

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

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III. Project Summary: The purpose of this study is to 1) remove as many smallmouth bass of all sizes in main channel riverine habitats in a 61-mile reach of the Upper Colorado River between Price-Stubb Dam and Westwater boat landing in eastern Utah. The goal is to reduce the abundance of smallmouth bass as quickly as possible in this reach which will ultimately benefit native listed fishes, and possibly contribute to their recovery. An additional objective was added for 2006: obtain an abundance estimate [for smallmouth bass] during 2006 and subsequent years by mark and recapture methods for the Upper Colorado River between Price Stubb Dam and Fruita State Park. This is the fourth year of this study which started in 2004. For 2007, four additional removal passes were added in the Grand Valley portions of the Upper Colorado and Lower Gunnison rivers. The Silt to Rifle reach was added and an additional removal pass was performed between Silt and Beavertail Mountain.

In the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers, smallmouth bass catch rates (fish  $\geq 100$  mm) declined to 2.27 fish/hr, the lowest in four years. The highest catch rate was 6.38 in both 2004 and 2005 for smallmouth bass  $\geq 100$  mm. This decline was consistent with the population estimate generated in 2006 and 2007 using a single mark and first removal pass. The abundance for smallmouth bass ( $\geq 100$  mm) in the 18- and 15- mile reaches plus the 2.3 miles of the Lower Gunnison River for 2007 using a single mark and first removal pass was estimated to be  $1,427 \pm 986$  individuals or about a mean of 40.4 smallmouth bass  $\geq 100$  mm/mile. This compares to a population estimate of  $3,197 \pm 2,100$  (91 fish/mile) smallmouth bass of the same length sizes in 2006 which was a 55 % decline. However, abundance of smallmouth bass  $< 100$  mm was 4.54 fish/hr in 2007 and has steadily increased since 2004. This is evidence that 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], and Rifle to Beavertail Mountain), smallmouth bass reproduced during 2007 as they did during 2004, 2005, and 2006. In the Silt to Beavertail Mountain reaches, overall smallmouth bass (all length sizes) abundance has declined for the third year in row.

On the other hand, largemouth bass abundance for fish < 100 mm and ≥ 100 mm both steadily increased over the past four years in the Grand Valley river reaches and were most abundant during 2007. Largemouth bass < 100 mm catch rate increased from 1.03 fish/hr (2004) to 4.54 fish/hr (2007). Largemouth bass ≥ 100 mm catch rate increased from 0.63 fish/hr (2004) to 4.04 fish/hr (2007). In the Silt to Beavertail Mountain reaches, no apparent trend from year to year appears to be evident. Largemouth bass catch rates declined from 5.62 fish/hr (2006) to 3.30 fish/hr (2007). Abundance of young-of-the-year and age-1 largemouth bass and smallmouth bass is considerably less than that of Grand Valley reaches suggesting that spawning for these centrarchid fishes in the upper reaches is not as successful as the downstream reaches of the Grand Valley. In the Grand Valley reaches, green sunfish, bluegill, and black crappie captures do not appear to be declining.

Mean total length for smallmouth bass ≥ 100 mm decreased in four of the major river reaches from 2006 to 2007. In two of these reaches, the decrease was statistically significant ( $\alpha=.05$ ). Between 2005 and 2006, mean total length increased in all five major river reaches, four being statistically significant ( $\alpha=.05$ ) which may have been due in part to the loss of smallmouth bass between 100 and 180 mm.

A draft final report of field results over the past 3 years (2004 – 2006) was prepared and submitted to the Recovery Program in early-March 2007 for review. This draft final report has been reviewed by four peer reviewers and their comments included in a revised version by the PI. Future field activities will be determined at the 2007 Recovery Program nonnative fish workshop in mid-December.

IV. Study Schedule:

- a. initial year: 2004
- b. final year: 2007

V. Relationship to RIPRAP:

Colorado River Action Plan: Mainstem  
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.

VI. Accomplishment of FY 2007 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY-2007 Tasks and Deliverables:

Task 1. Remove all sizes of smallmouth bass.

Sub-Task 1a. Mark and release smallmouth bass during pass 1 in 2007.

Tasks completed.

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

Task completed. Preparation of the annual report also sufficed for the December 2007 nonnative fish workshop.

## B. Findings (2007 Highlights)

### General

*Study Direction.* The study area encompassed a 61-mile section of the Colorado River in western Colorado from the Price-Stubb 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. The Lower Gunnison River was not identified as part of the removal area in the original scope of work. However, it was added because smallmouth bass were collected there in the spring of 2004 during the Colorado pikeminnow population monitoring.

The river segments from Price-Stubb Dam to the Loma Boat Landing include 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. The river segments between the Loma Boat Landing and the Westwater Ranger station have different hydro-geomorphic features than the upstream segments. The river downstream from the Loma Boat Landing flows through a canyon-bound area and is considered a quasi-alluvial section. For sampling logistics and data analyses purposes, the Colorado River was divided into eight different river segments and the Lower Gunnison River into one.

The decision was made during the December 2005, Biology Committee meeting to obtain an abundance estimate for smallmouth bass in concentration areas of the Upper Colorado River from Price Stubb Dam to Westwater, Utah. This endeavor entailed marking and releasing smallmouth bass during an initial pass starting in the summer of 2006, and lethally removing and recording previously marked smallmouth bass in all subsequent passes. Marking smallmouth bass included the river segments from the Grand Valley Irrigation Company (GVIC) Diversion Dam to the Loma Boat Landing and the 2.3 miles of the Lower Gunnison River from the Redlands Dam to the Colorado/Gunnison River confluence. These river segments had been identified as moderate to high concentrations areas for smallmouth bass based on capture data from the summers of 2004 and 2005. An additional first pass was added to accomplish the marking in 2006 and again in 2007. Four successive passes were performed during 2006 in the concentration areas to lethally remove smallmouth bass as was conducted in both 2004 and 2005.

In 2007, study direction was modified again. Four additional removal passes were added for the Grand Valley portion of the project area. Two additional passes were performed by Fish and Wildlife personnel and two by CDOW personnel. The last two removal passes performed by the CDOW were in river reaches where high concentration or high abundance of smallmouth bass had been determined during the past 3 years of sampling.

*Methodology.* Two electrofishing rafts were used to collect centrarchid fishes during the marking pass. All smallmouth bass  $\geq 100$  mm collected were marked and released. All smallmouth bass  $< 100$  mm and other centrarchid fishes collected were removed. The marking pass was performed over a 2-week period starting on 18 July. Following the marking pass, eight removal passes (six by FWS and two by CDOW personnel) were made using aluminum boat and raft-based electrofishing to collect centrarchid fishes from 25 July to 28 September 2007. Two electrofishing craft were used in every river segment during the marking and followup eight removal passes. The number of removal passes for areas of low densities of smallmouth bass as determined from 2004 and 2005 capture data (Burdick 2007) was reduced during 2006 and again in 2007. These river segments included the canyon-bound reaches of Ruby and Horsethief canyons to Westwater, Utah (RM 152.6 – 127.6). The reduced effort in these reaches was re-directed to increase the number of removal passes in river segments where smallmouth bass had proliferated over the past two years. Therefore, only one pass was performed from the Loma Boat Landing to Westwater, Utah, during 2006 and 2007. Some river segments were not electrofished during pass 4 (e. g., Loma Boat Landing to the Westwater Ranger Station and Price-Stubb Dam to GVIC).

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, a 7.6-mile reach from Silt to the Rifle Bridge was added to assess distribution of smallmouth bass upstream of Rifle. In addition to including the Silt to Rifle reach, an additional removal pass was performed between Silt and Beavertail Mountain. This sampling occurred between 26 June and 16 July. A river segment from the Rifle Bridge to river mile 236.6 was sampled again with one electrofishing boat on 3 October. This river reach was outside the original defined removal area. However, this reach was added in 2004 because there were unsubstantiated reports that anglers had encountered smallmouth bass in these upstream reaches, and it was determined that a “reconnaissance” sampling trip was warranted to confirm or refute these claims. Furthermore, a notable increase in smallmouth bass abundance was recorded between the Rifle Bridge and Beavertail Mountain during 2005 from 2004.

Although smallmouth bass were the target fish for removal in this project, all other centrarchid fishes encountered were collected. The reason for this was that the Colorado Division of Wildlife (CDOW) requested that the Fish and Wildlife Service remove and preserve all centrarchid fishes collected during the removal effort for their analyses of origin study. These fishes included largemouth bass, green sunfish, bluegill, and black crappie. During 2007, only a small number (~ 20 fish each) of various centrarchids, esocids, and percids were requested by Pat Martinez for the analyses of origin study. Where possible, FWS personnel provided Mr. Martinez samples of smallmouth bass, largemouth bass, black crappie, northern pike, and walleye for this study. All other centrarchids removed were frozen and then delivered to the Mesa County landfill.

The number of individuals and total length were recorded for each smallmouth bass and largemouth bass collected. For all other centrarchids total length was recorded for those

specimens that were greater than 100 mm. Capture date and corresponding river mile for each centrarchid fish collected were recorded along with actual time electrofished (seconds; converted to hrs fished). For the population estimate, smallmouth bass were marked with a Fiskars® hole punch (1/4-inch diameter) in the dorsal part of the caudal fin. 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 bass. Probability of capture ( $\hat{p}$ ) (after White et al. 1982) and the coefficient of variation (CV:  $SE/\hat{N} \times 100$  [where  $N$ =estimated population size]) (Pollock et al. 1990) were also computed.

## Results

### *Size Distribution–Length Frequency.*

#### **Smallmouth Bass**

Changes in size (i. e., length) have been used to detect changes in age composition of a fish population over time. Length-frequency distributions provide an important description of population structure (Anderson and Gutreuter 1985). In this instance, we are looking for an index that could reliably be used to detect changes in the overall size [age] structure of smallmouth bass in designated river segments over time. Size structure changes over time then could be used to evaluate whether mechanical removal is reducing the numbers of a particular size [length] group, and therefore, if this technique could be recommended as an effective management tool for removal or to detect failure of year classes.

Length frequency distribution of all sizes of smallmouth bass collected with electrofishing during 2004, 2005, 2006, and 2007 between Price-Stubb Dam and Westwater, Utah, and the Lower Gunnison River were plotted (Figure 1). Additionally, for 2007, length frequency was plotted separately for removal passes 1 – 3, 4 – 6, and 7 – 8 (Figure 2). Generating a time series of length frequencies partitioned by passes might provide some insight for annual comparisons of the magnitude of early-life smallmouth bass produced and growth and abundance progression of their first year of life. A separate length frequency distribution of all size of smallmouth bass collected during 2007 and former years (2004 – 2006) were plotted for the 45-mile reach between Rifle and Beavertail Mountain (Figure 3).

The mean total length and confidence intervals were calculated for smallmouth bass for all passes combined for five different river segments for 2004, 2005, 2006, and 2007 (Figure 4). Prior to 2007, annual reports for the Upper Colorado reaches have analyzed all length sizes of smallmouth bass. For 2007, length groups were partitioned to include smallmouth bass  $\geq 100$  mm; thus excluding the early-life stages of smallmouth bass. This analyses was performed to determine if there had been any change (increase or decrease) in the length structure of the smallmouth bass  $\geq 100$  mm captured during the removal

passes among 2004, 2005, 2006, and 2007. During 2006, overall mean total length increased in all five segments from 2005: Westwater Ranger Station to the Loma Boat Landing, Loma Boat Landing to the Colorado/Gunnison River confluence, Colorado/Gunnison River confluence to Price-Stubb Dam, the Lower Gunnison River, and Beavertail Mountain to Rifle (Figure 4). In four of these five river segments there was a statistically significant increase ( $\alpha=.05$ ) in the mean total length of smallmouth bass captured between 2006 and 2005. In only one reach (Loma to the Colorado/Gunnison River confluence) was the size increase not statistically significant ( $\alpha=.05$ )(Figure 4). This increase in average size is most probably due in part to the lack of or absence of smallmouth bass catches between 100 and 180 mm in the Grand Valley reaches of the Colorado River during 2006.

During 2007, the overall mean length of smallmouth bass  $\geq 100$  mm declined in four of the five river reaches from 2006. The decline was statistically significant ( $\alpha=.05$ ) in two of the reaches (Figure 4). In only one reach did the mean length increase (Westwater to Loma), but the increase was not statistically significant ( $\alpha=.05$ ).

All age groups of smallmouth bass (young-of-the-year, juveniles, and adults) were represented in the 2007 summer collections (Figures 1 and 2). These ranged from young-of-the-year (43 mm) to adult (432 mm) fish. Between Price-Stubb Dam and Westwater, Utah, and the Lower Gunnison River, it does appear that in 2006, there was a significant decline in the number of smallmouth bass comprising the size group between 100 and 180 mm (Figure 1). In viewing the 2005 length frequency, it appears that the size group of smallmouth bass between 50 and 100 mm were lost to the population during the winter of 2005/2006 or simply were not captured in 2006. In any event, if these fish did not recruit, the reason is unknown. It is also apparent that the number of smallmouth bass within all size groups in 2006 declined from 2004 and 2005.

In addition to the length frequency histograms, the number of smallmouth bass collected for marking and removal passes by seven length categories was tallied for 2004, 2005, 2006, and 2007 for the Grand Valley river reaches. Because the number of removal passes increased two-fold in 2007 from the earlier three years of sampling, a percentage of the smallmouth bass collected was also computed to directly compare numbers collected among years. Unlike largemouth bass collected in main channel riverine habitats of the Grand Valley where a vast majority (~ 90%) of the fish collected were < 150 mm, the length classes for smallmouth bass were more proportionately represented (Tables 1 and 2). For example, in 2007, 20.1% of all smallmouth bass collected in the Grand Valley reaches were  $\geq 255$  mm, 10.7% were  $\geq 306$  mm, and 1.9% were  $\geq 357$  mm. Four smallmouth bass were  $\geq 406$  mm. Of the total smallmouth bass in 2007, 79.9% were < 255 mm and 64.6% were < 100mm. The number of “trophy-size” ( $\geq 255$  mm [10-inch]) smallmouth bass collected have increased each year since 2004, being greatest in 2007 which is mostly attributed to the increased removal passes. The number of smallmouth bass  $\geq 306$  mm (41; 1.9%) and  $\geq 406$  mm (4; 0.2%) was greatest in 2007.

For the Silt to Beavertail Mountain reaches, the number of smallmouth bass collected from the removal passes by the same seven length categories was also tallied for 2004,

2005, 2006, and 2007 (Table 3). Because the number of removal passes have been increased steadily from 2004 (n=1) to two removal passes each in 2005 and 2006, and three in 2007, comparison of numbers collected among years is more difficult. However, there is one apparent similarity with the downstream Grand Valley reaches: the number of “trophy-size” smallmouth bass relative to the total number collected were well represented in collections in these upper reaches. For example, a four-year relative average of smallmouth bass  $\geq 255$  mm was 41.1% (172 of 419 total smallmouth bass) and smallmouth bass  $\geq 306$  mm was 22% (92 of 419 fish). Six percent (n=26) were  $\geq 357$  mm.

There is one dissimilarity between these upper reaches and the Grand Valley reaches. In the upper reaches, the number of smallmouth bass  $< 255$  and  $< 100$  mm collected during 2004 – 2007 were less than that of the Grand Valley reaches. For example, the four-year relative average of smallmouth bass  $< 255$  mm in the upper reaches was 58.9% (247 of 419 total smallmouth bass) compared to 72.5% (4,137 of 5,704 total smallmouth bass) in the Grand Valley reaches. The four-year relative average of smallmouth bass  $< 100$  mm was 27.2% (114 of 419 total fish) in the upper reaches compared to 34.8% (1,987 of 5,704 total fish) in the Grand Valley reaches. This dissimilarity in the percentage and actual numbers of younger age classes may be due to lower spawning success or survival of age-0 smallmouth bass in the upper reaches compared to that in the Grand Valley reaches where spawning success appears to be more successful.

Also, it was apparent from collections, that 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], and Rifle to Beavertail Mountain), smallmouth bass reproduced during 2004, 2005, 2006, and 2007. We cannot prove 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.

During 2007, it appears that smallmouth bass spawning was very successful compared to the three former years in the Grand Valley portion (Price-Stubbs to Loma) of the Upper Colorado River. The 2007 cohort is represented in Figures 1 and 2. Comparing the catch/effort (fish/hr) for smallmouth bass  $< 100$  mm over the past 4 years, relative abundance was highest in 2007 (4.15 fish/hr) compared to 2006 (1.61 fish/hr), 2005 (1.46 fish/hr) and 2004 (0.55 fish/hr)(Table 4). Nonetheless, these sizes of young smallmouth bass have proven to be highly susceptible to low survival to age-1. In the Silt to Beavertail Mountain reaches, young-of-the-year smallmouth bass catches have been less than that of the Grand Valley reaches. In 2007, the mean catch/effort was 0.20 fish/hr compared to 0.96 fish/hr (2006), 1.46 fish/hr (2005), and 0.15 fish/hr (2004)(Table 4). In the Rifle to Beavertail Mountain reach, smallmouth bass (all length sizes combined) abundance appears to have declined over the past two summers of sampling (Figure 9). Also apparent in the 2006 sampling was the lack or even absence of smallmouth bass between 100 and 200 mm, similar to that observed in the Grand Valley reaches of the Colorado River (Figure 3).

## Largemouth Bass

Recording lengths of all largemouth bass captured afield have been taken along with smallmouth bass since inception of the removal program in 2004. Length frequency provides researchers and managers important information on size structure with which to direct management actions. While largemouth bass were not the focus of this study, total length was recorded for all largemouth bass collected and removed during this study because there was interest in the location and distribution of 'trophy size' ( $\geq 254$  mm total length) largemouth bass in main channel river habitats. Furthermore, if enough trophy-size largemouth bass could be located, there could be consideration for re-locating these size of fish alive to other Colorado waters to provide additional sport fishing opportunities. Length-frequency distribution of all sizes of largemouth bass collected with electrofishing during 2004, 2005, 2006, and 2007 between Price-Stubb Dam and Westwater, Utah, and the Lower Gunnison River were plotted (Figures 5 and 6) and for the 45-mile reach between Rifle and Beavertail Mountain (Figure 7).

A high percentage (85% between Rifle and Beavertail Mountain; 90% between Price-Stubb Dam and Westwater, Utah) of all largemouth bass captured in both major portions of the Upper Colorado River and Lower Gunnison River were comprised of fish less than 150 mm total length. Between Price-Stubb Dam and Westwater, Utah, and the 2.3 miles of the Lower Gunnison River during 2004, 2005, and 2006, length data were recorded for 2,033 largemouth bass captured. Of this number, only 3% (59 fish) were  $\geq 254$  mm. Thirty-six largemouth bass were  $\geq 305$  mm. Sixty-two percent of all largemouth bass were  $< 100$  mm and 92% were  $< 254$  mm. A similar fish length distribution was apparent during 2007 in these same river reaches (Figure 5). Of the total of 2,884 largemouth bass captured for which length data were recorded in 2007, only 0.03 % (10 fish) were  $\geq 254$  mm. Three largemouth bass were  $\geq 305$  mm. Fifty percent of all largemouth bass were  $< 100$  mm and 97 % were  $< 254$  mm. As with smallmouth bass, length frequency was plotted separately for removal passes 1 – 3, 4 – 6, and 7 – 8 (Figure 6). It seems apparent that largemouth bass spawning in the Grand Valley river reaches were also successful in 2007. Comparing the catch/effort (fish/hr) for largemouth bass  $< 100$  mm over the past 4 years, catch rates have continued to increase steadily. In 2007 the catch/effort was 4.54 fish/hr, which is the highest of the four years in which main channel data have been recorded. Catch rates for 2006, 2005, and 2004 were 3.54 fish/hr, 2.66 fish/hr, and 1.03 fish/hr, respectively (Table 4). In reviewing Figure 6, the number of young-of-the-year largemouth bass appeared to decline significantly between passes 4 – 6 and passes 7 and 8.

Skipper's Island backwater (RM 154.0) consistently has had high densities of largemouth bass  $\geq 254$  mm during 2005 and 2006. In 2006, of the 8 largemouth bass  $\geq 254$  mm total length captured between Fruita State Park and the Loma Boat Landing, 7 (mean = 367 mm, 299 – 420 mm) were caught in the Skipper's Island backwater. In 2005, of the 14 largemouth bass caught between Fruita State Park and the Loma Landing that were  $\geq 254$  mm, 13 (mean = 343 mm, 259 – 340 mm) were caught in this backwater. However, in 2007 no largemouth bass  $\geq 254$  mm were caught in the downstream end of the Skipper's Island backwater. We were, however, unable to sample the upper most end with raft

electrofishing due to low water and blockage by a series of beaver dams.

From Silt to Beavertail Mountain, of the total 314 largemouth bass collected in this 45-mile reach, only 8% (25 fish) were greater than 254 mm in 2004, 2005, and 2006. Twelve largemouth bass were  $\geq 305$  mm. Sixty percent of all largemouth bass were  $< 100$  mm and 92% were  $< 254$  mm. Unlike the Grand Valley reaches, there were more “trophy-size” largemouth bass in the Silt to Beavertail Mountain reaches (Figure 5). Of the total of 287 largemouth bass captured for which length data were recorded in 2007, 8% (24 fish) were  $\geq 254$  mm. Twenty-two largemouth bass were  $\geq 305$  mm. Forty-three percent of all largemouth bass were  $< 100$  mm and 87 % were  $< 254$  mm. From 2004 – 2006, sixty-four percent (16 of 25) of all largemouth bass  $\geq 254$  mm total length were caught at RM 236.6, a large backwater located on the south side of the Upper Colorado. In 2007, capture location of “trophy-size” largemouth bass was similar to that of earlier years for this reach. Fifty-eight percent (14 of 24) of all largemouth bass  $\geq 254$  mm total length captured in this 52-mile section of the Upper Colorado River were caught in this same backwater at RM 236.6. This appears to be a likely site where trophy-size largemouth bass could be removed and translocated to perpetuate additional sport-fishing opportunities.

#### *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, four additional removal passes were added. 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.

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 12 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.

#### *Catch/Effort.*

### **General**

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, we calculated and interpreted catch effort indices (e. g., fish/hr) over time (i. e., by pass) in each river sub-reach. Because population estimates for smallmouth bass were not available for 2004 and 2005, effort was still recorded during 2006 and 2007 and catch/effort was computed for use as a trend to compare annual abundance of smallmouth bass and other centrarchids during 2004, 2005, 2006, and 2007.

Mean catch/effort (fish/hr) was computed separately for each of the five centrarchid fishes by each of the four sampling years, 2004 – 2007. To view the “big picture” in some analyses, river reaches and removal passes were consolidated. In 2007, for smallmouth bass and largemouth bass, catch/effort was computed for fish < 100 and for fish  $\geq$  100 mm total length. Catch rates were computed separately from the Silt to Beavertail Mountain reaches and the Grand Valley river reaches (Price-Stubb Dam to Westwater ranger station, Utah + the Lower Gunnison River).

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. 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.

### **Smallmouth Bass**

For the Grand Valley river reaches, overall mean catch rate was highest for smallmouth bass  $\geq$  100 mm during 2004 (6.38 fish/hr) and 2005 (6.38 fish/hr). However, we detected a 51 % decline in catch rate 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 8). This catch effort decline is consistent with the decline observed with the population estimate from 2006 to 2007 (see Population Estimate–Smallmouth Bass below). Has there been a measurable response of smallmouth bass to removal efforts? While there has been reduction in catch rate, it is uncertain if this can be exclusively attributed to mechanical removal efforts.

For the Grand Valley river reaches, overall mean catch rate for smallmouth bass < 100 mm total length was highest in 2007 (4.15 fish/hr) and lowest during 2004 (0.55 fish /hr)(Table 4). Initially, it appears that the 2007 cohort, initially, is one of the strongest in 4 years of sampling. However, this cohort can be subject to high mortality to age-1 due

to a myriad of environmental factors over the winter and until the following summer sampling season. The ultimate fate of the 2007 cohort and slower growing age-1 fish and whether they will successfully survive and recruit to the next size classes by the summer of 2008 will not be certain until the 2008 field sampling is completed.

For the Silt to Beavertail Mountain reaches, the recent trend for smallmouth bass abundance has also been downward. Overall mean catch rate for smallmouth bass (all length sizes) in 2007 was the lowest in four years (1.04 fish/hr). The highest year was 2005 (5.75 fish/hr)(Figure 9). Spawning success in these reaches appears not to be as successful as that in the Grand Valley reaches. Mean catch rates for smallmouth bass < 100 mm was lowest in 2004 (0.15 fish/hr); the highest was during 2005 (1.46 fish/hr)(Table 4). Only one smallmouth bass (237 mm) was collected between Rifle and Silt at RM 241.2.

### **Largemouth Bass**

Unlike the downward trend in catch rate for smallmouth bass  $\geq 100$  mm, for the Grand Valley river reaches, overall mean catch rate for largemouth bass  $\geq 100$  mm has steadily increased over the past 4 years and peaked in 2007 (4.04 fish/hr)(Figure 10). This is almost a magnitude greater than the catch rate for 2004 (0.63 fish/hr). Has there been a measurable response of largemouth bass to removal efforts? No, and a discouraging one at that.

For the Grand Valley river reaches, overall mean catch rate for largemouth bass < 100 mm total length has also steadily increased since 2004 from 1.03 fish/hr to a high of 4.54 fish/hr in 2007 (Table 4). Initially, it appears that the 2007 cohort is one of the strongest in 4 years as evidenced by collections during passes 1 – 3. However, captures during passes 4 – 6 declined from passes 1 – 3 and captures of largemouth bass young were about 50 % less during passes 7 & 8 from passes 4 - 6 (Figure 6). Similar to young smallmouth bass, early life largemouth bass can be subject to high mortality to age-1. And as with age-0 and age-1 smallmouth bass, the ultimate fate of the 2007 largemouth bass cohort and slower growing age-1 fish and whether they will successfully survive and recruit to the next size classes by the summer of 2008 will not be certain until the 2008 field sampling is completed.

There has been no definite trend in largemouth bass abundance (all length sizes combined) for the Silt to Beavertail Mountain reaches. The highest catch rate was in 2006 (5.62 fish/hr); lowest in 2005 (0.96 fish/hr). In 2007 the catch rate declined to 3.30 fish/hr (Figure 9). Spawning success in these reaches appears not to be as successful as that in the Grand Valley reaches. Mean catch rates for largemouth bass < 100 mm were lowest in 2005 (0.25 fish/hr); the highest was during 2006 (3.33 fish/hr)(Table 4).

### **Black Crappie, Bluegill, Green Sunfish**

Black crappie catch rates in the Grand Valley river reaches peaked in 2006 (0.43 fish/hr) and were lowest during 2004 (0.04 fish/hr)(Table 5). Bluegill still continue to be

captured in main channel riverine habitats of the Upper Colorado River, despite historically being found in lentic habitats. Bluegill catch rate was highest in 2006 (1.9 fish/hr) and 2005 (1.81 fish/hr). Green sunfish are the most abundant of these three centrarchid species. Their catch rates have steadily increased since 2004 (3.81 fish/hr) to 2006 (8.62 fish/hr) only to slightly decrease to 5.72 fish/hr in 2007 (Table 5).

#### *Population Size.*

### **Smallmouth Bass**

A total of 67 smallmouth bass  $\geq 100$  mm total length were marked and released alive between the GVIC Diversion Dam and the Loma Boat Landing and 2.3 miles of the Lower Gunnison River (Table 6). Fourteen smallmouth bass (238–381 mm) were later recaptured during six successive passes. Five of these fish were recaptured in pass 1, two each in passes 2, 3, 5 and 6 (Table 7). One fish was recaptured in pass 4. All but one smallmouth bass was caught within the original marking reaches. The one fish was recaptured at RM 149.2, some 3.4 miles downstream of the Loma boat landing. Six smallmouth bass were recaptured in the 15-mile reach, five in the 18-mile reach, and two in the Lower Gunnison River.

The population estimate generated was for the 15- and 18-mile reaches of the Colorado River and 2.3 miles of the Lower Gunnison River downstream from Redlands Diversion Dam using a single marking pass and first removal pass for smallmouth bass  $\geq 100$  mm. The 2007 population point estimate (95% C.I. in parenthesis) was  $1,427 \pm 986$  (441–2,413)(Table 6). The probability of capture ( $p$ -hat) was computed as 0.04; the CV: 35.2%. 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 annually or the exploitation rate based on the population estimate was as few as 5.2 % (125/2,413) or as many as 28.3% (125/441). This computes to about an average of 40.4 fish/mile.

The 2006 population estimate was  $3,197 \pm 2,100$  (1,097–5,297) or 91 smallmouth bass  $\geq 100$  mm. The 2007 population estimate is about a 55 % decline over the 2006 population estimate for the same reaches of river. These two population estimates serve as a baseline for any future abundance estimation comparisons.

#### *Concentration Areas.*

### **Smallmouth Bass**

Identifying concentration areas is important because it may allow managers to focus on riverine areas of high densities of smallmouth bass to expedite removal and reduction to control their proliferation/invasiveness and potential negative impacts to native fish conservation and endangered fish recovery. High to low smallmouth bass concentration areas in riverine reaches in the Colorado and Lower Gunnison rivers were determined

using 2004, 2005, 2006, and 2007 catch/effort values (Figure 11). A subjective relative concentration rating was developed and is provided.

The river reach between Corn Lake and the Colorado/Gunnison River confluence has consistently been the highest area of concentration for smallmouth bass during the summers of 2004, 2005, and 2006. However, in 2007 the highest catch rate was between the Colorado/Gunnison River confluence and Fruita State Park (9.23 fish/hr). In 2007, the next highest area was between Corn Lake and the Colorado/Gunnison River confluence (7.06 fish/hr). These two river reaches have consistently been the two highest concentration areas for smallmouth bass between 2004 and 2007. In 2007, the third highest concentration area was from the GVIC Dam to Corn Lake (4.06 fish/hr). The 2.3 miles of the Lower Gunnison River ranks fourth after 4 years which is no surprise because it is adjacent to the two highest concentration areas in the Upper Colorado River. One trend was observed in 2006: catch rate decreased in all river reaches from 2005. During 2007, this downward trend in smallmouth abundance continued except in two reaches where abundance increased: the Lower Gunnison River and the Colorado/Gunnison River confluence to Fruita State Park.

Monitoring these concentration areas will be continued because it provides a valuable guide to assist managers in maximizing nonnative fish control efforts to reduce abundance of those piscivorous fishes that might jeopardize the continued existence of the native fish fauna in the Grand Valley reaches of the Upper Colorado River.

#### *Other Nonnative Game Fishes.*

Four adult walleye pike (total length 495 – 567 mm) were collected near Rifle (river mile 236.4– 240.2) compared to one each in both 2004 and 2005, and six during 2006. Six young-of-the-year and juvenile yellow perch (68 – 155 mm) were collected in 2007 compared to only one in 2006. One yellow perch was collected in the Lower Gunnison River, three in the 18-mile reach and two in the 15-mile reach. One adult northern pike (552 mm) was collected during pass 5 in the 15-mile reach during 2007.

#### *Other Nonnative Non Game Fishes.*

Captures of adult gizzard shad in the Upper Colorado and Lower Gunnison rivers exploded during 2007. 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 by sampling crews (Table 8). No gizzard shad were collected upstream of Price-Stubb Diversion Dam in either 2006 or 2007.

- VII. Recommendations: (this assumes that some level of field activities will resume in 2008 in the Upper Colorado River)
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 during 2008.
  2. 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.
  3. Downstream from Price-Stubb Dam, electrofishing should commence following cessation of spawning of Colorado pikeminnow which should be sometime in mid- to late-July.
  4. Duplicate the number of electrofishing removal passes in river segments that have higher concentrations of smallmouth bass in 2008 as was performed in 2007. This should maximize catches of centrarchid fishes while at the same time minimizing harassment and negative impacts to native fishes in reaches where centrarchid abundance is low. Concomitantly, decrease electrofishing effort in river reaches of low smallmouth bass densities.
  5. 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.
  6. Continue sampling the Upper Colorado reaches from the Rifle Bridge to Beavertail Mountain in Debeque Canyon. This is necessary to 1) build upon the existing fishery community database and monitor abundance of nonnative centrarchid fishes in these reaches which is within critical habitat for Colorado pikeminnow and razorback sucker, and 2) particularly determine if smallmouth bass continue to proliferate in the river reach from Rifle to Rulison. Include fish sampling the Colorado River in Garfield County upstream through designated critical habitat to the bridge at Silt, Colorado, in the 2008 Colorado scientific collection permit. This sampling can be commence in early-July since there are no known Colorado pikeminnow spawning areas in this 52-mile river reach.
  7. **NEW.** Add more effort (electrofishing craft + personnel) during the marking pass in an attempt to capture, mark, and release more smallmouth bass  $\geq 100$  mm.
  8. **NEW.** Allocate funds and personnel for both FWS and CDOW to collect and translocate “trophy-size” (10 inches and larger) largemouth bass from the Skipper’s Island backwater to an approved reservoir to provide additional sport-fishing opportunities. The upper most end of a former flow-through side channel is

comprised of a series of pond complexes that are separated by upland areas and beaver dams. Main channel discharge only flows into the upstream part of this side channel during high-flow events. It is believed that these ponds provide habitat for adult largemouth bass and need to be sampled. Most of the captures of largemouth bass  $\geq 254$  mm in the Grand Valley reaches have come from the Skipper's Island backwater at the most downstream end of this side channel. This provides some evidence that the ponds upstream are a potential source of "trophy-size" largemouth bass.

VIII. Project Status:

- A. "On track". A draft final report (Burdick 2007) discussing results of centrarchid removal and trends in smallmouth bass abundance from 2004 to 2006 in the Upper Colorado River and Lower Gunnison rivers was prepared and submitted to the Recovery Program office in early-March 2007. The report has been revised to include the comments from four peer reviewers. The PI still needs to prepare a discussion on how the reviewer's comments were addressed and submit the report and discussion of reviewer's comments to the Biology Committee for review and approval.
- B. Presently, field activities for 2008 are planned. Study direction and field sampling design and effort for 2008 may be adjusted pending the outcome of the nonnative fish workshop in mid-December 2007.

IX. FY 2007 Budget Status

- A. Funds Provided: \$ 147,014
- B. Funds Expended: \$ 147,014
- C. Difference: \$ -0-
- D. Percent of the FY 2007 work completed, and projected costs to complete: 100%.
- E. Recovery Program funds spent for publication charges: \$ -0-

- X. Status of Data Submission (Where applicable): All endangered fish collected during this evaluation were checked for a PIT tag in the field. Those wild Colorado pikeminnow that did not have a PIT tag were implanted with one. Those razorback sucker that had 400 khz PIT tags were implanted with 134 khz tags. All data associated with the capture and release of endangered fish were computerized. These data are available and will be electronically transmitted to the UCRB database coordinator in Grand Junction upon his request. Data recorded for all centrarchid fishes collected were computerized on entered on EXCEL spreadsheet by FWS and CDOW personnel.

- XI. Signed: Bob B. Burdick 5 December 2007  
Principal Investigator Date

## APPENDIX:

A. More comprehensive/final project reports. If distributed previously, simply reference the document or report. None.

B. Appendix A: 8 tables attached  
11 figures attached

C. References

Anderson, R. O., and S. J. Gutreuter. 1985. Length, weight, and associated structural indices. Pages 283 – 300 in L. A. Nielsen and D. L. Johnson (editors). Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Burdick, B. D. 2007. Removal of smallmouth bass and four other centrarchid fishes from the Upper Colorado and Lower Gunnison Rivers: 2004–2006. Draft Final Report prepared for the Upper Colorado River Endangered Fish Recovery Program. Recovery Program Project Number 126. U. S. Fish and Wildlife Service, Colorado River Fishery Project, Grand Junction, Colorado. 57 pp + appendices.

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.

White, G.C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, Los Alamos, New Mexico. LA-8787-NERP. 235 pp.

APPENDIX

Table 1. Number of smallmouth bass by seven different length classes collected with electrofishing from marking and removal (REM-) passes from main channel riverine habitats from the Grand Valley river reaches of the Upper Colorado (river miles 187.8 – 127.6) and the Lower Gunnison (river miles 3.0 – 0.7) rivers during the summers of 2004 – 2007.

Reach: Grand Valley	Smallmouth Bass Length Classes-- mm {inches}						
Year Pass Type/No.	< 100 {< 4}	100-199 {4-8}	200-254 {8-10}	255-305 {10-12}	306-356 {12-14}	357-406 {14-16}	> 406 {> 16}
2007							
Marking	12	17	13	25	12	4	0
REM-1	5	16	17	48	38	5	0
REM-2	25	12	9	16	16	2	0
REM-3	115	10	5	16	13	4	1
REM-4	128	9	6	15	19	3	1
REM-5	152	8	3	12	13	5	0
REM-6	187	37	3	18	29	4	0
REM-7	282	69	1	20	22	5	0
REM-8	475	89	2	20	29	5	2
2006							
Marking	10	26	39	33	21	4	0
REM-1	23	25	61	77	41	6	0
REM-2	49	8	25	29	12	1	0
REM-3	100	9	22	43	17	0	0
REM-4	79	9	18	63	30	1	0
2005							
REM-1	30	152	182	69	35	5	0
REM-2	40	94	165	73	31	8	0
REM-3	99	79	80	38	14	3	0
REM-4	84	20	35	15	8	5	0

Table 1 (cont'd). Number of smallmouth bass by seven different length classes collected with electrofishing from marking and removal (REM-) passes from main channel riverine habitats from the Grand Valley river reaches of the Upper Colorado (river miles 187.8 – 127.6) and the Lower Gunnison (river miles 3.0 – 0.7) rivers during the summers of 2004 – 2007.

Reach: Grand Valley	Smallmouth Bass Length Classes-- mm {inches}						
Year Pass Type/No.	< 100 {< 4}	100-199 {4-8}	200-254 {8-10}	255-305 {10-12}	306-356 {12-14}	357-406 {14-16}	> 406 {> 16}
2004							
REM-1	0	91	76	34	15	1	1
REM-2	15	119	76	29	17	1	0
REM-3	44	309	74	53	23	2	0
REM-4	33	99	21	23	6	3	0

Table 2. Percentage and number (in parenthesis) comparison of smallmouth bass by six different length classes collected with electrofishing from marking and removal (REM-) passes from main channel riverine habitats from the Grand Valley river reaches of the Upper Colorado (river miles 187.8 – 127.6) and the Lower Gunnison (river miles 3.0 – 0.7) rivers during the summers of 2004 – 2007. Number of total passes per year in brackets [ ]. See Table 1 for number of smallmouth bass collected by pass by length class.

Year	Smallmouth Bass Length Categories					
	< 100 mm {< 4 "}	< 255 mm {< 10 "}	≥ 255 mm {≥ 10 "}	≥ 306 mm {≥ 12 "}	≥ 357 mm {≥ 14 "}	> 406 mm {> 14 "}
2007 [9]	64.6% (1,381)	79.9% (1,707)	20.1% (430)	10.7% (232)	1.9% (41)	0.2% (4)
2006 [5]	29.6% (261)	57.1% (503)	42.9% (378)	15.1% (133)	1.4% (12)	--- (0)
2005 [4]	18.5% (253)	77.7% (1,060)	83.5% (304)	8% (109)	1.5% (21)	--- (0)
2004 [4]	7% (92)	65.6% (867)	34.4% (455)	5.2% (69)	0.6% (8)	< 0.01% (1)

Table 3. Number of smallmouth bass by seven different length classes collected with electrofishing from marking and removal (REM-) passes from main channel riverine habitats from the Upper Colorado River (river miles 248.0 – 195.7) during the summers of 2004 – 2007.

Reach: Silt to Beavertail Mtn	Smallmouth Bass Length Classes-- mm {inches}						
Year Pass Type/No.	< 100 {< 4}	100-199 {4-8}	200-254 {8-10}	255-305 {10-12}	306-356 {12-14}	357-406 {14-16}	> 406 {> 16}
2007							
REM-1	0	3	0	1	4	3	0
REM-2	15	18	5	11	10	5	0
REM-3	2	7	0	1	4	1	0
2006							
REM-1	2	0	5	10	18	5	0
REM-2	34	2	0	1	1	1	0
2005							
REM-1	10	28	26	34	18	3	3
REM-2	48	26	6	13	10	2	2
2004							
REM-1	3	4	3	9	1	0	1

Table 4. Catch/effort (fish/hour) comparison by year for smallmouth bass and largemouth bass < 100 mm total length for the Silt to Beavertail Mountain reaches (river miles 248 – 195.7) in the Upper Colorado River and the Upper Colorado River from Price Stubb Dam to the Westwater BLM ranger station, Utah (river miles 187.7 – 127.6) and the Lower Gunnison River from the Redlands Diversion 2004 to the Colorado/Gunnison River confluence (river mile 3.0 – 0.7) from 2004 to 2007. Note: passes and river reaches were combined within years.

		Fish < 100 mm Total Length							
		Smallmouth Bass				Largemouth Bass			
		2007	2006	2005	2004	2007	2006	2005	2004
Rifle to Beavertail Mountain	No. of fish	17	36	58	3	122	125	10	45
	Catch/Effort	0.20	0.96	1.46	0.15	1.40	3.33	0.25	2.28
Price-Stubb to Westwater, Utah + Lower Gunnison River	No. of fish	1,358	261	254	93	1,485	573	465	173
	Catch/Effort	4.15	1.61	1.46	0.55	4.54	3.54	2.66	1.03

Table 5 . Catch/effort (fish/hour) comparison for three centrarchid fishes captured from the Upper Colorado River from Price Stubb Dam to Westwater BLM ranger station, Utah (river mile 187.7 - 127.6) and the Lower Gunnison River from the Redlands Diversion 2004 to the Colorado/Gunnison River confluence (river mile 3.0 – 0.7) from 2004 to 2007. Note: passes and river reaches were combined within years; all size lengths of each of the three fishes were combined.

		Fish Species		
		Black Crappie	Bluegill	Green Sunfish
2007	No. of Fish	50	456	1,872
	Catch/Effort (fish/hr)	0.15	1.39	5.72
2006	No. of Fish	70	307	1,395
	Catch/Effort (fish/hr)	0.43	1.90	8.62
2005	No. of Fish	41	316	1,051
	Catch/Effort (fish/hr)	0.23	1.81	6.02
2004	No. of Fish	7	111	643
	Catch/Effort (fish/hr)	0.04	0.66	3.81

Table 6. Population estimate with 95% confidence intervals (CI) for smallmouth bass ( $\geq 100$  mm) for the 15- and 18-mile reaches (river miles 185.3 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 and 2007. Chapman's (1951) modification of the Petersen-Lincoln estimator was used to determine the abundance of smallmouth bass. Only smallmouth bass  $\geq 100$  mm were marked and only smallmouth bass recaptures from the first removal pass were used in calculating the population estimates for 2006 and 2007.

<b>2006</b>	Total No. of All SmthBass Captured/Removed (All sizes)	Total No. of SmthBass Captured & Marked; Removed ( $\geq 100$ mm)	Total No. of SmthBass Captured/Removed ( $< 100$ mm)	No. of Marked SmthBass Recaps	Pop Estimate w/ 95% CI	CV	P-hat
Marking Pass	131	122	9	---	---	---	---
Removal Pass 1	200	181	19	6	<b>3,197 <math>\pm</math> 2,100</b>	33.5 %	0.033
% or proportion of smallmouth bass ( $\geq 100$ mm) removed annually [exploitation rate] based on pop' estimate: 3.4 - 16.5 % fish/mile based on pop' estimate & 95% CI: 31.1 – 90.6 – 150.1							

<b>2007</b>	Total No. of All SmthBass Captured/Removed (All sizes)	Total No. of SmthBass Captured & Marked; Removed ( $\geq 100$ mm)	Total No. of SmthBass Captured/Removed ( $< 100$ mm)	No. of Marked SmthBass Recaps	Pop Estimate w/ 95% CI	CV	P-hat
Marking Pass	79	67	12	---	---	---	---
Removal Pass 1	130	125	5	5	<b>1,427 <math>\pm</math> 986</b>	35.2 %	0.04
% or proportion of smallmouth bass ( $\geq 100$ mm) removed annually [exploitation rate] based on pop' estimate: 5.2 – 28.3 % fish/mile based on pop' estimate & 95% CI: 12.5 – 40.4 – 68.4							

Table 7. Number, date, and location of recaptured smallmouth bass previously marked during the 2007 marking pass from Grand Valley Irrigation Company Diversion Dam near Palisade to the Loma Boat Landing and Lower Gunnison River.

Removal Pass No.	No. of Smallmouth Bass Recaptured	Total Length (mm) @ recapture	River and River Mile	Date of Recapture
1	1	326	CO 177.6	7/25/07
1	1	249	CO 181	7/25/07
1	1	333	CO 170.9	7/27/07
1	1	335	CO 157.7	7/31/07
1	1	292	CO 149.2	8/02/07
2	1	265	GU 2.0	8/09/07
2	1	238	CO 158.5	8/13/07
3	1	297	CO 175	8/16/07
3	1	285	CO 175	8/16/07
4	1	279	CO 183.8	8/23/07
5	1	300	CO 170.5	9/06/07
5	1	288	CO 154.9	9/17/07
6	1	318	CO 175.5	9/12/07
6	1	381	GU 3.0	9/13/07
<b>Total</b>	<b>14</b>	<b>---</b>	<b>---</b>	<b>---</b>

Table 8. Number of adult and juvenile gizzard shad collected in the Upper Colorado River and Lower Gunnison rivers during 2007.

	GIZZARD SHAD			
	2006		2007	
	Adult	Juv/Age-0	Adult	Juv/Age-0
Redlands Fish Trap	3	0	<b>43<sup>b</sup></b>	<b>0</b>
“Bassing”	12 <sup>a</sup>	0	<b>139<sup>c</sup></b>	<b>1<sup>d</sup></b>
Total	15	0	<b>182<sup>e</sup></b>	<b>1</b>

<sup>a</sup> Range total length: 338 – 462 mm.

<sup>b</sup> Mean total length: 406 mm; range: 336 – 490 mm.

<sup>c</sup> Mean total length: 405 mm; range: 226 – 451 mm.

<sup>d</sup> Total length: 66 mm.

<sup>e</sup> Four adult shad were captured by CDOW personnel during passes 7 and 8.

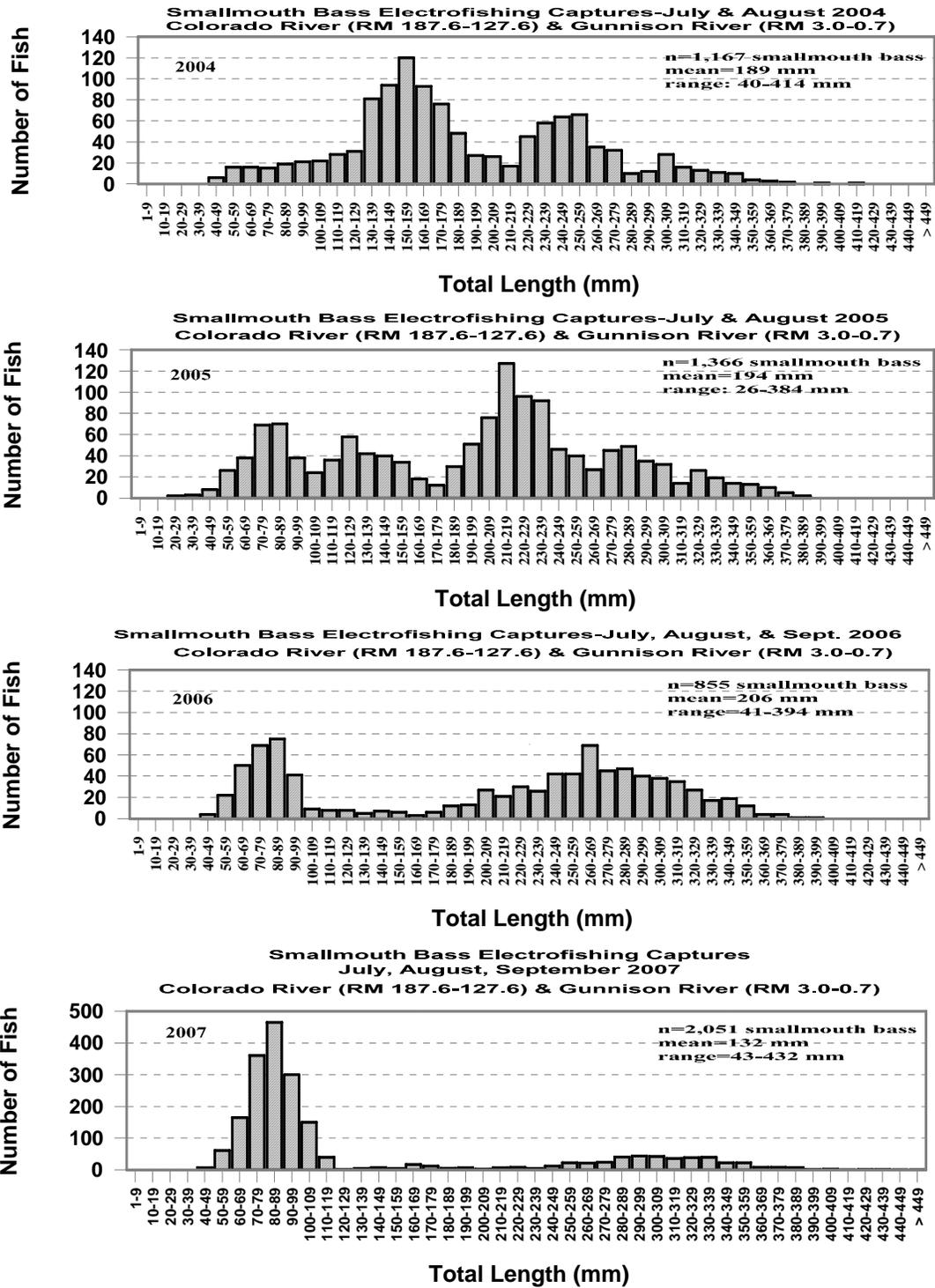


Figure 1. Length frequency comparison for all smallmouth bass collected during the summer of 2004, 2005, 2006, and 2007 in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

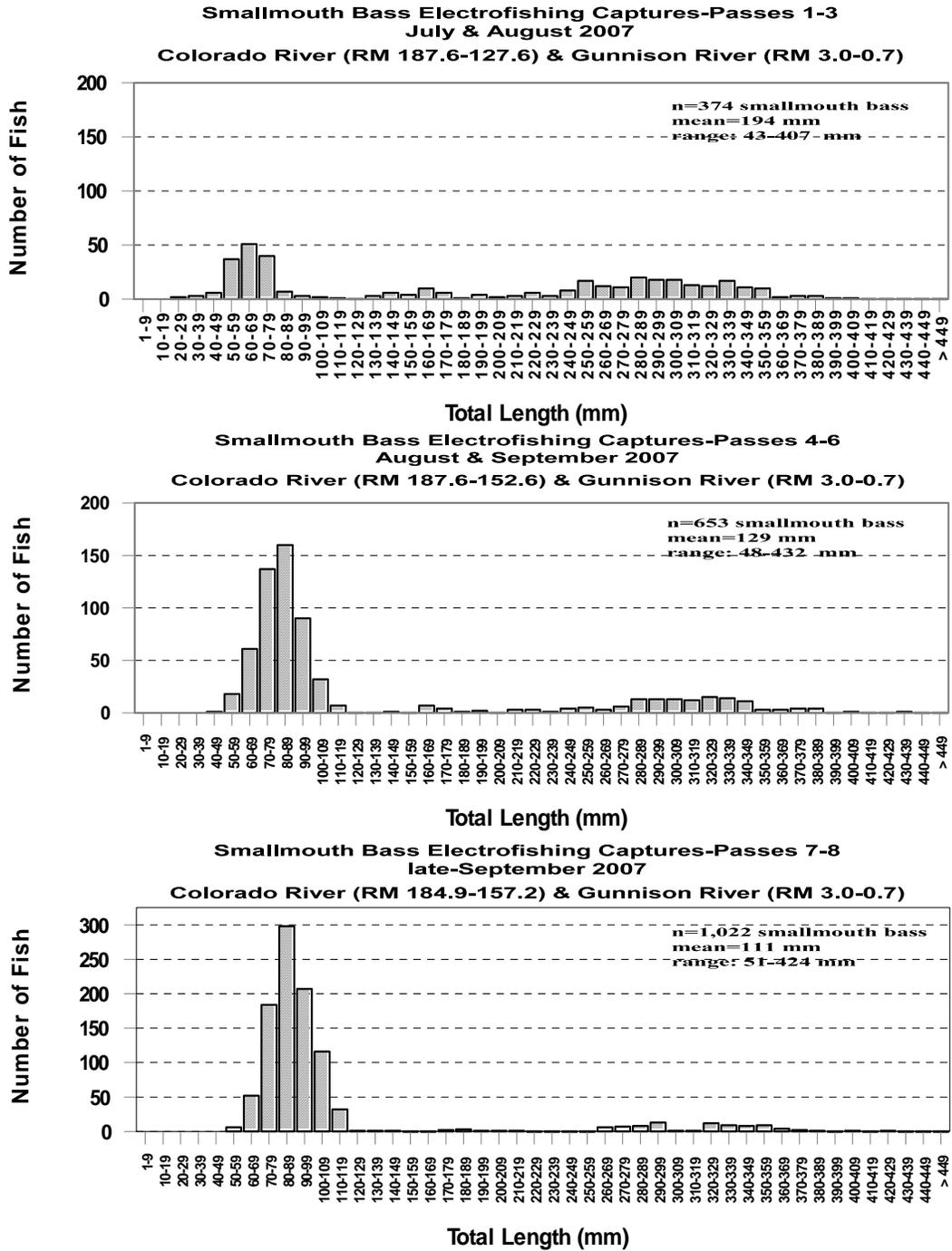


Figure 2. Length frequency comparison for all smallmouth bass collected during the summer of 2007 during passes 1 – 3 (top), passes 4 – 6 (middle), and passes 7 and 8 (bottom) in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

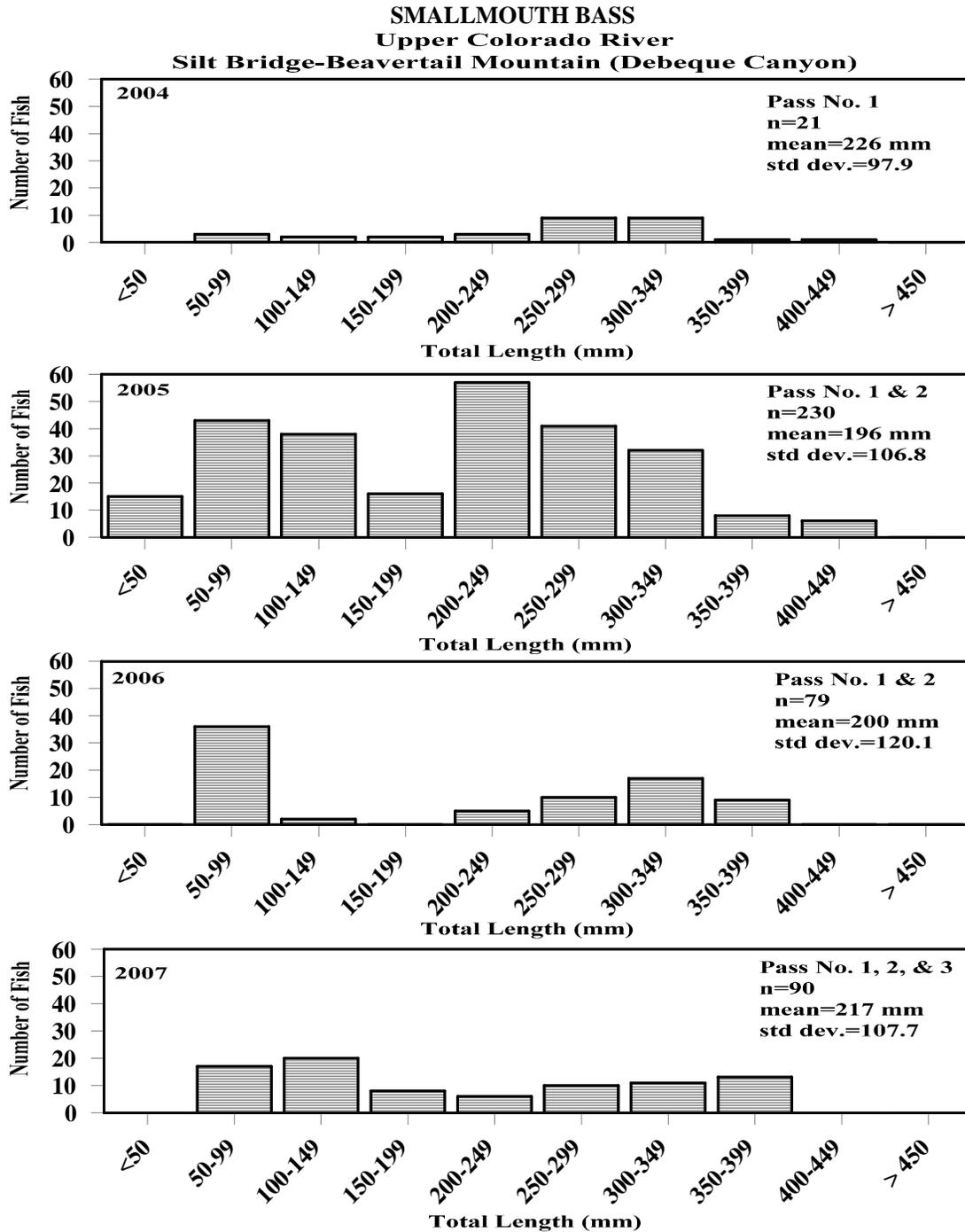


Figure 3. Total length frequency comparison of all smallmouth bass collected with electrofishing during 2004, 2005, 2006, and 2007 from the Silt Bridge to Beavertail Mountain in Debeque Canyon (river mile 248.0–195.7) in the Upper Colorado River.

**Smallmouth Bass Length Comparison (> 99 mm) by River Reach  
Colorado & Lower Gunnison Rivers  
2004 vs. 2005 vs. 2006 vs. 2007**

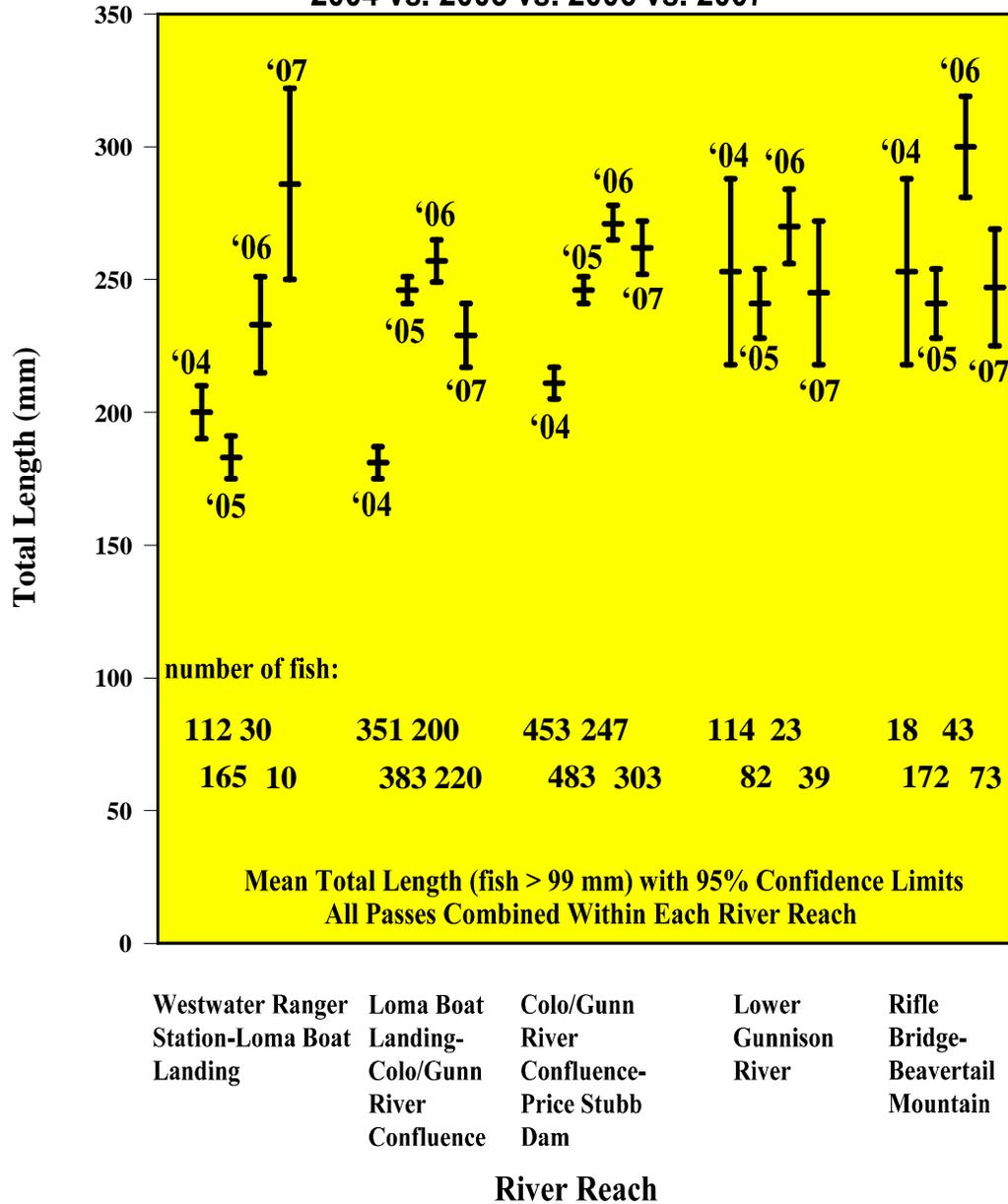


Figure 4. Comparison between the mean total length and 95% confidence interval for smallmouth bass ( $\geq 100$  mm) collected with electrofishing from five major river segments on the Colorado and Gunnison rivers during the summers of 2004, 2005, 2006, and 2007. The mean is the middle horizontal line; the 95% confidence intervals are represented by the error bars ( $\tau \perp$ ).

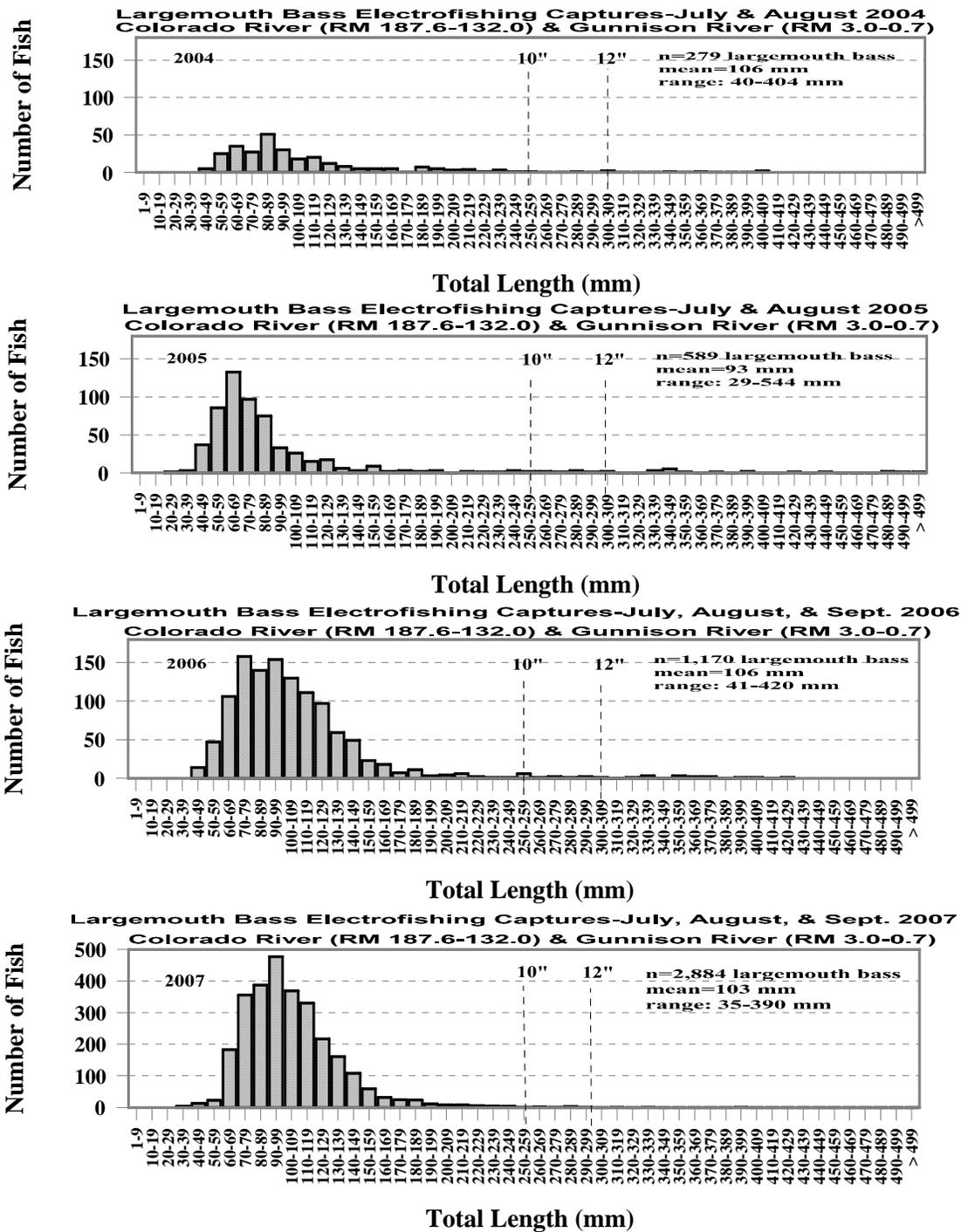


Figure 5. Length frequency comparison for all largemouth bass collected during the summer of 2004, 2005, 2006, and 2007 in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

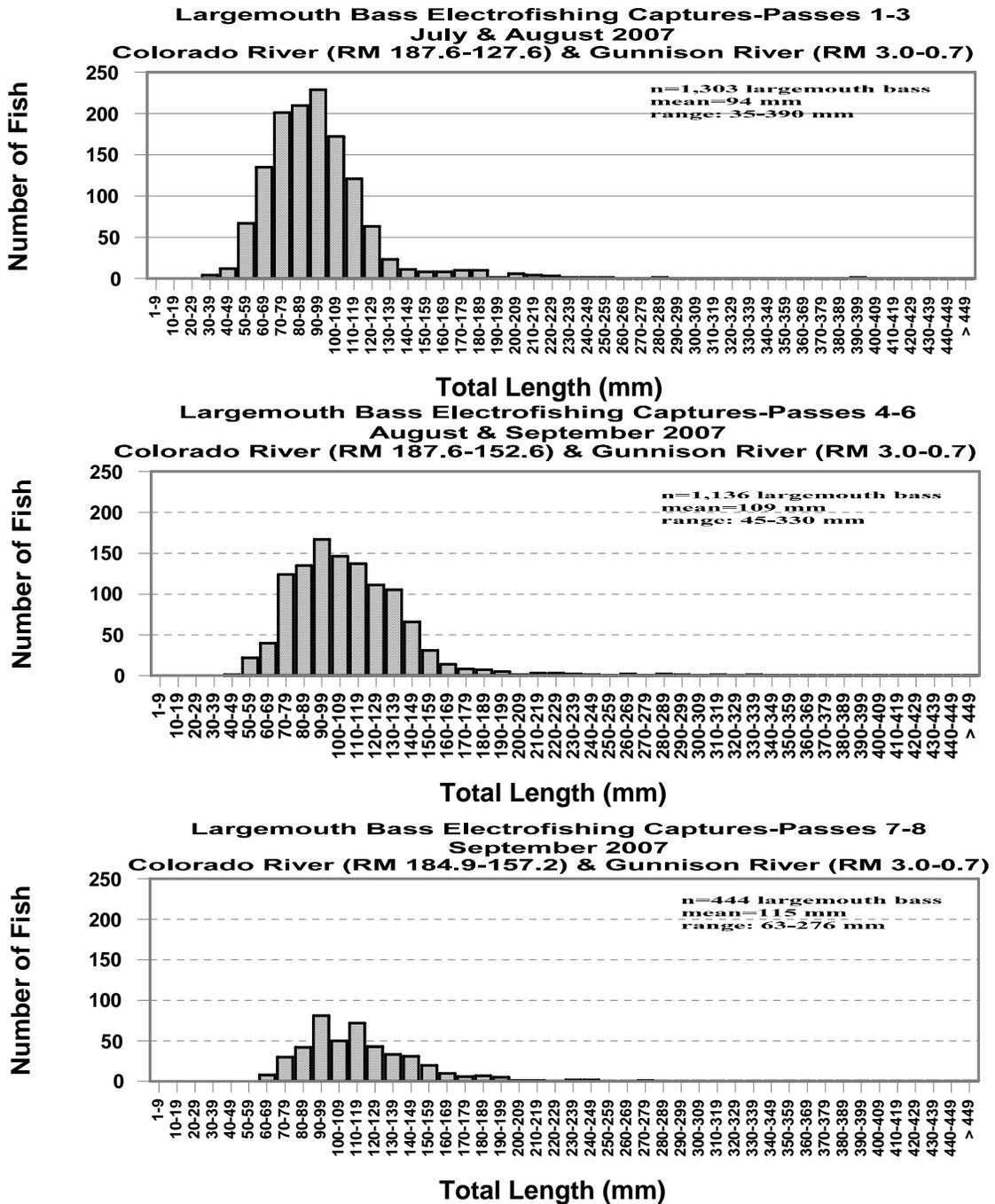


Figure 6. Length frequency comparison for all largemouth bass collected during the summer of 2007 during passes 1 – 3 (top), passes 4 – 6 (middle), and passes 7 and 8 (bottom) in the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

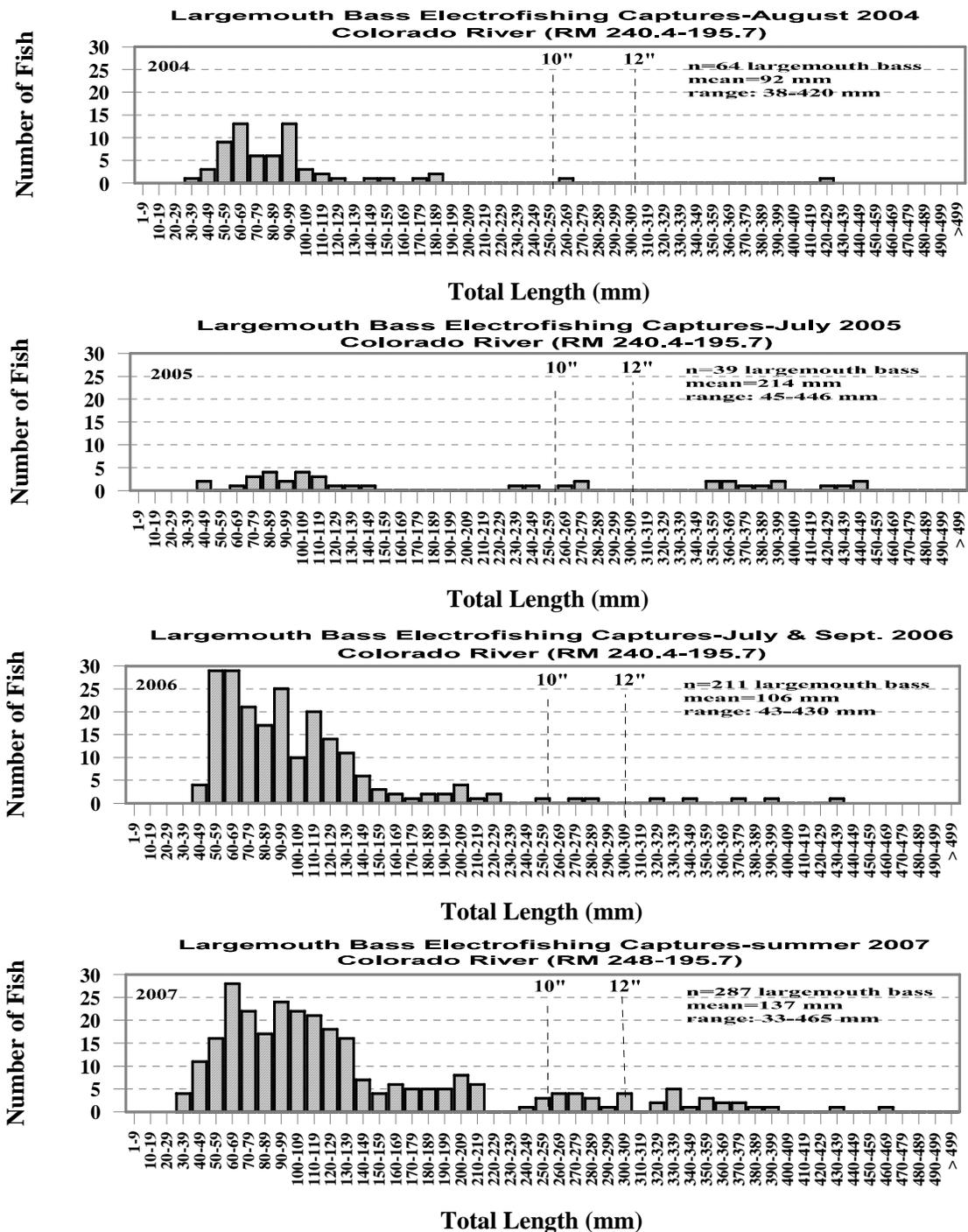


Figure 7. Length frequency comparison for all largemouth bass collected during the summer of 2004, 2005, 2006, and 2007 in the Silt to Beavertail Mountain reaches of the Upper Colorado River.

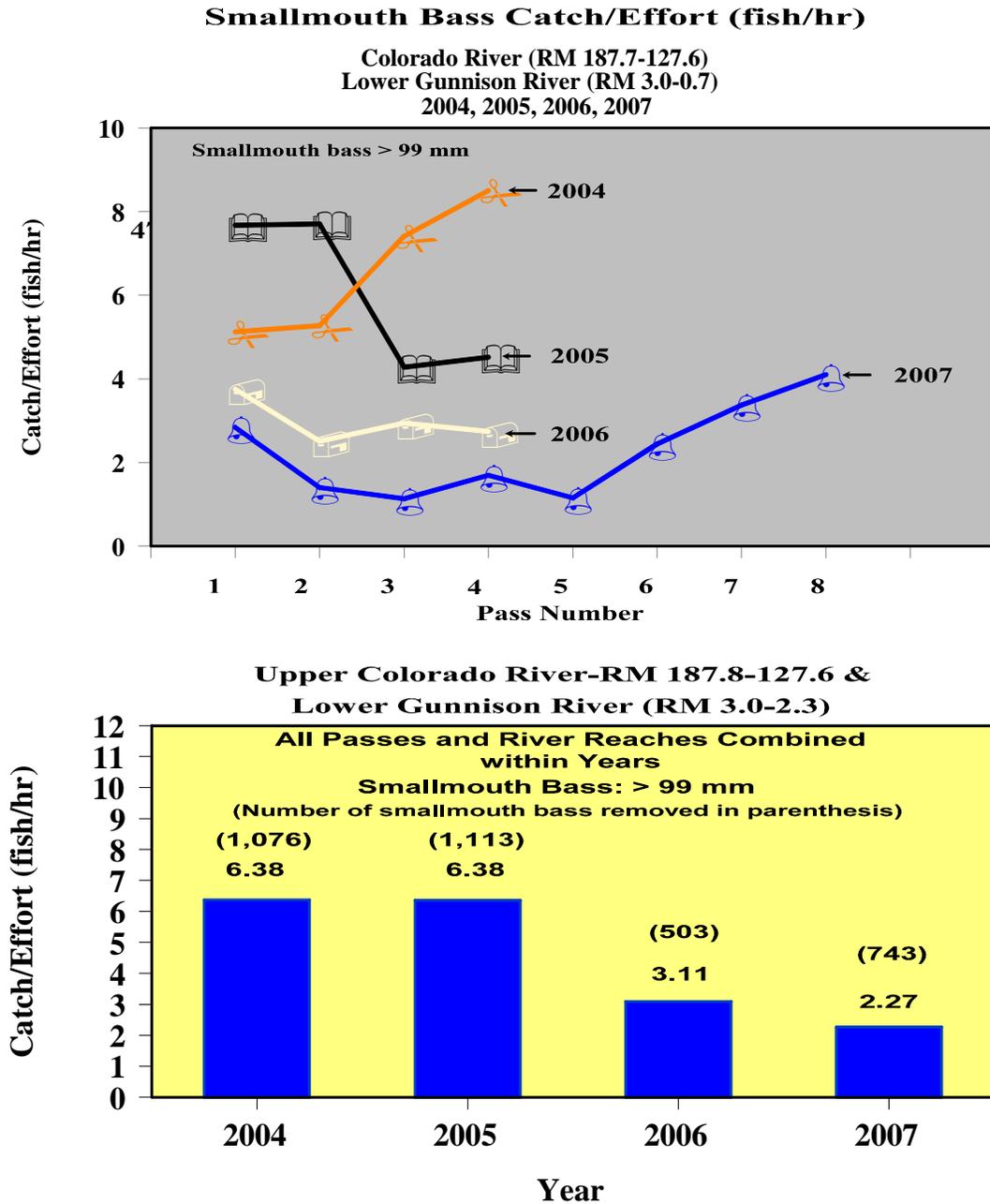


Figure 8. Four year comparison of catch/effort (fish/hr) for smallmouth bass ( $\geq 100$  mm) by pass (river reaches combined)(upper) and by year (river reaches and passes combined)(lower) for the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.

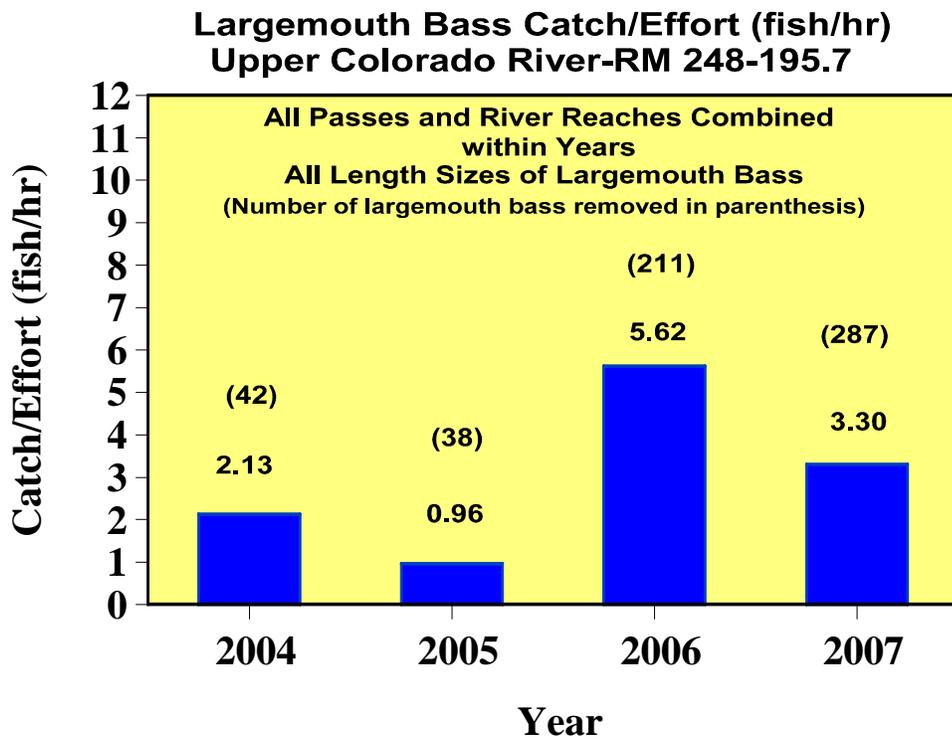
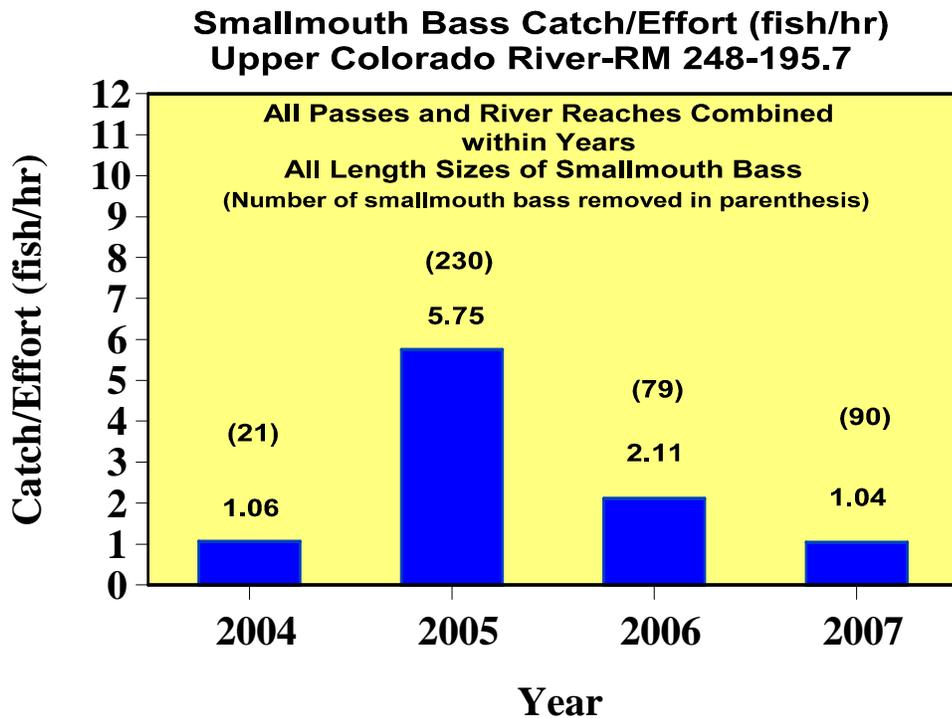
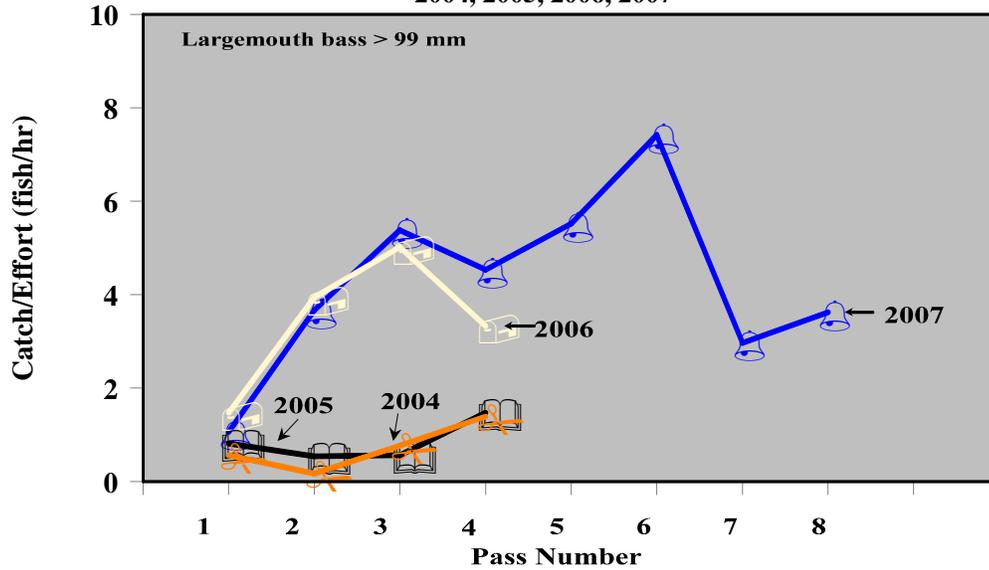


Figure 9. Four year comparison of catch/effort (fish/hr) for smallmouth bass (upper) and largemouth bass (lower) for the Upper Colorado River between Silt and Beavertail Mountain.

**Largemouth Bass Catch/Effort (fish/hr)**

Colorado River (RM 187.7-127.6)  
 Lower Gunnison River (RM 3.0-0.7)  
 2004, 2005, 2006, 2007



**Upper Colorado River-RM 187.8-127.6 &  
 Lower Gunnison River (RM 3.0-2.3)**

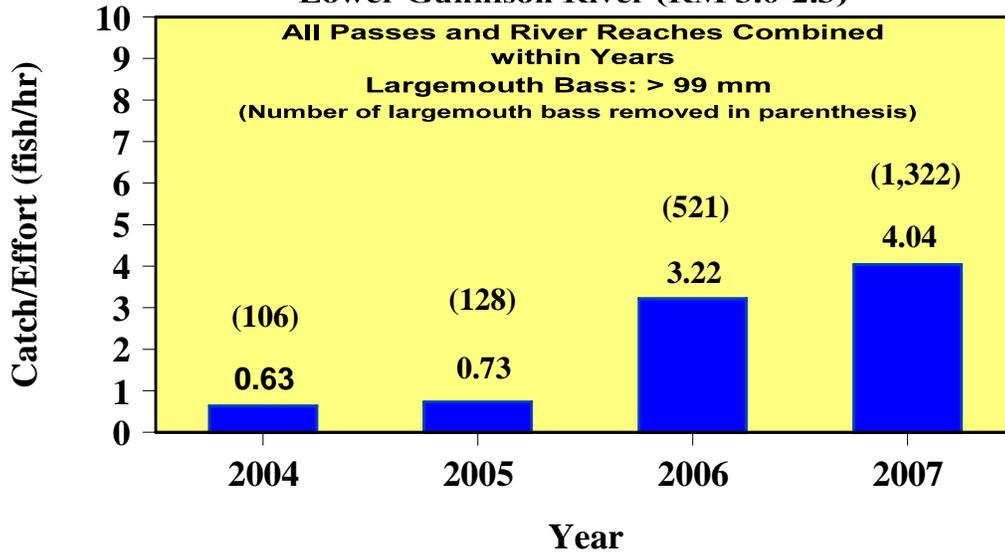
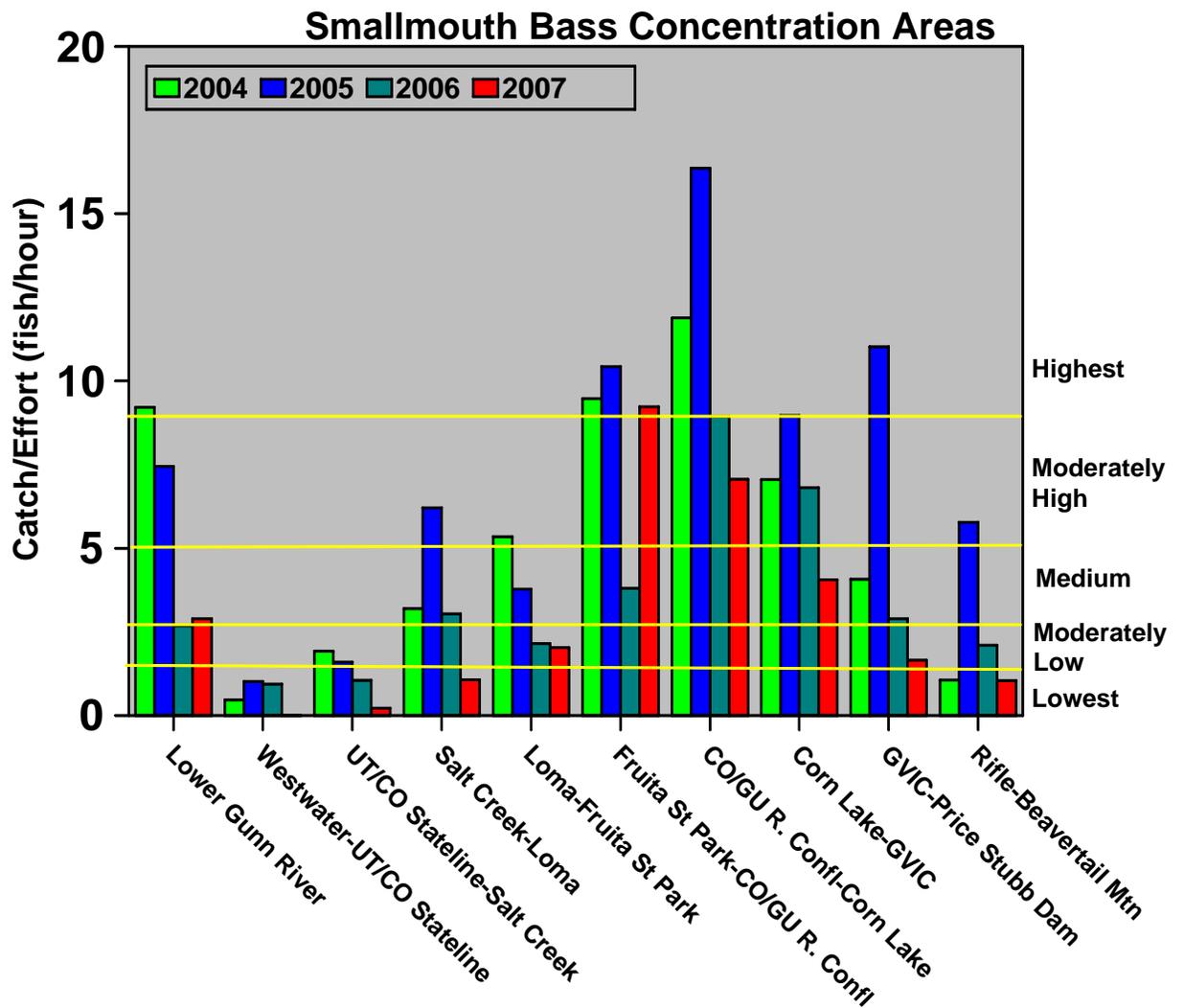


Figure 10. Four year comparison of catch/effort (fish/hr) for largemouth bass ( $\geq 100$  mm) by pass (river reaches combined)(upper) and by year (river reaches and passes combined)(lower) for the Grand Valley reaches of the Upper Colorado and Lower Gunnison rivers.



<u>Key</u>	
<u>Catch/Effort Value</u>	<u>Relative Concentration Rating</u>
12.00-9.00	Highest
8.99-5.00	Moderately High
4.99-3.00	Medium
2.99-2.00	Moderately Low
< 2.00	Lowest

Figure 11. Concentration areas for smallmouth bass in 10 different river reaches of the Upper Colorado and Lower Gunnison rivers during the summer of 2004, 2005, 2006, and 2007 using catch effort indices.