COLORADO RIVER RECOVERY PROGRAM
FY 2008 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 98a

I. Project Title: **Middle Yampa River northern pike removal and evaluation; smallmouth bass evaluation and limited removal**

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III. Project Summary:

Northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*) are two of 40 introduced fish species to Colorado currently found in the Colorado River basin (Nesler 2003). Northern pike were first introduced to the Yampa River basin, a sub-basin of the Colorado River basin, in Elkhead Reservoir in 1977. This species was introduced to reduce numbers of nonnative suckers (Roehm 2004). Smallmouth bass were also stocked in Elkhead Reservoir in the late 1970's or early 1980's (CDOW 2004). Elkhead Creek flows into and out-of Elkhead Reservoir, and has served as a conduit for downstream movement of northern pike and smallmouth bass into the Yampa River. Movement of northern pike into the Yampa River downstream of Elkhead Reservoir was demonstrated as early as 1979 (Tyus and Beard 1990). Conversely, capture of smallmouth bass in the Yampa River was considered an incidental occurrence prior to 1992 (Nesler 1995). Large draw-down events of Elkhead Reservoir in 1992 and 1994 may explain the greatest escape of smallmouth bass into the Yampa River (CDOW 2004). Both non-native species have established reproducing, self-sustaining populations in the mainstem, middle Yampa River.

Influences of such introductions on native fish fauna are cause for concern, especially in areas occupied by endangered species. The middle Yampa River downstream of Craig, Colorado, has been designated by the U.S. Fish and Wildlife Service (USFWS) as critical habitat for the federal- and state-listed Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*). Primary threats to these native species include competition with and predation by non-native fish species (USFWS 2002). Warmwater sportfishes, in particular, have been recognized as negatively influencing native fishes.

The northern pike has been identified as one of two principal, non-native hazards to juvenile and adult Colorado pikeminnow (USFWS 2002). Northern pike and Colorado pikeminnow utilize similar habitat in the spring and early summer during the spawning season. Both species also rely on native sympatric species as prey, including the

roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*Catostomus discobolus*), and speckled dace (*Rhinichthys osculus*) (Tyus and Beard 1990; Nesler 1995). Resource exploitation may also increase the likelihood of northern pike predation on young and adult endangered fishes (Tyus and Beard 1990; Nesler 1995). Northern pike may potentially influence native fish species through competition and/or predation.

The smallmouth bass has also been designated as a non-native fish species of concern (Hawkins and Nesler 1991) due to increased abundance, habitat preferences, and/or piscivorous habits (USFWS 2002). Smallmouth bass may negatively affect all endemic fishes in the Gila River basin of Arizona through predation (Hawkins and Nesler 1991). Specifically, smallmouth bass were identified as a major predator in Arizona, impeding successful reintroduction of Colorado pikeminnow (AGFD 2002). Further, Valdez and Muth (2005) note that smallmouth bass "pose significant threats to the survival of endangered fish," because smallmouth bass prey upon them and compete for food and space." Thus, smallmouth bass may also impact native fish species through predation and/or competition.

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Potential negative interaction between introduced, non-native sportfish and native fishes prompted the development of management plans including control of non-native fishes. A strategic plan for non-native fish control was developed for the upper Colorado River basin by 1997 (Tyus and Saunders 1996), and implemented by the Upper Colorado River Endangered Fish Recovery Program (Upper Colorado Recovery Program) (USFWS 2002). The three basic strategies recommended for non-native fish control within the plan include predation, removal, and exclusion. The Colorado Division of Wildlife (CDOW) developed and implemented an Aquatic Wildlife Management plan (CDOW 1998) specific to the Yampa River basin in 1998 that provides guidance on all aspects of fishery and conservation management in the basin. This plan includes reduction of northern pike and smallmouth bass numbers in riverine habitats, and evaluation of such actions through monitoring for significant temporal and spatial depletion of target species. The Upper Colorado Recovery Program adopted a Non-Native Fish Management Policy (UCRRIP 2004) in 2004. This policy indicates that the overall goals of non-native fish management are to: 1) attain and maintain fish communities where populations of the endangered and other native fish species can persist and thrive, and 2) achieve recovery goals for the endangered species. Successful implementation of such non-native fish management projects will benefit endangered fishes, as well as sympatric, native non-listed fish species.

This project is one of several designed for removal of northern pike and smallmouth bass within the Yampa River basin, with evaluation of such efforts. The objective of this report is to report results from the 2008 field season and provide recommendations for future sampling based on our field results and observations. Northern pike data collected by Colorado State University (CSU) is included, as the two agencies complimented each others' efforts across the years of study. Roles of the two agencies and level of effort, as well as goals and objectives changed from year to year. The study area, however, has remained the same, and includes approximately 76 river miles (RMs) of the middle

Yampa River from the upper terminus at Craig (RM 134.2-South Beach boat launch) to the lower terminus in Lily Park, (RM 50.5-downstream of Cross Mountain Canyon) (Figure 1 and Table 1).

CSU is considered the lead agency for smallmouth bass in RMs 124.0-100.0 (Little Yampa Canyon) and RMs 55.5-50.5 (Lily Park). However, this report includes an analysis of data for smallmouth bass in CDOW's study area only. Commencement of Smallmouth bass removal in the CDOW study area occurred in 2006, but for a limited section of river, from river mile 134.4 to 124.0. In 2007, smallmouth bass removal was continued from river mile 134.4 to 124.0, and mark release was initiated in the remaining CDOW study area. In 2008, commencement of smallmouth bass removal occurred from river mile 88.7 to 79.2. Thus, in 2008 smallmouth bass removal occurred in approximately 42% of the approximately 47 miles sampled by the CDOW, and smallmouth bass population monitoring occurred in the entire 47 miles sampled by the CDOW.

CDOW data are also presented for roundtail chub, Colorado pikeminnow, and incidental non-native fish species captured (i.e., ictalurids, centrarchids, and cyprinids). Data collected by CSU for smallmouth bass and species other than northern pike are presented in Hawkins (2008).

IV. Study Schedule:

Initial Year: 2005 (CDOW assisted Colorado State University (CSU) in 2004)
Final Year: Ongoing

V. Relationship to RIPRAP:

This study involved removing northern pike from the middle Yampa River, and smallmouth bass from certain portions of the middle Yampa, and evaluating the efficiency of that effort.

Green River Action Plan: Yampa and Little Snake Rivers:
III. Reduce negative impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management)
III.A.1. Implement Yampa Basin aquatic wildlife management plan in reaches of the Yampa River occupied by endangered fishes. Each control activity will be evaluated for effectiveness and then continue as needed.
III.A.1.b. Control northern pike.
III.A.1.b.(1) Remove and translocate northern pike and other sport fishes from the Yampa River.

VI. Accomplishments of FY 2005 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2008 Tasks and Deliverables

Task 1. Establish landowner contacts and obtain permission to access riverside and backwater property for fish sampling.
Schedule: March 2008
Deliverable: **Task Completed**

Task 2. Plan logistics, hire and train personnel, order and maintain equipment, and prepare for sampling.
Schedule: February-April, 2008
Deliverable: **Task Completed**

Task 3. Sample study area to capture, remove, and translocate northern pike. Limited data entry
Schedule: April 16 – June 26, 2008
Deliverable: **Task Completed**

Task 4. Maintenance of equipment. Data entry, data analysis, and prepare final report. Present findings during the Annual Nonnative Fish Control Workshop, and at the Annual Recovery Program Researchers Meeting.
Schedule: August-December, 2008
Deliverable: **Task Completed.** Presentations were given at the Annual Nonnative Fish Control Workshop, Recovery Program Researchers Meeting, and Colorado Wyoming Chapter of the American Fisheries Society.

B. Discussion of Initial Findings and Shortcomings

Study Area

The study area for this project with regard to northern pike has been consistent since 2005. It includes the entire portion of the middle Yampa River sampled by the CDOW and CSU combined, from river mile 134.2 to 50.5. This is the second consecutive year of a repeated study area for smallmouth bass in this project. It includes the CDOW study area only: Reach 1 (RM 134.2-124.0), Reach 2 (RM 100.0-91.0), Reach 3 (88.7-79.2), Reach 4 (79.2-71.0), and Reach 5 (RM 71.0-60.6). For the purposes of most smallmouth bass analysis, Reach 1 was treated as one study area and Reach 2, Reach 3, Reach 4, and Reach 5 were treated as a second study area, since these two areas are separated by a 24 mile reach sampled by CSU.

CDOW Study Methods/Approach

Four total sampling passes (1 mark/release and 3 removal for northern pike; 4 mark/release for smallmouth bass) were performed by the CDOW in Reach 2, Reach 4, and Reach 5. Seven total sampling passes (1 mark/release and 6 removal for both species) were performed by CDOW in Reach 1, and 8 total sampling passes (1 mark/release and 7 removal for both species) were performed by the CDOW in Reach 3. The CDOW's sampling occurred from April 17, 2008 to June 25, 2008. CSU's northern pike data are a result of 7 total sampling (1 mark/release; 6 removal) passes in Little Yampa Canyon (RM 124-100), and 9 total sampling passes (1 mark/release; 8 removal) in Lily Park (RM 58.9-55.5).

Northern pike and smallmouth bass were captured using Smith Root GPP 5.0 boat mounted electrofishing gear. Electrofishing effort was recorded by reach sampled and by date. "Block and shock" and "snare and scare" techniques were utilized with trammel nets at the mouths of backwaters. Water conductivity and temperatures were recorded at the beginning of each sampling day. CSU also used fyke nets to sample certain backwaters at various times during the study. Smallmouth bass greater than 149 mm and all northern pike captured during the first pass were marked near the dorsal fin with a unique, numbered, grey, t-bar FLOY tag. Northern pike that were tagged by CSU tag numbers ranged from number 0004 to 0370, but not continuously, as this same number series was used to tag smallmouth bass in the CSU study. Northern pike that were tagged by the CDOW ranged from 2501 to 2603. Smallmouth bass tag numbers ranged from 3701 to 3026. During tag and release passes, all fish were returned to the river alive near the collection location. Northern pike captured on the three subsequent passes were removed from the river, marked, and transported alive to Loudy Simpson ponds or Yampa State Park Headquarters, West Pond. Northern pike that were translocated received a new, purple FLOY tag, with tag numbers ranging from 19011 to 20816 for CSU, and tag numbers ranging from 21516 to 21749 for the CDOW. Smallmouth bass greater than 10 inches that were captured during passes subsequent to the marking pass on Reach 1 and Reach 3 were removed and transported alive to Craig Justice Center Pond and Elkhead Reservoir. Elkhead reservoir was not stocked until spill-over had ceased. Smallmouth bass that were translocated received a new, purple FLOY tag with tag numbers ranging from 22002 to 22526. Smallmouth bass less than 10 inches that were captured during passes subsequent to the marking pass on Reach 1 and Reach 3 were euthanized.

All northern pike, smallmouth bass, Colorado pikeminnow, roundtail chub, and incidental non-native centrarchids were measured for total length to the nearest millimeter (mm), and weighed to the nearest gram (g). Northern pike and smallmouth bass captured were examined for the presence of FLOY tags and fin clips. Colorado pikeminnow and roundtail chub were scanned for the presence of PIT (passive integrated transponder) tags. Individuals without pit tags were implanted with a new PIT tag following the protocol of the Upper Colorado River Recovery Program. All Colorado pikeminnow and roundtail chub were released back to the water immediately

Incidental non-native centrarchids, including black crappie and bluegill, and black bullheads were euthanized. Additionally, enough northern pike to comprise an adequate sample size for diet and age and growth analysis were euthanized.

Determination of Population Estimates, Catch Per Unit Effort, and Movement

Population Estimates

Timing of CDOW Pass 1 and Pass 2 corresponded well to that of CSU Pass 1 and Pass 2. Thus, CDOW and CSU northern pike data were combined to produce a northern pike population estimate for the middle Yampa River (approximately 84 river miles). Program CAPTURE Model (t) of Chao (White et al. 1982) was used to generate northern pike population estimates for middle Yampa River from downstream of Craig (RM 134.2) to near the confluence with the Little Snake River. The resulting population estimate was compared to population estimates from previous years. Northern pike that were less than 300 mm in total length were excluded from the analysis. Duplicate catches of the same fish within the same pass by CSU and CDOW were only counted once.

Population estimates for smallmouth bass greater than 199 mm were generated for two separate sections in the CDOW study area. One estimate was generated for Reach 1 (RM 134.2-124.0) and the other was generated for Reach 2, Reach 3, Reach 4, and Reach 5 combined (RM 100-60.6). Both population estimates were generated using the Lincoln-Petersen formula with Chapman's modification, and were used for comparison with previous years.

Catch Per Unit Effort (CPUE)

Catch per unit effort (CPUE) was reported in terms the number of fish captured per electrofishing hour for smallmouth bass and northern pike. All capture events were independent of one another, and all individuals that were recaptured on the same day or a different day, were included in total capture events. In two situations, electrofishing effort was recorded for one boat on one river bank, but not on the other. In these cases, the recorded effort was doubled. Additionally, high river flows accounted for one incomplete pass on Reach 1 on June 5, 2008. On this particular date, effort was concentrated in certain backwaters.

In addition to overall Catch per unit effort, CPUE was generated per pass, across the entire CSU and CDOW study reaches combined for northern pike, and across the entire CDOW study area for smallmouth bass. Nearly twice the number of passes occurred on CDOW Reach 1 and Reach 3, compared to Reach 2, Reach 4, and Reach 5, and these passes were interspersed as supplemental passes throughout the duration of the sampling season. As such, for the purpose of generating reach-wide CPUE for each pass that was reflective of environmental conditions during the certain time frames, two passes for Reach 3 were combined as 1 pass (Table 2).

Movement

Movement was broadly described in terms of the number of fish that were recaptured in the CDOW study area, which were initially tagged in a different study area. Additionally, movement was analyzed in terms of movement that occurred within the CDOW (CDOW and CSU combined for northern pike) in 2008, and within the CDOW study area between 2007 and 2008.

Three requirements had to be met before individual northern pike and smallmouth bass were included in the movement analysis. Individuals had to: (1) be captured more than once, (2) be captured on different days, and (3) have travelled more than one mile from their original point of capture. Movement distance for individuals was calculated by subtracting river mile at initial tagging location from the river mile at subsequent recapture location; negative values represented upstream movement and positive values represented downstream movement.

For both northern pike and smallmouth bass, within year movement calculations were generated for individuals that were initially captured in 2008 and subsequently recaptured on a later date in 2008. For northern pike this was reported as total number of individuals that travelled certain distances in increments of three miles. For smallmouth bass this was reported as total number of individuals that travelled certain distances in increments of five miles. Between year movement was also calculated for northern pike only, and was generated for individuals that were initially captured in 2007 and subsequently recaptured in 2008. Between year movement of northern pike was reported as the number of individuals that travelled certain distances in increments of five miles.

Results and Discussion

Eight different fish species were collected within Reach 1 through Reach 5, across 4 to 8 passes by the CDOW. Summary data for all species handled is presented in Table 3.

Northern Pike

Overview

Overall, the CDOW and CSU captured 503 individual northern pike and a total of 576 capture and recapture events occurred. Four hundred and seventeen (417) northern pike were removed, 82% of the northern pike individuals handled (Table 4). Two hundred and seventy-five northern (275) pike were translocated to State Park Headquarters West Pond and 63 were translocated to Loudy Simpson Pond in Craig, CO. Thirty-four (34) northern pike were euthanized and preserved by CSU for diet and age analysis and 45 were euthanized and preserved by CDOW for age and growth analysis (Table 5).

Population Structure and Estimates

One hundred and forty seven (147) northern pike were marked and released on the first pass. One hundred and thirty three (133) of these fish were marked by CDOW and CSU

in 2008, while the remaining 21 had been marked in previous studies by the USFWS, CSU, and CDOW. Forty one (41) of the 147 northern pike (28%) that were tagged on the first pass were recaptured on the second pass. An additional 31 first pass northern pike were recaptured across all subsequent passes. Thus, 47% of the northern pike initially marked during the first pass were recaptured during all subsequent passes; 53% of the northern pike handled and released on the first pass were never recaptured (Table 4)

Northern Pike total length frequency histograms for the entire section of the river sampled by CDOW and CSU from 2004 to 2007 are presented in Figure 2; the total length frequency histograms showing the transition from 2007 to 2008 are presented in Figure 3. The 2007 total length frequency histogram shows a greater proportion of northern pike in the 250 to 500 mm size range compared to previous years (Figure 2). Because these fish were not represented as a smaller size class in 2006 it is presumed that they resulted from an influx of fish into the CDOW and CSU sample areas. In 2008, such an influx was not observed and the predominant size class of fish ranged from 401 to 700 mm (Figure 3). The mean growth rate of northern pike that were tagged in 2007 and recaptured in 2008, and that were within the 401 to 700 mm size range when recaptured in 2008, was 167.7 mm/year (n=22, SE=10.8) or 0.47mm/day (n=22, SE=0.03). Thus, it is likely that the majority of northern pike sampled in 2008 were a result of the influx of fish observed in 2007.

Total number of northern pike capture events in 2008 (570) decreased from the total number of northern pike capture events in 2007 (966). This decrease is likely a result of two factors: (1) the high level of effort and exploitation that was achieved in 2007 that surely diminished northern pike numbers, and (2) increased flows in 2009 that rendered pike more challenging to capture. As reflected in the abundance estimate, it is likely that this decrease was a function of a northern pike population that decreased in size from 2007 to 2008.

The population estimate for northern pike in the middle Yampa River in 2008 suggests that the number of northern pike is back down to the level it was at in 2006, prior to the observed influx of fish in 2007 that boosted population numbers in that year (Table 6). The Program MARK Model (t) of Chao population estimate of northern pike in 2008 was 633 (518-806 95% C.I.; SE=72.5; CV=0.114; p-hat=0.28), and was significantly less than the 2007 estimate of 1073 (825-1321 95% C.I.; SE=164.5; CV=0.153; p-hat=0.23). In 2008, 65.9% of the northern pike population (estimate of 633) was removed (417 individuals), which was a higher rate of exploitation when compared to 2004, 2005, and 2006. However, it was less than the rate of exploitation in 2007, when 72.2% of the northern pike population (estimate of 1073) was removed (775).

Population estimates for northern pike in the middle Yampa River showed a decreasing trend from 2004 through 2006, though not significant (Figure 4). However, the 2007 estimate increased significantly and was greater than when northern pike removal began in 2004. It is likely that the high level of exploitation in 2007 (775 removed) and the lack of significant recruitment of new fish into the population in 2008, resulted in a 2008 estimate that was similar to 2006. It is also likely that had the 2007 influx not occurred

the declining trend observed in 2004 through 2006, would have continued into 2007 and 2008. Therefore, future success of northern pike removal in the Middle Yampa River, in terms of reaching the target northern pike density of 3 northern pike per mile in Critical Habitat, will be dependent on whether or not northern pike recruit in great numbers from outside the study area.

Catch Per Unit Effort (CPUE)

CPUE was calculated by pass, based on combined efforts from both agencies, and expressed as the number of northern pike captured per hour (# of NPK/hour) (Table 7). CPUE showed a declining trend as the study progressed from Pass 1 to Pass 5, and demonstrated a marked decrease subsequent to Pass 2 (Figure 5). This is similar to the general trend in previous years, and is likely a result of (1) decreased catchability as flows increase and pike become more difficult to locate and capture, and (2) depletion of pike numbers as removal begins on the second pass and continues through subsequent passes.

Overall CPUE for all passes in 2008 combined was lowest since the beginning of the study in 2004 (Figure 6), and was 0.86 NPK/hour. However, conclusions drawn from CPUE should be conservative. For example, 2007 and 2008 CPUE results (Figure 6) were not entirely reflective of the abundance estimate. In fact, 2008 CPUE was nearly half that of 2006, despite the fact that the abundance estimates were nearly the same for those two years. Both 2007 and 2008 CPUE could be biased low since effort was increased substantially in 2007, and even more so in 2008 (Table 7). This increase in effort can only occur later in the study, when catch rates for northern pike have been demonstrated to be relatively low. CPUE in 2008 was particularly biased low by a marked increase in magnitude and duration of spring runoff flows in that year. Nonetheless, CPUE remains a good tool to validate abundance estimates and assess trends in catch rate that may be associated with various factors such as discharge.

Movement

For a more in depth analysis of northern pike movement from 2004 to 2007, please see Martin and Wright (2007). Nineteen northern pike were recaptured that were tagged and released by project 98b in 2008 or previous years. One northern pike was recaptured that was tagged and released in Catamount Reservoir. One-hundred and three northern pike were recaptured that were tagged by this study in 2008 or previous years (Table 8).

Northern pike movement was also described in terms of the number of recaptured northern pike that (1) moved different distances in both upstream and downstream directions within the 2008 sampling year (Figure 7), and (2) moved different distances in both upstream and downstream directions between the 2007 and 2008 sampling years (Figure 8). Fifty-four northern pike that were tagged and recaptured in 2008 moved more than one mile in a downstream direction, while only 7 northern pike moved distances greater than one mile upstream. Northern pike that demonstrated downstream movement within 2008 moved distances as great as 58 miles, while the greatest distance moved in

an upstream direction was 15.8 miles. Fifty percent of northern pike that exhibited downstream movement within 2008 moved less than 9 miles, 75% moved less than 21miles, and 90% moved less than 33 miles.

Northern pike between 2007 and 2008 also showed a trend for downstream movement, though not as pronounced (Figure 8). Twelve northern pike that were tagged in 2007 and recaptured in 2008 moved greater than one mile in a downstream direction, and 10 northern pike that were tagged in 2007 and recaptured in 2008 moved greater than one mile in an upstream direction. Though nearly equal proportions moved in either direction between 2007 and 2008, northern pike that moved downstream moved significantly greater distances than those that moved upstream. Northern pike that moved downstream traveled an average distance of 21.98 miles (n=12, SE=3.71), while northern pike that moved upstream traveled an average distance of 9.57 miles (n=10, SE=2.12). However, limited conclusions can be drawn from this movement information because within year movement represents a snapshot in time, during which certain variables that may influence pike movement direction and magnitude, such as flow, temperature, and prey availability, are vastly different than other times of year. Moreover, between year movement lacks insight into movement tendencies during the majority of the year. Nonetheless, spring runoff appears to be a factor driving downstream within year movement, since vast downstream movements are observed during a short time period, in which flows are highest. Likewise, it appears that decreasing flows enable northern pike to move upstream, though overall movement in greater distances downstream is observed. Since very little reproduction occurs downstream of Craig (Hill 2005), it is certain that this trend for downstream movement in great distances is what replenishes the northern pike population in critical habitat.

Smallmouth Bass

Overview

Overall, the CDOW captured 1,987 individual smallmouth bass; this number includes 927 fish that were less than 150 mm in total length. A total of 2024 smallmouth bass capture and recapture events occurred. Fourteen hundred and one (1,401) smallmouth bass were removed, including 391 that were translocated to other waters for recreational fishing opportunities and 1,010 that were less than 200 mm in total length and were euthanized. As such, 70.5% of smallmouth bass handled were removed (Table 9). Three hundred and seventeen (317) smallmouth bass were translocated to Craig Justice Center Pond and 74 were transferred to Elkhead Reservoir.

Population Structure and Estimates

In Reach 1, eight smallmouth bass greater than 150 mm in total length were tagged and released on the first pass. All eight of these fish were new captures and were marked by the CDOW in 2008. One (1) of the eight smallmouth bass (12.5%) was recaptured on the second pass, when a total of 25 bass were captured. During the subsequent five passes at Reach 1, no additional bass that were tagged on Pass 1 were recaptured.

In Reaches 2 through 5 combined, 85 smallmouth bass were marked and released on the first pass. Seventy six (76) of these fish were marked by the CDOW in 2008, while the remaining nine had been marked in previous years by the CDOW and CSU. Two (2) of the 85 smallmouth bass (2.4%) were recaptured on the second pass, when a total of 80 bass were recaptured. One-hundred and ninety nine (199) additional smallmouth bass greater than 150 mm total length were tagged and released during Passes 2 through 4 at Reach 2, Reach 4, and Reach 5, where smallmouth bass removal did not occur in 2008.

Smallmouth bass total length frequency histograms for the CDOW study reaches are presented in Figure 9. In Reach 1, where smallmouth bass removal has been occurring since 2006, there were fewer bass captured in all size classes than in the previous year. Furthermore, there were markedly fewer bass in the 251 to 450 mm total length size range than in previous years. In Reach 2 through Reach 5, where removal did not occur in 2006 and 2007, there were no particularly noticeable changes in population size structure, with the exception of a slight increase in smallmouth bass in 51 to 150 mm total length range in 2008. This increase appears pronounced in Reach 3, where smallmouth bass removal occurred for the first time in 2008; however, the 2008 size structure data for Reach 3 was likely biased due to the increased effort of four additional removal passes that occurred in 2008. Catch rates for smallmouth bass generally increase later in the study season (Figure 10), with a greater proportion of the catch being smallmouth bass less than 250 mm in total length (Figure 11). Therefore, the increased effort for Reach 3 in 2008 might make it appear that there were greater numbers of small fish. However, it is also likely that the relatively low water year in 2007 boosted overwinter success in that year class, which in 2008 had recruited into the 51 to 150 mm total length size class.

There were also some noteworthy changes in the longitudinal distribution of smallmouth bass in 2008 (Figure 12). Overall numbers of smallmouth captured decreased as much as 11 orders of magnitude across various sections of Reach 1, where smallmouth bass removal had occurred in the previous two years. Conversely, overall smallmouth bass numbers increased across most portions of Reach 2 through Reach 5. Smallmouth bass numbers increased across all sections of Reach 2 (River Miles 100 to 91), with increases of as much as 4 orders of magnitude, which occurred at RM 96.5 to 98.5. However, it is difficult to tease apart the effect that the increase in magnitude and duration of peak flows may have had on the distribution of bass densities in the CDOW study areas. It is likely that two years of removals have decreased bass numbers across all of Reach 1, but it is also plausible that increased flows flushed bass out of Reach 1 in 2008. Likewise, it is plausible that these increased flows flushed more bass out of CSU's study area in Little Yampa Canyon, and into CDOW's Reach 2, though it is also likely that smallmouth bass numbers are generally increasing in this reach.
The population estimate for smallmouth bass greater than 199 mm for Reach 1 in 2008 was 116 (0-265 95% C.I.; SE=75.83; CV=0.654; p-hat=0.12), suggesting a density of 11.4 smallmouth bass per mile in this 10.2 mile section of the Yampa River (Table 10). This marks a decrease, though not significant, from the 2007 estimate of 516 (100-931 95% C.I.; SE=211.99; CV=0.412; p-hat=0.10) smallmouth bass greater than 199 mm, and

a significant decrease since the initial 2006 estimate of 1139 (409-1869 95% C.I.; SE=372.32; CV=0.327; p-hat=0.06) smallmouth bass greater than 199 mm total length (Figure 13). Ninety six smallmouth bass greater than 199 mm in total length were removed, resulting in an exploitation rate of 83%. The population estimate for smallmouth bass greater than 199 mm for Reach 2 through Reach 4 was 2,321 (0-4885 95% C.I.; SE=1308.08; CV=0.564; p-hat=0.02), suggesting a density of 62.6 smallmouth bass per mile in this 37.1 mile section of river. However, there was not a significant difference from the 2007 estimate of 588 (167-1008 95% C.I.; SE=214.60; CV=0.365; p-hat=0.17).

Smallmouth bass estimates in 2008, like previous years, included extreme uncertainty. Capturing so few fish on the first and second pass resulted in imprecise and possibly inaccurate estimation of abundance. Therefore, limited conclusions should be drawn from the abundance estimates presented here. It has been suggested that bass electrofishing catch rates in rivers of the Upper Colorado River Basin are positively related to variables such as flow, turbidity, and water temperature (Martin and Wright 2007, Burdick *personal correspondence*, Hawkins 2007). These variables generally increase as the study progresses each year, just as CPUE does. Precise abundance estimates rely upon capturing a greater proportion of the actual population size on the mark and recapture effort than what has been achieved in this study (Robson and Reiger 1964). For example, if it is assumed that the point estimate of 2,321 smallmouth bass greater than 199 mm inhabiting Reach 2 through Reach 5 is truth, then according to Robson and Reiger (1964) approximately 500 to 1,100 fish should be tagged on the marking effort and approximately 50 to 700 should be captured on the recapture effort to obtain a 95% confidence interval with a capture probability of 0.25. The greater the number of tagged fish on the marking pass, the fewer need to be captured on the subsequent recapture pass. In 2009, 85 smallmouth bass greater than 200 mm were tagged on the marking pass and 80 were checked for tags on the recapture pass. Had the marking and recapture pass been delayed to the third and fourth pass, respectively, for Reach 2 through Reach 5, then 167 smallmouth bass greater than 199 mm would have been tagged and 149 would have been checked for tags on the subsequent recapture pass. Movement of smallmouth bass is also confounding our estimates and accounting for this movement may additionally strengthen abundance estimates. The role of smallmouth bass movement is discussed in greater depth in the *Movement* section of this report.

Catch Per Unit Effort (CPUE)

Catch Per Unit Effort (CPUE) was calculated by pass and expressed as the number of smallmouth bass captured per hour (# of SMB/hour/pass) (Table 11). CPUE showed an increasing trend as the study progressed subsequent to Pass 1 and Pass 2 (Figure 10). This trend was described in depth in Martin and Wright (2007), and as previously discussed, is likely due to a combination of variables including, but not limited to, increasing flows, increasing turbidity, and increasing water temperature.

Catch Per Unit Effort (CPUE) for all passes combined for Reach 1 decreased by more than 3 orders of magnitude from 2007 to 2008, 9.2 SMB/hour in 2007 to 2.8 SMB/hour

in 2008 (Figure 12). This decrease was proportionate to the observed decrease in the abundance point estimate for Reach 1. The observed decrease in CPUE was consistent across three size classes: (1) less than 100 mm total length, (2) 100 to 199 mm total length, and (3) greater than 199 mm total length (Table 12). However, the most marked decrease in CPUE was for bass greater than 199 mm in total length, which decreased from 6.20 SMB/hour to 1.57 SMB/hour. It is possible that the decrease in CPUE across all size classes was a result of the removal efforts that began in 2006 for Reach 1; however, it is also plausible that CPUE was affected by the increased magnitude and duration of high flows during runoff in 2008. The 2008 water year featured the most pronounced and extensive peak in the hydrograph since the beginning of this study in 2004. Thus, high flows may have flushed bass out of Reach 1.

Conversely, CPUE increased across all of three size classes (< 100 mm TL, 100-199 mm TL, and >199 mm TL) in Reach 2 through Reach 5 combined, with the most notable increase occurring for smallmouth bass less than 200 mm in total length (Table 12). Smallmouth bass less than 100 mm in total length increased from 1.16 SMB/hour in 2007 to 2.96 SMB/hour in 2008. Smallmouth bass 100 mm to 199 mm in total length increased from 1.40 SMB/hour in 2007 to 3.30 SMB/hour in 2008. Reach 3 accounted for the majority of this increase, where CPUE for smallmouth bass less than 200 mm in total length was 11.98 SMB/hour and CPUE for smallmouth bass greater than 200 mm in total length was 6.27 SMB/hour (Table 13).

Movement

Smallmouth bass that were recaptured in 2008 by the CDOW were originally tagged by both CSU and the CDOW (Table 14). Twenty-five recaptured smallmouth bass were originally tagged by CSU in 2008, which is only 10 fewer recaptures than the 35 smallmouth bass that were originally tagged by the CDOW in 2008. An additional 32 smallmouth bass recaptures were originally tagged by the CDOW in 2007 and one recapture was tagged by CDOW in 2006, which was the first year CDOW began tagging smallmouth bass in Reach 1. One recaptured smallmouth bass was originally tagged by CSU in 2007. Four smallmouth bass were originally tagged by CSU in 2006, and 4 were originally tagged by CSU from 2004 to 2005. An additional two recaptured smallmouth bass had an undetermined tagging origin, and 4 were apparent escapees that were translocated to Elkhead Reservoir either by CDOW or CSU in 2007.

Smallmouth bass movement was also described in terms of the number of recaptured smallmouth bass that moved certain distances in both upstream and downstream directions within the 2008 sampling year (Figure 14). Seventeen smallmouth bass that were tagged by CDOW and recaptured by CDOW in 2008 moved more than one mile in an downstream direction, while 10 smallmouth bass moved distances greater than one mile upstream. However, smallmouth bass moved greater distances in an upstream direction than downstream, with one smallmouth bass having travelled 64.7 miles upstream. Previous years' results have suggested that there is a greater tendency for smallmouth bass to move upstream during our sampling season (Martin and Wright 2007,

Hawkins 2007). The 2008 tendency toward downstream movement may have been a result of increased flows in 2008, or displacement following initial capture.

For two consecutive years the CDOW has demonstrated that there is considerable movement of smallmouth bass between CDOW and CSU study areas (also see Hawkins 2008). Thus it is inappropriate to treat these sections of river separately, and flagrantly violate assumptions of the estimator when generating population estimates. Combining smallmouth bass data from CSU and CDOW sampling efforts, as is done with northern pike data, would account for this movement, and potentially increase the precision of smallmouth bass abundance estimates.

Colorado Pikeminnow

Overall, 15 Colorado pikeminnow individuals were captured by CDOW (Table 15). Four (4) Colorado pikeminnow were captured during Pass 1 (April 17 to April 22), one was captured during Pass 2 (April 23 to April 30), 4 were captured during Pass 3 (May 7 to May 29), and 6 were captured during Pass 4 (May 30 to June 13). No Colorado pikeminnow were captured subsequent to Pass 4, though only Reach1 and Reach 3 were sampled with additional passes. None of the Colorado pikeminnow that were handled by CDOW in 2008 were captured more than once by CDOW in 2008. Colorado pikeminnow capture locations ranged from river mile 60.6 to river mile 99.5. A total length frequency histogram was developed for all Colorado pikeminnow captured (Figure 15). Mean total length of Colorado pikeminnow captured by CDOW in 2008 was 586.2. Twelve (12) Colorado pikeminnow were captured in the main channel, while only 3 were captured in backwaters. Three (3) Colorado pikeminnow displayed evidence of presumed northern pike attacks that had healed. Tissue samples in the form of muscle plugs were taken from the dorsal region of 5 Colorado pikeminnow. These tissues were submitted to Barb Osmundson (USFWS) for a mercury contamination study.

Roundtail Chub

Overall, 62 roundtail chub individuals were captured by CDOW (Table 16). Ten (10) roundtail chub were captured during Pass 1 (April 17 to April 22), 17 were captured during Pass 2 (April 23 to April 30), 14 were captured during Pass 3 (May 7 to May 29), and 21 were captured during Pass 4 (May 30 to June 16). No Roundtail chub were captured subsequent to Pass 4 in Reach 1 and Reach 3. No roundtail chub were captured in Reach or Reach 3, while 22 were captured in Reach 2, 8 were captured in reach 4, and 32 were captured in Reach 5. A total length frequency histogram was developed for all roundtail chub individuals (Figure 16). The mean total length of roundtail chub captured was 419. Two juvenile roundtail chubs were captured that certainly skewed mean total length. They were 90 and 149 mm in total length.

VII. Recommendations:

A. Repeat 2008 northern pike removal effort
B. Coordinate mark and recapture passes with Project 98b. and generate a combined estimate that incorporates the section of river from Hayden, CO to Craig, CO. Also continue separate estimates for these projects to evaluate project 98a progress in reaching the objective of three northern pike per mile in critical habitat.
C. Revise CDOW's Yampa River Aquatic Wildlife Management Plan to address upstream sources of pike recruitment.
D. Implement revised Aquatic Wildlife Management Plan.
E. Delay marking and subsequent removal passes for smallmouth bass to optimize catch rates during these passes and produce more precise population estimates. Smallmouth bass captured prior to the marking pass should be removed from the population, but added to the estimate.
F. Expand smallmouth bass removal to include the entire middle Yampa River within Critical Habitat.
G. Combine CSU and CDOW smallmouth bass data to generate population estimates for the entire middle Yampa River.
H. The flexibility to manage water levels in Elkhead Reservoir to affect nonnative fish escapement should be considered, along with Program storage in Elkhead Reservoir to maintain flows in critical habitat.
I. Continue marking and documentation of roundtail chub and Colorado pikeminnow.
J. Increase communication between project 98a and 98b regarding sampling logistics.
K. Continue contacts with Yampa River landowners and stakeholders before, after, and during the study.

VII. Acknowledgements: The author wishes to thank in particular Jenn Logan, CDOW, for her leadership assistance in the field and Lori Martin, CDOW, for her lead on this project from 2004 to 2007. The author also appreciates the assistance of numerous CDOW personnel and personnel from other agencies who assisted during the field season. The author recognizes Aaron Weber and John Hawkins for sharing and exchanging data.

IX. Project Status: This project is considered on track, with minor revisions to be considered. Study direction and sampling design for 2009 may be adjusted per results from the 2008 Nonnative Fish Control Workshop.

X. FY 2008 Budget Status:

A. Funds Provided: $134.457.00, Funds Requested: $134.457.00
B. Funds Expended: $134.457.00
C. Difference: -0-
D. Percent of the FY 2008 work completed: 100%
E. Recovery Program funds spent for publication charges: -0-

X1. Status of Data Submission: Data for Colorado pikeminnow collected by the CDOW will be provided to the database Manager by March 1, 2009.

XII. Signed: F. Boyd Wright March 2, 2009
Principal Investigator Date

XIII. Literature Cited:

Arizona Game and Fish Department. 2002. *Ptychocheilus lucius*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Colorado Division of Wildlife. 1998. Aquatic wildlife management plan Yampa River Basin, Colorado. Colorado Division of Wildlife, Denver, Colorado.

Colorado Division of Wildlife. 2004.

Hawkins, J.A. and T.P. Nesler. 1991. Nonnative fishes of the Upper Colorado River Basin: an issue paper.

Hawkins, J.A. 2007. Smallmouth bass in the middle Yampa River: 2003-2007. Synthesis Report to the Colorado River Recovery Implementation Program.

Hawkins, J.A. 2008. Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Annual Report to the Colorado River Recovery Implementation Program.

Hill, C.G. 2005. Dynamics of northern pike spawning and nursery habitat in the Yampa River. Report to the Colorado River Recovery Implementation Program.

Martin L.M., and F.B. Wright. 2007. 2004-2007 Middle Yampa River Northern Pike Removal and Evaluation South Beach (RM 134.2) to Lily Park (RM 50.5); Smallmouth Bass (Limited Removal) and Evaluation South Beach (RM 134.2) to Cross Mountain Canyon (RM 60.6). Synthesis Report to the Colorado River Recovery Implementation Program.

Nesler, T.P. 1995. Interactions between endangered fish and introduced gamefishes in the Yampa River, Colorado, 1987-1991. Final report to the Colorado River Recovery Implementation Program (Project # 91-29). Colorado Division of Wildlife, Fort Collins, Colorado.

Nesler, T.P. 2003. Native and introduced fish species by major river basins in Colorado. Colorado Division of Wildlife, Fort Collins, Colorado.

Robson, D.S. and H.A. Reiger. 1964. Sample size in Petersen mark-recapture experiments. Transaction of the American Fisheries Society 93:215-226.

Roehm, G.W. 2004. Management plan for endangered fishes in the Yampa River Basin and environmental assessment. U.S. Fish and Wildlife Service, Mountain-Prairie Region 6, Denver, Colorado.

Tyus, H.M. and J.M. Beard. 1990. *Esox lucius* (Esocidae) and *Stizostedion vitreum* (Percidae) in the Green River Basin, Colorado and Utah. Great Basin Naturalist 50:33-39.

Tyus, H.M. and J.F. Saunders, III. 1996. Nonnative fishes in the upper Colorado River basin and a strategic plan for their control. Final report to the U.S. Fish and Wildlife Service (Contract No. 14-48-0006-95-923). University of Colorado Center for Limnology, Boulder, Colorado.

Upper Colorado River Recovery Implementation Program. 2004. Final nonnative fish management policy. Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

U.S. Fish and Wildlife Service. 2002. Colorado pikeminnow (*Ptychocheilus lucius*) Recovery Goals: amendment and supplement to the Colorado Squawfish Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region 6, Denver, Colorado.

Valdez, R.A and R.T. Muth. 2005. Ecology and conservation of native fishes in the Upper Colorado River Basin. American Fisheries Society Symposium 45:157-204.

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.

XIV. Appendix: Table and Figures

Table 1. Middle Yampa River reaches, river sections, reach descriptions, river miles, and agency responsible by year across the project, from 2004-2007. *CSU=Colorado State University. **CDOW=Colorado Division of Wildlife. *** River Mile 58.5 is a backwater on river left that was sampled downstream of the lower terminus of Reach 5.

River Reach	River Section	Reach Description	River Miles	Agency Responsible
1	Juniper	South Beach launch to Round Bottom	134.2-124.0	*CSU (2004-2005); **CDOW (2005-2007)
CSU 1	Juniper	Little Yampa Canyon	124.0-112.0	CSU (2004-2007)
CSU 2	Juniper	Little Yampa Canyon	112.0-100.0	CSU (2004-2007)
2	Juniper	Ups. Government bridge to mouth of Juniper Canyon	100.0-91.0	CSU (2004-2005); CDOW (2004-2007)
3	Maybell	Dwn. Juniper Canyon to Old Maybell launch	88.7-79.2	CSU (2004??); CDOW (2004-2007)
4	Maybell	Old Maybell launch to Sunbeam launch	79.2-71.0	CSU (2004??); CDOW (2004-2007)
5	Maybell	Sunbeam launch to ups. Cross Mountain launch	71.0-60.6; ***(58.5)	CSU (2004??); CDOW (2005-2007)
CSU 3	Lily Park	Lily Park	55.5-50.5	CSU (2004-2007); CDOW (2004)

Table 2. Middle Yampa River, Colorado Division of Wildlife sampling dates that correspond with each pass number that were used for catch per unit effort by pass analysis. *** Reach 3, Pass 4 was supplemental and was combined with Reach 3, Pass 3.

Pass Number	Date Range	Sampling Trips Included	Date of Sampling Trip
Pass 1	April 17 – April 22, 2008	Reach 4, Pass 1	April 17, 2008
		Reach 2, Pass 1	April 18, 2008
		Reach 5, Pass 1	April 19, 2008
		Reach 1, Pass 1	April 21, 2008
		Reach 3, Pass 1	April 22, 2008
Pass 2	April 23 – April 30, 2008	Reach 4, Pass 2	April 23, 2008
		Reach 2, Pass 2	April 24, 2008
		Reach 5, Pass 2	April 25, 2008
		Reach 1, Pass 2	April 29, 2008
		Reach 3, Pass 2	April 30, 2008
Pass 3	May 7 – May 29, 2008	Reach 1, Pass 3	May 9, 200
		Reach 2, Pass 3	May 29, 2008
		Reach 3, Pass 3	May 7, 2008
		Reach 3, Pass 4***	May 15, 2008
		Reach 4, Pass 3	May 8, 2008
		Reach 5, Pass 3	May 13, 2008
Pass 4	May 30 – June 13, 2008	Reach 1, Pass 4	June 5, 2008
		Reach 2, Pass 4	June 13, 2008
		Reach 3, Pass 5	May 30, 2008
		Reach 4, Pass 4	June 4, 2008
		Reach 5, Pass 4	June 6, 2008
Pass 5	June 10 – June 11, 2008	Reach 1, Pass 5	June 11, 2008
		Reach 2, Pass 6	June 12, 2008
Pass 6	June 17 – June 18, 2008	Reach 1, Pass 6	June 18, 2008
		Reach 3, Pass 7	June 17, 2008
Pass 7	June 24 – June 25	Reach 1, Pass 7	June 25, 2008
		Reach 3, Pass 8	June 24, 2008

Table 3. A summary of the total number of individuals captured for all species of interest in the Middle Yampa River in 2008, including incidentals nonnatives that were lethally removed: black bullhead, black crappie, bluegill, green sunfish, and white crappie.

Species	Number of Individuals Captured
Northern Pike	503
Smallmouth Bass	1987
Colorado Pikeminnow	15
Roundtail Chub	62
Black Bullhead	2
Black Crappie	29
Bluegill	14
Green Sunfish	3
White Crappie	2

Table 4. Number of northern pike tagged on the first pass, number northern pike that were tagged on the first pass and recaptured on the second pass, number of northern pike that were tagged on the first pass and removed during all subsequent passes, % of fish that were tagged on the first pass and removed on subsequent passes, total number of northern pike handled during study period, total number of northern pike that were removed during study period, and percent of handled northern pike that were removed in the middle Yampa River from 2004 through 2008.

Year	# NPK Tagged on First Pass	# NPK Recaptured on the Second Pass	# NPK Tagged Recovered and Removed on Subsequent Passes	% Recovery of Tagged NPK	Total # of NPK Individuals Handled	Total # NPK Removed	% NPK Handled that were Removed
2004	159	NA	76	48%	942	665	90%
2005	195	NA	83	43%	526	410	78%
2006	214	NA	79	37%	520	384	74%
2007	191	NA	93	49%	878	775	88%
2008	154	41	72	47%	503	417	72%

Table 5. Disposition totals for northern pike removed from the middle Yampa River in 2008. Northern pike were either moved to the State Park Headquarters Pond, Preserved by CSU-LFL, euthanized for removal of cleithra by CDOW for age and growth analysis, or placed in Loudy Simpson pond.

Disposition	Number of Northern Pike
State Park Headquarters Pond	275
Preserved by CSU	34
Cleithra Taken for Age and Growth by CDOW	45
Loudy Simpson	63
TOTAL	417

Table 6. Northern pike population estimate and the 95% confidence interval, generated using Program CAPTURE Model (t) of Chao, total number of northern pike removed, and exploitation rate of northern pike in terms of percent of the abundance point estimate removed for 2004 through 2008 in the middle Yampa River.

Year	NPK > 300 mm Population Estimate (95% C.I.)	Number of NPK Removed	NPK Exploitation Rate
2004	981(774-1288)	563	57.4%
2005	678 (555-861)	391	57.7%
2006	623 (517-780)	344	55.2%
2007	1073 (825-1321)	775	72.2%
2008	633 (518-806)	417	65.9%

Table 7. 2008 electrofishing effort, number of northern pike captured via electrofishing only, and northern pike electrofishing catch per unit effort (CPUE; number of northern pike/hour) for nine passes on the middle Yampa River. Pass 8 and Pass 9 are from CSU's Lily Park efforts only.

	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6	Pass 7	Pass 8	Pass 9	Total
Effort (hours)	86.2	100.6	109.4	76.5	59.6	61.0	73.4	8.5	7.9	583.1
# of NPK Captured	155	176	91	33	17	17	43	4	3	539
CPUE (# NPK/hour)	1.80	1.75	0.83	0.43	0.29	0.28	0.59	0.47	0.38	0.92

Table 8. Movement of recaptured northern pike among study areas in 2004 through 2008. Categories are for number of fish that moved into the most upstream study site (USFWS) from upstream sources including fish that were tagged from Steamboat Spring to Hayden as part of Project 98c in 2004 and 2005, fish that moved into USFWS from the downstream study site (CDOW and CSU), fish that moved into CDOW/CSU study site from upstream sources, fish that moved into RM 40 – 0 from upstream sources, and fish that moved into the Green River from upstream Yampa River sources. Northern pike that were initially tagged in Catamount Reservoir by CDOW biologist Bill Atkinson and recaptured in the Yampa River are indicated in parenthesis.

Year	Into USFWS from Upstream	Upstream Into USFWS from CDOW/CSU	Into CDOW/CSU from USFWS Upstream	Downstream into RM 40 – 0 From Upstream Sources	Downstream into Green River From Upstream Yampa River Sources
2004	40	6	17	1	6
2005	26	10	52	2	3
2006	15 (7 Catamount)	6	22 (1 Catamount)	0	3
2007	4	7	16 (1 Catamount)	0	1 (1 Catamount)
2008	5 (1 Catamount)	4	20 (1 Catamount)	0	6 (1 Catamount)

Table 9. Disposition totals of smallmouth bass captured in the middle Yampa River by CDOW in 2008, including number of fish that were released back in to the river alive, euthanized (SMB < 250 mm in Reach 1 and Reach 3 only), relocated to Craig Justice Center Pond (SMB > 250 mm from Reach 1 and Reach 3 only), or relocated to Elkhead Reservoir (occurred post spill-over; SMB > 250 mm in Reach 1 and Reach 3 only).

Disposition	Total number of SMB
Released Alive	605
Euthanized (SMB < 250 mm from Reach 1 and Reach 3)	1010
Craig Justice Center Pond (SMB > 250 mm from Reach 1 and Reach 3)	317
Elkhead Reservoir (SMB > 250 mm from Reach 1 and Reach 3)	74
TOTAL	2006

Table 10. Smallmouth bass (>200 mm) population estimates, based on the Lincoln Petersen (Chapman's Modification) Equation, for Reach 1 only in 2006, 2007, and 2008, and for Reach 2, Reach 3, Reach 4, and Reach 5 combined in 2007 and 2008. Each population estimate is accompanied by the number of smallmouth bass (>200 mm) removed and the exploitation rate for smallmouth bass (>200 mm) associated with each population estimate.

Reach/Year	SMB > 199 mm Population Estimate (95% C.I.)	Number of SMB >199 mm Removed	SMB Exploitation Rate
Reach 1			
2006	1139 (409-1869)	198	17.3%
2007	516 (100-931)	352	68.2%
2008	116 (1-265)	96	83.0%
Reach 2, 3, 4, and 5			
2007	588 (167-1008)	NA	NA
2008	2321 (1-4885)	421(Reach 3 only)	18.1%

Table 11. 2008 electrofishing effort, number of smallmouth bass captured via electrofishing, and smallmouth bass electrofishing catch per unit effort (CPUE; number of smallmouth bass/hour) for seven passes on the middle Yampa River, for the study area sampled by the CDOW.

	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6	Pass 7	Total
Effort (hours)	51.0	50.2	54.7	39.4	16.4	16.7	18.3	246.70
# of SMB Captured	295	208	537	291	164	207	321	2024
CPUE (# SMB/hour)	5.78	4.14	9.81	7.39	9.99	12.41	17.53	8.2

Table 12. 2008 and 2007 smallmouth bass catch per unit effort (CPUE; #SMB/hour), for two sections of the Middle Yampa River in the CDOW study area; CPUE for each section and year is divided into three size categories: less than 100 mm total length, 100 to 199 mm total length, and greater than 199 mm total length.

	Smallmouth Bass Catch Per Unit Effort (# SMB/hour)					
	Reach 1			Reach 2, Reach 3, Reach 4, and Reach 5 Combined		
Year	< 100 mm TL	100 – 199 mm TL	> 199 mm TL	< 100 mm TL	100 – 199 mm TL	> 199 mm TL
2007	1.22	1.81	6.20	1.16	1.40	3.38
2008	0.77	0.45	1.57	2.96	3.30	3.94

Table 13. 2008 catch per unit effort for Reach 3 only, divided into two sized classes: (1) Sub adults, with are considered to be 200 mm in total length or smaller, and (2) adults, which are considered to be greater than 200 mm in total length.

Size Class of SMB	# of SMB Captured	Effort (hours)	CPUE (# of SMB/hour)
All Sizes	1324	72.5	18.3
Adults (> 200 mm TL)	455	72.5	6.3
Sub-adults (≤ 200 mm TL)	869	72.5	12.0

Table 14. Number of smallmouth bass (SMB) recaptured by CDOW that came from various sources of initial tagging, including SMB tagged by CDOW in 2008, SMB tagged by CSU in 2008, SMB tagged by CDOW in 2007, SMB tagged by CSU in 2007, SMB tagged by CDOW in 2006, SMB tagged by CSU in 2006, SMB tagged by CSU in 2004 and 2005, SMB that were relocated from the Yampa River into Elkhead Reservoir in 2007, and those whose original source is unknown.

Source of Recaptured SMB	Number Recaptured in 2008	Number Removed in 2008
CDOW 2008	35	17
CSU 2008	25	11
CDOW 2007	32	20
CSU 2007	1	1
CDOW 2006	1	1
CSU 2006	4	1
CSU 2004-2005	4	4
Elkhead Reservoir 2007	4	4
Unknown	2	2

Table 15. Number of Colorado pikeminnow (CPM) capture events, number of CPM marked, number of CPM recaptures, number of CPM released, number of CPM removed, and number of CPM mortalities for Yampa River Reach 1 through Reach 5 downstream of Craig across Pass 1 through Pass 4 in 2008 by the Colorado Division of Wildlife (CDOW). Three additional passes were completed in Reach 1 and Reach 3, but no CPM were captured during these passes. *= one CPM that was captured was not scanned for a PIT tag, but was presumed to be a recapture based on probability.

CDOW Pass #	# CPM Capture Events	# CPM Marked	# CPM Recaptures	# CPM Released	# CPM Removed	# CPM Mortalities
1	4	1	3*	4	0	0
2	1	0	1	1	0	0
3	4	0	4	4	0	0
4	6	2	4	6	0	0
Total	15	3	12*	15	0	0

Table 15. Number of roundtail chub (RTC) capture events, number of RTC marked, number of RTC recaptures, number of RTC released, number of RTC removed, and number of RTC mortalities for Yampa River Reach 1 through Reach 5 downstream of Craig across Pass 1 through Pass 4 in 2008 by the Colorado Division of Wildlife (CDOW). Three additional passes were completed in Reach 1 and Reach 3, but no CPM were captured during these passes. *= an addition 3 fish were captured but were not tagged, because they were gravid females. **= 8 additional fish were captured but were not tagged, because they were gravid females

CDOW Pass #	# RTC Capture Events	# RTC Marked	# RTC Recaptures	# RTC Released	# RTC Removed	# RTC Mortalities
1	11	7	4	11	0	0
2	17	15	2	17	0	0
3	14	8*	3	14	0	0
4	21	9**	4	21	0	0
Total	63	39	13	63	0	0

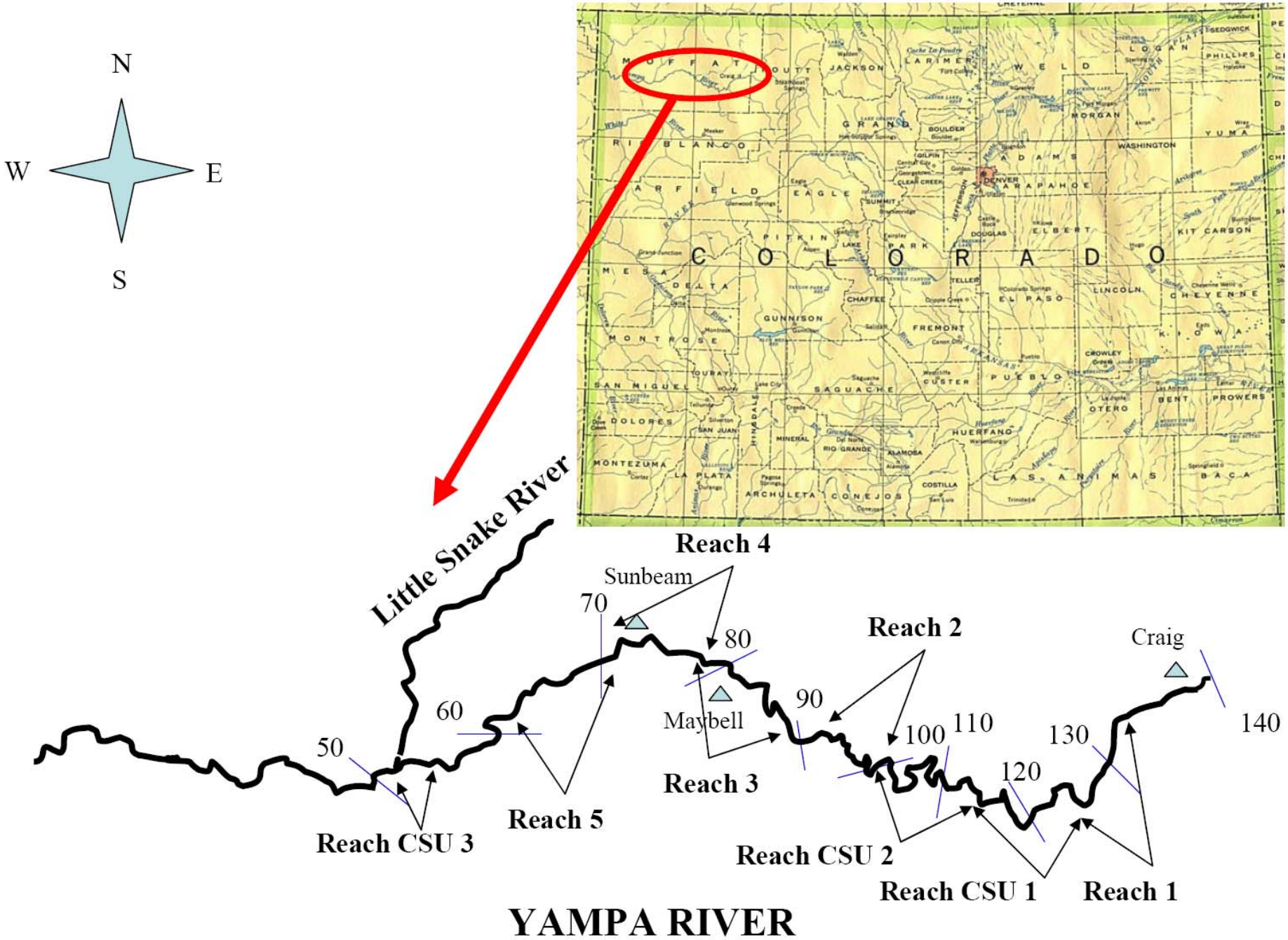

Figure 1. River reaches of the middle Yampa River sampled by the CDOW and CSU (Graphics courtesy of P. Martinez and R. Anderson)

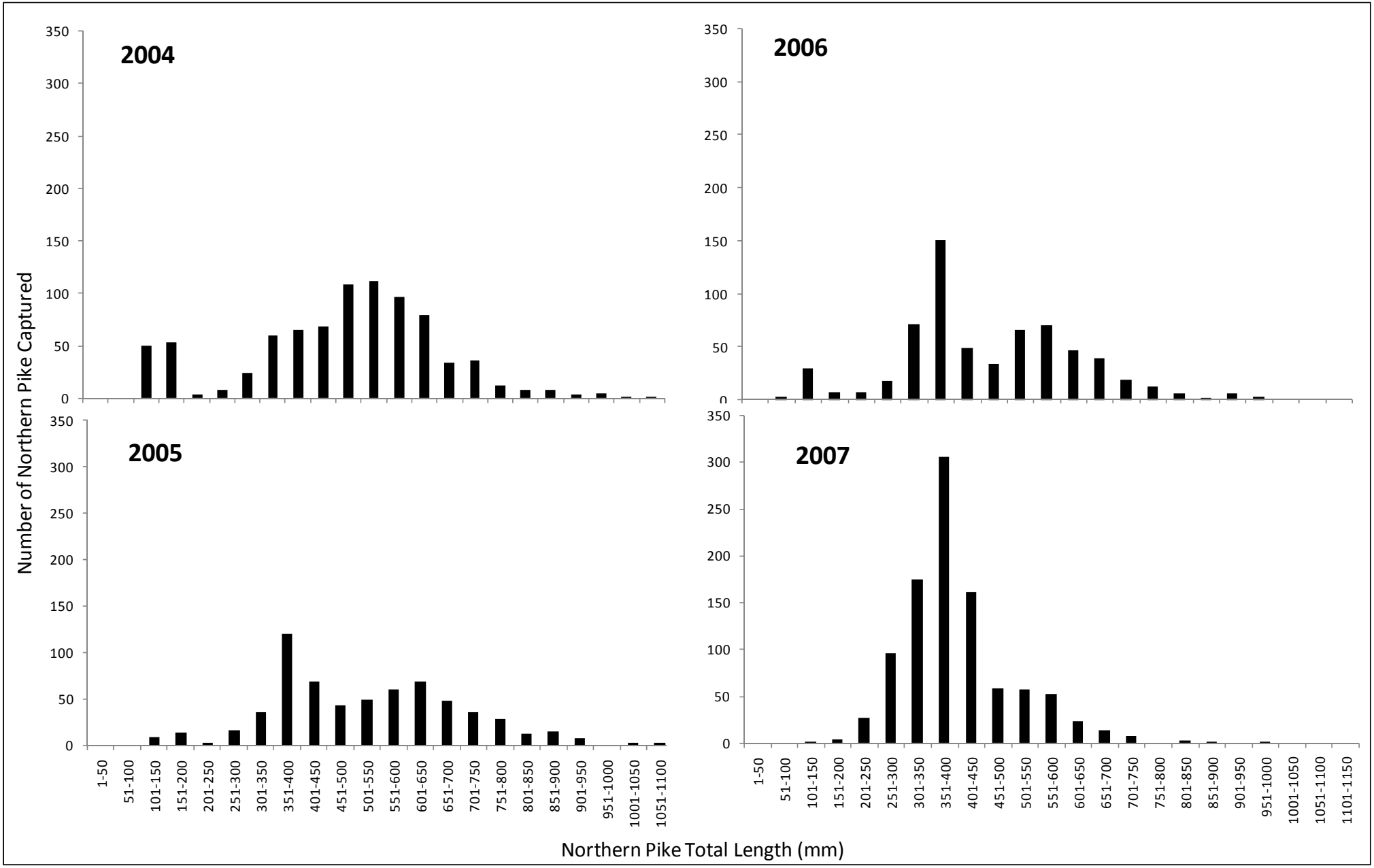

Figure 2. Northern pike total length frequency distributions in increments of 50 mm, from 2004 to 2007, in the middle Yampa River, from South Beach (RM 134.2) to Lily Park (RM 50.5).

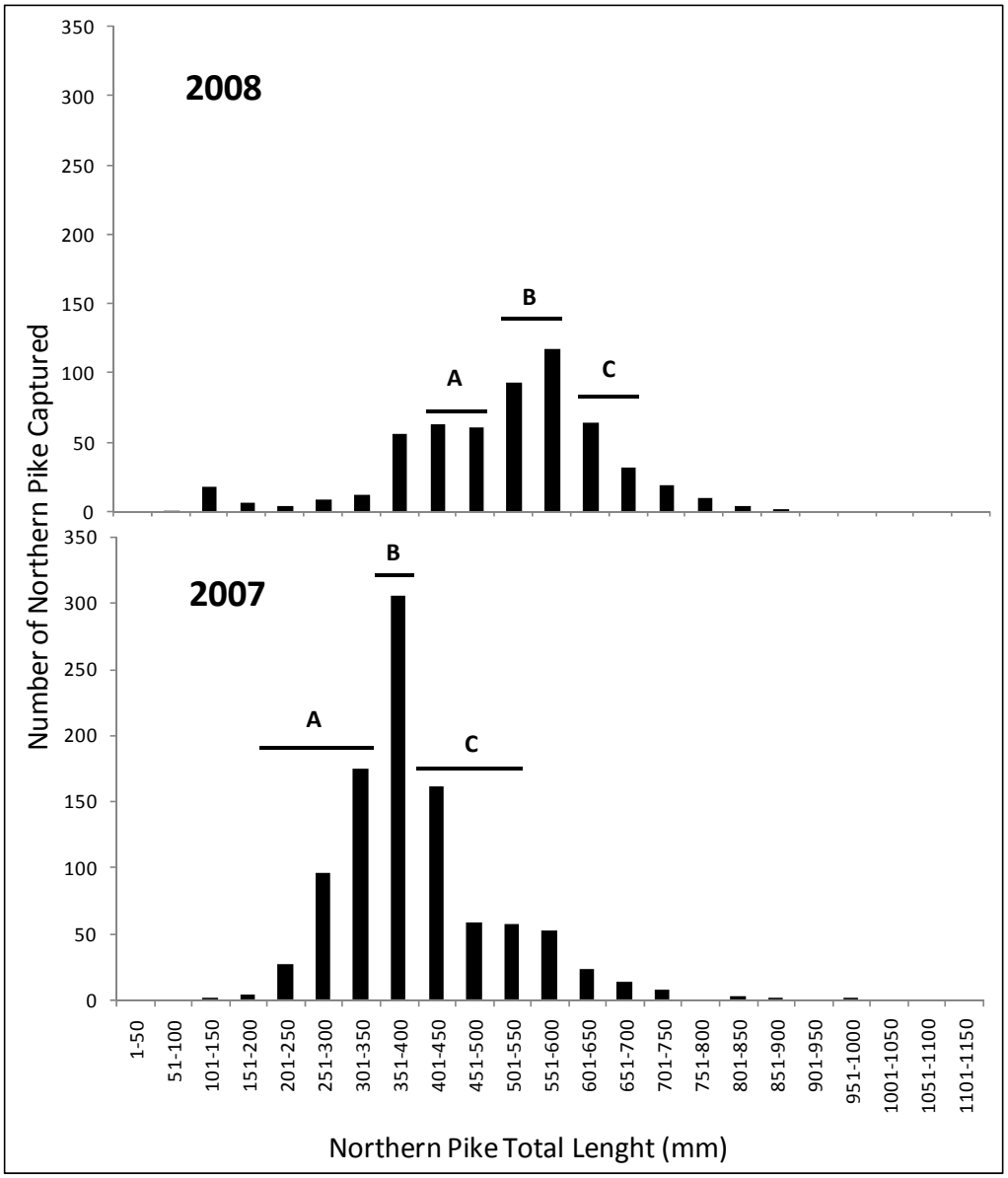

Figure 3. 2008 and 2007 northern pike total length frequencies, with size classes in increments of 50 mm, for all northern pike captured across all passes in the middle Yampa River from South Beach (RM 134.2) downstream to Lily Park (50.5). Total length of northern pike that were initially tagged in 2007 and recaptured in 2008, and that fell within a 200 to 700 mm size rang in 2008, were examined for total length at time of initial capture and realease in 2007. These northern pike were grouped into the following categories: (A) 400 to 500 mm TL at time of recapture in 2008, (B) 500 to 600 mm TL at time of recapure in 2008, and (C) 600 to 700 mm TL at time of recapture in 2008. The same letters and corresponding shows the mean total length (mm), +/- two standard errors, grouping of these size size classes at intital capture and release in 2007.

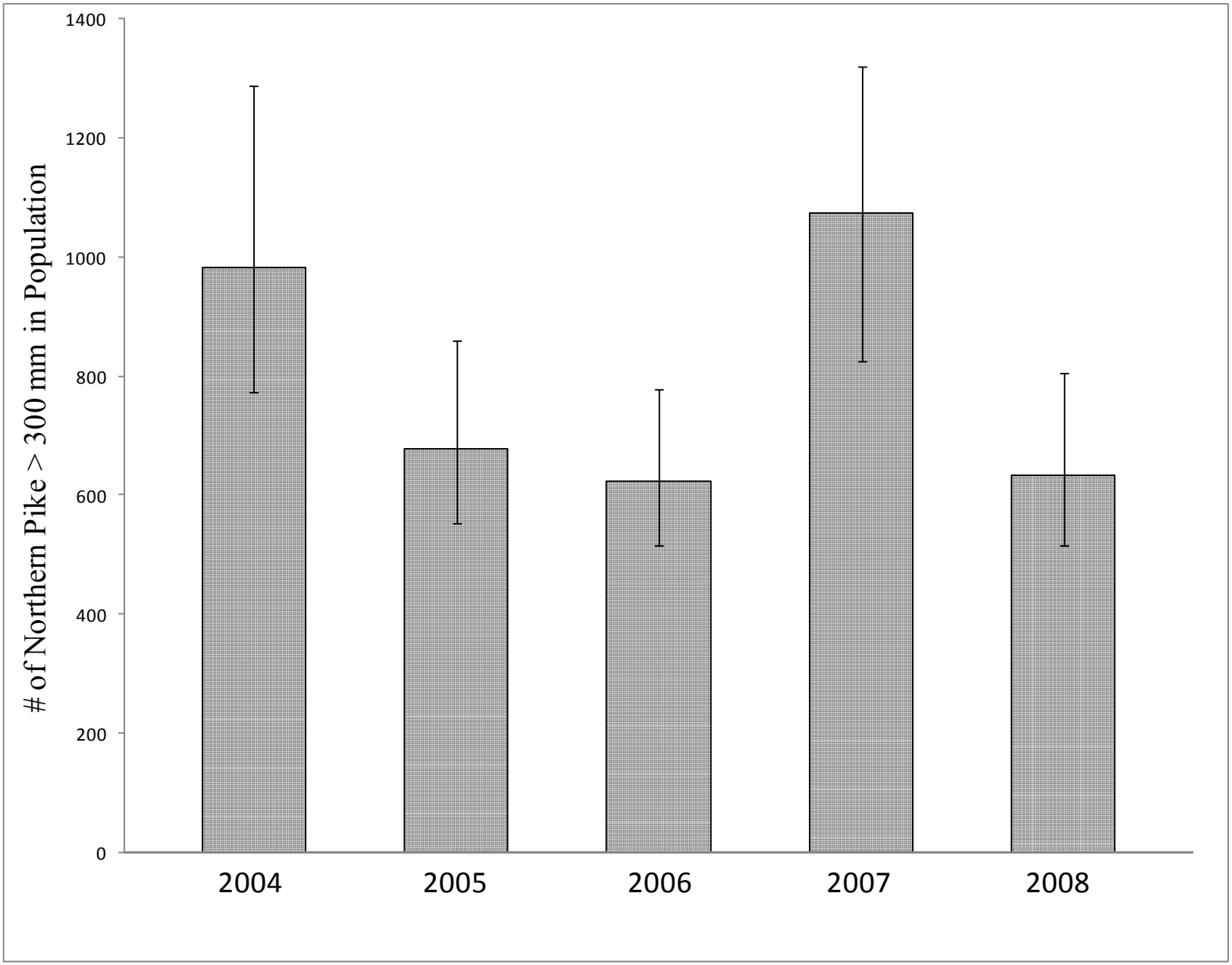

Figure 4. Northern pike > 300 mm population estimates and the 95% confidence interval, generated using Program CAPTURE Model (t) of Chao, for the middle Yampa River (RM 134.2- 50.5), from 2004 through 2008.

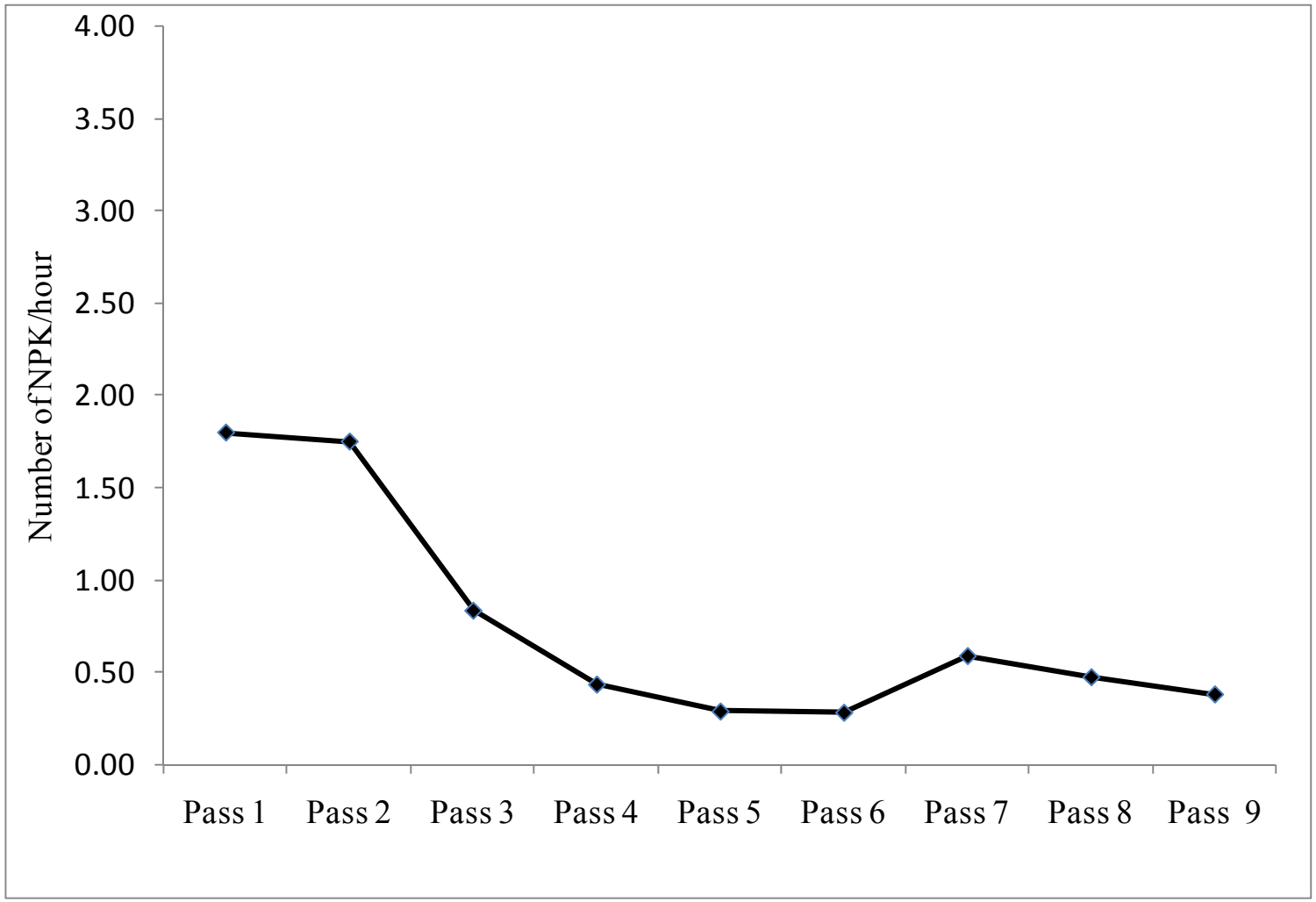

Figure 5. 2008 Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) across all passes completed for the Middle Yampa River from South Beach (RM134.2) to Lily Park (RM 50.5),

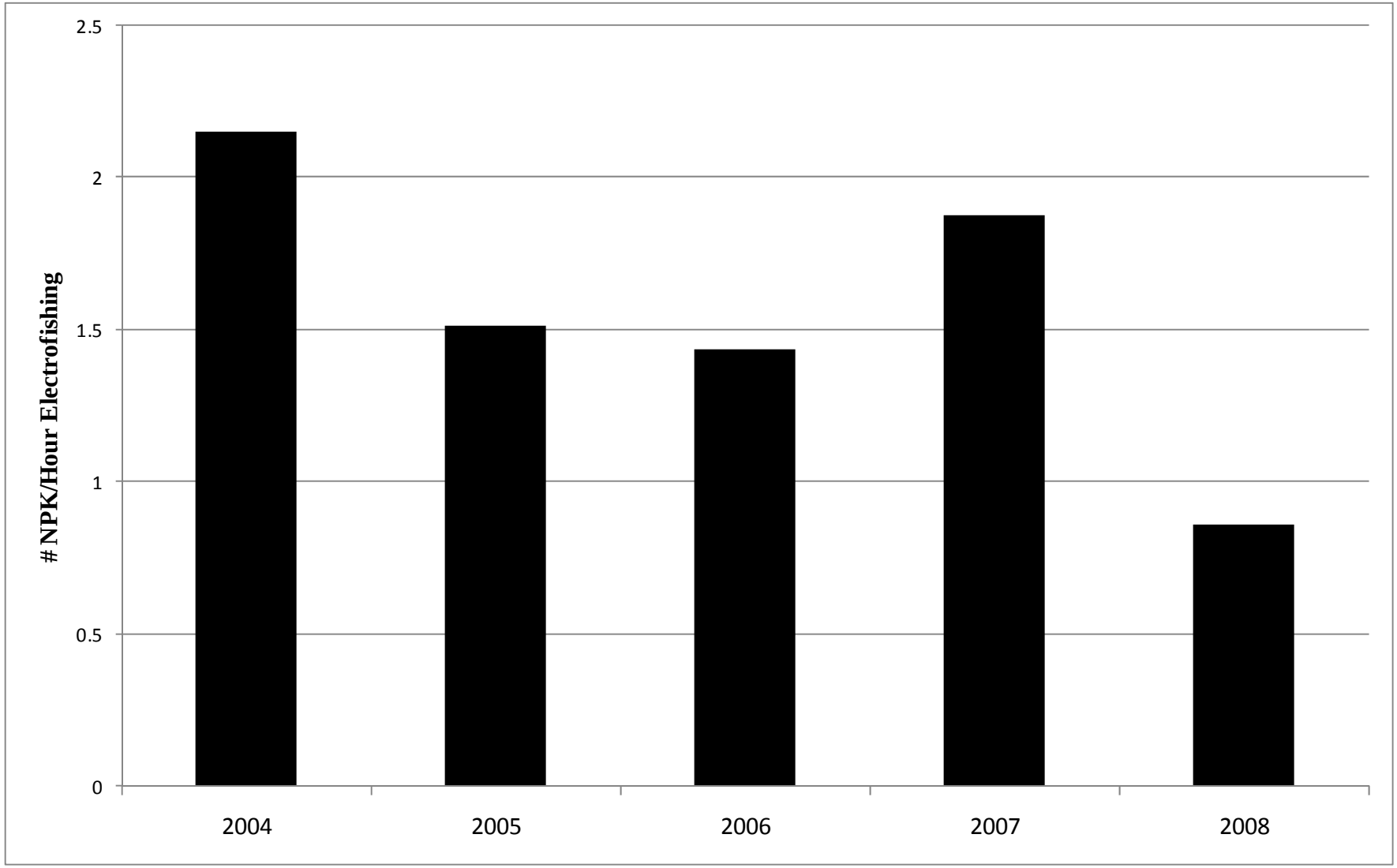

Figure 6. Northern pike electrofishing Catch Per Unit Effort (CPUE; # NPK/hour) in the middle Yampa River (RM 134.2-50.5) from 2004 to 2008.

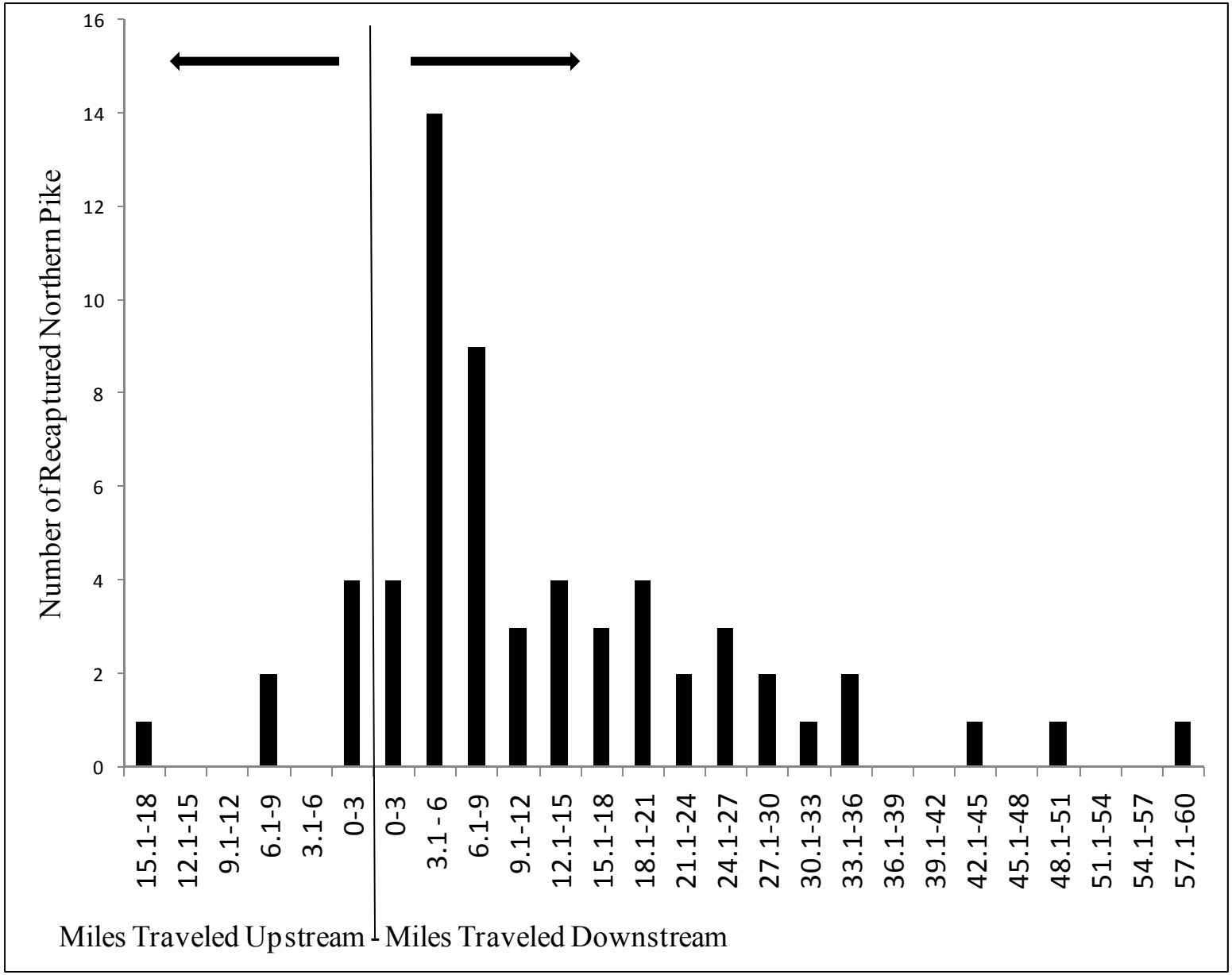

Figure 7. Total number of northern pike (NPK) that were tagged and reacaptured in 2008, and that moved a minimum of 1 mile in either an upstream or downstream direction, divided into categories of total distance traveled in increments of 3 miles, for the middle Yampa River (RM 134.2-50.5)

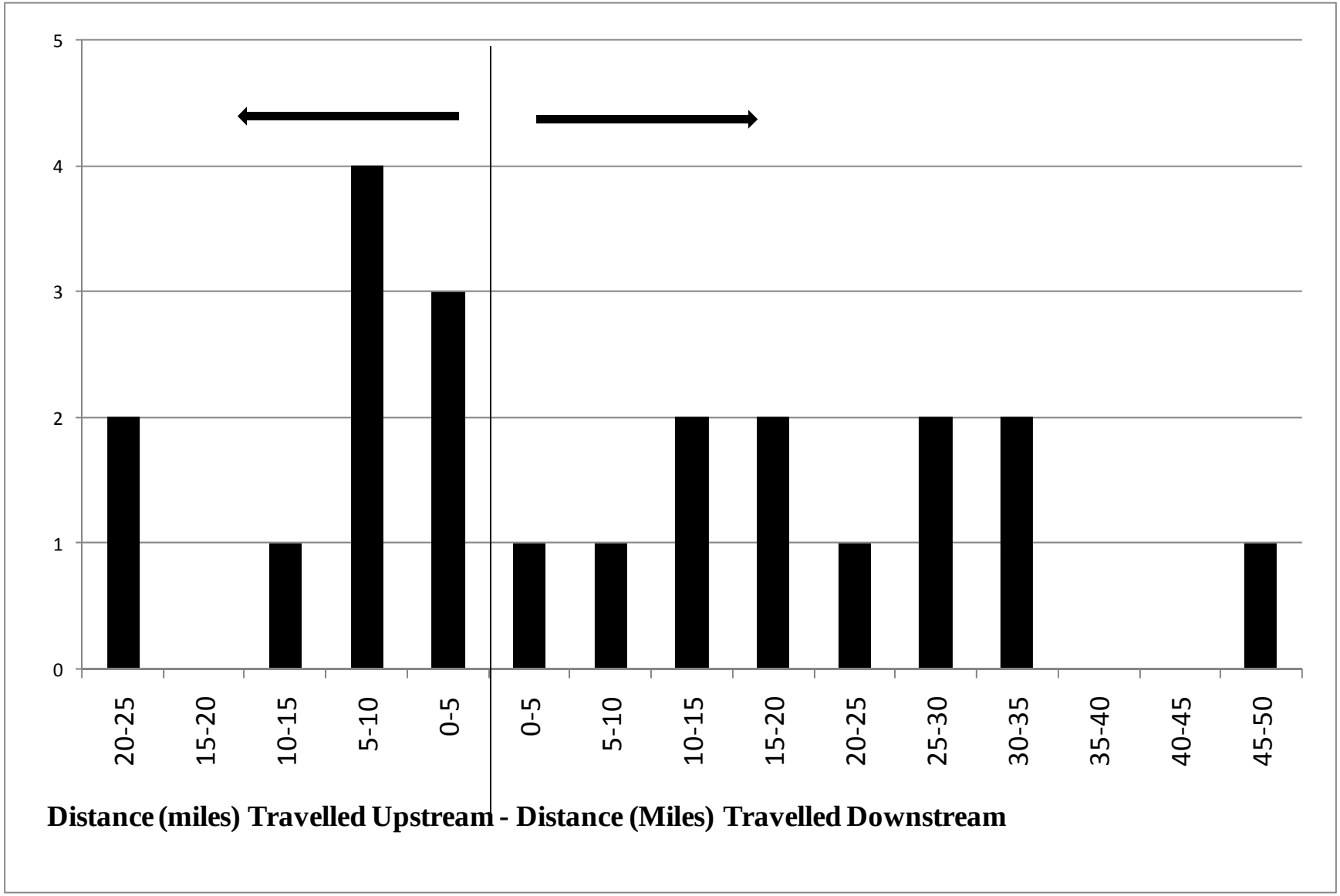

Figure 8. Total number of northern pike (NPK) that were tagged in 2007 and reacaptured in 2008, and that moved a minimum of 1 mile in either an upstream or downstream direction, divided into categories of total distance traveled in increments of 5miles, for the five reaches in th middle Yampa River sampled by the CDOW.

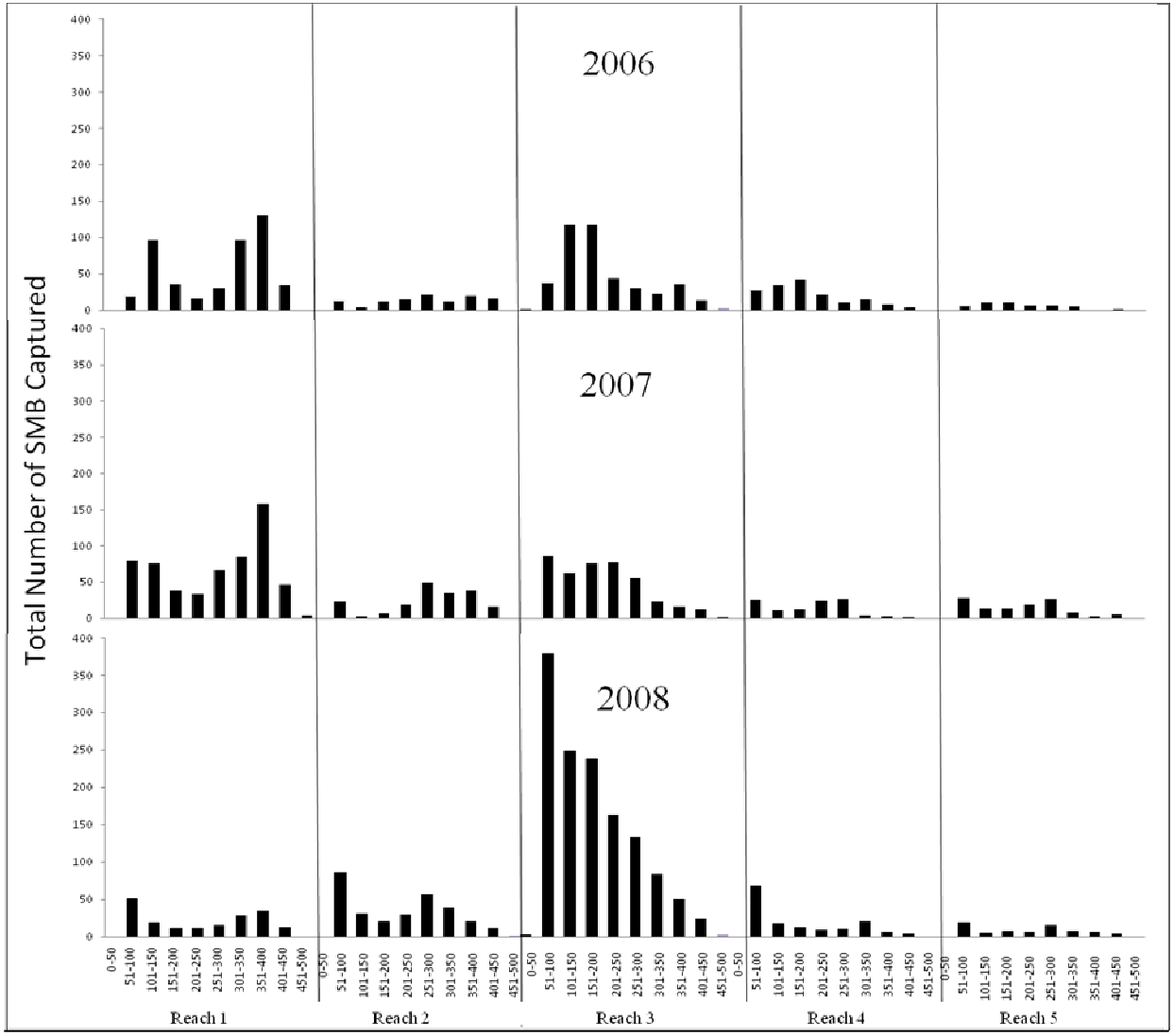

Figure 9. 2006, 2007, and 2008 total length (mm) frequency distributions, with size classes in increments of 50mm, for smallmouth bass (SMB) separated into the five reaches that the CDOW samples in the middle Yampa River

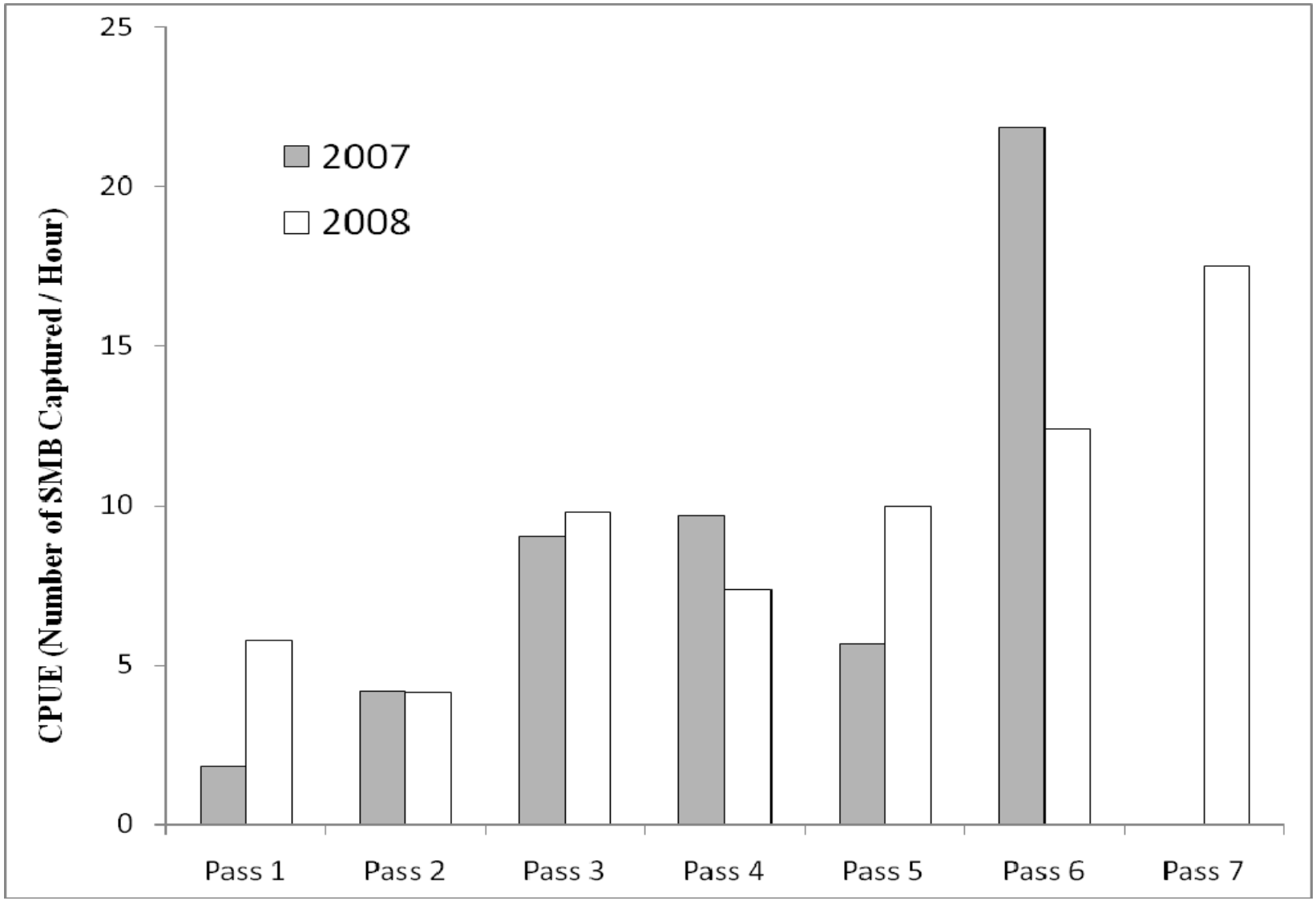

Figure 10. Smallmouth bass (SMB) Catch Per Unit Effort (CPUE; #SMB/hour) verses pass number in 2007 and 2008, for all five reaches sampled by the CDOW combined, in the middle Yampa River.

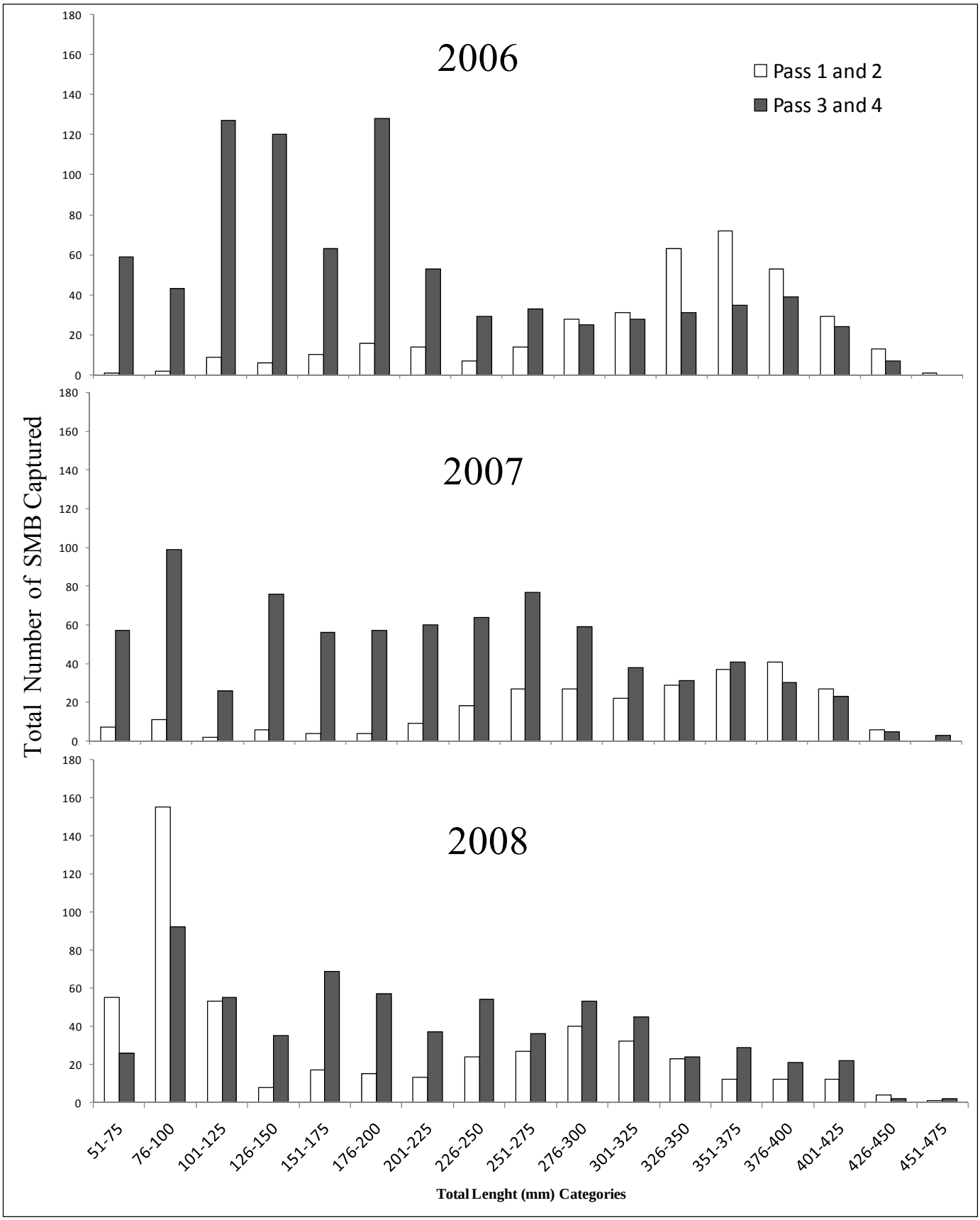

Figure 11. Total length frequency distributions for smallmouth bass during the first and second passes combined and third and fourth passes combined, with size classes in increments of 25 mm, for all five reaches sampled by CDOW combined in 2006, 2007, and 2008

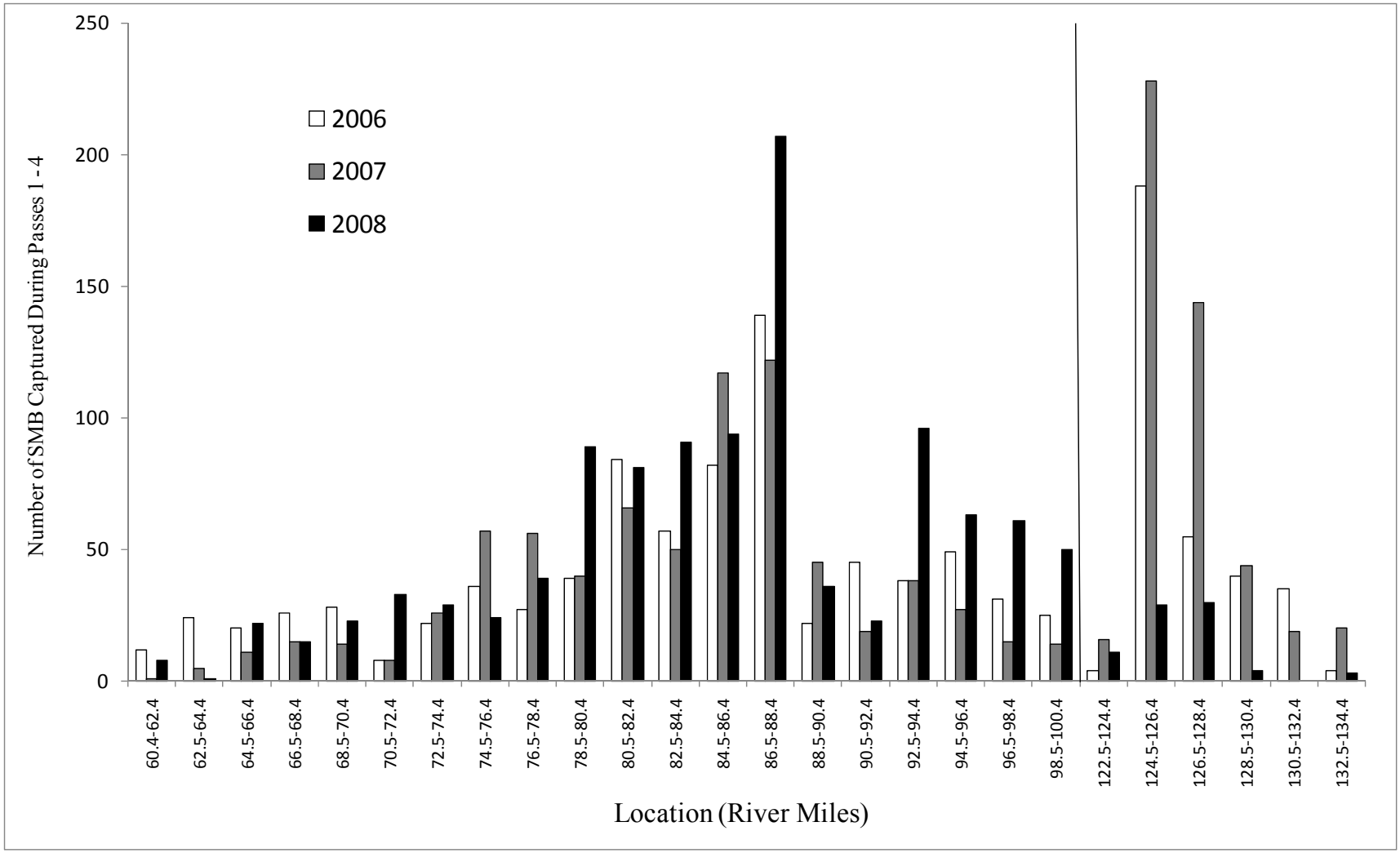

Figure 12. Longitudinal distribution of smallmouth bass in the CDOW study area on the middle Yampa River in 2006, 2007, and 2008, shown as number of SMB captured in each 2 mile river section during passes 1 through 4. The vertical line indicates the break, in which CSU-LFL has a 20 mile study reach (RM 124.0 to 100.0) embedded in the CDOW study area.

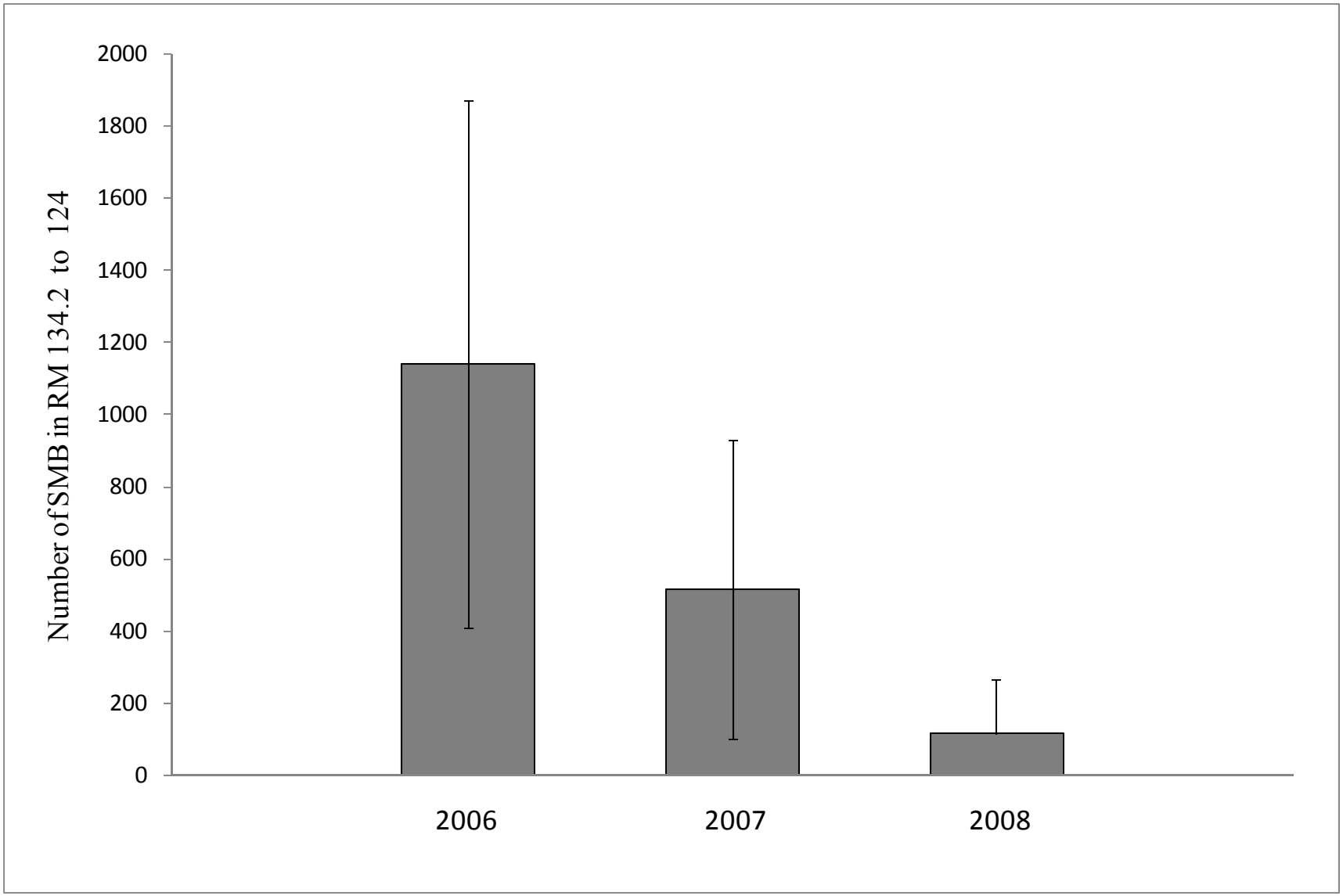

Figure 13. Smallmouth population estimates and the 95% confidence interval generated using the Lincoln-Petersen, Chapman's modification, equation for adult bass (> 199 mm) in Reach 1 (River Miles 134.2 – 124.0) only, in 2006 through 2008.

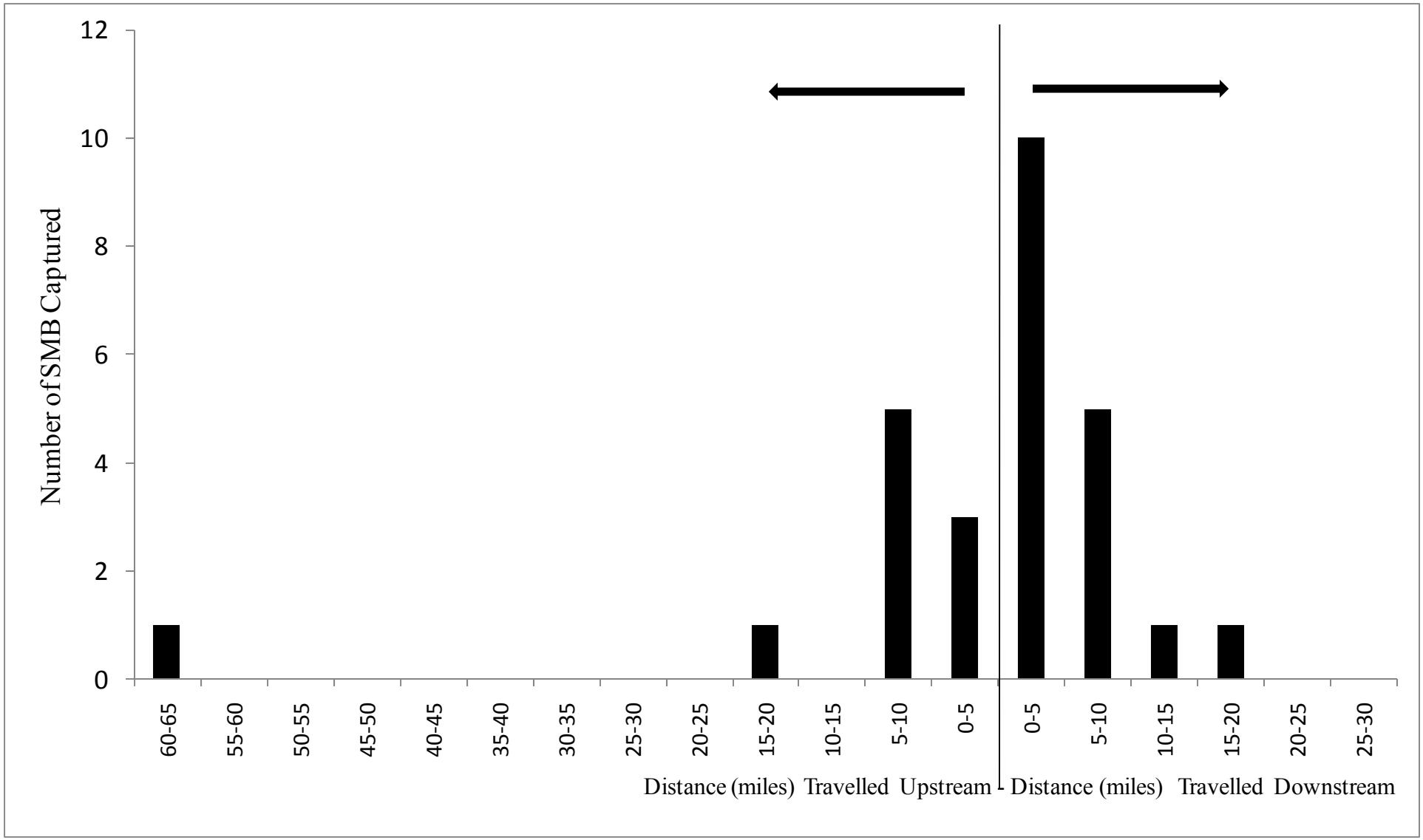

Figure 14. Total number of smallmouth bass (SMB) that were tagged and reacaptured in 2008, and that moved a minimum of 1 mile in either an upstream or downstream direction, divided into categories of total distance traveled in increments of 5 miles, for the middle Yampa River (RM 134.2-50.5).

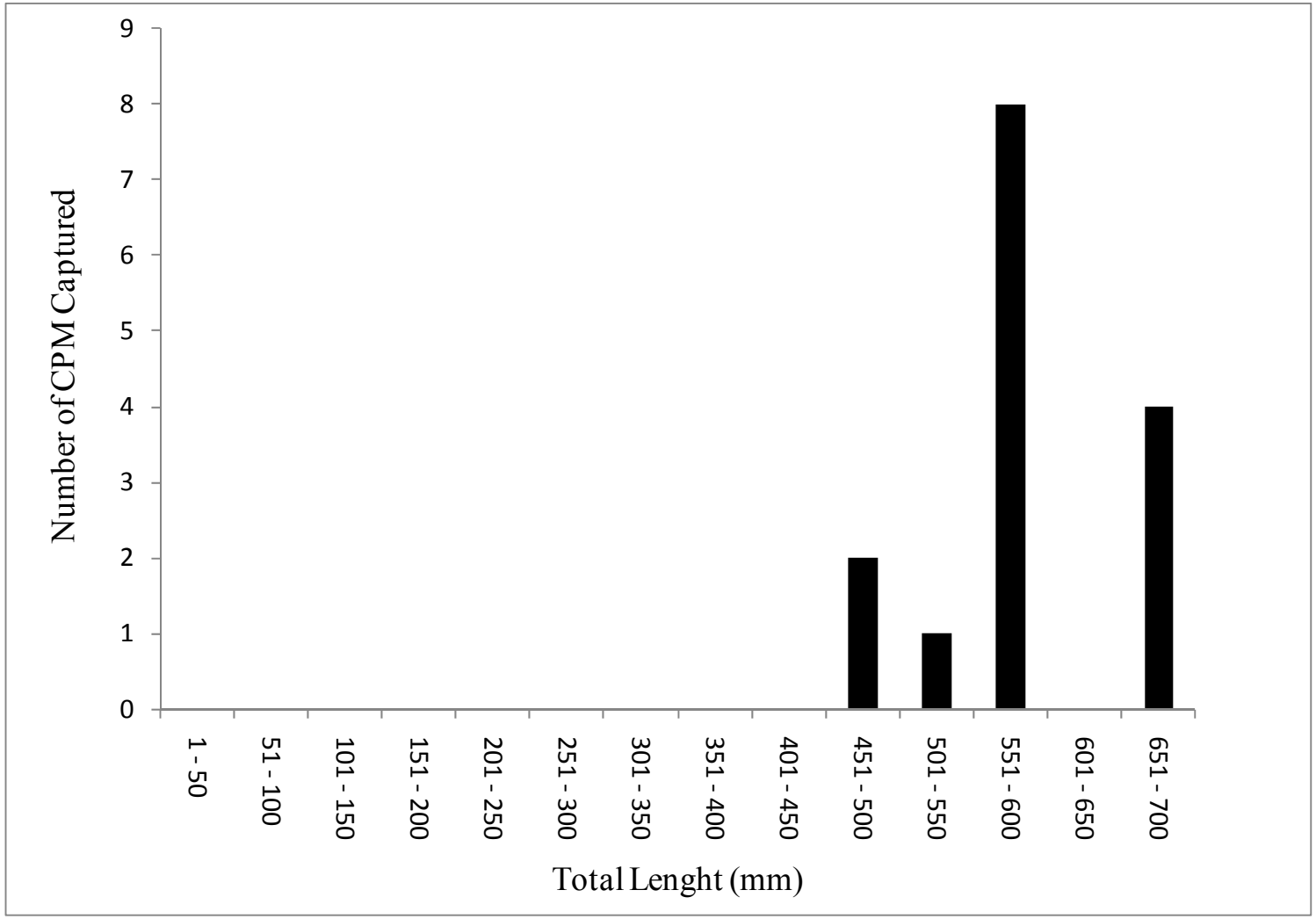

Figure 15. Colorado pikeminnow (CPM) total length (mm) frequency distribution, with size classes in increments of 50mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2008

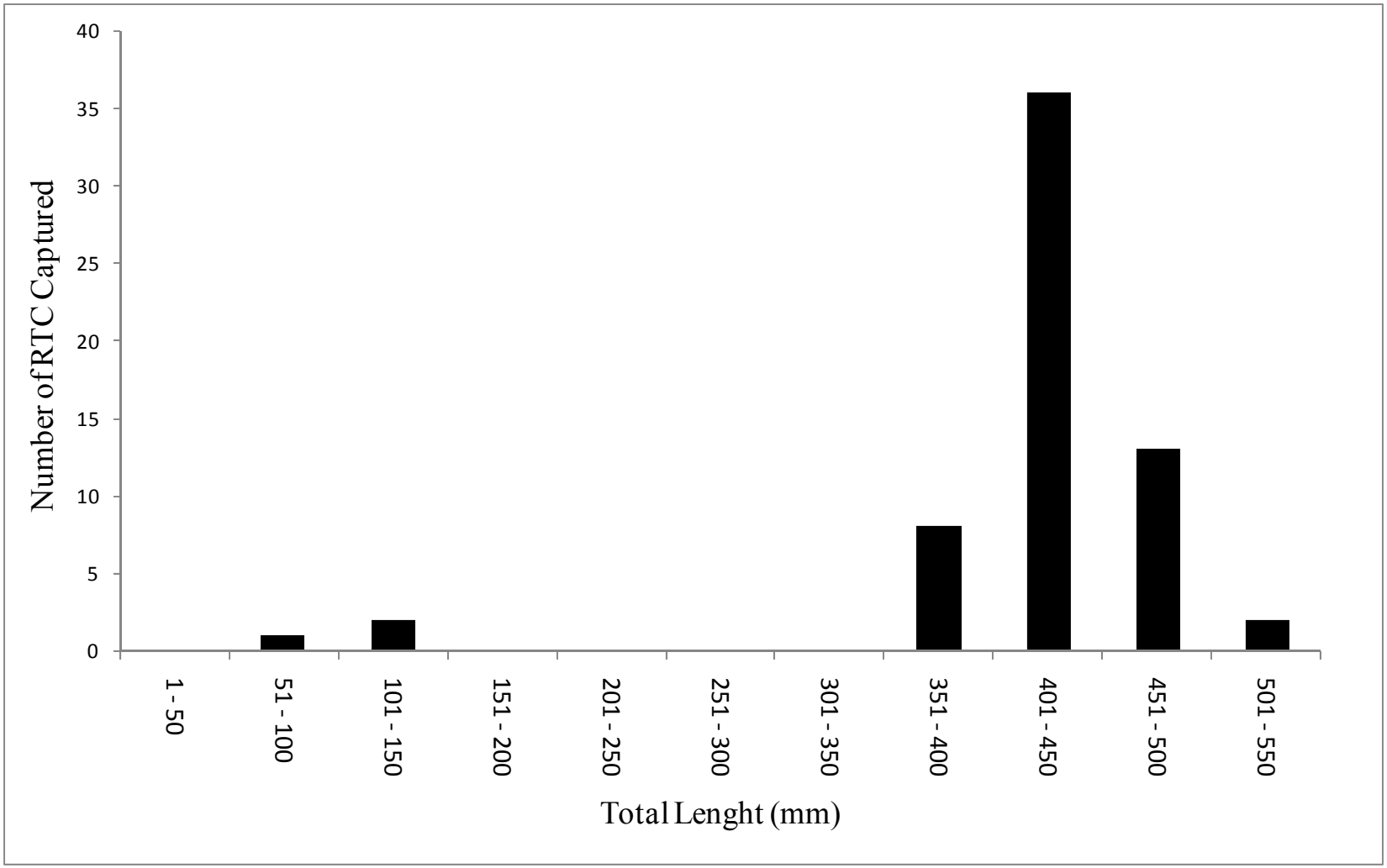

Figure 16. Roundtail chub (RTC) total length (mm) frequency distribution, with size classes in increments of 50 mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2008.