

I. Project Title: **Humpback chub population estimates for Desolation/Gray Canyons, Green River Utah.**

II. Bureau of Reclamation Agreement Number: R19AP00059

Project/Grant Period: Start Date: 10/01/2018
End Date: 09/30/2019
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Is this a final report? Yes _____ No X

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IV. Abstract: Achievement of recovery goals for humpback chub calls for six self-sustaining populations in the upper and lower Colorado River basins, of which Desolation and Gray Canyons is the sole extant population in the Green River subbasin. We monitored multiple life stages of Humpback chub at four sites in Desolation and Gray Canyons with trammel nets, scented hoop nets, and submersible PIT antennas during September and October of 2019. Sites included three of the four long-term sites, with an additional site chosen from previously sampled sites. Logistical issues led to eliminating the fourth long-term site from sampling in 2019. Number of sites was reduced (four sites were sampled in 2019 as opposed to six sites in 2018) so effort could be doubled at two sites, in order to increase adult recapture rates and improve abundance estimate precision. Three-pass mark and recapture techniques were used to calculate population estimates for each individual site and then extrapolated to the entire reach. Mean catch per unit effort (CPUE) for humpback chub captured via trammel nets at all sites sampled was 0.07 fish per net hour and ranged from 0.01 to 0.18. Mean CPUE was similar to previous years when sampling occurred during fall. Hoop nets resulted in documentation of juvenile chub. The proportion of first year adult humpback chub captured was 8% and was similar to 2006 – 2015 but lower than 2018. Antennas detected 20 individual chubs. Population estimates were calculated for all sites. Three of the four sites met the previously set criteria for reliable estimates. Site population estimates ranged from 32 to 137 chub.

V. Study Schedule: Initial year 2018 – final year 2019 (calendar years).

VI. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

- V. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).
- V.A. Measure and document population and habitat parameters to determine status and biological response to recovery actions.

GREEN RIVER ACTION PLAN: MAINSTEM

- V. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).
- V.A. Conduct research to acquire life history information and enhance scientific techniques required to complete recovery actions.
- V.B. Conduct population estimate for humpback chub.
- V.B.1. Desolation/Gray

VII. Accomplishments of FY19 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Complete three sampling trips in Desolation/Gray Canyon from August to October 2019

Three sampling passes were completed through Desolation and Gray Canyons on 9/12–9/19/19, 9/27–10/4/19, and 10/9–10/16/19. Mean daily flows during sampling ranged from 2480 – 2720 cubic feet per second (USGS gauge #09315000, Green River at Green River). Average water temperatures measured on site during each pass were 19° C, 13° C, and 11° C respectively.

Sampling sites included three of the four long-term trend sites (Cedar Ridge, Cow Swim, Coal Creek) and one site selected from those previously sampled during the 2001-2015 sampling (Wild Horse). Specific site locations were at river miles 185.0 (Cedar Ridge), 178.5 (Wild Horse), 160.0 (Cow Swim), and 145.5 (Coal Creek). All sites were sampled with trammel nets (eight per site), scented hoop nets (15 per site), and submersible PIT antennas (two per site). Twelve antennas were deployed during the first pass and retrieved during the third pass. Effort was increased at Cedar Ridge and Cow Swim by sampling an additional night during each pass to increase captures and recaptures. Wild Horse and Coal Creek were sampled a single night each pass.

Task 2: Data entry, analysis, and reporting:

The 2019 compiled and quality checked data will be transferred to the UCREFRP database manger by January 15, 2020.

Total effort included 1543 trammel net hours, 4700 hoop net hours, and 4977 antenna set

hours over three passes (Table 1). Humpback chub were captured at all locations. Trammel and hoop nets resulted in the capture of 107 individual humpback chub; 106 adults and one juvenile. Antennas detected 20 individual humpback chub. Mean catch per unit effort (CPUE) for trammel nets at all sites was 0.07 fish per net hour and ranged from 0.01 to 0.18 (Table 2). Mean CPUE at all sites was similar to the means of previous fall sampling years suggesting a stable population (Figure 1). Total length of chubs captured ranged from 154 to 360 mm (Figure 2). The single juvenile humpback chub was captured with hoop nets. The proportion of first year adult (200-220 mm) humpback chub captured was 8% and was similar to 2006 – 2015 but lower than 2018 (Figure 3).

Due to landowner access concerns Cedar Ridge was sampled approximately 0.5 miles upstream of the historic location during pass one. Thus, results from pass one at Cedar Ridge were not included in any totals or analyses with the exception of length frequency and are summarized here separately. Total effort from pass one included 215 trammel net hours, and 639 hoop net hours, and 356 antenna hours. One adult humpback chub was captured in a trammel net.

Extreme weather conditions during the second pass prevented sampling during the first morning at Cedar Ridge resulting in less effort than expected.

Table 1. Effort for each gear type, total number of captures and/or encounters of identified humpback chub, and unidentifiable juvenile chub (*Gila sp.*) in Desolation and Gray Canyons, 2001 – 2019. All captures and encounters from all sampled sites are included except antenna detections; only the total number of individuals detected is reported

Year	Month (passes)	# Sites sampled	Trammel nets		Submersible Antennas		Hoop net/minnow trap		Electrofishing	
			Hours	HBC	Hours	HBC	Hours	HBC (<i>Gila sp.</i>)	Hours	HBC
2001	6-7 (3)	12	2803	214	-	-	-	-	8	3
2002	6-7 (3)	12	2008	239	-	-	1440	6 (1)*	22.5	38
2003	9-10 (3)	12	3042	236	-	-	1946	4 (1)*	11	1
2006	9-10 (3)	12	3289	119	-	-	729	9	16.4	12
2007	9-10 (3)	12	2727	130	-	-	988	6	-	-
2010	9-10 (3)	5	1163	68	-	-	-	-	7	5
2011	9-10 (3)	6	1013	55	-	-	-	-	6.4	8
2014	9-10 (3)	6	1276	99	471	11	346	15 (1)	9.3	6
2015	9-10 (3)	6	1596	85	1567	20	1825**	10 (7)	-	-
2018	9-10 (3)	6	1883	105	6402	27	4658	24 (4)	-	-
2019	9-10 (3)	4	1543	104	4977	20	4700	22	-	-

*Includes minnow trap capture and effort

**Hoop net effort from trip 1 not included in total due to incorrect setup

Table 2. Catch per unit effort (fish per net hour) of humpback chub by site and pass from trammel net sampling in Desolation and Gray Canyons, 2019.

Pass	Site	CPUE	Standard Error
1	Cedar Ridge*	0.004	0.05
	Coal Creek	0.01	0.01
	Cow Swim	0.07	0.02
	Wild Horse	0.06	0.03
2	Cedar Ridge	0.16	0.05
	Coal Creek	0.12	0.04
	Cow Swim	0.02	0.01
	Wild Horse	0.14	0.04
3	Cedar Ridge	0.02	0.01
	Coal Creek	0.18	0.05
	Cow Swim	0.06	0.02
	Wild Horse	0.04	0.02

*data not included in analyses or totals reported elsewhere in this report

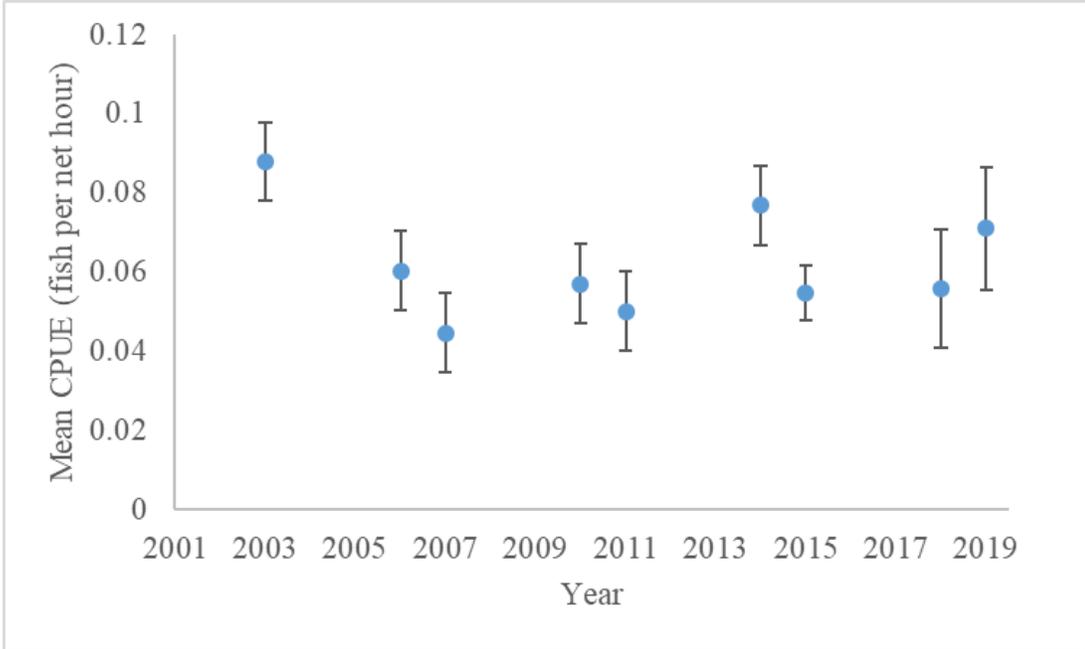


Figure 1. Mean trammel net catch per unit effort of humpback chub in Desolation and Gray Canyons of all sites sampled during years when sampling occurred in fall.

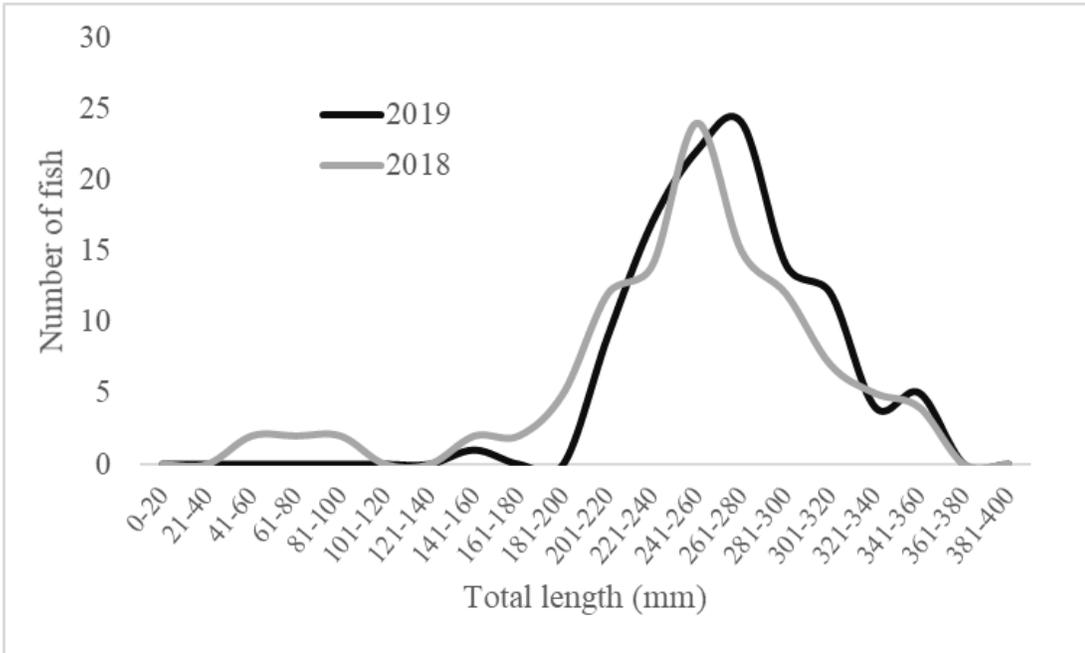


Figure 2. Length frequencies of humpback chub captured by trammel and hoop nets in Desolation and Gray Canyons, 2018 and 2019.

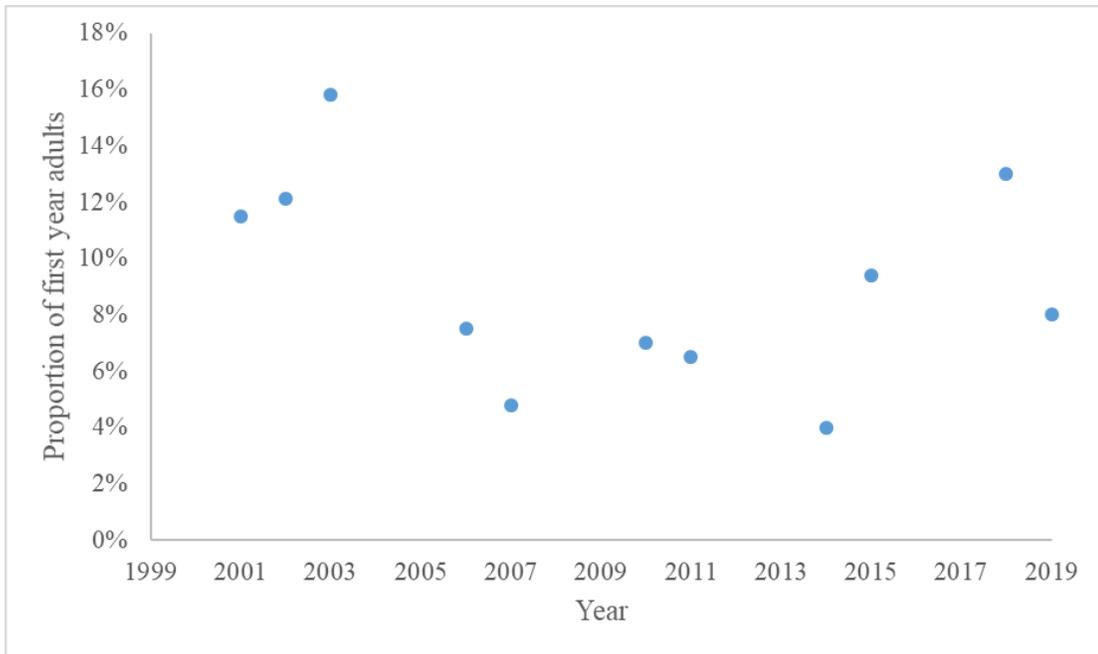


Figure 3. Proportion of total number of adult chubs (>200 mm) captured that were first year adults (200–220 mm), 2001 – 2019.

Closed population estimates were calculated for all sites with Program MARK using the Huggins p (capture probability) and c (recapture probability) model. Three of the four sites (Cedar Ridge, Cow Swim and Coal Creek) met the previously established criteria for reliable estimates; at least 15 individuals and 2 recaptures (Table 3). Three models were developed for each site: M_0 (constant capture probability; $p(.)=c(.)$), M_t (time varying capture probability; $p(t)=c(t)$), and M_b (behavioral response; capture probability differs from recapture probability; $p(.),c(.)$). Model averaging was used for all parameter and population estimation. Program MARK’s output for all models used are summarized in Table 4. Population estimates are reported for all sites and summarized in Table 5. Parameters estimates are summarized in Table 6. The population estimate for Wild Horse should be interpreted with caution, as it did not meet the criteria for a reliable estimate.

Table 3. Total number of all humpback chub captured with hoop nets and trammel nets and the total number of recaptures by site.

Site	Individuals captured	Recaptures
Cedar Ridge	20	2
Wild Horse*	21	1
Cow Swim	32	2
Coal Creek	34	3

*Did not meet reliable estimate criteria of at least 15 captures and two recaptures

Table 4. Program MARK Huggins p and c model output by site for all models used in population estimation. Models are listed from top to bottom by AIC weight (highest to lowest).

Site	Model	AICc	AIC weighted	Model likelihood	Number of Parameters	Deviance
Cedar Ridge	p(.),c(.)	33.548	0.491	1.00	2	84.67
	p(t)=c(t)	33.548	0.491	1.00	1	84.67
	p(.)=c(.)	40.062	0.019	0.04	1	93.40
Wild Horse	p(t)=c(t)	55.816	0.480	1.00	3	92.24
	p(.)=c(.)	56.280	0.380	0.79	1	97.04
	p(.),c(.)	58.282	0.140	0.29	2	96.91
Cow Swim	{p(.),c(.)	85.744	0.526	1.00	2	166.13
	{p(t)=c(t)	87.271	0.245	0.47	3	165.53
	{p(.)=c(.)	87.402	0.229	0.44	1	169.88
Coal Creek	p(t)=c(t)	89.546	0.979	1.00	3	179.41
	p(.)=c(.)	97.221	0.021	0.02	1	191.29

Table 5. Summary by site of Desolation and Gray Canyons humpback chub population estimates, the associated standard errors, and confidence intervals generated in program MARK for 2019. Model averaging was used to generate all estimates.

Site	Population estimate	Standard error	Lower 95% confidence interval	Upper 95% confidence interval
Cedar Ridge	32	12	0	71
Wild Horse*	137	133	0	407
Cow Swim	109	61	0	321
Coal Creek	130	65	2	259

*Did not meet reliable estimate criteria of at least 15 captures and two recaptures

Table 6. Capture probability (p) and recapture probability (c) estimates generated in program MARK using model averaging humpback chub mark and recapture data from Desolation and Gray Canyons, 2019.

Site	Parameter	Parameter estimate	Standard error	Lower 95% confidence interval	Upper 95% confidence interval
Cedar	p ₁	0.60	0.16	0.14	0.94
	p ₂	0.47	0.09	0.05	0.94
	c ₁	0.12	0.08	0.03	0.37
Wild Horse*	p ₁	0.06	0.07	0.00	0.71
	p ₂	0.08	0.09	0.00	0.64
	p ₃	0.05	0.06	0.00	0.77
	c ₁	0.06	0.06	0.01	0.39
	c ₂	0.04	0.04	0.00	0.24
Cow Swim	p ₁	0.24	0.10	0.04	0.71
	p ₂	0.23	0.09	0.03	0.72
	p ₃	0.23	0.09	0.03	0.73
	c ₁	0.05	0.04	0.01	0.19
	c ₂	0.05	0.03	0.01	0.18
Coal	p ₁	0.03	0.02	0.01	0.13
	p ₂	0.11	0.06	0.03	0.29
	p ₃	0.14	0.08	0.05	0.37
	c ₁	0.11	0.06	0.03	0.29
	c ₂	0.14	0.08	0.05	0.37

*Did not meet reliable estimate criteria of at least 15 captures and two recaptures

The mean site density of 102 fish per site was extrapolated across the 63 available habitats (Badame 2012) found in Desolation and Gray Canyons for a reach-wide population estimate of 6426 humpback chub and was higher than the 2018 estimate (4410). However, the reach-wide estimate should be interpreted with caution given that one of the sites did not meet the set criteria and there were large standard errors associated with the individual site estimates. In addition, four sites only represent 6% of the 63 total sites and the accepted standard for representation is 20%.

The large standard errors and confidence intervals associated with the site estimates reinforces the difficulty of generating an accurate reach-wide population estimate. Increasing effort in all sampling methods, as previously recommended, successfully resulted in capturing more fish in a variety of size classes in 2018. Further increasing effort in 2019 at two sites resulted in both of those sites meeting the criteria for reliable estimates. Thus, a large amount of effort is necessary at each sampling site to obtain accurate site estimates.

Task 3: Final Report

A final report will be prepared in 2020 detailing the sampling that occurred in 2018 and 2019.

VIII. Additional noteworthy observations:

A large quantity of filamentous algae was present in the river and drifting into trammel nets at Cow Swim and Coal Creek during the first pass. The algae appeared to saturate some nets and may have negatively influenced catch rates.

Access to river left Ute Reservation property in Desolation and Gray Canyons is currently not an option, which resulted in no sampling at Log Cabin and sampling in a different Cedar Ridge location during pass 1 in 2019. However, locations on river right public property where long-term trend sites are accessible have been identified and can be used for future sampling.

Other endangered and native species encountered during sampling are summarized in Table 7. Non-native species encountered during sampling are summarized in Table 8.

Table 7. Non-target endangered and native species encountered during Desolation and Gray Canyons humpback chub sampling with trammel nets and hoop nets, 2019.

	Bonytail	Colorado pikeminnow	Razorback sucker	Bluehead sucker	Flannelmouth sucker
Trammel nets	13	5	37	195	458
Hoop nets	0	0	0	0	0
Total	13	5	37	195	458

Table 8. Non-native species encountered during Desolation and Gray Canyons humpback chub sampling with trammel nets and hoop nets, 2019.

	Black bullhead	Black crappie	Channel catfish	Common carp	Green sunfish	Smallmouth bass	Walleye
Trammel nets	6	17	393	38	3	59	1
Hoop nets	2	1	153	0	1	0	0
Total	8*	18*	546	38	4*	59*	1*

*removed

IX. Recommendations:

- Trammel nets, however stressful to fish, continue to account for the majority of adult humpback captures and therefore should continue to be used in sampling.

Continue to schedule sampling passes to avoid water temperatures above 22° C.

- The large hoop net sampling effort in 2019 did not result in the quantity of juveniles and young-of-the-year that it did in 2018. However, a single juvenile was captured in 2019 providing evidence of reproduction. Additionally, several adults were captured. The large hoop net effort should continue so reproduction and recruitment can be monitored and to supplement adult trammel net captures.
- Increasing effort in 2018 resulted in more chub captures, better documentation of reproduction and recruitment but failed in improving site estimates. Further increasing effort at individual sites in 2019 resulted in three of the four sites meeting the set criteria. Future sampling should plan for multiple nights at all sites sampled.
- Given the difficulty to obtain a reasonable reach-wide population estimate, it may be beneficial to change recovery goals for this specific population to metrics that are more feasible to monitor such as reproduction, recruitment, survival, CPUE, and population estimates specific to individual sites.

X. Project Status: Project is on track and ongoing.

XI. FY 2019 Budget Status

- A. Funds Provided: \$114,641
- B. Funds Expended: \$94,697
- C. Difference: \$19,944 (funds provided to complete final report)
- D. Percent of the FY 2019 work completed: 83%; projected costs to complete: \$19,944 for final report
- E. Recovery Program funds spent for publication charges: \$0

XII. Status of Data Submission: The 2019 compiled and quality checked data will be transferred to the STReAMS database manger by January 15, 2020.

XIII. Signed: John Caldwell November 12, 2019
Principal Investigator Date

XIV. Literature Cited:

Badame, P.V. 2012. Population estimates for humpback chub (*Gila cypha*) in Desolation and Gray Canyons, Green River, Utah 2006-2007. Final report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, Colorado.