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

II. Bureau of Reclamation Agreement Number: R14AP00007

     Project/Grant Period: Start Date: 05/01/2014
                                    End Date: 09/30/2018
                                    Reporting period end date: 10/31/2015
                                    Is this a final report? Yes____ No__X__

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IV. Abstract: Achievement of recovery goals (2002 amended recovery plan) for humpback chub requires monitoring six self-sustaining populations in the upper and lower Colorado River basins. Population estimates for Desolation and Gray Canyons were completed in 2001–2003. During the next round of estimates in 2006–2007 it was determined that humpback chub site fidelity in fall when sampling occurred was high (90-100%). As very little movement was occurring among humpback chub among sites, population estimates were calculated for each site and extrapolated across a determined number of available sites within Desolation and Gray Canyons (n=63; Badame, 2010). The same population estimation technique was followed in the 2010–2011 and 2014 sampling; due to low numbers of humpback chub captures at three of the six sites sampled no canyon-wide population estimate was calculated for 2015. Catch rates at long term trend sites have declined since 1997–2000 when values peaked (0.23 fish/net hour; however, there is no significant declining trend in annual catch rate from 1985–2015 (r^2=0.213, p=0.125). The addition of hoop nets to the sampling scheme resulted in the capture of seven young-of-year humpback chub (70–90 mm) verifying that reproduction is occurring within the reach.

V. Study Schedule: Initial year 2014 – final year 2015.

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 FY15 Tasks and Deliverables, Discussion of Initial Findings and
     Shortcomings:

Task 1: Complete three sampling trips in Desolation/Gray Canyon from August to
October:
Three sampling passes were completed through Desolation and Gray Canyons on 9/1–
9/8/15, 9/16–9/23/15, and 10/1–10/8/15. Mean daily flows during sampling ranged from
2,000–3,600 cfs (USGS gauge #09315000, Green River at Green River). Average water
temperatures during each pass were 19.6^{o}C, 16.7^{o}C and 14.8 ^{o}C respectively.

A total of six sites were sampled including four long-term trend sites and two sites
randomly selected from those previously sampled during the 2001–2007 population
estimates. Four sites were sampled in Desolation Canyon and two sites were sampled in
Gray Canyon; sites were located at river miles (RM) 185, 174.4, 166.8, 160.4, 148, and
145.7 (Figure 1). There are a number of sites (n=63) within Desolation and Gray
Canyons that have been characterized as having the necessary habitat for maintaining
humpback chub through the fall and winter (Badame 2012). The six sites sampled in
2015 represent approximately 10% of the estimated available sites.

Total effort included 1,596 trammel net hours, 2,538 hoop net hours and 1,567 antenna
set hours over three passes (Table 1). Electrofishing in Desolation and Gray canyons has
had limited success and was discontinued in 2015 to allow for the reallocation of effort to
hoop net and antenna sampling. Trammel and hoop net efforts resulted in 95 adult
humpback chub encounters (63 individuals) and seven juvenile *Gila*. Antenna sets
resulted in 30 humpback chub re-sights of 20 individuals; four chub were not detected by
other sampling methods. Mean catch per unit effort (CPUE) for the long term trend sites

sampled was 0.06 fish/net hour and ranged from 0.01–0.11 fish/net hour. Catch rates have declined since 1997–2000 when values peaked (0.23 fish/net hour), however, there is no significant declining trend in annual catch rate from 1985–2015 (r^2=0.083, p=0.194; Figure 2). Mean CPUE for humpback chub captured via trammel nets at all sites sampled averaged 0.06 fish/net hour and ranged from 0.01 to 0.11. Since 2003 trammel net CPUE for adult humpback chub in Desolation and Gray Canyons is stable (r^2=0.078, p=0.544) and has ranged between 0.04–0.08 fish/net hour (Fig. 3); years when sampling occurred in the summer were excluded (2001–2002).

Closed population estimates were calculated for each site with an appropriate sample size (n>10) with Program MARK utilizing the Huggins p and c model. Model averaging was utilized when the AIC weights were less than 0.90; all site population estimates were completed using model averaging of M_o (constant p), M_t (time varying p), and M_b (behavioral response) models when appropriate. Initial capture (p-hat) and recapture (c) probabilities were calculated through model averaging and are reported in Figure 4. Population estimates are reported for those sites with an appropriate number of captures and recaptures; the numbers of humpback chub encountered were reported for those sites with sample sizes too small to calculate population estimates. The adult humpback chub population estimate for the site at Cedar Ridge (RM 185) is 18 (SE= 2.9, 95% C.I. 12-23, C.V.=16.2%). At Log Cabin (RM 174.4) 8 individuals were captured. At Chandler Falls (RM 166.8) 8 individuals were captured. The estimate for Cow Swim (RM 160.4) is 41 (SE=19.2, 95% C.I. 4-79, C.V.=45.8%). At Curry (RM 148) 8 individuals were captured. The estimate for Coal Creek (RM 145.7) is 37 (SE=25.4, 95% C.I. 0-86, C.V.=69.6%). There are no significant trends in site specific population estimates between 2006 and 2015 (Figure 5); only sites with more than two years of estimates were included.

Observed site fidelity by humpback chub during 2015 sampling was 100%. Since 2006 almost all within year and between year recaptures have occurred in their site of original capture. Due to such high site fidelity among humpback chub site specific population estimates were calculated and used to determine an average site density for each year. The average site density was extrapolated across the 63 available habitats found in Desolation and Gray Canyons to provide a total annual population estimate (Table 3). In 2015, population estimates were only possible at 5% of available habitats (n=3 of 63); an annual population estimate based on an average site density extrapolation is not advisable and would not be representative of the existing humpback chub population. In 2014, the mean estimate per site (29.6) multiplied by the 63 available habitat sites, resulted in a total estimate of 1,863 humpback chub within Desolation and Gray Canyons (95% CI=924–2,802; p-hat=0.264). Although catch rates were slightly lower in 2015 than 2014, the probability of capture (p-hat) and recapture (c) were similar to 2014 and were the highest reported since the new sampling protocol began in 2001 and may be partially explained by the increased effort via hoop nets and submersible antennas (Figure 4).

The length frequencies of humpback chub captured in 2015 covered a similar range to that observed in past years. The addition of hoop nets to the sampling scheme resulted in

the capture of seven young-of-year humpback chub (70–90 mm) verifying that reproduction is occurring within the reach; however the presence of juvenile humpback chub (100–200 mm) continues to be difficult to document (Figure 6). The metric of first-year adults (200–220 mm) as a percentage of total adults captured continues to be used as a measure of recruitment (Jackson and Hudson 2005). The proportion of captured individuals in 2015 that were first-year adults was 7.9%; there is a significantly declining trend in this metric since the 2001–2003 sampling period (r^2=0.52, p=0.028; Figure 7). Although long-term data currently shows a stable population, the significant decline in the chosen recruitment metric may be an indication that the future stability of the population is uncertain.

Task 2 – Data entry:
The 2015 data have been entered and quality checked and will be transferred to the UCRRP database manger by January 15, 2016.

Task 3 –Annual reporting:
An annual progress report including a summary of the 2015 data and comparisons among present and past monitoring efforts will be submitted by November 13, 2015. A summary report is scheduled to be completed by spring of 2015 and will address trends in the population, survival and CPUE for 2001–2015.

VIII. Additional noteworthy observations: Other native fish collected and detected with the antennas during the study included Colorado pikeminnow (n=6), bonytail chub (n=7), roundtail chub (n=1), razorback sucker (n=145), flannelmouth sucker (n=220), and bluehead sucker (n=44). The notable nonnative fishes collected during the study include walleye (n=9) with a median total length of 572 mm (363–617 mm), smallmouth bass (n=9) with a median total length of 225 mm (199–285 mm) and green sunfish (n=5) with a median total length of 155 mm (57–223).

IX. Recommendations:
- Trammel net sampling should continue as the primary sampling tool for adult humpbacks. Discontinue electrofishing as it is the least effective method for humpback chub capture within this reach. Shift effort to submersible antennas and hoop net sampling which should bolster humpback chub encounters and increase young-of-year and juvenile *Gila* captures.
- Determine the best method for monitoring humpback chub populations in Desolation and Gray Canyons. The current method is to extrapolate chub density based on a site estimate average (n=6) and the estimated number of available habitat sites (n=63); however, the generation of population density estimates from 5-10% of available sites could be considered unreliable as the accepted methodology suggests at least 20% of available habitat would be representative of the population. A summary report is scheduled to be completed by spring of 2015 and once completed should be useful in determining how to proceed when the project resumes in 2018; the report may also be helpful during the upcoming re-

evaluation of the humpback chub recovery plan by highlighting a potential need for reach specific evaluation criteria.

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

XI. FY 2015 Budget Status

    A.   Funds Provided: $83,018
    B.   Funds Expended: $70,139
    C.   Difference: $12,879; to be used for summary report due spring/summer 2016
    D.   Percent of the FY 2015 work completed, and projected costs to complete: 100%
    E.   Recovery Program funds spent for publication charges: $0

XII.   Status of Data Submission: The 2015 data have been entered and quality checked and will be transferred to the UCRRP database manger by January 15, 2016.

XIII.   Signed: <u>   Julie Howard   November 13,2015   </u>
                    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.
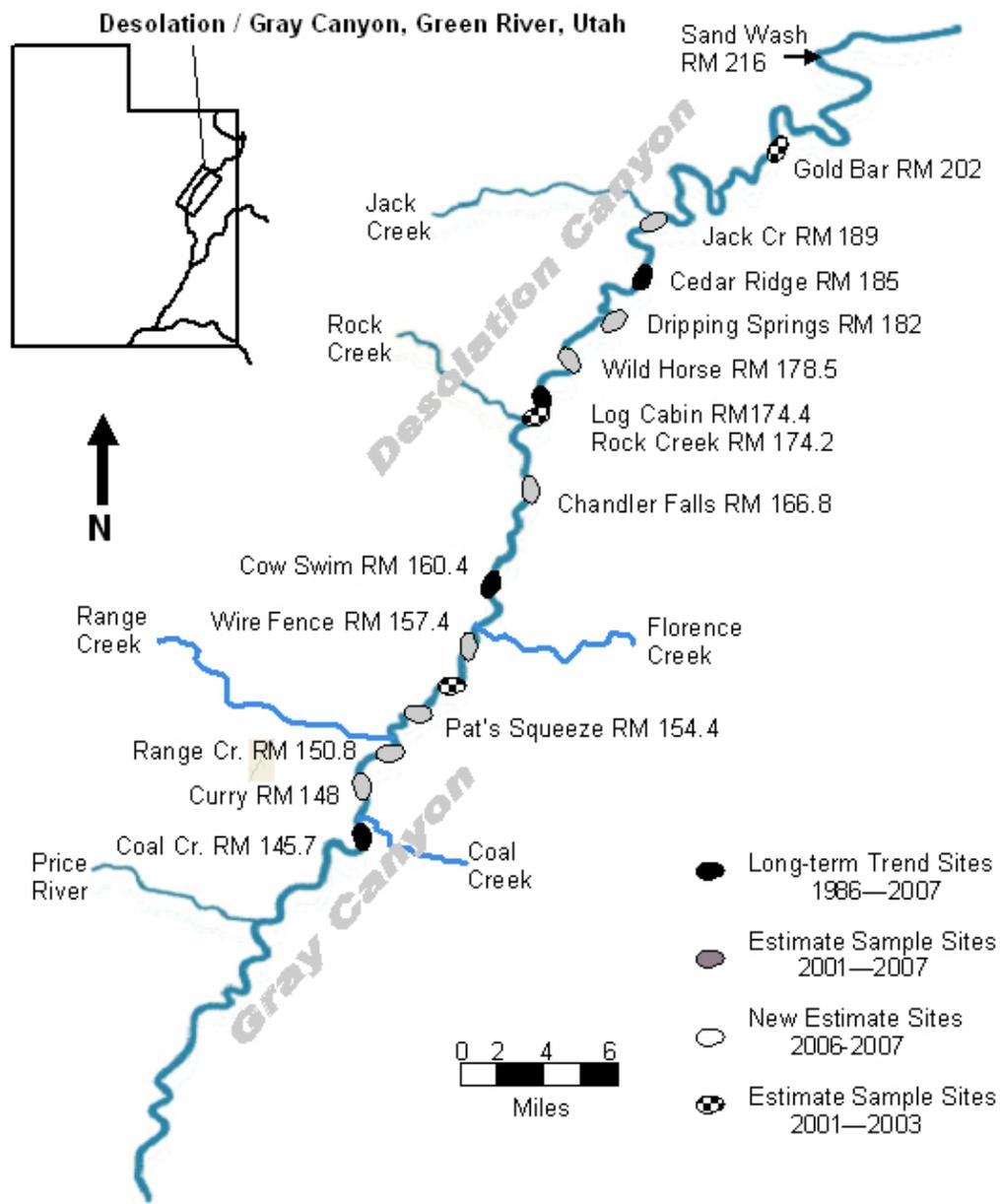
Jackson, J.A., and J.M. Hudson. 2005. Population Estimate for Humpback Chub *(Gila cypha)* in Desolation and Gray Canyons, Green River, Utah 2001-2003. Final Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Figure 1. Fifteen sample sites located within Desolation and Gray Canyons of the Green River.

Table 1. Effort for each gear type and total number of humpback chub (HBC) and unidentified juvenile *Gila sp.* encountered during population sampling in Desolation and Gray Canyons, 2001-2015, includes all captures from all sites. *Hoop net effort from trip 1 not included due to incorrect setup

| Year	Month (passes)	# Sites sampled	Trammel nets Hours	HBC	Submersible Antennas Hours	HBC	Hoop net/minnow trap Hours	HBC (*Gila sp.*)	Electofishing Hours	HBC
2001	6-7 (3)	12	2,803	214	-	-	-	-	8	3
2002	6-7 (3)	12	2,008	239	-	-	1,440	6 (1)	22.5	38
2003	9-10 (3)	12	3,042	236	-	-	1,946	4 (1)	11	1
2006	9-10 (3)	12	3,289	119	-	-	729	9	16.4	12
2007	9-10 (3)	12	2,7,27	130	-	-	988	6	-	-
2010	9-10 (3)	5	1,163	68	-	-	-	-	7	5
2011	9-10 (3)	6	1,013	55	-	-	-	-	6.4	8
2014	9-10 (3)	6	1,276	99			346	12 (1)	9.3	6
2015	9-10 (3)	6	1,596	58	1,567	20	1,825*	9 (7)	-	-

FY 2015 Ann. Rpt. Project # 129 - 7
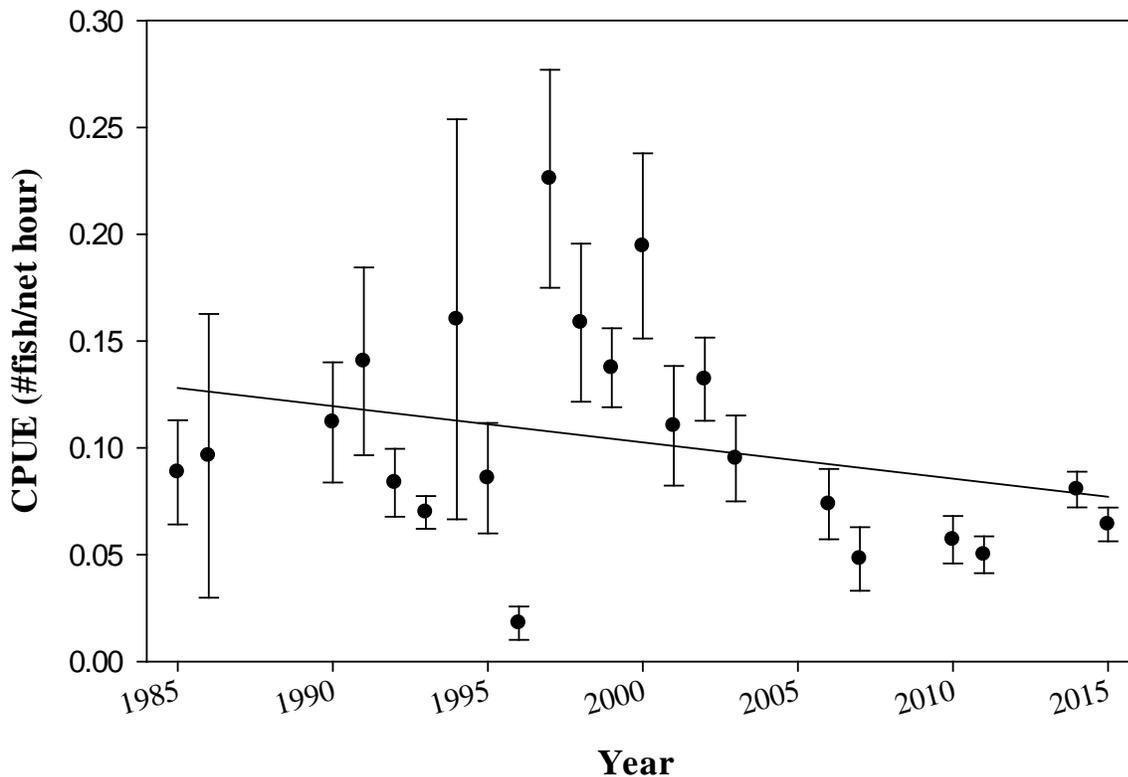
Figure 2. Long term trend site mean CPUE for all humpback chub (trammel net captures only), 1985-2015 including both summer and fall sampling events. The 1989 data point has been excluded as an outlier (0.59) to maintain scale. Error bars represent one standard error. The trend line is based on linear regression and was not significant ($r^2=0.083$, $p=0.194$).
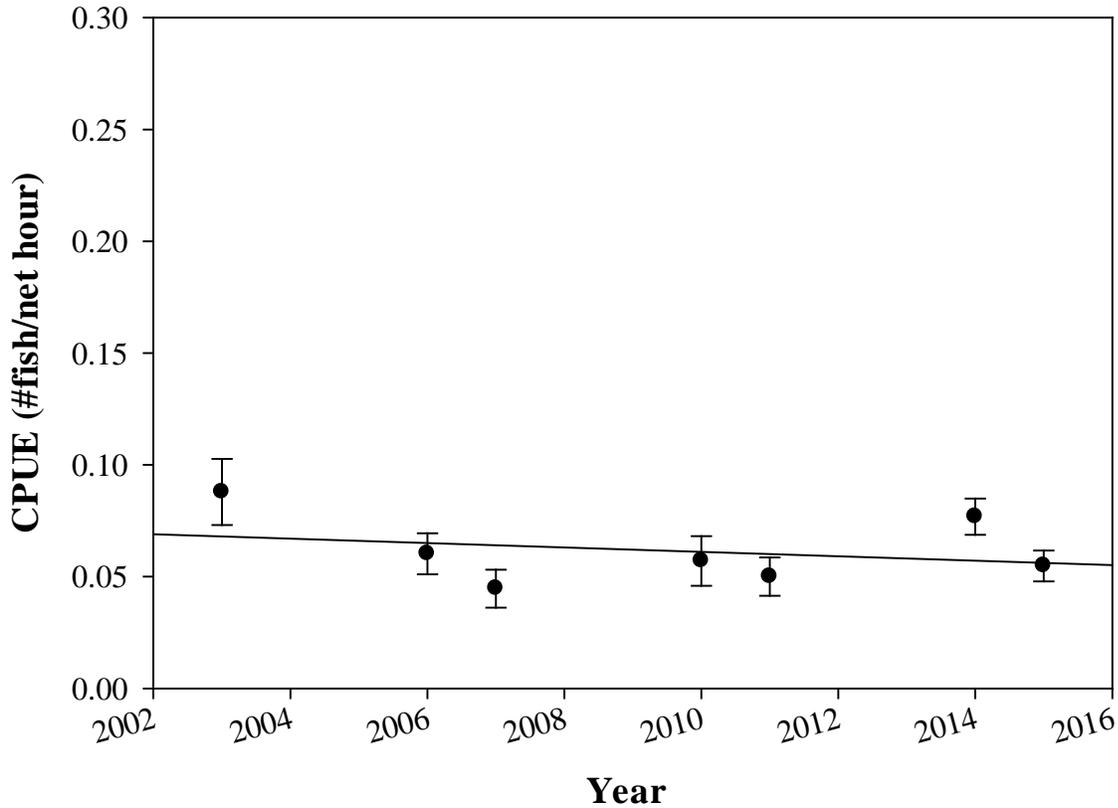

Figure 3. Mean CPUE for all sites sampled in Desolation and Gray Canyons for all humpback chub (trammel net captures only), 2003–2015. Only those years where sampling took place in the fall are included (excludes 2001-2002). Error bars represent one standard error. The trend line is based on a linear regression and is not significant ($r^2=0.078$, $p=0.544$).

Table 2. Program MARK Huggins model output by site for all models used in model averaging; models are listed from top to bottom by AIC weight (highest to lowest). Models were averaged at all sites where AIC weights for the top model were <0.90.

	Model	AICc	Delta AICc	AICc Weights	Deviance
Cedar Ridge	$\{p(.)=c(.)\}$ M_o	60.059	0	0.53794	59.5692
	$\{p(t)=c(t)\}$ M_t	61.375	1.3161	0.27858	56.3929
	$\{p(.),c(.)\}$ M_b	62.210	2.1513	0.18348	59.5278
Cow Swim	$\{p(.)=c(.)\}$ M_o	55.655	0	0.81128	73.6778
	$\{p(t)=c(t)\}$ M_t	58.572	2.9167	0.18872	72.1655
Coal Creek	$\{p(.)=c(.)\}$ M_o	47.018	0	0.47082	61.4379
	$\{p(.),c(.)\}$ M_b	47.693	0.6746	0.33602	59.9197
	$\{p(t)=c(t)\}$ M_t	48.800	1.7820	0.19315	58.7275

Table 3. Summary of population estimates (N) for Desolation/Gray Canyons 2001–2011. Column headings include the 95% confidence interval (C.I.), probability of capture (p-hat), and coefficient of variation (C.V.). No 95% C.I was calculated for 2014 due to insufficient time for reporting. Methods of estimation prior to 2006 combined all annual capture data into one population estimate and likely underestimated the population size significantly. *Number of individuals encountered (estimate was not calculated due to insufficient recaptures)

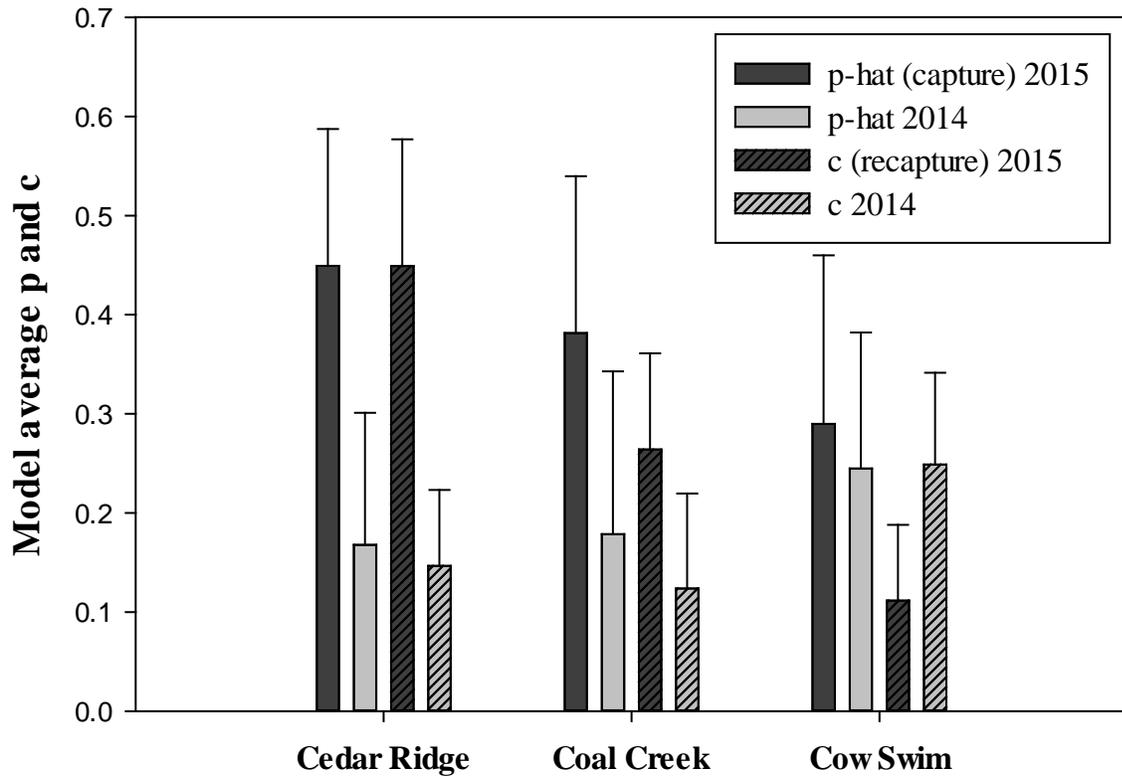| Year	N	95% CI	C.V.	p-hat
2015*	70	-	-	-
2014	1,863	924-2,802	0.26	0.264
2011*	55	-	-	-
2010	1,625	1,023–5,465		0.173
2007	1,108	1,071–4,914		0.188
2006	2,578	1,151–9,736		0.141
2003	937	636–1,520	0.21	0.083
2002	2,612	1,477–8,509	0.36	0.045
2001	1,254	733–2,697	0.31	0.053

Figure 4. Model averaged probability of capture (p-hat) and recapture (c) by site, 2014-2015. Error bars represent one standard error.
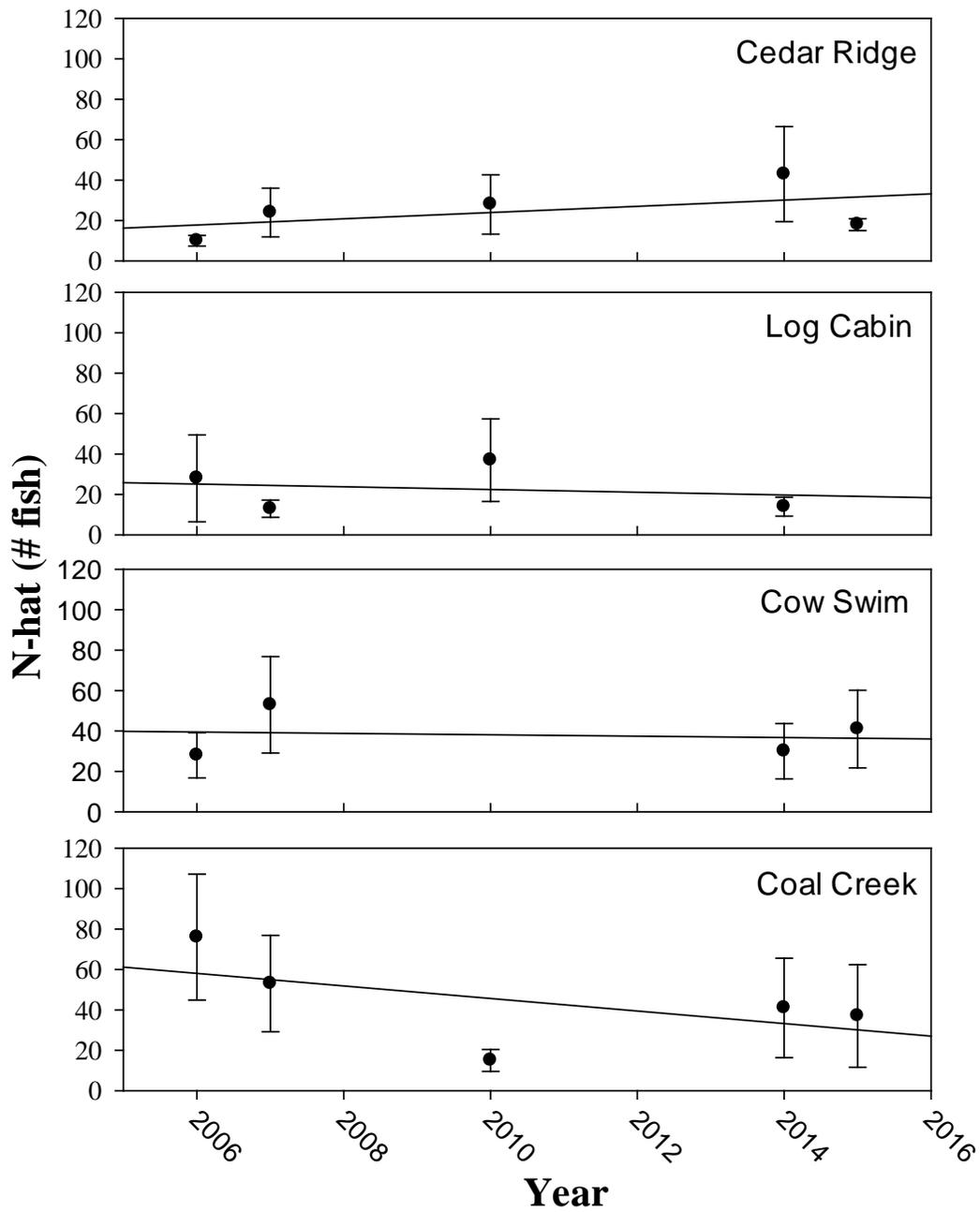
Figure 5. Population estimates by site, 2006–2015. Error bars represent one standard error. Regression trend lines are not significant for all of the sites (p>0.05).
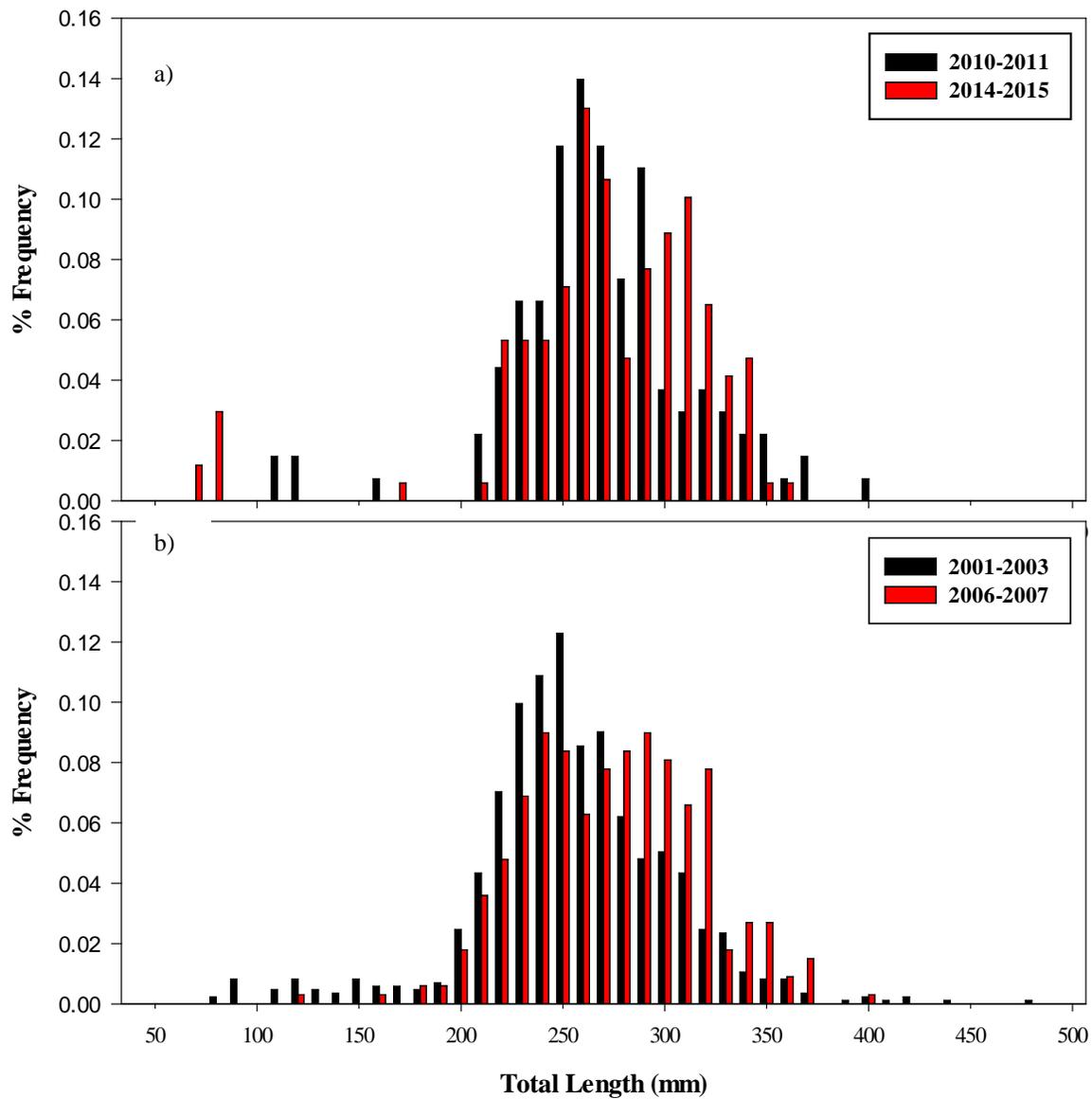
Figure 6. Desolation and Gray Canyon humpback chub length frequency histograms for all humpback chub captured via all methods for a) 2010–2011, 2014 and b) 2001–2003, 2006–2007.
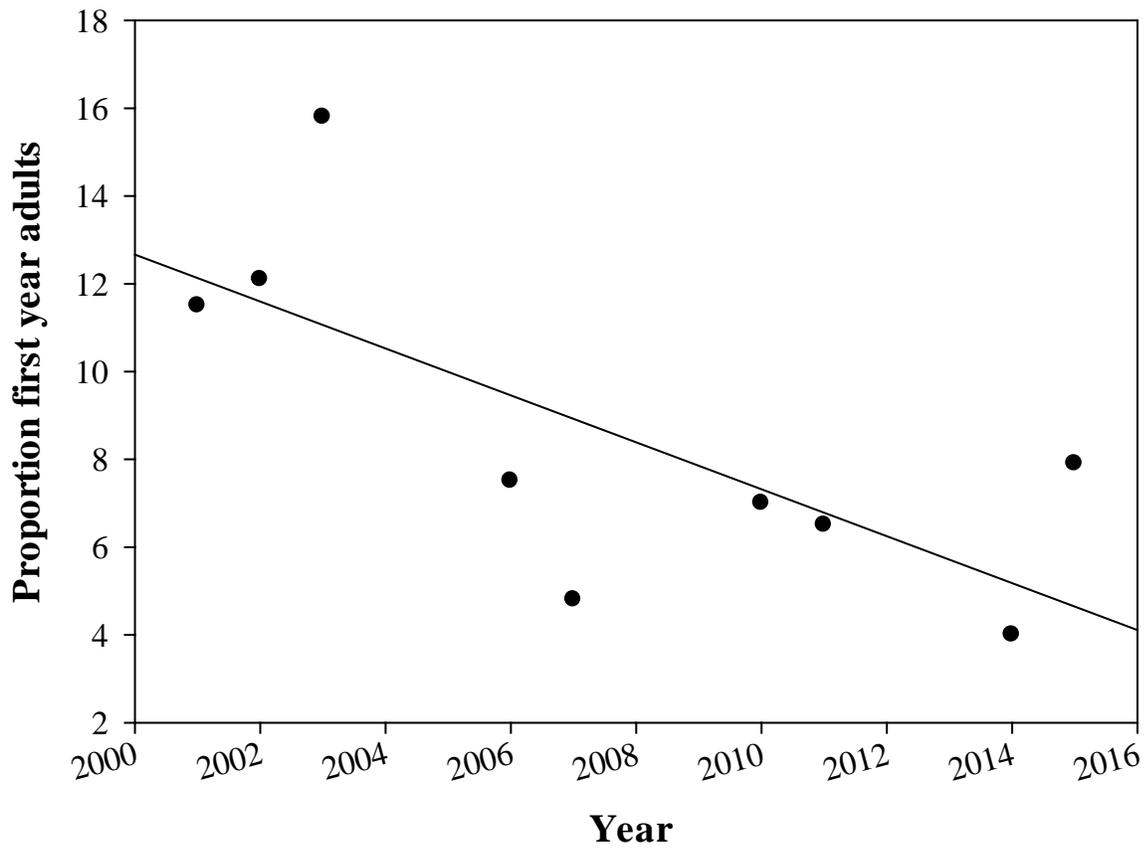
Figure 7. The proportion of first year adults (200–220 mm) of humpback chub captured using all sampling methods, 2001–2015. The trend is based on a linear regression and is significant (r^2=0.520, p=0.028).