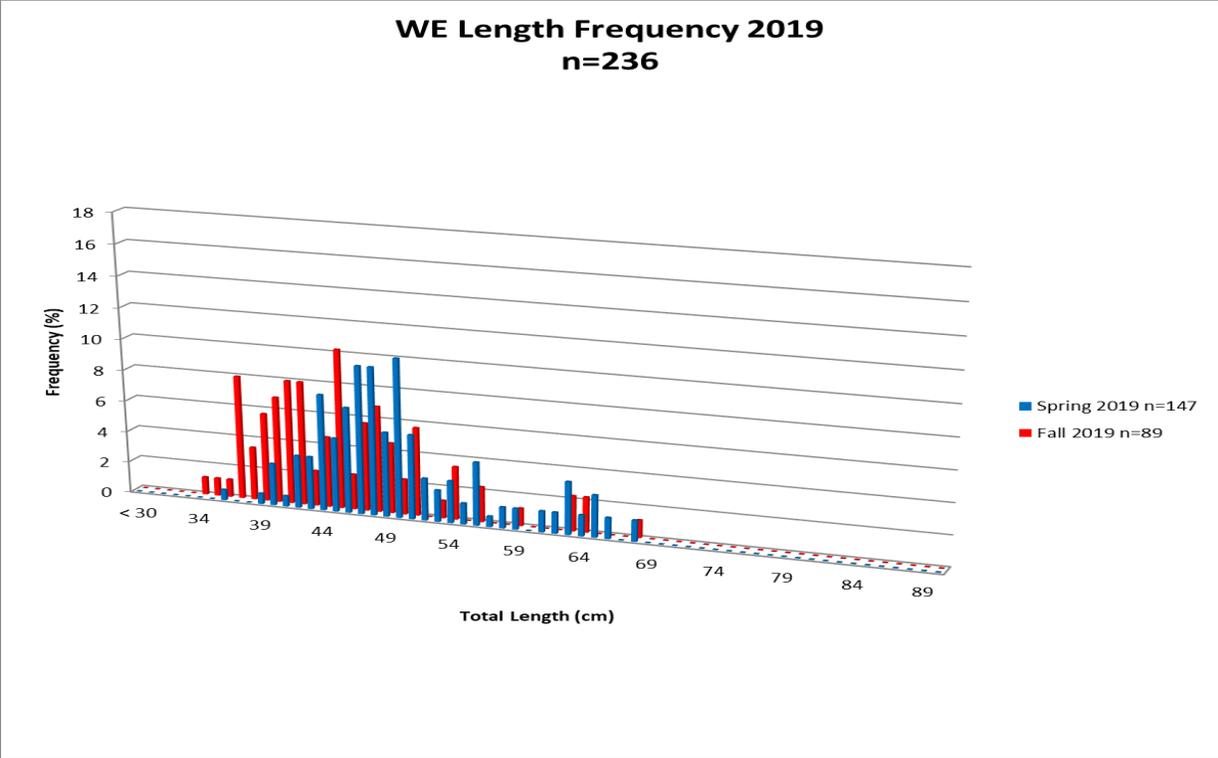


Figure 11. Length frequency histograms for walleye removed from the Colorado River from river mile 116 to the confluence of the Green River (RMI 0.0), UT 2013 through 2019.

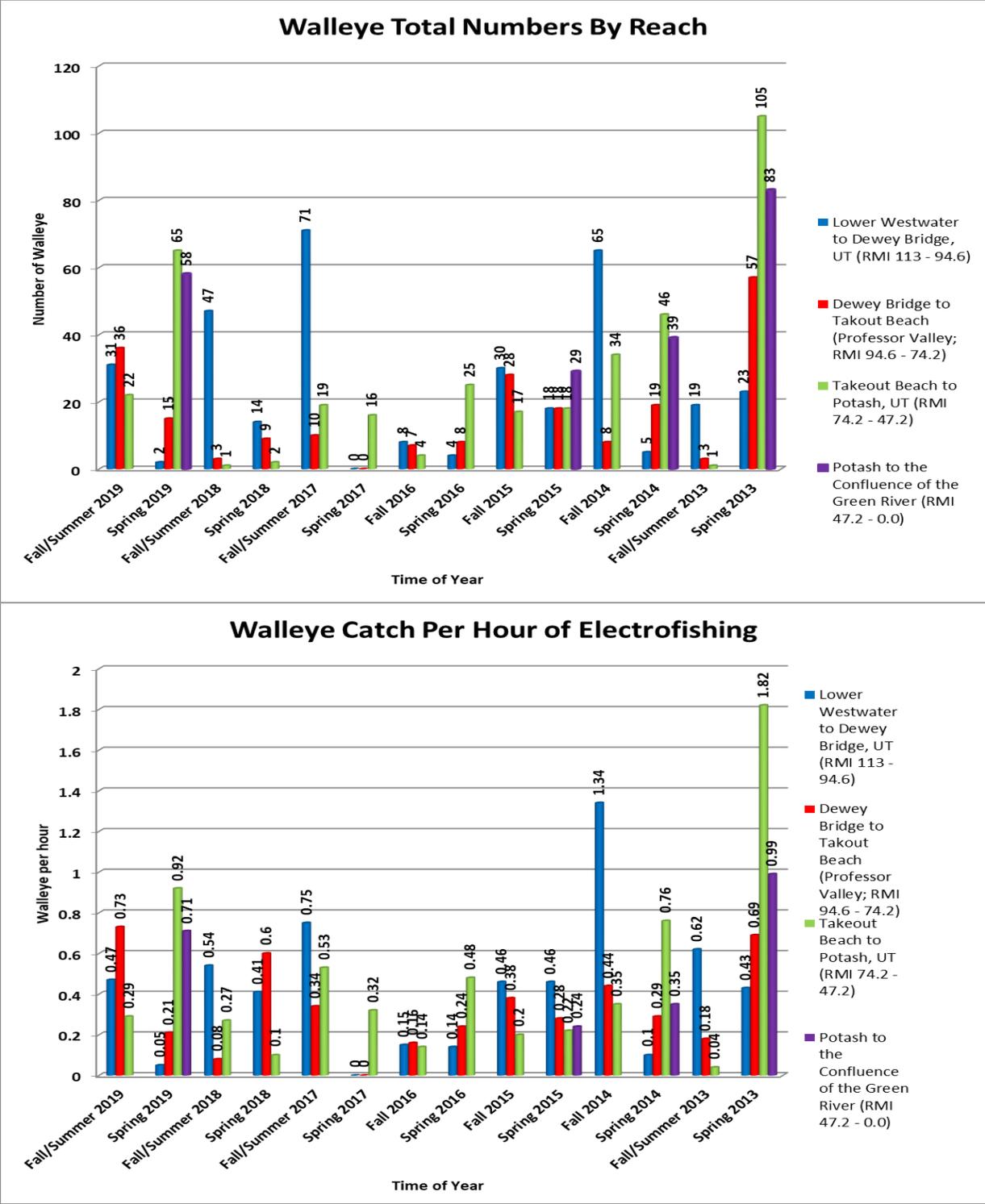
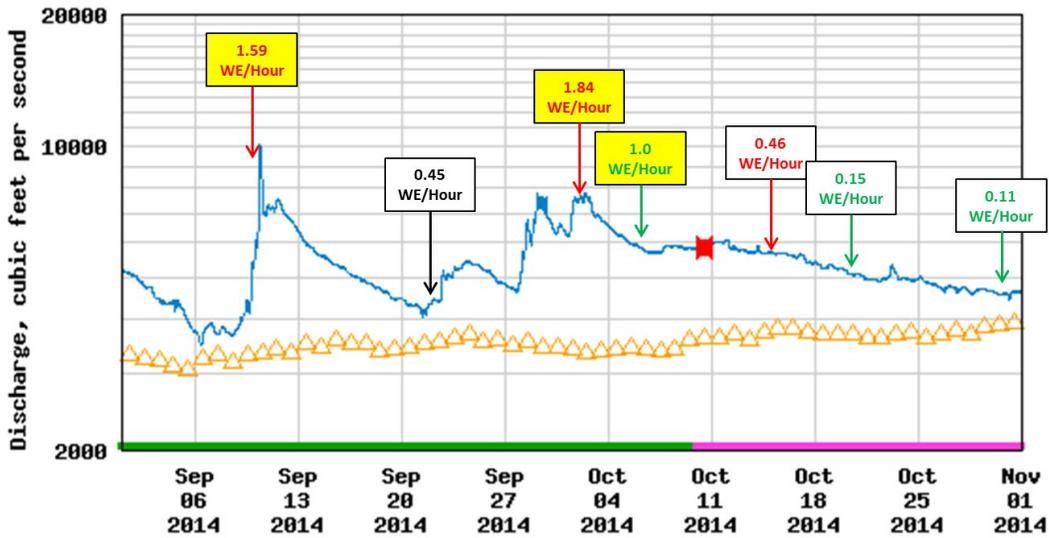


Figure 12. Walleye catch per effort and total numbers removed by season 2013-2019.



2014

USGS 09180500 COLORADO RIVER NEAR CISCO, UT



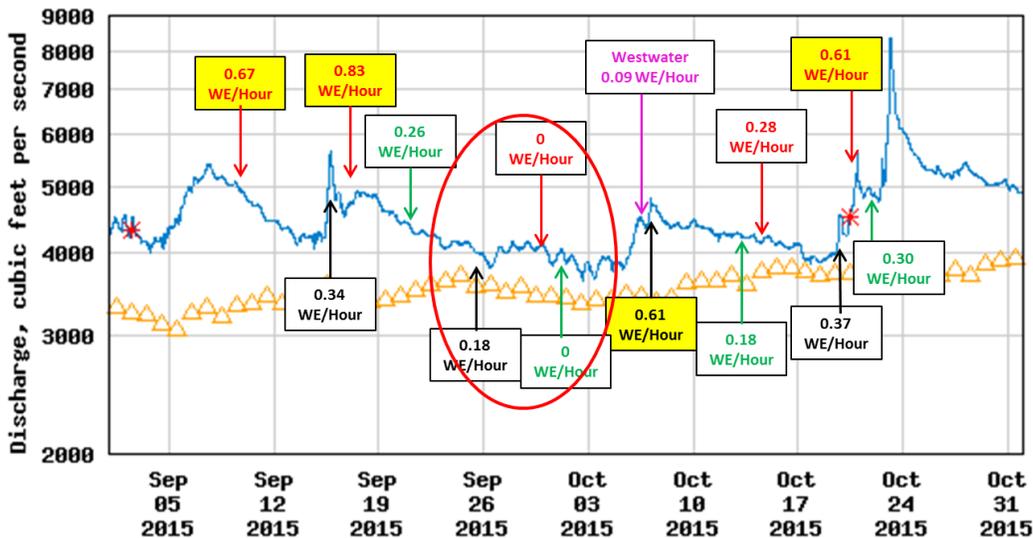
△ Median daily statistic (96 years) — Period of approved data
 — Discharge * Measured discharge
 — Period of approved data

Red Cisco to Dewey
 Black Dewey to Takeout
 Green Moab



2015

USGS 09180500 COLORADO RIVER NEAR CISCO, UT



----- Provisional Data Subject to Revision -----

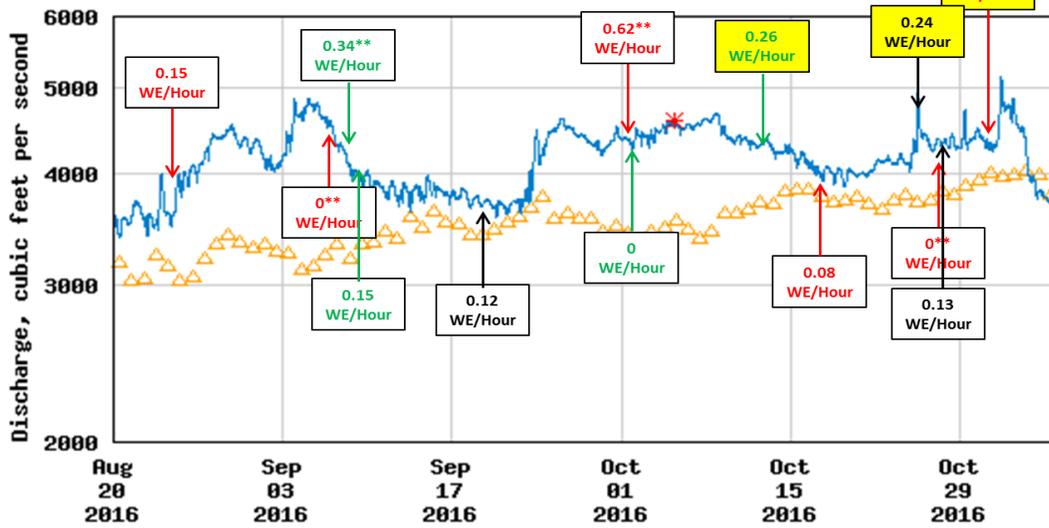
△ Median daily statistic (96 years) * Measured discharge
 — Discharge

Red Cisco to Dewey
 Black Dewey to Takeout
 Green Moab



2016

USGS 09180500 COLORADO RIVER NEAR CISCO, UT



----- Provisional Data Subject to Revision

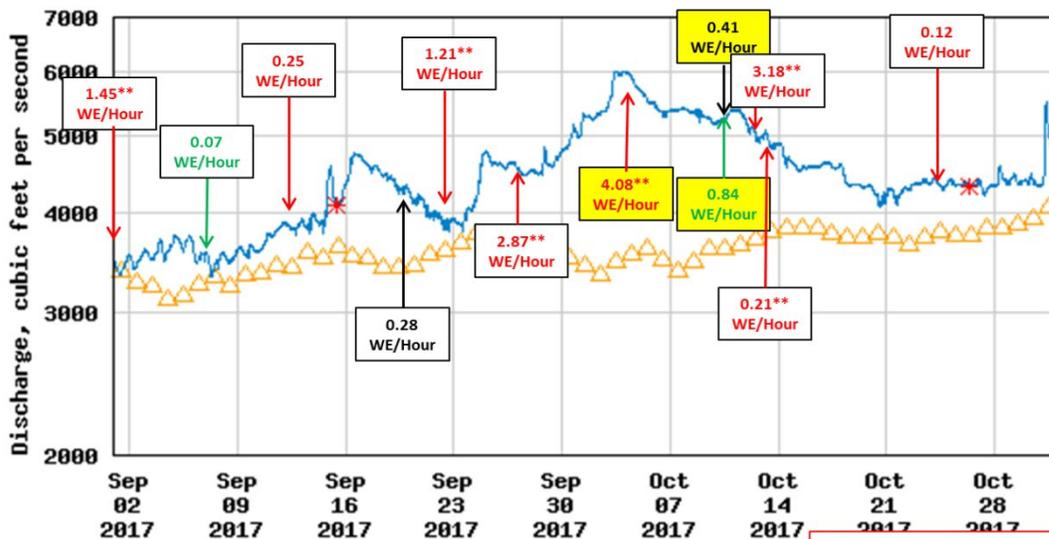
△ Median daily statistic (97 years) * Measured discharge
 — Discharge

Red Westwater to Dewey
 Black Dewey to Takeout
 Green Moab
 ** UDWR Moab shortened reaches



2017

USGS 09180500 COLORADO RIVER NEAR CISCO, UT



----- Provisional Data Subject to Revision

△ Median daily statistic (98 years) * Measured discharge
 — Discharge

Red Westwater to Dewey
 Black Dewey to Takeout
 Green Moab
 ** Shortened extra passes Bighorn Camp to Cisco

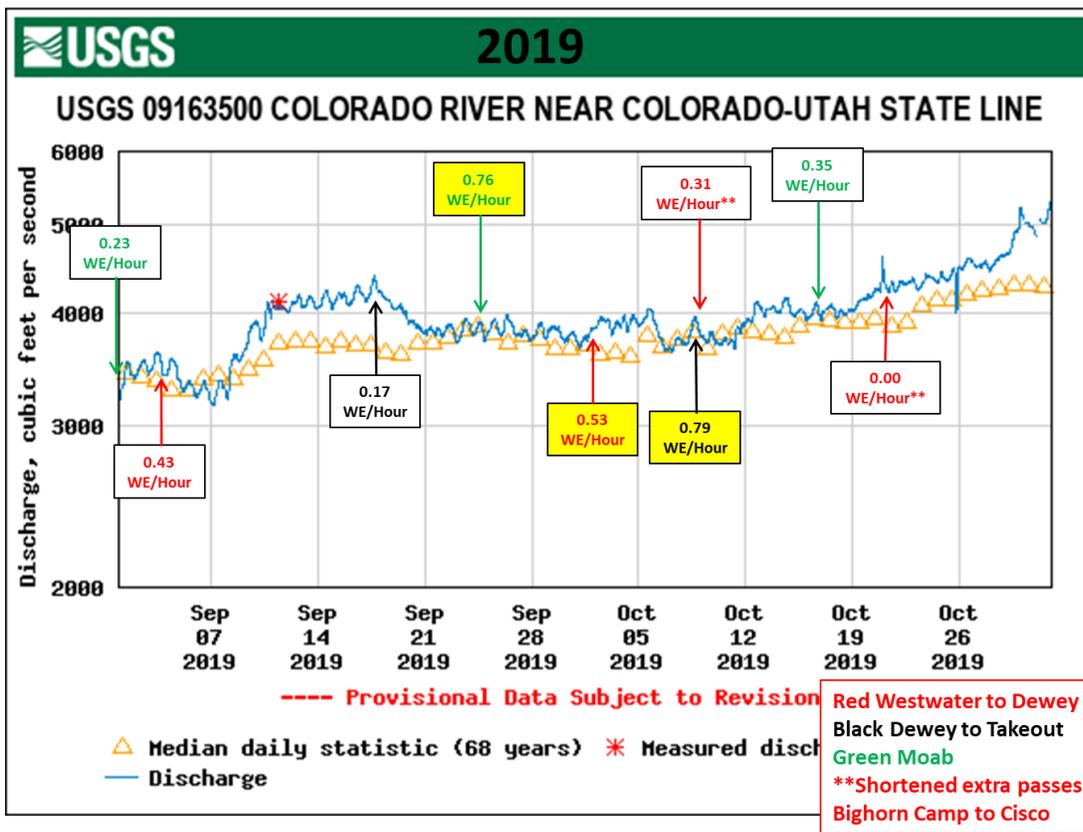
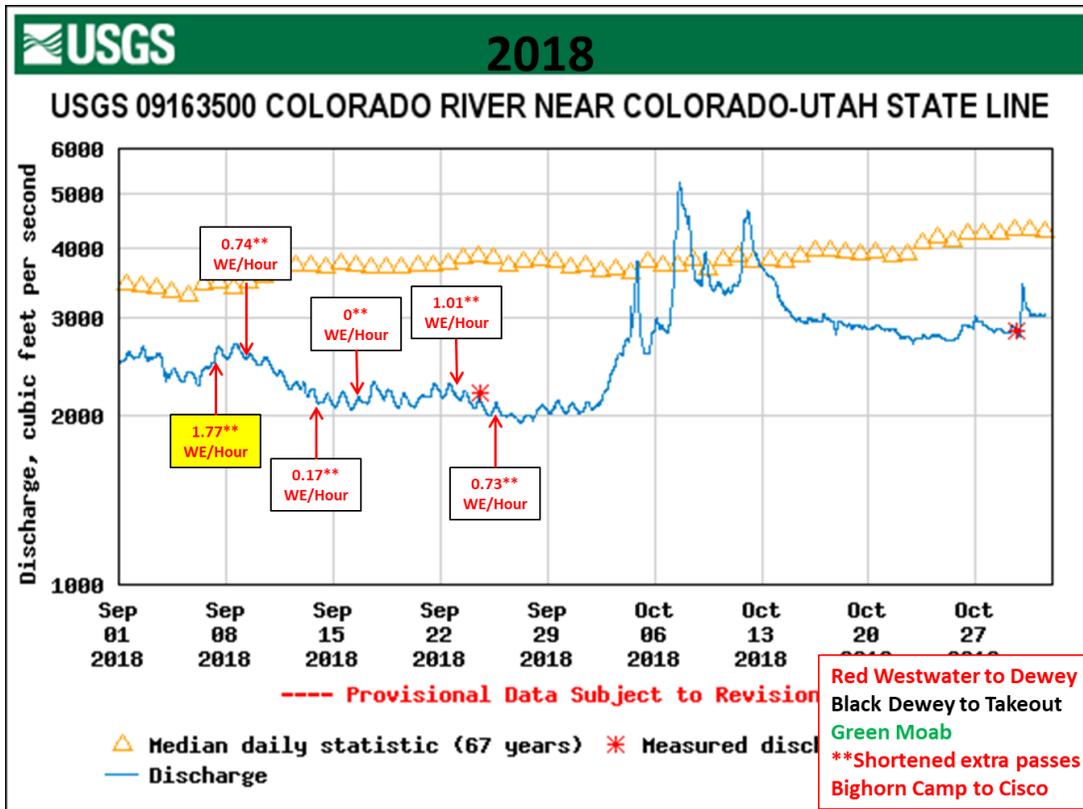


Figure 13. Fall walleye catch per effort plotted on USGS hydrograph data collected from their gauge on the Colorado River downstream of the Dolores River confluence near Dewey Bridge; 2014-2019.