I. Project Title: **Removal of Smallmouth Bass in the Upper Colorado River between Price-Stub Dam near Palisade, Colorado, and Loma, Colorado.**

II. Bureau of Reclamation Agreement Number(s): R10PG40045 & R11PG40024

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IV. Abstract: The purpose of this study has been to remove as many non-native smallmouth bass of all sizes in main channel riverine habitats in a 61-mile reach of the Upper Colorado River between Price-Stub Dam and Westwater boat landing in eastern Utah and a 45-mile reach between Rifle and Beavertail Mountain. This is the ninth year of this study which started in 2004. For 2012, removal passes were reduced to six; Colorado Parks and Wildlife (CPW) performed all of the work in the 45-mile reach between Rifle and Beavertail Mountain; and no removal work was completed between Loma, Colorado and Westwater boat landing in eastern Utah. Low base flows in 2012 made it impractical to sample the 2.3-mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence, the additional reach between the Government Highline Dam and the Cameo Bridge, and from Cameo Bridge to Grand Valley Irrigation Company (GVIC) Diversion Dam.

V. Study Schedule:
A. initial year: 2004
B. final year: Ongoing

VI. Relationship to RIPRAP:
Colorado River Action Plan: Mainstem

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

III.A. Develop and implement control programs in reaches of the Colorado River occupied by endangered fishes.

VII. Accomplishment of FY 2012 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1. Remove all sizes of smallmouth bass.

Sub-Task 1a. Mark and release smallmouth bass (100-199 mm and ≥ 200 mm) during pass 1 in 2012.

Tasks completed. However, because of an early start due to the early onset of low base flows and staffing limitations during this time, three pre-marking passes were completed before the three boat marking pass was completed. Six post-marking passes were also completed with the exception of the 2.3- mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence, the additional reach between the Government Highline Dam and the Cameo Bridge, and from Cameo Bridge to GVIC because of low water (to shallow to float with electrofishing rafts).

Task 2. a) analyze data; b) prepare annual RIP reports.

Task completed. Preparation of the annual report also sufficed for the December 2012 nonnative fish workshop.

B. Findings (2012 Highlights)

<u>General</u>

Study Direction. From 2004 to 2011, the study area encompassed a 61-mile section of the Colorado River in western Colorado from the Price-Stub Dam to the Westwater, Utah, BLM River Ranger Station, and a 2.3-mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence. For 2012, the study area was shortened to 38 miles including river segments from Price-Stub Dam to the Loma Boat Landing including the 15- and 18-mile reaches. These river segments along with the Lower Gunnison River flow through a wide alluvial section of the Grand Valley.

In 2012, study direction was further modified. Colorado Parks and Wildlife (CPW) personnel performed all of the work in the upstream portion of the river from Silt to Beavertail Mountain Tunnel (52.3 miles).

Project study goals in 2012 were similar to that of 2007 through 2011. An abundance

estimate for juvenile (100-199 mm) and adult (≥ 200 mm) smallmouth bass in concentration areas of the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers was performed in 2006-2012. However, in 2012, an abundance estimate for largemouth bass juvenile (100-199 mm) and adult (≥ 200 mm) was also performed. This endeavor entailed marking and releasing smallmouth and largemouth bass during an initial pass and lethally removing and recording previously marked smallmouth and largemouth bass in all subsequent (n=6) and the pre-marking (n=3) passes. The abundance estimate was generated from the initial marking pass and a single removal pass that immediately followed the marking pass. Marking smallmouth and largemouth bass included the river segments from GVIC to the Loma Boat Landing, a total of 32.5 river miles.

Methodology

General

Methodology differed slightly during 2012 from some of the earlier years. Three electrofishing craft were used in 2012 and 2008 through 2010 to collect smallmouth (and largemouth in 2012) bass for marking and other centrarchids in the Grand Valley reaches of the Upper Colorado River. The additional sampling craft was used in an attempt to increase the number of marked smallmouth and largemouth bass. Two electrofishing craft were used for the marking pass during the 2006, 2007, and 2011 marking passes. During the marking pass all smallmouth and largemouth bass > 100 mm collected were marked and released whereas all smallmouth and largemouth bass < 100 mm and other centrarchid fishes collected were removed. An absent spring runoff, and a concern that lower than average base flows necessitated an early start for non-native removal, three pre-marking passes (removing all centrarchids) were completed from 21 May to 6 July. The 2012 marking pass was performed over a 1-week period starting on 9 July. Following the marking pass, six removal passes were made using raft-based electrofishing to collect centrarchid fishes from 16 July to 22 August. Two electrofishing craft were used in every river segment during the six removal passes.

During 2004, 2005, and 2006, a 45-mile reach of the Upper Colorado River from the Rifle Bridge (river mile 240.4) to Beavertail Mountain in Debeque Canyon (river mile 195.7) was sampled with raft electrofishing. In 2007 and 2008, a 7.6-mile reach from Silt to the Rifle Bridge was added to assess distribution of smallmouth bass upstream of Rifle. This reach was eliminated from sampling in 2009 because only one smallmouth bass was collected in this reach in 2007 and 2008. During 2011, the number of passes in this 45-mile reach was reduced from three to one. Moreover, the only reaches sampled during 2011 were between Rifle and Rulison and Rulison and Cottonwood Park boat landing at Parachute (RM 222.2). In 2012, CPW conducted all of the removal (two electrofishing passes) from Silt to Beavertail Mountain. However, CPW crews were not able to sample the Colorado River from Parachute (RM 223.0) to Debeque (RM 209.7) due to access

issues and a dangerous river diversion (Bluestone Ditch) upstream of Debeque. This work was completed sporadically from 13 June to 28 September.

Although smallmouth bass were the target fish for removal in this project, all other centrarchid fishes encountered were collected. These fishes included largemouth bass, green sunfish, bluegill, and black crappie. All centrarchids removed were frozen and then delivered to the Mesa County landfill.

The number of individuals and total length and weight were recorded for each smallmouth bass and largemouth bass collected. Capture date and corresponding river mile for each centrarchid fish collected were recorded along with actual time electrofished (seconds; converted to hours fished).

Catch Rate

Catch rate or catch/effort is often used as an index of population size if it is consistently proportional to absolute abundance (Ricker 1975). Unfortunately, catch/effort can be highly variable and is not the most reliable metric for population analyses or comparing trends in population abundance densities among years. It is more likely that unexplained variations in capture probability or "catchability" (not catch per unit of effort per se) preclude the use of catch per unit of effort as an abundance estimate.

During 2004 and 2005, since the initial study objective was to lethally remove as many smallmouth bass and other centrarchids as quickly as possible, fish were not marked and released and, therefore, a population estimate was not possible. For those years, effort was recorded and catch/effort was calculated and used to monitor increases and declines in centrarchid populations. To determine if densities of smallmouth bass and largemouth bass were being depleted as a result of the removal effort, catch effort indices (e.g., fish/hr) over time (i.e., by pass) in each river sub-reach were calculated and interpreted. Because population estimates for smallmouth bass were not available for 2004 and 2005, effort was still recorded during 2006 – 2011 and catch/effort was computed for use as a trend to compare annual abundance of smallmouth bass and other centrarchids during 2004 – 2012. Where abundance estimates were not performed for a population statistic, catch/effort was a useful metric in comparing relative abundance and interpreting year class strengths among years, particularly for juvenile smallmouth and largemouth bass (< 100 mm).

Abundance Estimate

For the population estimate in 2012, juvenile smallmouth and largemouth bass (100-199 mm) were marked by removing the ventral lobe of the caudal fin with scissors. Adult smallmouth and largemouth bass (≥ 200 mm) were marked by removing the dorsal lobe of the caudal fin with scissors. Chapman's (1951) modification of the Petersen-Lincoln estimator was used to determine the abundance of smallmouth bass. This estimator was

believed to be the most appropriate because it would reduce bias due to the small number of recaptured smallmouth and largemouth bass.

Probability of capture (p-hat) for juvenile and adult smallmouth and largemouth bass was determined for the single marking pass and first post-mark removal pass. To obtain the best representative capture probability for calculating an annual exploitation rate, the capture probability from the two passes were weighted. This was accomplished by determining the inverse of their respective variances, thus providing more weight to the more precise estimate (personal communication, Bruce Haines, USFWS, [ret.], Vernal, Utah. Exploitation rate (μ)(personal communication, Bruce Haines, USFWS [ret.], Vernal, Utah) for juvenile and adult smallmouth bass was computed as:

$\mu = 1 - [(1 - p)^n]$, where

p is the probability of being captured on one pass as computed from the first removal pass,

$1 - p$ is the probability of fish surviving one removal pass,

$(1 - p)^n$ is the probability of surviving n passes, and

$1 - [(1 - p)^n]$ is the probability of being captured after n passes.

The coefficient of variation (CV: SE/N-hat x 100 [where N=estimated population size])(Pollock et al. 1990) was also computed.

Results and Conclusions

Results presented herein are a compilation of the efforts of the FWS in the Grand Valley reaches of the Upper Colorado River during 2012. Removal passes performed by the CPW in the Upper Colorado River between Silt and Beavertail Mountain are also reported here. Data are presented for main channel habitats only which include hydrologically connected backwaters. Integration and comparison of results from earlier years (2004 – 2011) of this study are provided where appropriate.

Size Distribution–Length Frequency.

Smallmouth Bass

Length frequency distribution of all sizes of smallmouth bass collected with electrofishing during 2012 between GVIC and Loma were plotted (Figure 1). All age groups of smallmouth bass (age-0, juveniles, and adults) were represented in the 2012 summer collections (Figure 1). These ranged from age-0 (26 mm) to adult (436 mm) fish with a mean of 156 mm. A total of 1,500 smallmouth bass were collected and 1,368 were removed. A strong year class of smallmouth bass (< 100 mm) was produced in 2012 in the Grand Valley reaches of the Upper Colorado similarly to the 2007 year class (Figure 2). However, an earlier than expected spawn must have occurred because these fish were being collected as early as 21 June, two and a half weeks prior to our marking pass.

In 2009, age-0 smallmouth bass were first detected in the Grand Valley reaches starting in mid-August (39 mm total length). Length frequency comparison between 2008 (see 2008 annual report no. 126(a)) and 2009 suggest that the 2009 year class may be stronger than 2008. However, overall catch rates for juvenile smallmouth bass (< 100 mm) in the Grand Valley sections of the Upper Colorado and Lower Gunnison rivers are almost identical during these two years (Figure 4).

However, in 2010, there was some reason for concern. The highest number of juvenile smallmouth bass (< 100 mm) during this eight-year study was collected in 2010 from the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. The catch rate for this juvenile size class of fish (C/E=5.82 fish/hr, n=2,054) exceeded catches during the 2007 removal passes (C/E=4.15 fish/hr, n=1,358) (Table 1). A strong year class of smallmouth bass was produced in 2007 which was documented throughout upper Colorado River basin rivers. During the 2010 marking pass in the Grand Valley reaches, (Figure 2) age-0 smallmouth bass were first detected during the last week of July (31 mm).

In 2011, the catch rate for juvenile size fish < 100 mm declined precipitously (91%) from 2010 from 5.82 fish/hr to 0.55 fish/hr, similar to catch rates during 2004 and 2009 (Figure 4). The hypothesized reason for this decline was the prolonged high stream discharge from the 2011 spring runoff. Elevated discharge extended into July, which delayed river waters from warming. Decreased and prolonged cooler river temperature may have resulted in smallmouth bass delaying spawning, larvae hatching later, or even weak, young smallmouth bass being swept away from nests or quiet near-shore habitat resulting in high mortality. This in turn probably led to a shorter growing season and, ultimately, reduced growth for age-0 smallmouth bass. In any event, these environmental conditions probably lead to a shorter growing season and a weak year class of smallmouth bass in 2011.

In 2012, a smaller (in magnitude) and shorter (in duration) than average peak runoff season and lower (in magnitude) and longer (in duration) base flows that began earlier in the season hypothetically produced an increase in our catch rate for juvenile and age-0 size fish < 100 mm from .55 fish/hr (2011) to 2.62 fish/hr (n=761, Table 1).

In some river segments (15-mile reach [GVIC Diversion Dam to the Colorado/Gunnison River confluence], 18-mile reach [Colorado/Gunnison River confluence to the Loma Boat Landing], smallmouth bass reproduced during 2011 as they did between 2004 and 2010. It cannot be proven if these fish were produced in the river, or in off-channel habitats (e. g., ponds or irrigation returns that connect to the main river) and later escaped to the river. In the Grand Valley reaches, the numbers of smallmouth bass within the 2008 and 2009 year classes (<50mm or <100mm) were noticeably less than those of the three previous years (2005, 2006, and 2007) from catch rate data. Catch rates for smallmouth bass < 100 mm declined significantly from the high in 2007 (4.15 fish/hr) to 0.63 fish/hr in 2008 and 0.55 fish/hr in 2009 (Table 1; Figure 4). Except for the 2007 and 2010 year classes,

young smallmouth bass (<100mm) have proven to be highly susceptible to low survival to age-1. The strong 2012 year class (age-0) may have produced enough individuals to provide concern as to how many may survive to age-1.

Largemouth Bass

A total of 5,299 largemouth bass were collected in the Grand Valley reaches in 2012 and 5,258 were removed, a substantial increase over 2011's catch. Our catch ranged from age-0 fish (31 mm) to adult fish (461 mm) with a mean of 104 mm (figure 3). However, our catch was proportionate in size classes to our 2011 catch: 97% (n=5,080) were less than 150 mm, 67% (n=3,484) were less than 100 mm, and only .07% (n=32) were adults greater than 250 mm.

In 2011, a total of 3,320 largemouth bass were collected during the ten removal passes. Eighty-eight percent (n=2,938) of these fish were less than 150 mm; and 76% (n=2,507) were less than 100 mm. Only 0.1% (n=33) of the total number of largemouth bass were greater than 250 mm. This suggests that survival of juvenile largemouth bass to adults in the river is relatively low due to the very low number of adult fish (i.e., >250 mm) in electrofishing collections vs. the high number of juvenile size fish.

Actual Numbers.

During 2004, 2005, and 2006 the number of removal passes were identical (4) and direct comparison of actual numbers of fish removed was justified. However, starting in 2007 and continuing through 2010, four additional removal passes were added. In 2011, two additional removal passes were added totaling ten and in 2012 passes were reduced to six. Therefore, comparing actual numbers of fish removed per pass or by combining passes and river reaches with the three earlier sampling years is not warranted. Actual numbers of smallmouth bass removed are provided among the various figures and tables by major river section and by year in the attached appendices.

There is one location that could be consistently used to compare total number of fish captured to establish annual trends. This is the fish trap at the Redlands Diversion Dam fish passageway on the Lower Gunnison River. The number of smallmouth bass collected in the fish trap of the Redlands Diversion Dam passageway has been recorded for 16 years. From 1996–2001, only one smallmouth bass was captured. However, 13 were collected in 2002, 6 in 2003, 9 in 2004, and 21 in 2005. To no surprise and keeping with the pattern of lower smallmouth bass catches in main channel habitats, no smallmouth bass were found in the Redlands fish trap during 2006 or 2007. In 2008, four smallmouth bass were collected in the Redlands fish trap, none in 2009, and three in 2010. No smallmouth bass were collected at Redlands in 2011. 2012 produced the second largest total of smallmouth bass (n=14) collected at Redlands. However, this number may be skewed because low water levels, in 2012, didn't allow the removal crew to launch their craft and remove fish in the lower Gunnison River making more available

(hypothetically) to run up the ladder.

Catch/Effort.

General

Mean catch/effort (fish/hr) was computed separately for smallmouth bass and largemouth bass for each of the nine sampling years, 2004 – 2012 (Tables 1 & 2; Figures 4 & 5). To view the "big picture", for some analyses, river reaches and removal passes were consolidated. Catch rates were computed separately from the Rifle to Beavertail Mountain reaches and the Grand Valley river reaches (Government Highline Dam to Westwater, Utah, plus the Lower Gunnison River).

Effort Fished

Electrofishing effort in 2004 (168.665 hours) was similar to 2005 (174.560 hours) between Price Stubb Dam and the Westwater, Utah, ranger station and the Lower Gunnison River. In 2006, electrofishing effort in these reaches was 161.906 hours. The electrofishing effort increased to 327.101 hours in 2007 because of the addition of four removal passes. The total effort (1 marking and 8 removal passes) during 2008 was 349.889 hours. In 2009, the total effort (1 marking and 8 removal passes) was 416.851 hours. A 3.9-mile reach between Government Highline Dam and the Cameo XCEL Bridge was added in 2009 which accounts for some of the increased effort in 2009 over earlier years. In 2010, the total effort was (1 marking and 8 removal passes) was 413.555 hours. In 2011, the total effort was (1 marking and 10 removal passes) was 449.934 hours. Effort was decreased in 2012 because low water levels in certain reaches (2.3-mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence, the additional reach between the Government Highline Dam and the Cameo Bridge, and from Cameo Bridge to GVIC) made them impassible by electrofishing craft. In addition, no passes were conducted from Loma boat landing to Westwater Ranger Station. Three pre-marking passes, one marking pass, and six post-marking passes expended 290.326 hours of electrofishing effort.

Between Rifle and Beavertail Mountain, the effort expended in 2004 was 19.750 hours compared to 39.799 hours during 2005 and 37.512 hours during 2006. During 2007, electrofishing effort increased to 86.84 hours which was related to adding the river reach from Silt to Rifle and an additional removal pass from Silt to Beavertail Mountain. In 2008, the total effort was 86.038 hours, which was almost identical to 2007. The total effort during 2009 was 62.321 hours and in 2010, 78.985 hours. During 2011, the total effort (12.626 hours) was much less than former years due to only one pass being performed and some reaches not being sampled. In 2012, CPW conducted two passes; one pass included two boats electrofishing both banks in all reaches except the reach between Parachute and Debeque, and the second included electrofishing all backwaters and slack water sloughs in the same reaches this pass also included experimental gill

netting effort. In total, CPW expended 45.68 electrofishing hours and 10.8 gill net hours. The increased effort was in response to the increase in northern pike catch in this reach in 2011.

Smallmouth Bass

For the Grand Valley river reaches, the trend for smallmouth bass relative abundance from 2006-2009 was downward. Overall mean catch rate was highest for smallmouth bass juveniles (100-199 mm) and adults (≥ 200 mm) during 2004 (6.37 fish/hr) and 2005 (6.36 fish/hr). However, a 51% decline in catch rate was detected from 2005 to 2006. In 2007, the catch rate dropped even lower to a 4-year low (2.27 fish/hr; 27 % decline from 2006, Figure 4). And again in 2008 and 2009, the overall catch rate continued to decline to 1.19 and 0.90 fish/hr, respectively. This catch effort decline is consistent with the decline observed with the population estimate between 2006 and 2007, and between 2007 and 2008 (see Population Estimate–Smallmouth Bass below). During 2010, the catch rate for smallmouth bass > 99 mm (0.98 fish/hr) increased slightly from 2009. During 2012, another increase in catch per effort occurred from the juvenile and adult size classes to 2.55 fish per hour.

During the summer of 2010, for the Grand Valley river reaches, overall mean catch rate for smallmouth bass < 100 mm total length was the highest in this eight-year removal study (5.82 fish/hr). Formerly, 2007 had the highest catch rate (4.15 fish/hr) and the lowest was during 2004 (0.55 fish /hr) (Table 1; Figure 4). Initially, it appeared that the 2007 cohort was one of the strongest in five years of sampling between 2004 and 2009. However, the 2010 cohort exceeded the strong year class of 2007. These young life stages can be subject to high mortality to age-1 due to a myriad of environmental factors over the winter. Small age-0 smallmouth bass going into winter may be susceptible to higher overwinter mortality because their relatively small body size limits energetic reserves that may run out before spring arrives. Therefore, overwinter survival is not known until the following summer sampling season. Now that the 2012 sampling is complete, from the abundance estimate for juvenile smallmouth bass (100-199 mm), the 2011 cohort apparently survived overwinter. Catch rates for this juvenile size class (100-199 mm) increased from 0.45 fish/hr in 2010 to 1.47 fish/hr in 2011, a 3.3 fold increase. The 2012 catch for juvenile smallmouth bass continues to be large at 1.09 fish/hr. The strong year classes produced in both 2007, 2010 and 2011 may continue to recruit to the adult smallmouth bass population which may contribute to the persistence of this species in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

It also appeared that a weak year class was produced in 2008 (0.63 fish/hr)(Table 1; Figure 4) since this study commenced in 2004. The high spring flows during the 2008 runoff in the Upper Colorado River could have swept weak swimming young smallmouth bass away from nests or quiet near-shore habitat resulting in high mortality. From catch/effort comparisons, the 2009 year class (0.55 fish/hr) also appeared to be similar to 2008.

The hydrologic conditions of 2008, 2009, and 2011 in the Upper Colorado River were similar, 2011 being the most dramatic because of the prolonged high discharge extending into July. These three years have been characterized as average or moderately wet with sustained runoff compared to former years (2003-2007) and 2012 that were dryer with shorter runoff magnitude and duration. The three wetter years with accompanying prolonged cooler water temperatures may have disrupted or delayed spawning resulting in slower growth of early-life stages (i. e., age-0) of smallmouth bass, and ultimately reducing survival and recruitment. However, 2012's catch of juvenile (100-199 mm) smallmouth bass (1.09 fish/hr) suggests 2011's recruitment may have been negatively impacted but a mild winter may have allowed for better survival of the few that were still alive after the high run-off.

Survival of smaller age-0 fish entering the winter period could be reduced under these hydrologic scenarios. The timing or detection of the first captures of age-0- smallmouth bass may provide one means to predict recruitment success into later years. For example, the first date age-0 smallmouth bass were detected in wetter years (2008, 2009) in which weak year classes were produced was 8 and 14 of August, respectively. It appears that smallmouth bass spawned later in 2011 than any previous years of this eight-year study. In 2011, age-0 smallmouth bass were first detected on 24 August (n=3; 22, 35, and 46 mm). Other age-0 smallmouth bass (n=12; 25-32 mm) were collected between 5 October and 11 October. Compared to dryer years, 2007, in which a strong year class was produced, age-0 fish were first detected on 23 July, some 2-3 weeks earlier than 2008 and 2009. In 2010, age-0 smallmouth bass were first detected on 28 July. In 2012, the earliest detection of age-0 fish (n=6; 36 – 56 mm) occurred on 21 June, a full month earlier than the strong year class detected in 2007.

Catch rate for all length sizes of smallmouth bass declined to 0.09 in 2012 in the upstream reaches between Silt and Beavertail Mountain. Prior to this drop in mean catch per effort in 2012, the lowest value was achieved during 2009 (0.24 fish/hr) compared to 2011 (0.49 fish/hr), 2010 (0.92 fish/hr), 2008 (0.95 fish/hr), 1.04 fish/hr (2007), 2.11 fish/hr (2006), and highest during 2005 (5.75 fish/hr)(Table 1). Spawning success in these reaches appears not to be as successful as that in the Grand Valley reaches. Age-0 (< 100 mm) smallmouth bass catches have been less than that of the Grand Valley reaches throughout the eight-year project. Only 57 age-0 smallmouth bass (0.72 fish/hr) were collected in these upper reaches during 2010. No age-0 smallmouth bass were collected in these upper reaches during 2009 or 2011. Only one smallmouth bass (237 mm) was collected between Rifle and Silt at RM 241.2 during 2007 and 2012; none were collected during 2008. Mean catch rates for smallmouth bass < 100 mm was the lowest in 2004 (0.15 fish/hr); the highest was during 2005 (1.46 fish/hr)(Table 1). During 2008, the catch rate for smallmouth bass < 100 mm was 0.25 fish/hr.

Largemouth Bass

Unlike the downward trend in catch rate for smallmouth bass juveniles and adults, for the Grand Valley river reaches, overall mean catch rate for largemouth bass juveniles (100-199 mm) and adults (≥ 200 mm) steadily increased from 2004 – 2007 and peaked in 2007 (3.122 fish/hr; n= 1,083)(Figure 5). This was 6.7 times greater than the catch rate for 2004 (0.587 fish/hr). During 2008, this trend was reversed for largemouth bass ≥ 100 mm. The catch rate declined to 1.011 largemouth bass/hr (n=430). In 2009, the catch rate increased slightly to 1.325 fish/hr. Catch rate increased to 2.403 fish/hr in 2010. Catch rate, however, declined in 2011 to 1.938 fish/hr. 2012 produced the largest catch of juvenile and adult largemouth bass to date at 6.004 fish/hr (n=1,743).

For the Grand Valley river reaches, in 2011, catch rate for largemouth bass < 100 mm (5.481 fish/hr) declined 50 % from 2010 (10.093 fish/hr). It now appears that the 2012 (12 fish/hr) year class has been the strongest in this nine-year study which was initiated in 2004. Overall mean catch rate for largemouth bass < 100 mm total length steadily increased since 2004 from 1.133 fish/hr to a high of 12 fish/hr in 2012 (Table 2; Figure 5). The 2008 year class of largemouth bass was only slightly less (3.363 fish/hr) than 2007 and 2009. So, where the 2008 high spring runoff flows reduced the spawning success of smallmouth bass, it did not appear that largemouth bass young were as negatively impacted. This may be attributed to differences in spawning habitat and/or timing (temperature conditions) between smallmouth bass and largemouth bass spawning. In the Upper Colorado River, largemouth bass may be spawning in off main channel riverine habitats that may shelter young fish from the high velocities of runoff thus increasing survival, whereas young smallmouth bass, which are typically spawned in main channel riverine habitats, may suffer higher mortality during such high flow events. The high abundance of largemouth bass found during summer removal passes in main channel habitats may be due to young fish that have migrated out of off-channel habitats into main channel habitats following high spring runoff.

There has been no definite trend in largemouth bass abundance (all length sizes) for the Rifle to Beavertail Mountain reaches. The highest catch rate was recorded during 2008 (6.9 fish/hr; Table 2). The second highest year was in 2006 (5.6 fish/hr); lowest in 2010 (0.86 fish/hr). In 2007 the catch rate declined to 3.30 fish/hr (Table 2). In 2005, catch effort (0.93 fish/hr) was the second lowest in this eight-year study. Prior to 2008, spawning success in these reaches appeared not to be as successful as that in the Grand Valley reaches. Mean catch rate for largemouth bass < 100 mm was lowest in 2005 (0.25 fish/hr); the highest during 2008 (5.4 fish/hr)(Table 2). In 2010, catch rate (0.3 fish/hr) was the second lowest in this eight-year study. In 2011, overall catch rate (all length sizes) was 2.14 fish/hr and 2012 brought a reduction in the catch to 1.27 fish/hr.

Population Size.

Smallmouth Bass

During the marking pass performed in July 2012, a total of 132 smallmouth bass (50 juvenile size [100-199 mm], 82 adult size [≥ 200 mm]) were marked and released alive. Seventeen (9 juvenile, 8 adult) of these marked fish were later recaptured during six removal passes (Table 3). Since a 'batch' mark was employed and smallmouth bass were not marked with a serially numbered tag, detections of individual fish were not possible. Eight marked fish (six juvenile, two adult) were recaptured in removal pass 1. One marked fish (one adult) was captured during pass 2, four marked fish (two juvenile, two adult) were captured during pass 3, one marked adult was captured during pass 4, two marked fish (one juvenile, one adult) were captured during pass 5, and one marked adult was captured during pass 6. Crews were instructed to look for marked fish during all six removal passes. Starting in 2010, a different mark was employed and it appeared that this new mark could be more reliably detected throughout all removal passes than previous batch marks employed (e.g., fin punches) which extended from early-August through late-October. All 17 marked smallmouth bass were recaptured within the original marking reaches. The total number of smallmouth bass removed over six removal passes after the marking pass was 201 juveniles (100-199 mm) and 233 adults (≥ 200 mm)(Table 3). During the three pre-marking passes, 70 juveniles and 78 adult smallmouth bass were removed.

The 2012 population point estimate (95% C.I. in parenthesis) was 232 ± 133 (99 –365) for smallmouth bass 100-199 mm and 1,853 ± 1,748 (105 – 3,601) for smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.159 and 0.037, respectively, for these two length groups. The CV was 29.2 % and 48.0 %, respectively, for these two length classes. The CV can be used as a measure of estimate precision and Pollock et al. (1990) suggests a good 'rule of thumb' is to achieve a CV of 20% or less. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 10 % (37/365) for juvenile fish 100-199 mm which computes to about an average of 6.6 juvenile smallmouth bass/mile. For smallmouth bass ≥ 200 mm, the proportion or percentage of smallmouth bass of these sizes removed annually or the exploitation rate for this first pass based on the population estimate was a few as 2 % (68/3,601) or an average of 52.5 adult smallmouth bass/mile.

The 2011 population point estimate (95% C.I. in parenthesis) was 1,718 ± 1,115 (603 – 2,833) for smallmouth bass 100-199 mm and 110 ± 108 (2 – 218) for smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.056 and 0.071, respectively, for these two length groups. The CV was 10.4 % and 50.0 %, respectively, for these two length classes. The proportion or percentage of smallmouth bass of these

sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 4 % (117/2,833) for juvenile fish 100-199 mm which computes to about an average of 48.7 juvenile smallmouth bass/mile. For smallmouth bass ≥ 200 mm, the proportion or percentage of smallmouth bass of these sizes removed annually or the exploitation rate based on the population estimate was a few as 7 % (16/218) or an average of 3.1 adult smallmouth bass/mile.

The 2010 population point estimate (95% C.I. in parenthesis) was 255 ± 196 (59 –451) for smallmouth bass 100-199 mm and 823 ± 671 (152-1,494) for smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.097 and 0.053, respectively, for these two length groups. The CV was 39.3 % and 41.6 %, respectively. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 7 % (31/451) for juvenile fish 100-199 mm which computed to about an average of 7.2 juvenile smallmouth bass/mile. For smallmouth bass ≥ 200 mm, the proportion or percentage of smallmouth bass of these sizes removed annually or the exploitation rate based on the population estimate was a few as 4 % (60/1,494) or an average of 23.3 adult smallmouth bass/mile.

The 2009 population point estimate (95% C.I. in parenthesis) was 2,044 ± 2,238 (- 194 – 4,282) for smallmouth bass 100-199 mm and 755 ± 802 (- 471 – 1,557) for smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.014 and 0.017, respectively, for these two length groups. The CV was 55.9% and 54.2%, respectively. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 1% (46/4,282) for juvenile fish 100-199 mm which computes to about an average of 57.9 juvenile smallmouth bass/mile. For smallmouth bass ≥ 200 mm, the proportion or percentage of smallmouth bass of these sizes removed annually or the exploitation rate based on the population estimate was a few as 1 % (20/1,557) or an average of 21.4 adult smallmouth bass/mile.

The low number of recaptured marked juvenile and adult smallmouth bass during the first removal pass compared to earlier years obviously contributed to very poor capture probabilities, abundance estimates, and exploitation rates for 2009. The same could be said for the 2011 and 2012 adult smallmouth abundance estimate where only one and two (respectively) adult fish were recaptured in the first removal pass to compute the abundance estimate. This low precision of the abundance estimate was reflected in the high CVs (50 % and greater) for 2009 and 2010 (adults)(Table 3). In 2009 as in 2008, declining catch rates reflected a downward trend in relative abundance. The 2009 abundance estimate did not correlate well with the calculated catch effort indices for juvenile and adult smallmouth bass (≥ 100 mm; see Figure 4) during 2009 in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. Therefore, the abundance estimates for 2009, as well as the adult abundance estimate for 2011 and 2012, should be viewed with caution with earlier and future year comparisons.

The 2008 population point estimate (95% C.I. in parenthesis) was 804 ± 423 (381–1,227)(Table 5) for juvenile smallmouth bass (100-199 mm). The weighted probability of capture (p-hat) was computed as 0.10; the CV: 26.9%. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 6.7 % (82/1,227) or as many as 21.5% (82/381). This computes to an average of about 22.8 fish/mile. For adult smallmouth bass (≥ 200 mm) the population point estimate (95% C.I. in parenthesis) was 393 ± 276 (117– 669). The weighted probability of capture was computed as 0.07; the CV: 35.9%. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 4.2 % (28/669) or as many as 23.9% (28/117). This computed to an average of about 11.1 fish/mile.

The 2007 population point estimate (95% C.I. in parenthesis) was 1,007 ± 686 (321–1,693)(Table 5) for adult smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.06; the CV: 34.8%. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 6.4 % (109/1,693) or as many as 3.4% (109/321). This computed to an average of about 28.5 fish/mile.
The 2006 population point estimate (95% C.I. in parenthesis) was 2,295 ± 1,500 (795–3,795)(Table 5) for adult smallmouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.04; the CV: 33.3%. The proportion or percentage of smallmouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 4.3 % (163/3,795) or as many as 20.5% (163/795). This computed to an average of about 65 fish/mile.

A weak year class of fish produced in 2011 produced a small abundance estimate (232 fish) for juvenile smallmouth bass (100 – 199 mm). Abundance estimates for juvenile (100-199 mm) smallmouth bass peaked in 2011 (1,718 fish) due to a strong year class of smallmouth bass being produced in 2010. Juvenile smallmouth abundance was most similar in 2010 (255 fish) to 2012 in the 35.3 miles of the Upper Colorado and Lower Gunnison rivers in the Grand Valley reaches. Abundance of adult smallmouth bass (≥ 200 mm) slowly decreased from a high of 2,295 fish in 2006, 1,007 in 2007, 393 in 2008, but increased to 823 during 2010. The adult abundance increase in 2010 could be attributed to the strong year class of smallmouth bass produced in 2007. Abundance estimates for both juvenile and adult smallmouth bass in 2009 and adult smallmouth bass in 2011 and 2012 were not included here because of the low number of recaptures necessary to generate a reliable estimate.

Exploitation Rates. Exploitation rates were computed for two length groups (100-199 mm and ≥ 200 mm) of smallmouth bass from the Upper Colorado and Lower Gunnison rivers for 2006 – 2012 (Table 4). Exploitation rates by year and length class were: 2006 (fish ≥ 200 mm): 27.9; 2007 (fish ≥ 200 mm): 39.1; 2008 (fish 100-199 mm): 57.0, (fish

≥ 200 mm): 44.0; 2009 (fish 100-199 mm): 10.7, (fish ≥ 200 mm): 12.8; 2010 (fish 100-199 mm): 55.7, (fish ≥ 200 mm): 35.2; 2011 (fish 100-199 mm): 42.0, (fish ≥ 200 mm): 52.1; . 2012 (fish 100-199 mm): 64.7, (fish ≥ 200 mm): 20.1. This method attempts to reduce bias from fish moving outside the sampling area, mortality during the sampling period, and growth (personal communication, Bruce Haines, USFWS [ret.], Vernal, Utah). This method attempts to extrapolate the exploitation rate over the number of removal passes for the six years abundance estimates have been computed.

Largemouth Bass

2012 was the first year attempting at a mark-recapture population estimate for largemouth bass. During the marking pass performed in July 2012, a total of 41 largemouth bass (32 juvenile size [100-199 mm], 9 adult size [≥ 200 mm]) were marked and released alive. Fifteen (10 juvenile, 5 adult) of these marked fish were later recaptured during six removal passes. Since a 'batch' mark was employed and largemouth bass were not marked with a serially numbered tag, movements of individual fish were not possible. Ten marked fish (7 juvenile, 3 adult) were recaptured in removal pass 1. Three marked fish (2 juvenile, 1 adult) were captured during pass 3, and two marked fish (1 juvenile, 1 adult) were captured during pass 4. All 15 marked largemouth bass were recaptured within the original marking reaches. The total number of largemouth bass removed over six removal passes after the marking pass was 1,616 juveniles (100-199 mm) and 47 adults (≥ 200 mm). During the three pre-marking passes, 17 juveniles and 10 adult largemouth bass were removed.

The 2012 population point estimate (95% C.I. in parenthesis) was 399 ± 219 (180 – 618) for largemouth bass 100-199 mm and 34 ± 20 (14 – 54) for largemouth bass ≥ 200 mm. The weighted probability of capture (p-hat) was computed as 0.258 and 0.471, respectively, for these two length groups. The CV was 27.9 % and 30.1 %, respectively, for these two length classes. The proportion or percentage of largemouth bass of these sizes removed during the first removal pass or the exploitation rate for this first pass based on the population estimate was as few as 17 % (103/618) for juvenile fish 100-199 mm which computes to about an average of 11.3 juvenile largemouth bass/mile. For largemouth bass ≥ 200 mm, the proportion or percentage of largemouth bass of these sizes removed annually or the exploitation rate for this first pass based on the population estimate was as large as 30% (16/54) or an average of 1.5 adult largemouth bass/mile.

Exploitation Rates. Exploitation rates were computed for two length groups (100-199 mm and ≥ 200 mm) of largemouth bass from the Upper Colorado and Lower Gunnison rivers for 2012. Exploitation rates by year and length class were: 2012 (fish 100-199 mm): 83.3, (fish ≥ 200 mm): 97.8. These rates are perplexing considering more fish were actually removed than what were estimated to be in the population, a strong indication that simple closed population models are not suitable to a large complex riverine system.

Northern Pike and Other Nonnative Game Fishes.

Sixteen adult northern pike were collected by CPW near Rifle (RM 238 – 241.8) in 2012. These fish ranged in total length from 434 mm to 825 mm with a mean total length of 712 mm. Ten adult northern pike were captured in the 2011 centrarchid removal efforts by FWS and CPW. Nine of these fish were collected from the Rifle Bridge to Cottonwood Park boat landing near Parachute in mid-October. Three northern pike were captured immediately underneath the I-70 bridge at RM 238.2; seven northern pike were captured between RM 238.2 and the Rifle Bridge. For reference point, Rifle Creek empties into the Colorado River at RM 239.8. One other northern pike was collected in September between Price-Stubb fishway and GVIC Diversion Dam at Palisade (RMs 187.7-184.9). One other northern pike (680 mm) was captured in the fish trap of the Redlands fishway on the Lower Gunnison River in 2011. All 11 of these fish have been preserved (frozen) for future otolith microchemisty analyses. Such analyses can help in determining their possible origin, i.e., had this fish escaped from off-channel riverine habitats such as isolated gravel pits breached by the 2011 high spring flows and now connected to the mainstem river, escaped from nearby reservoirs, or possibly illicitly translocated.

Four adult walleye were removed from the Grand Valley reaches between RM 158.7 and 183.6 in 2012. Their total lengths ranged from 417 to 459 mm. All 4 of these fish have been preserved (frozen) for future otolith microchemisty analyses.

One adult striped bass collected just upstream of the town of Fruita at RM 161.3. The fish's total length was 572 mm.

Captures of adult gizzard shad in the Upper Colorado and Lower Gunnison rivers exploded during 2007 (total=179). One hundred thirty-nine adult gizzard shad were collected during the 2007 smallmouth bass removal project. An additional 43 were collected in the fish trap of the Redlands Dam fish passageway. This compares to 12 captured during the smallmouth bass removal study in 2006 and only 3 in the Redlands fish passageway fish trap. One age-0 or age-1 gizzard shad (66 mm) was collected in the Upper Colorado River during 2009.

However, in 2008 the number of gizzard shad collected declined markedly from 2007, almost one magnitude less. Eighteen gizzard shad were collected during 2008, all from Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. No gizzard shad were found in the fish trap at the Redlands fish passageway in 2008. During the 2009 centrarchid removal, 36 gizzard shad (three juvenile and 33 adult) were collected in the Grand Valley reaches. Three adult gizzard shad were also collected in the fish trap of the Redlands fish passageway during 2009.

In 2010, 40 adult gizzard shad were captured during the centrarchid removal study and five adults were collected in the fish trap at the Redlands fishway. In 2011, no gizzard shad were observed or collected from the centrarchid removal study or Redlands fish trap.

No gizzard shad were collected in the Government Highline fish passageway between 2006 and 2011.

In 2012, 72 gizzard shad were collected during centrarchid removal in the Grand Valley reaches. This marks the first year that both juvenile and adult shad were found in our catch with total lengths ranging from 53 to 485 mm and a mean total length of 413 mm. In 2012, 22 adult gizzard shad were collected Redlands fish trap. It appears that drought stricken years allow for the upstream expansion of gizzard shad's range in the Colorado and Gunnison Rivers.

In 2012, 614 white sucker and white sucker hybrids were removed from the Grand Valley reaches. Their total length ranged from 53 to 519 mm with a mean total length of 255 mm. These fish were removed opportunistically when white sucker catch wouldn't overwhelm the crew's primary focus on centrarchid removal.

VIII. Recommendations:

1. Continue to collect and lethally remove all centrarchids from the Colorado and Gunnison rivers during all station sampling studies which includes sampling on the Colorado and Gunnison rivers.

2. Continue using three electrofishing craft during the marking pass in an attempt to capture, mark, and release more smallmouth bass $\geq$ 100 mm.

3. Investigate and implement management measures to prevent escapement of smallmouth bass and other piscivorous fishes into riverine areas from bodies of water known to be occupied by species that could negatively impact native riverine fishes.

4. Target specific in-river features that provide habitat for centrarchid fishes. These include but are not limited to beaver lodges, tree stumps and logs, rock piles, and concrete rip-rap. Sampling these features with electrofishing may increase catches of centrarchid fishes.

5. Continue having CPW sample the Upper Colorado reaches from Silt to Beavertail Mountain in Debeque Canyon.

6. Restore nonnative fish removal passes in river reach between the Loma Boat Landing and Westwater Ranger Station, Utah, to annually monitor and detect potential increased smallmouth and largemouth bass abundance. 2012's Black Rocks humpback chub work produced over 70 largemouth bass.

7. Evaluate the feasibility of sampling floodplain ponds (specifically those tied to gravel pit operations and others that have hydrologic connections directly to the Colorado River) in the Silt and Rifle areas to determine fish species presence and

abundance/density.

8. Complete otolith microchemistry analyses to determine the origin of northern pike collected in the Colorado River, and evaluate other potential habitable locations these fish may have occupied beyond their origination.

9. Suspend all electrofishing operations when it is determined that Colorado pikeminnow show signs of preparing to spawn, e.g., mid- to late-June. Electrofishing will be suspended during this period to eliminate the likelihood of harassment, interference, and injury to spawning Colorado pikeminnow.

10. Downstream from Price-Stubb fish passage, electrofishing should commence following cessation of spawning of Colorado pikeminnow which should be sometime in mid- to late-July.

11. Considering a large recruitment year (761 Smallmouth Bass & 3,484 Largemouth Bass < 100 mm TL) in 2012, increase the number of passes back up to ten to eradicate potential future spawners in the Upper Colorado River.

12. Little to no large bodied fishing effort has been expended in the Colorado River below the Colorado/Utah state line to the confluence of the Green River since 2010. In 2010, during the Colorado pikeminnow estimate work, walleye captures were equal to pikeminnow captures at 46. For the first time in 9 years of centrarchid removal work, 2012 produced 4 walleye in the Grand Valley reaches. If 2013's pikeminnow estimate work provides more evidence in an increased abundance of walleye potentially moving upstream, consideration should be given to effort in this reach during the years pikeminnow work isn't occurring.

IX. Project Status: "on track and ongoing"

X. FY 2012 Budget Status

A. Funds Provided: 125,760
B. Funds Expended: 125,760
C. Difference: -0-
D. Percent of the FY 2012 work completed, and projected costs to complete: 100%
E. Recovery Program funds spent for publication charges: -0-

XI. Status of Data Submission (Where applicable): Will be submitted to UCRRP database by January 2012.

XII. Signed: Travis Francis 11/16/2012
Principal Investigator Date

APPENDIX:

Literature Cited:

Chapman, A. D. 1951. Some properties of the hypergeometric distribution with applications to zoological sample censuses, University of California Publ. Stat. 1(7):131–160.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Dept. of Environment, Fisheries and Marine Service, Ottawa, Canada, 382 pp.

Pollock, K. H., J. D. Nichols, C. Brownie, and J. E. Hines. 1990. Statistical inference for capture-recapture experiments. Wildlife Monographs 107.

Table 1. Catch/effort (C/E, fish/hr) comparison by year for three different length classes (total length) of smallmouth bass (< 100mm = age-0; 100–199 mm = juveniles; ≥ 200 mm = adults) for the Rifle to Beavertail Mountain reaches (river miles 240.4 – 195.7 in the Upper Colorado River and the Upper Colorado River from Government Highline Dam to the Westwater BLM ranger station, Utah (river miles 193.7.7 – 136.0) and the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence (river miles 3.0 – 0.7) from 2004 – 2012. Note: a) all removal passes and all reaches were combined within years for the Rifle to Beavertail Mountain and Government Highline Dam to Westwater, Utah, plus the Lower Gunnison River reaches, b) Silt to Rifle reach sampled only during 2007 and 2008, and c) Government Highline to Cameo XCEL Bridge reach added in 2009, d) in 2011, some reaches were not sampled which included Black Rocks to Westwater Ranger Station, Government Highline to Cameo, and Cottonwood Park boat landing to Beavertail Mountain, e) some reaches not sampled in 2012 include the 2.3- mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence, the additional reach between the Government Highline Dam and the Cameo Bridge, from Cameo Bridge to GVIC, and Parachute to Debeque .

			Smallmouth Bass								
River Section	Length Class (mm)		Year								
			2012	2011	2010	2009	2008	2007	2006	2005	2004
Rifle ▸ Beavertail Mountain	< 100	No. of fish	1	0	57	0	21	17	36	58	3
		C/E	0.02	0	0.72	0	0.25	0.2	0.96	1.46	0.15
	100-199	No. of fish	1	6	0	3	29	28	2	54	4
		C/E	0.02	0.48	0	0.05	0.34	0.32	0.05	1.36	0.2
	> 200	No. of fish	3	5	39	12	32	45	41	118	14
		C/E	0.05	0.01	0.49	0.19	0.37	0.52	1.09	2.96	0.71
Government Highline Dam ▸ Westwater, Utah + Lower Gunnison River	< 100	No. of fish	761	226	2,054	191	185	1,358	261	254	93
		C/E	2.62	0.55	5.82	0.55	0.63	4.15	1.61	1.46	0.55
	100-199	No. of fish	316	611	159	137	214	250	54	345	618
		C/E	1.09	1.47	0.45	0.39	0.73	0.76	0.33	1.98	3.66
	> 200	No. of fish	423	147	188	177	135	429	449	768	456
		C/E	1.46	0.35	0.53	0.51	0.46	1.31	2.77	4.39	2.7

Table 2. Catch/effort (C/E, fish/hr) comparison by year for three different length classes (total length) of largemouth bass (< 100mm = age-0; 100–199 mm = juveniles; ≥ 200 mm =

adults) for the Rifle to Beavertail Mountain reaches (river miles 240.4 – 195.7 in the Upper Colorado River and the Upper Colorado River from Government Highline Dam to the Westwater BLM ranger station, Utah (river miles 193.7 – 127.6) and the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence (river miles 3.0 – 0.7) from 2004 – 2012. Note: a) all removal passes and all reaches were combined within years for the Rifle to Beavertail Mountain and Government Highline Dam to Westwater, Utah, plus the Lower Gunnison River reaches, b) Silt to Rifle reach sampled only during 2007 and 2008, and c) Government Highline to Cameo XCEL Bridge reach added in 2009, d) in 2011, some reaches were not sampled which included Black Rocks to Westwater Ranger Station, Government Highline to Cameo, and Cottonwood Park boat landing to Beavertail Mountain, e) some reaches not sampled in 2012 include the 2.3- mile section of the Lower Gunnison River from the Redlands Diversion Dam to the Colorado/Gunnison River confluence, the additional reach between the Government Highline Dam and the Cameo Bridge, from Cameo Bridge to GVIC, and Parachute to Debeque ..

		Largemouth Bass									
River Section	Length Class (mm)		Year								
			2012	2011	2010	2009	2008	2007	2006	2005	2004
Rifle ▸ Beavertail Mountain	< 100	No. of fish	37	9	24	36	462	122	125	10	53
		C/E	0.66	0.71	0.3	0.58	6.05	1.4	3.33	0.25	2.68
	100-199	No. of fish	35	13	31	29	90	109	71	10	11
		C/E	0.62	1.03	0.39	0.47	1.05	1.26	1.89	0.25	0.56
	> 200	No. of fish	0	5	13	5	43	56	15	17	2
		C/E	0	0.4	0.16	0.08	0.5	0.64	0.4	0.43	0.1
Government Highline Dam ▸ Westwater, Utah + Lower Gunnison River	< 100	No. of fish	3,484	2,463	4,281	1,952	1,272	1,507	573	465	173
		C/E	12	6.05	12.1	5.58	4.32	4.61	3.54	2.66	1.03
	100-199	No. of fish	1,674	712	1,141	609	344	1,332	487	86	85
		C/E	5.766	1.72	3.23	1.74	1.17	4.07	3.01	0.49	0.5
	> 200	No. of fish	69	102	29	32	39	43	36	38	21
		C/E	0.24	0.25	0.08	0.09	0.13	0.13	0.22	0.22	0.12

Table 3. Population estimate with 95% confidence intervals (CI) and other statistics for smallmouth bass (100-199 mm and ≥ 200 mm) for the 15- and 18-mile reaches (river miles 185.6 to 152.6) of the Upper Colorado River and 2.3 miles of the Lower Gunnison River (Redlands Diversion Dam to the Colorado/Gunnison River confluence) for the summers of 2006 - 2012. Note: length of the area for the population estimate was 35.3 miles.

Year	Fish Length Size (mm)	Pop Estimate with 95% CI	SE	SmBass/ mile	Number Marked; No. Removed 1st Removal	Number Recaptured (1st Removal Pass)	Total Number Recaptured (all removal passes)	Total Number of Removal Passes	Total Number of SmBass Removed (all removal passes)	Percentage Removed (All Removal Passes)	CV (%)	p-hat (weighted)
2004/ 2005	NO POPULATION ESTIMATE PERFORMED											
2006	100-199	No Pop Est.	- - -	- - -	25;18	0	0	4	54	- - -	- - -	- - -
	≥ 200	2,295 ± 1,500	765	65.0	97;163	6	8	4	449	19.6	33.3	0.043
2007	100-199	No Pop Est.	- - -	- - -	13;16	0	0	8	250	- - -	- - -	- - -
	≥ 200	1,007 ± 686	350	28.5	54;109	5	14	8	429	42.6	34.8	0.060
2008	100-199	804 ± 423	216	22.8	96;82	9	10	8	214	26.6	26.9	0.101
	≥ 200	393 ± 276	141	11.1	67;28	4	17	8	135	34.4	35.9	0.073
2009	100-199	2,044± 2,238	1,142	57.9	86;46	1	6	8	138	6.8	55.9	0.014
	≥ 200	755 ± 802	409	21.4	71;20	1	4	8	178	23.6	54.2	0.017

Table 3. (cont'd).

Year	Fish Length Size (mm)	Pop Estimate with 95% CI	SE	SmBass/ mile	Number Marked; No. Removed 1st Removal	Number Recaptured (1st Removal Pass)	Total Number Recaptured (all removal passes)	Total Number of Removal Passes	Total Number of SmBass Removed (all removal passes)	Percentage Removed (All Removal Passes)	CV (%)	p-hat (weighted)
2010	100-199	255 ± 196	100.2	7.2	31;31	3	11	8	159	62.4	39.3	0.097
	≥ 200	823 ± 671	342	23.3	53;60	3	9	8	188	22.8	41.6	0.053
2011	100-199	1,718 ± 1,115	569	48.7	101;117	6	10	10	611	35.6	10.4	0.056
	≥ 200	110 ± 108	55.1	3.1	12;16	1	3	10	147	135	50.0	0.071
2012	100-199	232 ± 133	67.7	6.6	50;37	6	9	6	201	86.6	29.2	0.159
	≥ 200	1,853 ± 1,748	889	52.5	82;68	2	8	6	233	12.6	48.0	0.037

Table 4. Exploitation rates for smallmouth bass (100 – 199 mm and ≥ 200 mm) collected in the Upper Colorado (river miles 187.8 – 152.6) and the Lower Gunnison (river miles 3.0 – 0.7) rivers during 2006 – 2012.

Year	Length Class (mm)	Probability of Being Captured on each pass (p-hat) (weighted) [a]	Probability of Being Captured after "n" Passes (or) Exploitation Rate (μ)
2006 [b]	100-199	- - -	- - -
	≥ 200	0.043	27.9 [b, d]
2007 [c]	100-199	- - -	- - -
	≥ 200	0.060	39.1 [c, d]
2008 [c]	100-199	0.101	57.0 [c, d]
	≥ 200	0.073	44.0 [c, d]
2009 [c]	100-199	0.014	10.7 [c, d]
	≥ 200	0.017	12.8 [c, d]
2010 [d]	100-199	0.097	55.7 [c, d]
	≥ 200	0.053	35.2 [c, d]
2011 [e]	100-199	0.056	42.0 [d, e]
	≥ 200	0.071	52.1 [d, e]
2012	100-199	0.159	64.7 [d, e]
	≥ 200	0.037	20.1 [d, e]

[a] Formula for inverse/variance weighting: $p = [(1/var1) * p_1 + (1/var2) * p_2]/[(1/var1) + (1/var2)]$. Variance for p_1 hat & p_2 hat = $p * (1-p)/n$; n=sample size (e.g., number of removal passes). For example, 2006 smallmouth bass ≥ 200 mm, p_1 var=6/97=0.62, p_2 var=6/163=0.37. 6=number of marked fish recaptured during first removal pass; 97=number of fish marked during marking pass, 163=number of fish removed during the first removal pass.

[b] Four removal passes ("n").

[c] Eight removal passes ("n"). Includes fish removed by FWS (passes 1 – 6) and CDOW (passes 7 – 8).

[d] Exploitation rate (□) computed as, □ = $1 – [(1 – p)^n]$, where p is the probability of being captured on one pass as computed from the first removal pass, 1 – p is the probability of fish surviving one removal pass, $(1 – p)^n$ is the probability of surviving n passes, and $1 – [(1 – p)^n]$ is the probability of being captured after n passes (personal communication, Bruce Haines,

USFWS [ret.], Vernal, Utah).

[e] Ten removal passes, for 2012 six removal passes (“n”).

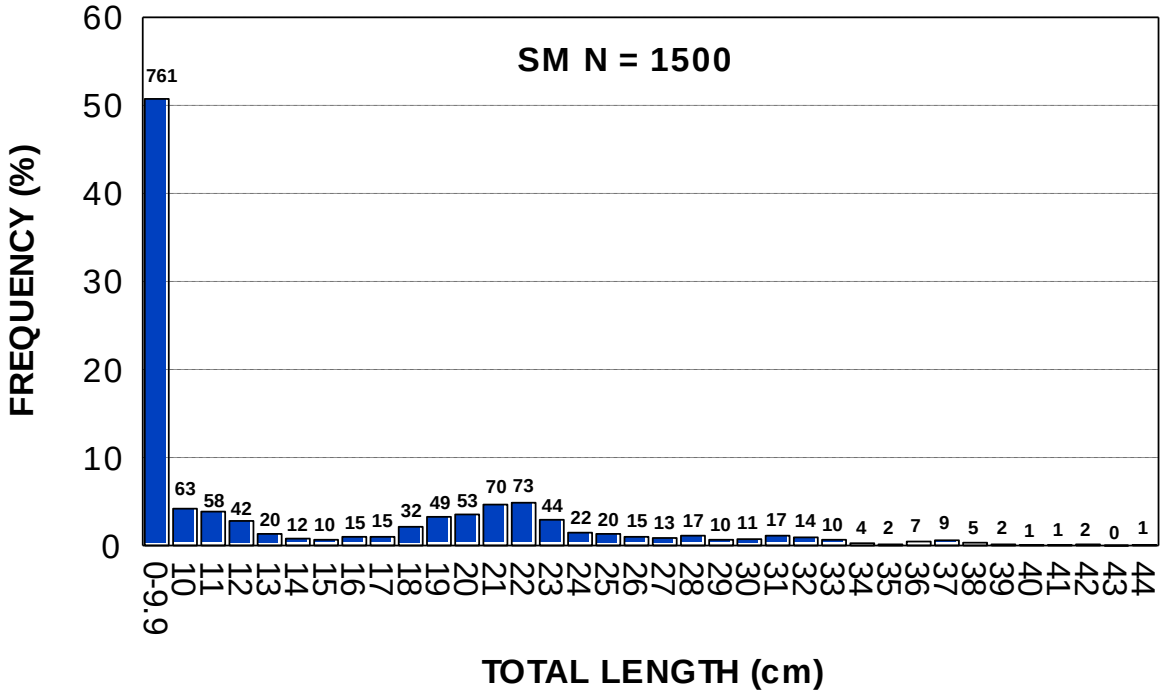

Figure 1. Length (cm) frequency histogram for all smallmouth bass captured in the Grand Valley reaches in 2012. The numbers above the bars are the total number of individuals represented by the bar.

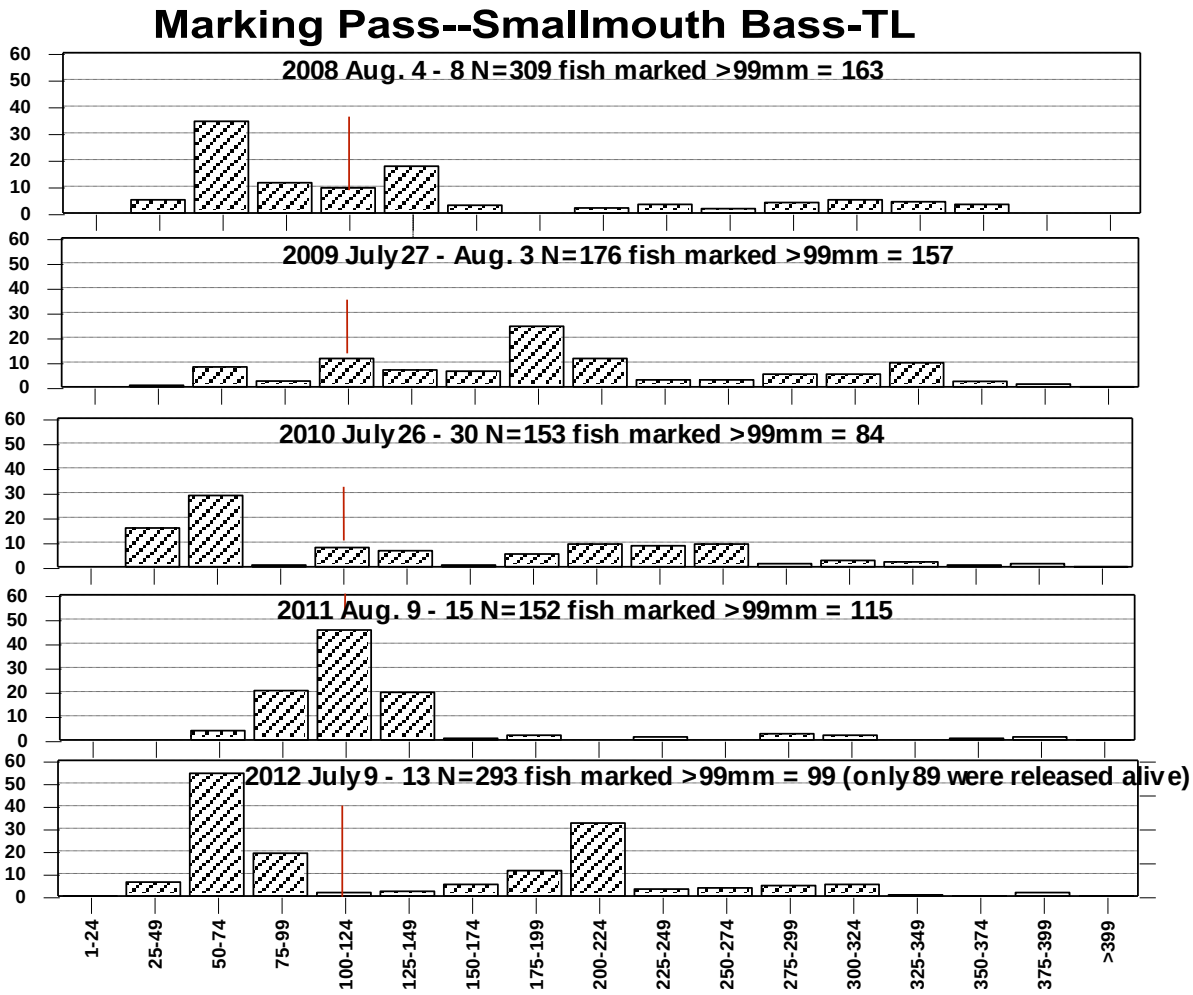

Figure 2. Length frequency comparison among 2008 – 2012 for all smallmouth bass collected during the marking pass in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. Three electrofishing craft were used for all years except 2011 when two were utilized.

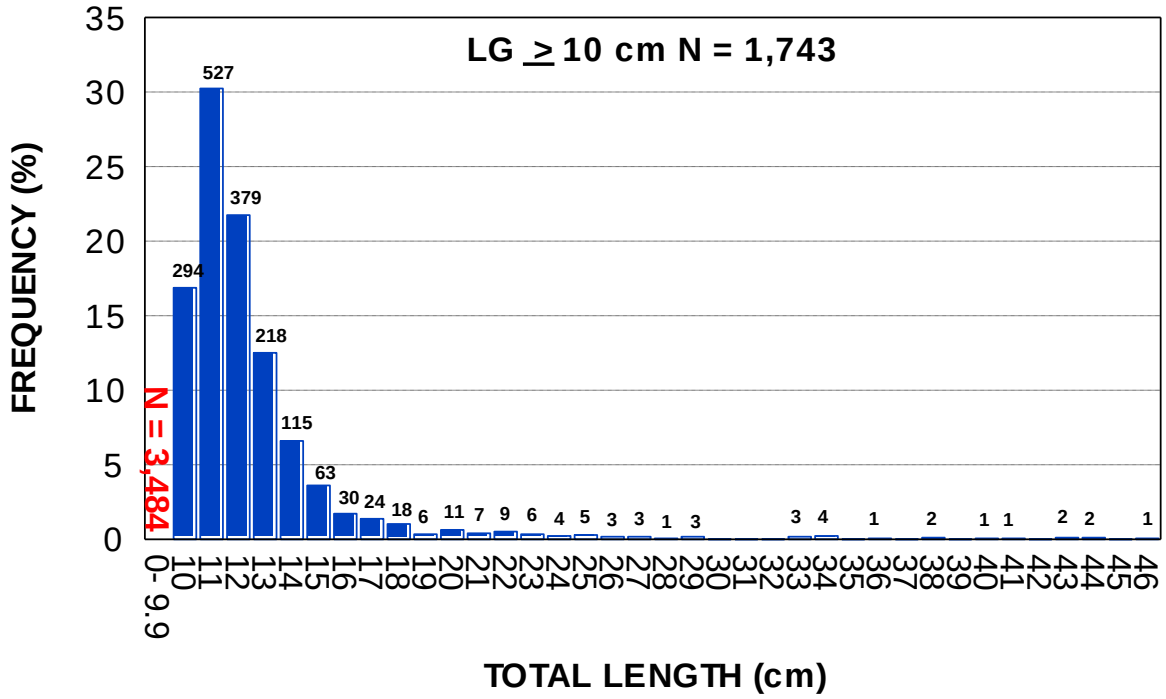

Figure 3. Length (cm) frequency histogram for all largemouth bass captured in the Grand Valley reaches in 2012. The numbers above the bars are the total number of individuals represented by the bar. Largemouth bass form 0 to 9.9 cm were so numerous (n=3,484) that they skewed the histogram; thus, they were not included in the calculation.

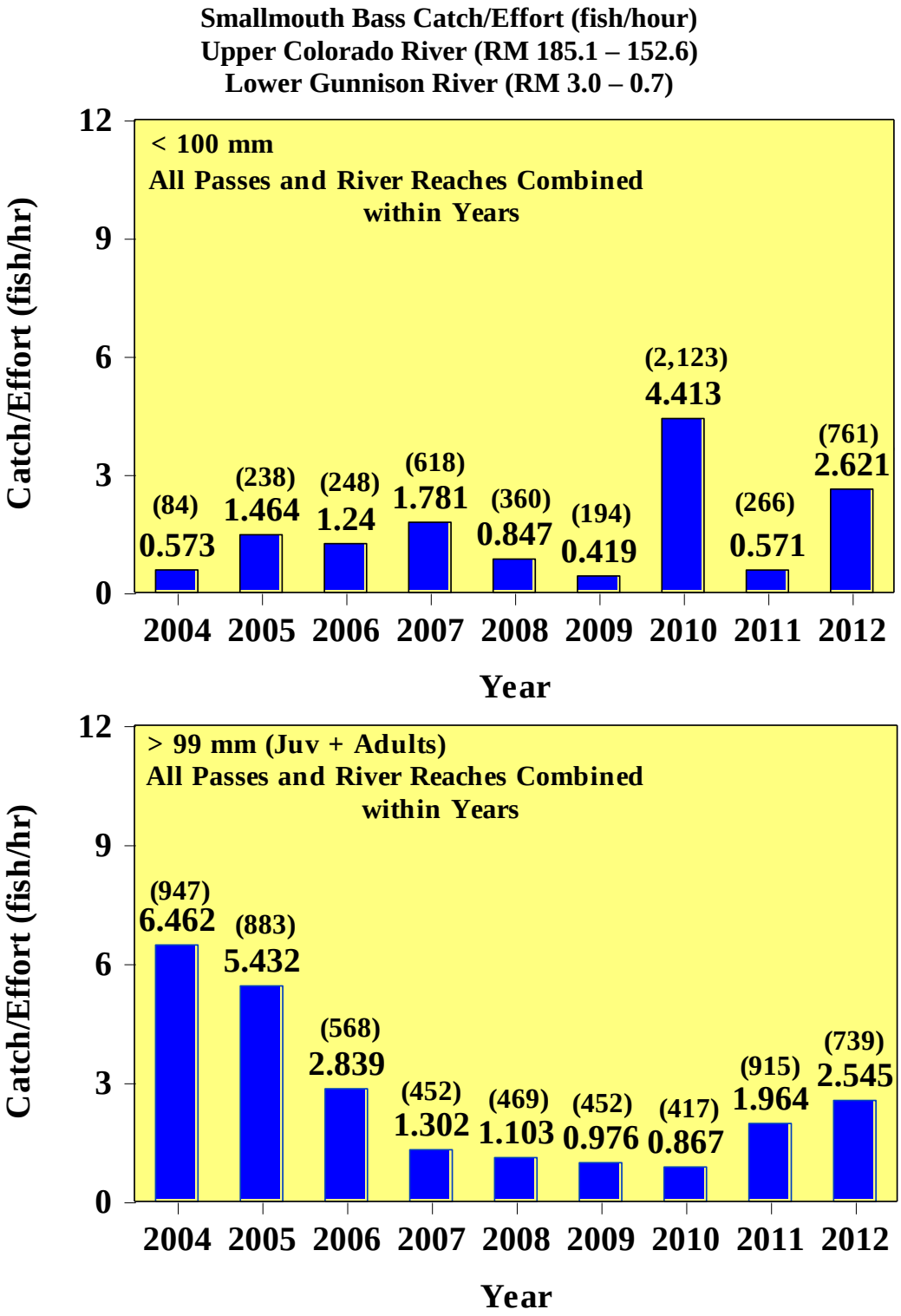

Figure 4. Nine year comparison of catch/effort (fish/hr) for smallmouth bass (< 100 mm) (upper) and juvenile and adult smallmouth bass (≥ 100 mm) (lower), 2004-2012, for the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. Note: numbers of smallmouth bass collected in parentheses.

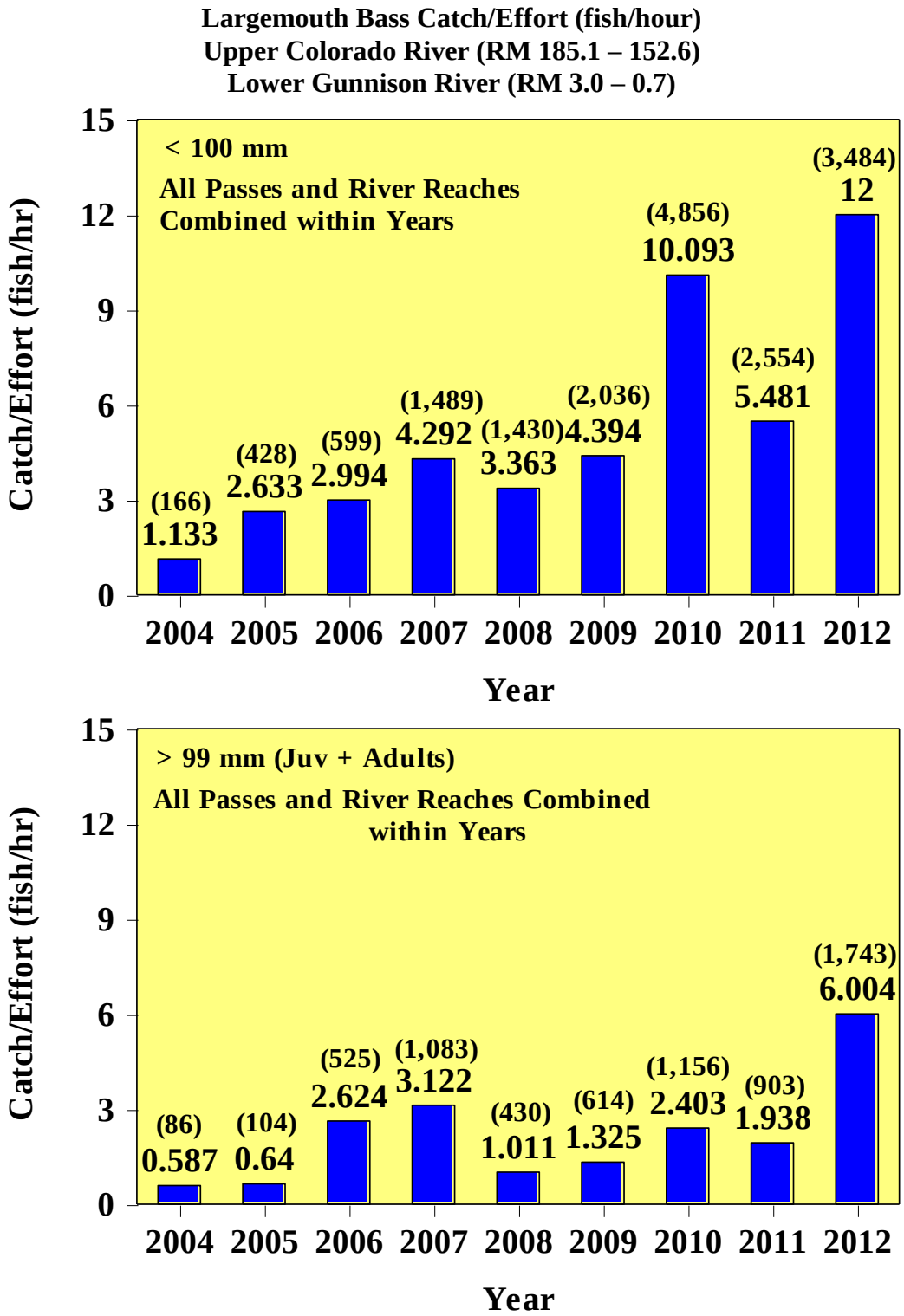

Figure 5. Nine year comparison of catch/effort (fish/hr) for largemouth bass (< 100 mm) (upper) and juvenile and adult smallmouth bass (≥ 100 mm) (lower), 2004-2012, for the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers. Note: numbers of largemouth bass collected in parentheses.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: 07FG402653

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: 126 b

Project Title: Colorado River Centrarchid, Etc. Removal for 2012

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Project/Grant Period: Start date: 09/21/07
End date: 09/30/12
Reporting period start/end date: 10/01/11 to 9/30/12
Is this the final report? Yes _____ No _X__

- Performance The Colorado River was sampled by CPW crews via two, 16' rafts with Smith-Root 5.0 GPP mounted electrofishing gear. Rafts electrofished downstream along both shorelines, and utilized experimental gill nets at the mouths of and within backwaters to complete "block and shock" sampling on several occasions. Fish captured were measured in length to the nearest millimeter and weighed to the nearest gram. All non-native, non-salmonid fish captured were lethally removed. Otoliths and cleithra will be extracted from the northern pike collected to assist in determination of fish origination.

- One electrofishing pass was completed from Silt (RM 248.0) to Parachute (223.0) and from Debeque (RM 209.7) to Beavertail Tunnel (195.7). This pass included sampling the main channel and backwaters via electrofishing. Northern pike, black bullheads, and most centrarchids were all captured within backwater/slackwater/eddy habitats.

- A second electrofishing pass was completed from Rifle to Parachute, where only backwater/slackwater/eddy habitats were targeted utilizing the "block and shock" technique.

- One backwater upstream of Rifle (RM 241.8) and two backwaters downstream of Rifle (RM 240.4 and RM 238.0) where northern pike were concentrated (as determined during the first two passes) were also sampled on multiple occasions (one sample event for RM 241.8 and four sample events each for RM 240.4 and RM 238.0). These backwaters were accessible by shore once river discharge declined and conditions became too dangerous for rafts to access the sites. Multiple, experimental gill nets were set at the mouths of and within these backwaters while backpack electrofishers were utilized to complete "block and shock" sampling.

- CPW crews were not able to sample the Colorado River from Parachute (RM 223.0) to Debeque (RM 209.7) due to access issues and a dangerous river diversion (Bluestone Ditch) upstream of Debeque.

- Total Number of Fish Captured = 417
  Total Number of Black Bullhead = 7 (Total length ranged from 121mm-210mm)
  Total Number of Black Crappie = 5 (Total length ranged from 73mm-218mm)
  Total Number of Bluegill = 2 (Total length was 150mm)
  Total Number of Green Sunfish = 310 (Total length ranged from 36mm-156mm)
  Total Number of Largemouth Bass = 72 (Total length ranged from 56mm-195mm);
  43 fish $\leq$ 100mm; 26 fish > 100mm and <150mm; 3 fish $\geq$ = 150mm
  Total Number of Northern Pike = 16 (Total length ranged from 434mm-825mm);
  1 fish $\leq$ 500mm; 15 fish > 500mm
  Total Number of Smallmouth Bass = 5 (Total length ranged from 66mm-322mm);
  1 fish $\leq$ 100mm; 1 fish > 100mm and <150mm; 3 fish $\geq$ = 150mm

- Total Effort Expended (Electrofishing Hours = 45.68 hours) and (Gill Net Hours = 10.8 hours) = 56.5 hours overall

- Centrarchid CPUE = 6.97 fish/hour; Northern pike CPUE = 0.28 fish/hour