

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

II. Principal Investigator:

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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.

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 2009 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). In 2009, for the first time, all smallmouth bass data were submitted to CSU for their analysis.

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 2009 Annual Report #125.

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 2009 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2009 Tasks and Deliverables

Task 1. Establish landowner contacts and obtain permission to access riverside and backwater property for fish sampling.

Schedule: March 2009

Deliverable: **Task Completed**

Task 2. Plan logistics, hire and train personnel, order and maintain equipment, and prepare for sampling.

Schedule: February-April, 2009

Deliverable: **Task Completed**

Task 3. Sample study area to capture, remove, and translocate northern pike and smallmouth bass. Limited data entry

Schedule: April 14 – June 26, 2009

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, 2009

Deliverable: **Task Pending Completion.** Annual Report Completed and presentation will be given at the Annual Nonnative Fish Control Workshop.

## 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 (RM) 134.2 to 50.5 (Figure 1). The CDOW samples Reach 1 (RM 134.2 – 124.0), CSU samples Little Yampa Canyon (LYC; RM 124 – 100), the CDOW samples Reaches 2 through 4 (RM 110 – 60.6), and CSU samples Lily Park (RM 55.5 – 50.5) (Table 1).

### CDOW Study Methods/Approach

Fiscal Year 2009 marks the first year in which all smallmouth bass data collected by CDOW were submitted to CSU for a combined analysis of smallmouth bass, as has been done by CDOW with northern pike data since 2005. Thus, the focus of this report is on northern pike. See 2009 report # 125 for a detailed analysis of smallmouth bass data collected in the study area.

Four total sampling passes (1 mark/release, 3 removal) were performed by the CDOW in Reach 2, Reach 4, and Reach 5. Seven total sampling passes (1 mark/release and 6 removal) were performed by CDOW in Reach 3, and 6 total sampling passes (1 mark/release and removal) were performed by the CDOW in Reach 1. The CDOW's sampling occurred from April 14, 2009 to June 12, 2009. CSU also assisted CDOW in their removal effort by conducting a seventh concentrated removal pass in Reach 1 on July 9, 2009 and a fifth concentrated removal pass in Reach 2 on July 14, 2009. In

CSU's study area, 11 total sampling (1 mark/release; 10 removal) passes were conducted in Little Yampa Canyon (RM 124-100), and 8 total sampling passes (1 mark/release; 7 removal) were conducted in Lily Park (RM 58.9-55.5). CSU's sampling effort occurred from April 7, 2009 to July 14, 2009.

In past study years the first pass constituted the mark/release pass and all subsequent passes constituted removal efforts. However, in 2009 marking was postponed, per recommendations to the Biology Committee, in an effort to increase the number of smallmouth bass tagged by tagging bass when catch rates are highest. Such practice resulted in removal passes that occurred prior to the mark/release pass on most sample reaches. The CDOW conducted one removal pass on Reaches 1 through 4 prior to conducting the marking effort on the second pass, but tagged and released bass on the first pass in Reach 5. CSU conducted three removal passes in LYC prior to conducting the mark/release pass, but tagged and released northern pike on the first pass in Lily Park.

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. All northern pike captured during the tag/release 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 0616 to 1143, 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 2552 to 2635. Northern pike captured during the removal passes were removed from the river and were either marked and transported alive to Loudy Simpson ponds or Yampa State Park Headquarters West Pond, or were euthanized for age and growth and diet analysis. State Park Headquarters pond was used as a translocation site prior to peak runoff and Loudy Simpson was used after runoff had peaked and there was no threat of connection with the river. If northern pike that were translocated were not already tagged, they received a new, grey FLOY tag, with tag numbers ranging from 0505 to 0616 and 1154 to 1755 for CSU, and from 3201 to 3375 for the CDOW.

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.

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

### *Population Estimates*

In 2009 two separate population estimates were conducted: (1) an estimate for the section of river spanning from South Beach (RM 134.2) to Lily Park (RM 50.5), which is a repeated measure from 2004 through 2009 and (2) an estimate spanning the reach from Hayden (RM 171) to Lily Park (RM 50.5). This is the first year that such an estimate of northern pike abundance was generated which combines the 38 river-miles studied by project 98b with the adjacent 84 river miles covered by projects 98a and 125.

CDOW and CSU northern pike data were combined to produce a northern pike population estimate for the Yampa River from South Beach to Lily Park (approximately 84 river miles). CDOW, CSU, and USFWS data were combined to produce a northern pike population estimate for the Yampa River from Hayden to Lily Park (approximately 122 river miles). Program CAPTURE Model (t) of Chao (White et al. 1982) was used to generate these estimates. Northern pike that were less than 300 mm in total length were excluded from the analysis.

### *Catch Per Unit Effort (CPUE)*

Catch per unit effort (CPUE) was reported in terms the number of northern pike captured per electrofishing hour. 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 addition to overall Catch per unit effort, CPUE was reported for three sub-sections within the study area: (1) Juniper (Reach 1, LYC, and Reach 2), (2) Maybell (Reach 3, Reach 4, and Reach 5), and (3) Lily Park. CPUE was also reported for each pass within each of the above sub-sections. Since the number of passes for each sub-section varied between certain areas, in some cases new pass numbers had to be assigned so that pass number was representative of a certain time frame and so CPUE analysis for each pass was reflective of environmental conditions during those time frames (Table 2a – 2c).

### *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 study area in 2009.

Individual northern pike had to be captured more than once to be included in the movement analysis. 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 downstream movement and positive values represented

upstream movement. Distance moved was plotted against number of days at large between capture events.

## **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 558 individual northern pike and a total of 587 capture and recapture events occurred. Total number of northern pike capture events in 2009 (587) slightly increased from the total number of northern pike capture events in 2008 (576). However, more effort was expended in 2009, which surely increased capture numbers. Four hundred and ninety-five (495) northern pike were removed in 2009, 89% of the northern pike individuals handled (Table 4). Two hundred and forty (240) pike were translocated to State Park Headquarters West Pond and 100 were translocated to Loudy Simpson Pond in Craig, CO. One hundred and fifty-five (155) northern pike were euthanized and preserved for Viral Hemorrhagic Septicemia (VHS) testing, age and growth analysis, and diet analysis (Table 5).

#### *Population Estimate and Population Structure: South Beach to Lily Park*

Eighty six (86) northern pike  $\geq 300$  mm TL were marked and released during the marking effort. Eighty-four (84) of these fish were marked by CDOW and CSU in 2009, while the remaining 2 had been marked in previous studies by the USFWS, CSU, and CDOW. Thirteen (13) of the 86 northern pike (15%) that were tagged on the marking pass were recaptured on the subsequent recapture pass. An additional 16 northern pike that were tagged and released on the marking pass were recaptured across all subsequent passes. Thus, 32% of the northern pike initially tagged and released during the marking pass were recaptured during all subsequent passes; 68% of the northern pike handled and released during the marking 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 2007 to 2009 are presented in Figure 2. Multiple age classes existed in the northern pike population, which are represented in the 2009 length frequency histogram. Two hundred and twenty-two (222; 38%) of the northern pike captured were within the 451 – 700 mm TL size range. Fish that fell within this size range were presumed to be members of the cohort of fish that entered the population during the 2007 influx that is discussed in greater depth in the 2008 Annual Report and 2007 Synthesis Report. Two hundred and thirty-seven (237; 40%) of the northern pike captured fell within the 351 – 500 mm size range. It is presumed that fish in this size range represented a new cohort of fish that recruited to the population between 2008 and 2009, since none of these were recaptures from the 2008 mark/release effort and they are

underrepresented as a smaller size class in the 2008 length frequency histogram. Ninety-three (93; 16%) of the northern pike captured fell within the 101 – 200 mm size range. Ninety-seven percent (97%) of these fish were captured by CSU after June 26, 2009 in Reach 1 and LYC (the upper 34 miles of our study area). Aging results from fish collected in the 101 – 200 mm TL size range are forthcoming, but it is thought that these fish are 2009 young of year, since they did not recruit to electrofishing gear until the latter portion of the study. Further, several of these fish were captured in and around the ColoWyo backwater at river mile 130.9, which suggests that successful spawning may have occurred in this backwater within Critical Habitat in 2009.

The population estimate for northern pike in the middle Yampa River in 2009 suggests that northern numbers remained relatively stable between 2008 and 2009, and that the population remains lower than when the study was initiated in 2004 (Table 6). The Program MARK Model (t) of Chao population estimate of northern pike in 2009 was 765 (553-1160 95% C.I.; SE=149.2; CV=0.20; p-hat=0.15), and was not significantly different than the 2008 estimate of 633 (518-806 95% C.I.; SE=72.5; CV=0.114; p-hat=0.28), though the point estimates suggest a slight increase in the population size. In 2009, 64.7% of the northern pike population (estimate of 765) was removed (495 individuals), which was a higher rate of exploitation when compared to 2004, 2005, and 2006. However, it was consistent with the 2008 exploitation rate of 65.9% and 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 3). However, the 2007 estimate increased significantly and was greater than when northern pike removal began in 2004. In 2008, abundance had decrease to levels reflective of the 2006 estimate. In 2009, it appears that the population remained relatively stable and is similar to the 2008 estimate. However, capture probability decreased substantially from 0.28 in 2008 to 0.15 in 2009, which doubled the confidence interval breadth. The decreased capture probability is likely a result of two factors: (1) Removal of northern pike occurred throughout most of the study area prior to marking and releasing fish in 2009. In past years, highest catch rates of pike have occurred during the first and second pass. Thus, not tagging pike on the first pass as was done in 2004 through 2008 decreased the number of pike that were tagged and available for recapture. For example, 147 northern pike were tagged in released in 2008; whereas, only 86 northern pike were tagged and released in 2009. (2) Capture probability in 2009 was also greatly impacted by the lack of synchronization between CSU's and CDOW marking and recapture passes (Figure 4). CSU was conducting their marking pass during the same time frame that CDOW was conducting their recapture pass. Further, CSU began their recapture pass 11 days following the conclusion of CDOW's recapture pass. Consequently, all of the fish that CDOW recaptured that were tagged by CSU, occurred subsequent to CDOW concluding their recapture pass for the population estimate. Typically, recaptures fitting such description account for 5% of the overall recaptures in the estimate. In the interest of generating combined population estimates with better precision, researchers studying northern pike in the middle Yampa River should practice better communication to

optimize synchronization of marking and recapture efforts.

Over the course of 6 years of northern pike mechanical removal in Critical Habitat of the Yampa River, we have demonstrated a decrease in northern pike abundance and an altered size structure of the population, featuring an overall reduction of large northern pike. When conducted annually, these efforts help minimize the predatory threat of northern pike on the native fish community by reducing predator numbers on a yearly basis. However, it appears that long term success of such efforts is limited by the continuous influx of northern pike from source populations in the basin. Annual length frequency histograms have been a sufficient means to demonstrate the influx of distinct northern pike cohorts that originate outside of our study area, and that replenish northern pike densities within Critical Habitat, despite intensive removal efforts on a yearly basis. Control of source populations is perhaps the only measure that will aid researchers working within Critical Habitat to significantly reduce northern pike numbers below the current level.

#### *Combined Population Estimate: Hayden to Lily Park*

Two thousand and nine (2009) marks the first year that data was combined from three different projects within the Yampa River (98a, 98b, 125) to generate one abundance estimate for 122 miles of river, from Hayden, CO to Lily Park (Figure 5). The northern pike abundance estimate for this section of river was 1,260 (929-1803 95% C.I.; SE=217.5; CV=0.17; p-hat=0.13). Such practice decreased confidence interval breadth when compared to the estimate for the Hayden to Craig section, but increased confidence interval breadth when compared to the South Beach to Lily Park section. Further, it decreased the point estimate by 22% when compared to the sum of the individual estimates for the two separate sections of river. Timing of marking and recapture efforts between CDOW and USFWS were well synchronized with one another; however, they were not synchronized well with CSU's effort. Thus, the capture probability was likely negatively affected by the lack of synchronization of efforts, as was the case for the combined estimate between CDOW and CSU. The Hayden to Lily Park estimate should be repeated in future years for comparison, but researchers will need to better align their efforts.

#### *Catch Per Unit Effort (CPUE)*

CPUE was calculated for three sub-sections (Juniper, Maybell, and Lily Park), and expressed as the number of northern pike captured per hour (# of NPK/hour) (Table 7). CPUE showed a continued declining trend across all three sections when compared to previous years (Figure 6). Most notable is the continued substantial decrease in northern pike CPUE below Cross Mountain, in Lily Park, where CPUE had decreased nearly eightfold since 2004. CPUE of northern pike in Juniper and Maybell has also decreased since 2004, but remained relatively unchanged between 2008 and 2009, increasing slightly in the Juniper section in 2009. The Juniper section represents the upper 43 miles of the study area and therefore CPUE in Juniper is most affected by movement of pike into the study area.

CPUE was also calculated for each pass within each of the above sub-sections (Table 8; Figure 7). In Juniper and Maybell, CPUE generally declined as the study progressed, but slightly increased in Lily Park as the study unfolded. However, CPUE did increase in Juniper once runoff diminished and reached a maximum CPUE of 2.13 northern pike/hour on the final pass of the study. This increase in CPUE was largely a result of northern pike that were captured in the 101 – 200 mm TL size range, which were absent from the sample prior to June 26<sup>th</sup>. As discussed in the above *Population Estimate and Size Structure* section, it is believed those small fish may account for documented natural recruitment within Critical Habitat, a phenomenon that has rarely been documented in previous years.

Overall CPUE for all passes across the entire study area in 2009 increased by 8% from 2008 (Figure 8). This trend was reflective of the same trend in population estimates, and suggests that northern pike numbers were slightly higher in 2009. CPUE remains a suitable index for validating abundance estimates and assessing trends in catch rate that may be associated with various factors such as discharge and depletion of northern pike numbers as the study progresses.

#### *Movement*

Nine (9) northern pike were recaptured that were tagged and released by project 98b in 2009 or previous years. One (1) northern pike was recaptured that was tagged and translocated to Loudy Simpson Pond in 2007. Seven (7) northern pike were recaptured that were tagged during this study in 2008 and 2007; however there were no recaptures of northern pike that were tagged in this study prior to 2007. Twenty-nine (29) northern pike were recaptured that were tagged by CDOW and CSU in 2009 (Table 9).

Northern pike movement was also described in terms of the number of recaptured northern pike that moved different distances in both upstream and downstream directions, and was plotted against number of days at large within the 2009 sampling year (Figure 9). Twenty-four (24) northern pike that were tagged and recaptured in 2008 moved more than one mile in a downstream direction, while only 4 northern pike moved distances greater than one mile upstream. Northern pike that demonstrated downstream movement within 2009 moved distances as great as 30 miles, while the greatest distance moved in an upstream direction was 7 miles. Sixty one percent (61%) of northern pike that exhibited downstream movement within 2009 moved less than 10 miles, 72% moved less than 20 miles, and 100% moved less than 30 miles. Distance travelled appeared to be a function of time at large between initial capture and recapture; northern pike at large for greater periods of time generally moved greater distances. There is also evidence to suggest that much of the movement that occurs within the first 15 days at large is a result of displacement during our sampling activities. Northern pike fitting this description did not move distances greater than 10 miles, but accounted for 61% of recaptured northern pike.

### Colorado Pikeminnow

Overall, 21 Colorado pikeminnow individuals were captured by CDOW (Table 10). Two (2) Colorado pikeminnow were captured during Pass 1, 7 were captured during Pass 2, 4 were captured during Pass 3, 8 were captured during Pass 4, 2 were captured during pass 6 in Reach 3, and 1 was captured during pass 7 in Reach 3. None of the Colorado pikeminnow that were handled by CDOW in 2009 were captured more than once by CDOW in 2009. Colorado pikeminnow capture locations ranged from river mile 61.1 to river mile 124.4. A total length frequency histogram was developed for all Colorado pikeminnow captured (Figure 10). Mean total length of Colorado pikeminnow captured by CDOW in 2009 was 595 mm. Thirteen (13) Colorado pikeminnow were captured in the main channel, and 11 were captured in backwaters. Three (3) Colorado pikeminnow displayed evidence of presumed northern pike attacks that had healed. On June 2, 2009, 8 Colorado pikeminnow were captured in the Sand Creek backwater at river mile 72.9 marking the greatest number of pikeninnow captured in one location on a given day since the inception of this study. Five (5) of those eight fish were recaptures, while 3 were fish that had not been tagged.

### Roundtail Chub

Overall, 43 roundtail chub individuals were captured by CDOW (Table 11). Nine (9) roundtail chub were captured during Pass 1, 13 were captured during Pass 2, 15 were captured during Pass 3, and 6 were captured during Pass 4. No Roundtail chub were captured subsequent to Pass 4 in Reach 1 and Reach 3. No roundtail chub were captured in Reach 1 or Reach 3, while 24 were captured in Reach 2, 5 were captured in reach 4, and 14 were captured in Reach 5. A total length frequency histogram was developed for all roundtail chub individuals (Figure 11). The mean total length of roundtail chub captured was 444 mm. One juvenile roundtail chub was captured that was 52 mm in total length.

## VII. Recommendations:

- A. Repeat 2009 northern pike removal effort and repeat CSU's late season sampling effort at South Beach and Little Yampa Canyon to detect presence of YOY northern pike.
- B. Repeat the combined population estimate between projects 98b and 98a/125. Increase communication between researchers so that marking and recapture passes are better synchronized between the three projects.
- C. Continue work to control potential northern pike source populations within the Yampa River basin. Prioritize work schedule to focus on populations of immediate concern.
- D. Implement revised Aquatic Wildlife Management Plan.
- E. Continue marking and documentation of roundtail chub and Colorado pikeminnow.

- F. 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 2010 may be adjusted per results from the 2009 Nonnative Fish Control Workshop.
- X. FY 2009 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-
- XI. Status of Data Submission: Data for Colorado pikeminnow collected by the CDOW will be provided to the database Manager by March 1, 2010.
- XII. Signed:            F. Boyd Wright            November 23, 2009  
Principal Investigator            Date
- XIII. Literature Cited:
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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.

<u>River Reach</u>	<u>River Section</u>	<u>Reach Description</u>	<u>River Miles</u>	<u>Agency Responsible</u>
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 2a. Summary of how pass numbers were assigned to the Juniper sub-section sampling efforts, based on the date that various efforts occurred.

<u>Pass Number</u>	<u>Reach</u>	<u>Date of Effort</u>	<u>Actual Pass Number</u>	<u>Action</u>
Pass 1	Little Yampa Canyon	April 7, 2009	1	Removal
Pass 2	Little Yampa Canyon	April 14, 2009	2	Removal
	Reach 2	April 15, 2009	1	Removal
	Reach 1	April 17, 2009	1	Removal
Pass 3	Little Yampa Canyon	April 18, 2009	3	Removal
	Reach 1	April 22, 2009	2	Mark/Release
	Reach 2	April 27, 2009	2	Mark/Release
Pass 4	Reach 1	April 28, 2009	3	Removal
	Little Yampa Canyon	April 30, 2009	4	Mark/Release
	Reach 2	May 1, 2009	3	Removal
Pass 5	Little Yampa Canyon	May 12, 2009	5	Removal
	Reach 1	May 13, 2009	4	Removal
Pass 6	Little Yampa Canyon	May 15, 2009	6	Removal
Pass 7	Little Yampa Canyon	May 28, 2009	7	Removal
	Reach 1	June 3, 2009	5	Removal
Pass 8	Reach 1	June 11, 2009	6	Removal
	Little Yampa Canyon	June 11, 2009	8	Removal
	Reach 2	June 12, 2009	4	Removal
Pass 9	Little Yampa Canyon	June 24, 2009	9	Removal
Pass 10	Little Yampa Canyon	June 28, 2009	10	Removal
Pass 11	Reach 1	July 8, 2009	7	Removal
	Little Yampa Canyon	July 9, 2009	11	Removal
	Reach 2	July 13, 2009	5	Removal

Table 2b. Summary of how pass numbers were assigned to the Maybell sub-section sampling efforts, based on the date various efforts occurred.

<u>Pass Number</u>	<u>Reach</u>	<u>Date of Effort</u>	<u>Actual Pass Number</u>	<u>Action</u>
Pass 2	Reach 4	April 14, 2009	1	Removal
	Reach 3	April 16, 2009	1	Removal
Pass 3	Reach 4	April 20, 2009	2	Mark/Release
	Reach 3	April 21, 2009	2	Mark/Release
	Reach 5	April 24, 2009	1	Mark/Release
Pass 4	Reach 3	April 29, 2009	3	Removal
	Reach 4	April 30, 2009	3	Removal
	Reach 5	May 4, 2009	2	Removal
Pass 5	Reach 5	May 11, 2009	4	Removal
	Reach 3	May 12, 2009	3	Removal
Pass 6	Reach 3	May 14, 2009	5	Removal
Pass 7	Reach 4	June 2, 2009	4	Removal
	Reach 3	June 4, 2009	6	Removal
Pass 8	Reach 3	June 9, 2009	7	Removal
	Reach 5	June 10, 2009	4	Removal

Table 2c. Summary of how pass numbers were assigned to the Lily Park sub-section efforts, based on the date various efforts occurred.

<u>Pass Number</u>	<u>Reach</u>	<u>Date of Effort</u>	<u>Actual Pass Number</u>	<u>Action</u>
Pass 4	Lily Park	April 28, 2009	1	Mark/Release
Pass 5	Lily Park	May 4, 2009	2	Removal
Pass 6	Lily Park	May 26, 2009	3	Removal
Pass 7	Lily Park	June 1, 2009	4	Removal
Pass 8	Lily Park	June 9, 2009	5	Removal
Pass 9	Lily Park	June 15, 2009	6	Removal
Pass 10	Lily Park	June 23, 2009	7	Removal
Pass 11	Lily Park	July 7, 2009	8	Removal

Table 3. A summary of the total number of individuals captured for all species of interest in the Middle Yampa River in 2009, including incidental nonnatives that were lethally removed: black bullhead, black crappie, bluegill, green sunfish, and white crappie.

<u>Species</u>	<u>Number of Individuals Captured</u>
Northern Pike	558
Smallmouth Bass	2184
Colorado Pikeminnow	21
Roundtail Chub	43
Black Bullhead	11
Black Crappie	2
Bluegill	2
Green Sunfish	5
White Crappie	2

Table 4. Number of northern pike tagged on the marking pass, number northern pike that were tagged on the marking pass and recaptured on the recapture pass, number of northern pike that were tagged on the marking pass and removed during all subsequent passes, % of fish that were tagged on the marking 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 2009.

<u>Year</u>	<u># NPK Tagged on First Pass</u>	<u># NPK Recaptured on the Second Pass</u>	<u># NPK Tagged Recovered and Removed on Subsequent Passes</u>	<u>% Recovery of Tagged NPK</u>	<u>Total # of NPK Individuals Handled</u>	<u>Total # NPK Removed</u>	<u>% NPK Handled that were Removed</u>
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%
2009	92	13	16	32%	558	495	89%

Table 5. Disposition totals for northern pike removed from the middle Yampa River in 2009. Northern pike were either moved to the State Park Headquarters Pond; placed in Loudy Simpson Pond; or euthanized for Viral Hemmoragic Septicemia (VHS) testing, age and growth analysis, or diet analysis, or placed in Loudy Simpson pond.

<u>Disposition</u>	<u>Number of Northern Pike</u>
State Park Headquarters Pond	240
Loudy Simpson	100
Euthanized for VHS testing, Age and Growth, and Diet Analysis	155
<u>TOTAL</u>	495

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 2009 in the middle Yampa River.

<u>Year</u>	<u>NPK &gt; 300 mm Population Estimate (95% C.I.)</u>	<u>Number of NPK Removed</u>	<u>NPK Exploitation Rate</u>
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%
2009	765 (553-1160)	495	64.7%

Table 7. Northern pike Catch Per Unit Effort (CPUE) from 2004 to 2009 in three sub sections of the middle Yampa River: (1) Juniper (RM 134.2 – 91.0), (2) Maybell (RM 88.7 – 79.2), and (3) Lily Park (RM 55.5 – 50.5)

<u>Year</u>	<u>Juniper CPUE</u>	<u>Maybell CPUE</u>	<u>Lily Park CPUE</u>
2004	2.01	2.92	1.96
2005	1.69	1.23	0.81
2006	1.48	1.64	0.58
2007	1.90	2.26	0.54
2008	0.93	1.15	0.49
2009	1.05	1.04	0.27

Table 8. 2009 northern pike Catch Per Unit Effort (CPUE, number of northern pike captured per hour via electrofishing only) during each pass for the three sub-sections of the middle Yampa River: Juniper (RM 134.2 – 91.6), Maybell (RM 88.7 – 60.5), and Lily Park (RM 55.5 – 50.5).

	<u>Pass 1</u> <u>CPUE</u>	<u>Pass 2</u> <u>CPUE</u>	<u>Pass 3</u> <u>CPUE</u>	<u>Pass 4</u> <u>CPUE</u>	<u>Pass 5</u> <u>CPUE</u>	<u>Pass 6</u> <u>CPUE</u>	<u>Pass 7</u> <u>CPUE</u>	<u>Pass 8</u> <u>CPUE</u>	<u>Pass 9</u> <u>CPUE</u>	<u>Pass 10</u> <u>CPUE</u>	<u>Pass 11</u> <u>CPUE</u>
Juniper	1.09	1.92	0.96	1.11	0.98	0.17	0.55	0.79	0.41	0.53	2.13
Maybell		2.26	1.02	1.47	0.60	0.80	0.55	0.72			
Lily Park				0.22	0.37	0.13	0.27	0.33	0.30	0.23	0.27

Table 9. 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. Northern pike that were translocated to Loudy Simpson (LS) and which presumably escaped and were recaptured in the Yampa River are also indicated in parenthesis as ‘LS’.

<u>Year</u>	<u>Into USFWS from Upstream</u>	<u>Upstream Into USFWS from CDOW/CSU</u>	<u>Into CDOW/CSU from USFWS Upstream</u>	<u>Downstream into RM 40 – 0 From Upstream Sources</u>	<u>Downstream into Green River From Upstream Yampa River Sources</u>
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)
2009	15(1 Catamount, 1 LS)	2	10 (1 LS)	?	?

Table 10. 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 7 in 2009 by the Colorado Division of Wildlife (CDOW). Three additional passes were completed in Reach 1 and Reach 3, CPM captured during these passes were captured in Reach 3.

<u>CDOW Pass #</u>	<u># CPM Capture Events</u>	<u># CPM Marked</u>	<u># CPM Recaptures</u>	<u># CPM Released</u>	<u># CPM Removed</u>	<u># CPM Mortalities</u>
1	2	0	2	2	0	0
2	7	2	5	7	0	0
3	4	2	2	4	0	0
4	8	3	5	8	0	0
5	0	0	0	0	0	0
6	2	2	0	2	0	0
7	1	0	1	1	0	0
<u>Total</u>	24	9	15	24	0	0

Table 11. 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 2009 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.

<u>CDOW Pass #</u>	<u># RTC Capture Events</u>	<u># RTC Marked</u>	<u># RTC Recaptures</u>	<u># RTC Released</u>	<u># RTC Removed</u>	<u># RTC Mortalities</u>
1	9	4	4	9	0	0
2	18	13	5	18	0	0
3	10	5	5	10	0	0
4	6	4	1	6	0	0
<u>Total</u>	43	26	15	43	0	0

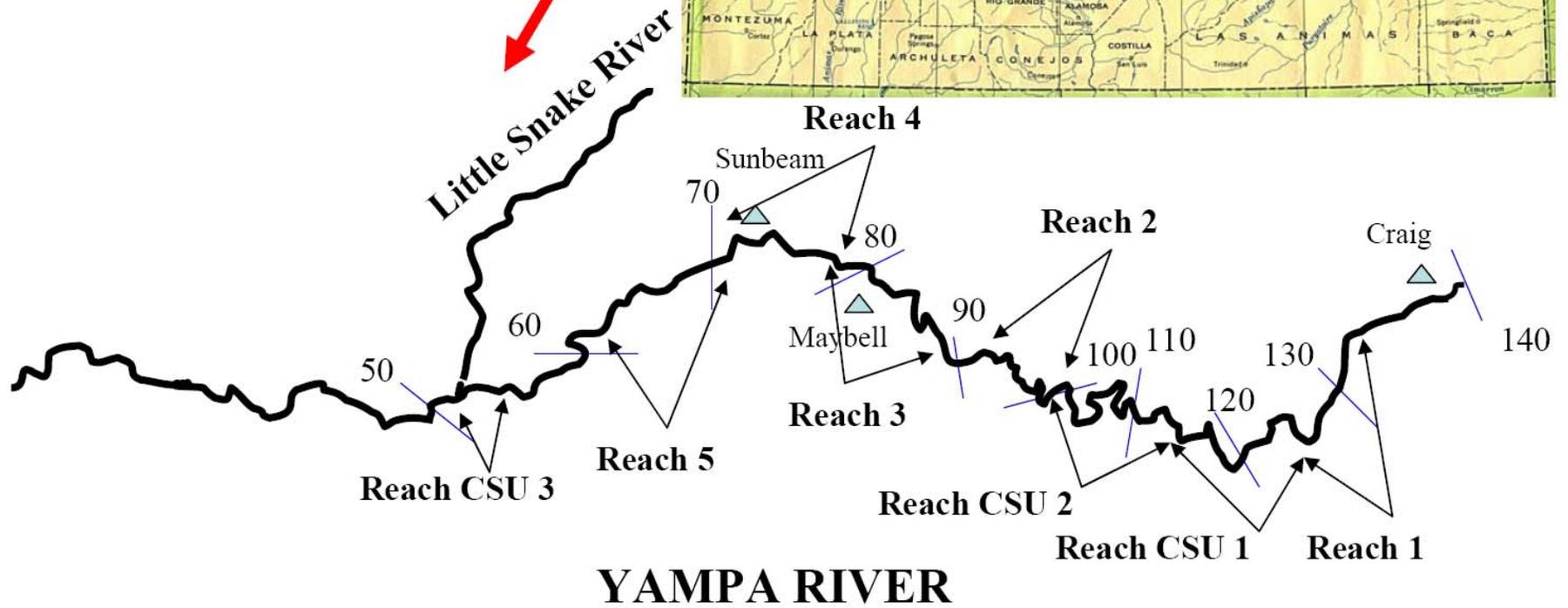
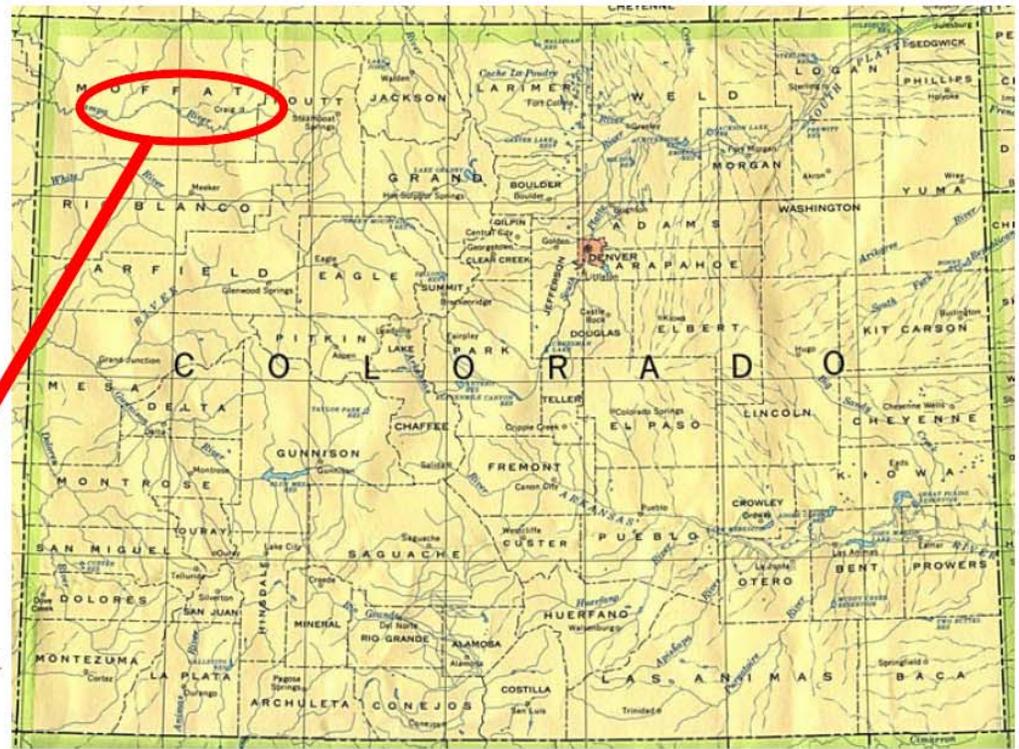
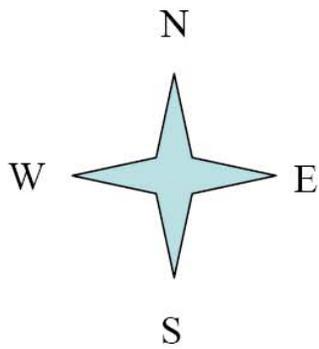


Figure 1. River reaches of the middle Yampa River sampled by the CDOW and CSU (Graphics courtesy of P. Martinez and R. Anderson)

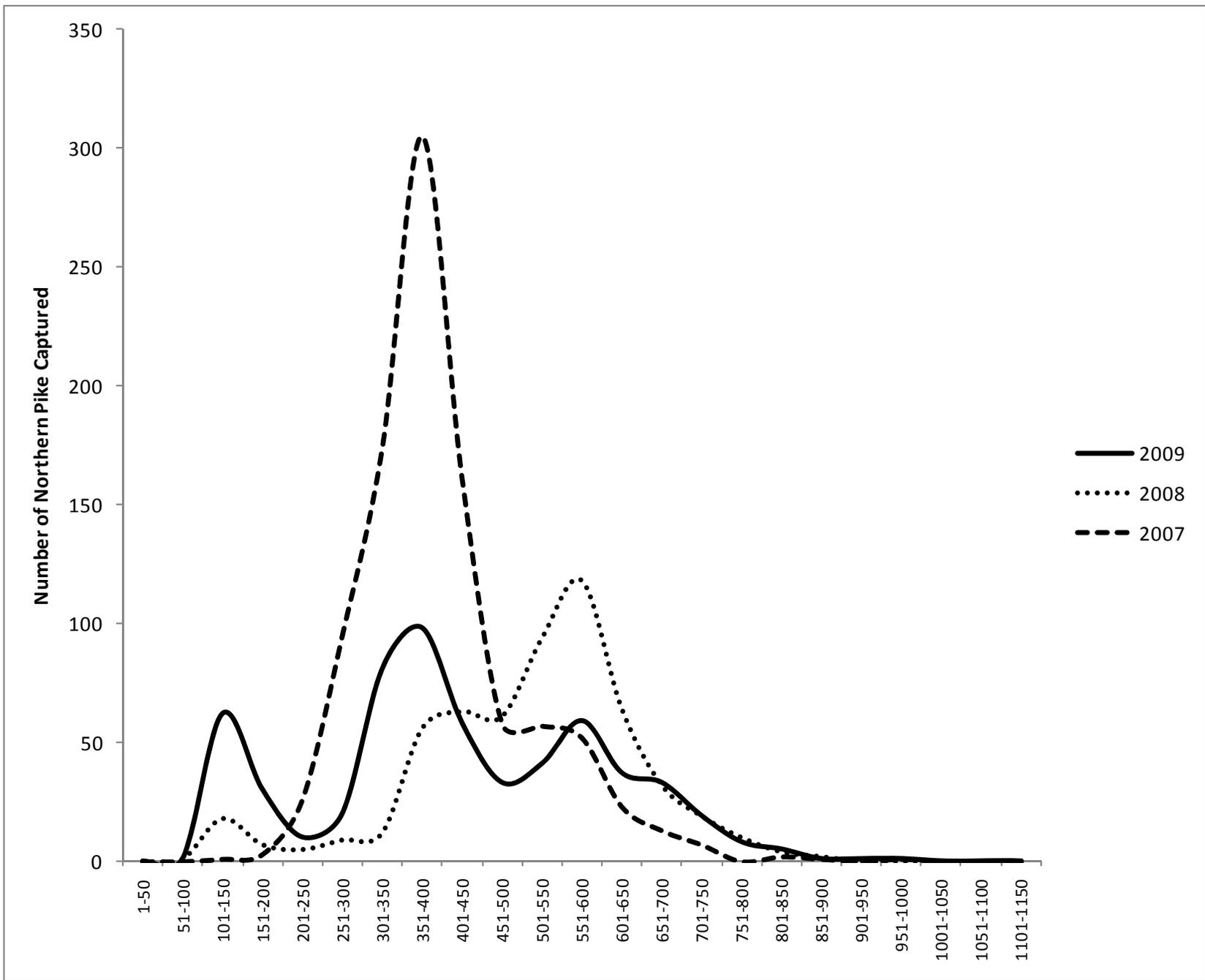


Figure 2. Northern pike total length frequency distributions in increments of 50 mm, from 2007 to 2009, in the middle Yampa River, from South Beach (RM 134.2) to Lily Park (RM 50.5). 2009 is depicted as a solid line, 2008 is depicted as a small dashed line, and 2007 is depicted as a large dashed line.

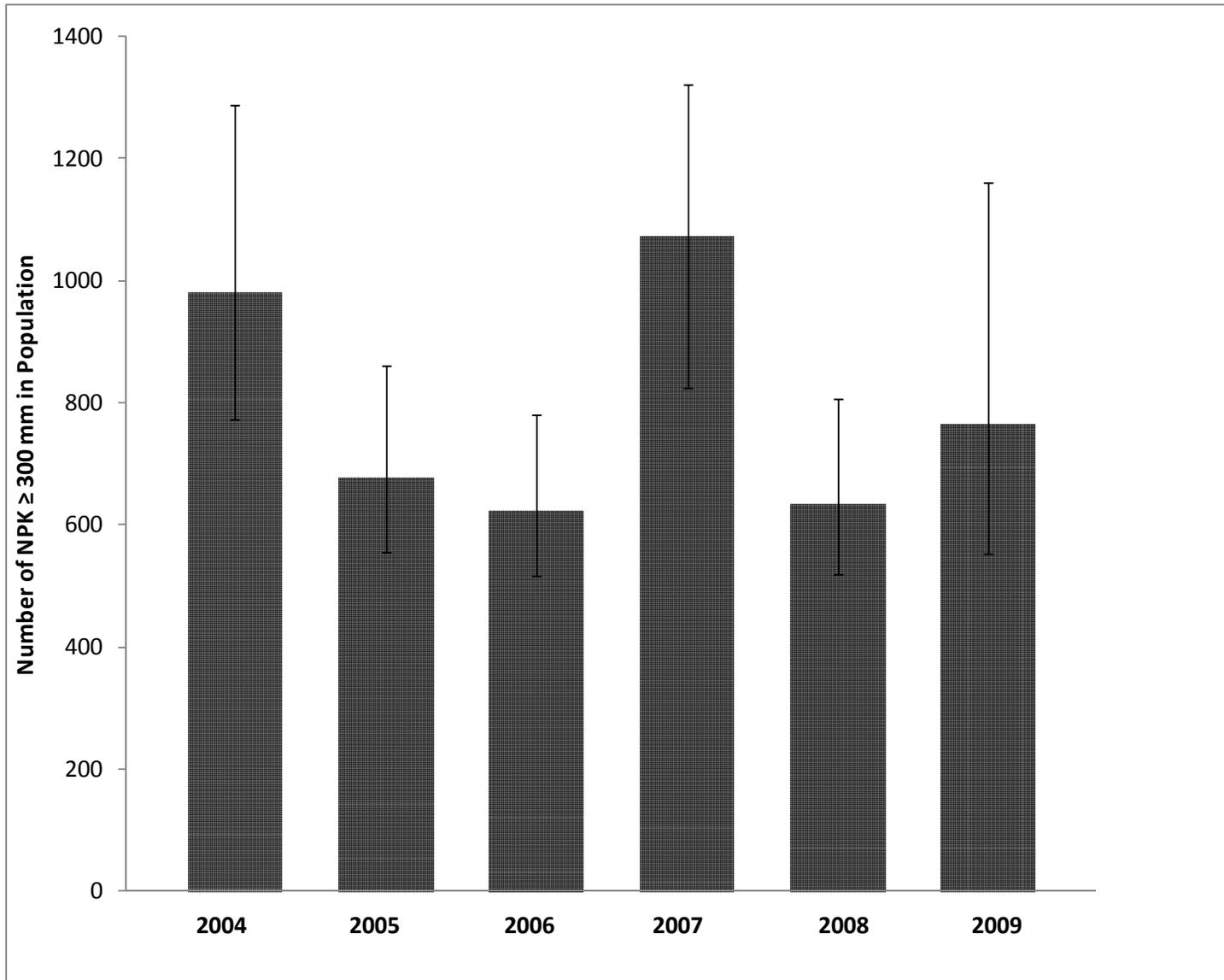


Figure 3. Northern pike  $\geq 300$  mm population estimates and the 95% confidence interval, generated using Program CAPTURE Model (t) of Chao, for the middle Yampa River (RM 134.2- 50.5), from 2004 through 2009.

Date	River Miles											
	170-161	160-151	150-141	140-131	130-121	120-111	110-101	100-91	90-81	80-71	70-61	60-51
4/19/2009												
4/20/2009	98b Mark									98a Mark		
4/21/2009		98b Mark							98a Mark			
4/22/2009				98b Mark	98a Mark							
4/23/2009	98b Recap											
4/24/2009			98b Recap								98a Mark	
4/25/2009												
4/26/2009												
4/27/2009				98b Recap				98a Mark				
4/28/2009					98a Recap							
4/29/2009									98a Recap			125 Mark
4/30/2009							125 Mark			98a Recap		
5/1/2009						125 Mark*		98a Recap				
5/2/2009						125 Mark**						
5/3/2009												
5/4/2009											98a Recap	125 Recap
5/5/2009												
5/6/2009												
5/7/2009												
5/8/2009												
5/9/2009												
5/10/2009												
5/11/2009												
5/12/2009							125 Recap					
5/13/2009							125 Recap					
5/14/2009								125 Recap				
5/15/2009								125 Recap				
5/16/2009												

Figure 4. Chart showing the timing of mark/release and recapture passes that were used to produce combined northern pike population estimates between three different projects (98a, 98b, and 125) in multiple reaches within the Yampa River. The top axis shows river miles in increments of nine miles and the left axis shows the corresponding date. In several cases river miles covered by the three projects were approximated so that they fit within the nine mile increments on the top axis.

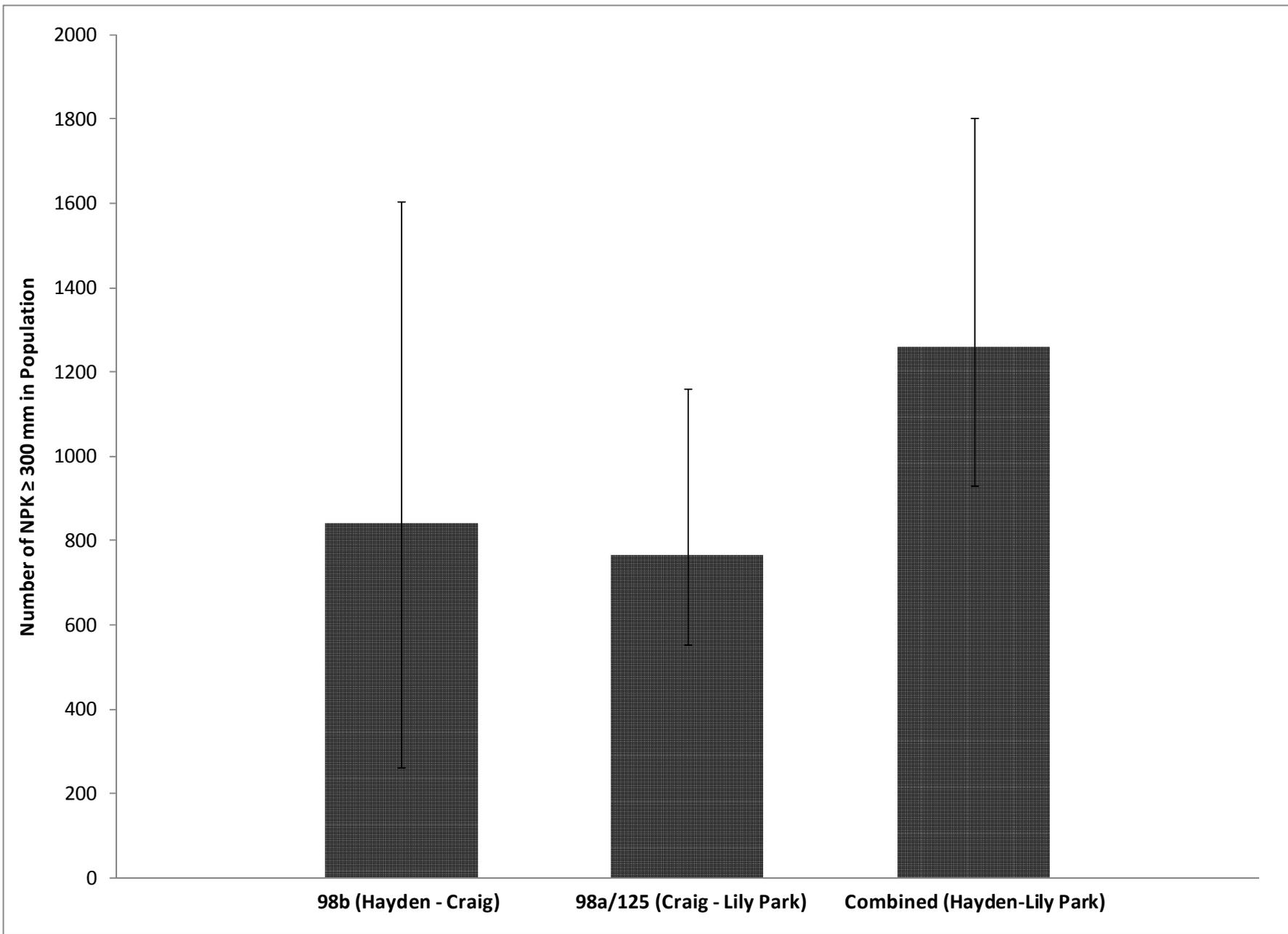


Figure 5. 2009 northern pike populations and the 95% Confidence Interval generated for the section of the Yampa River from Hayden to Craig, the section from Craig to Lily Park, and for those two sections combined (Hayden to Lily Park).

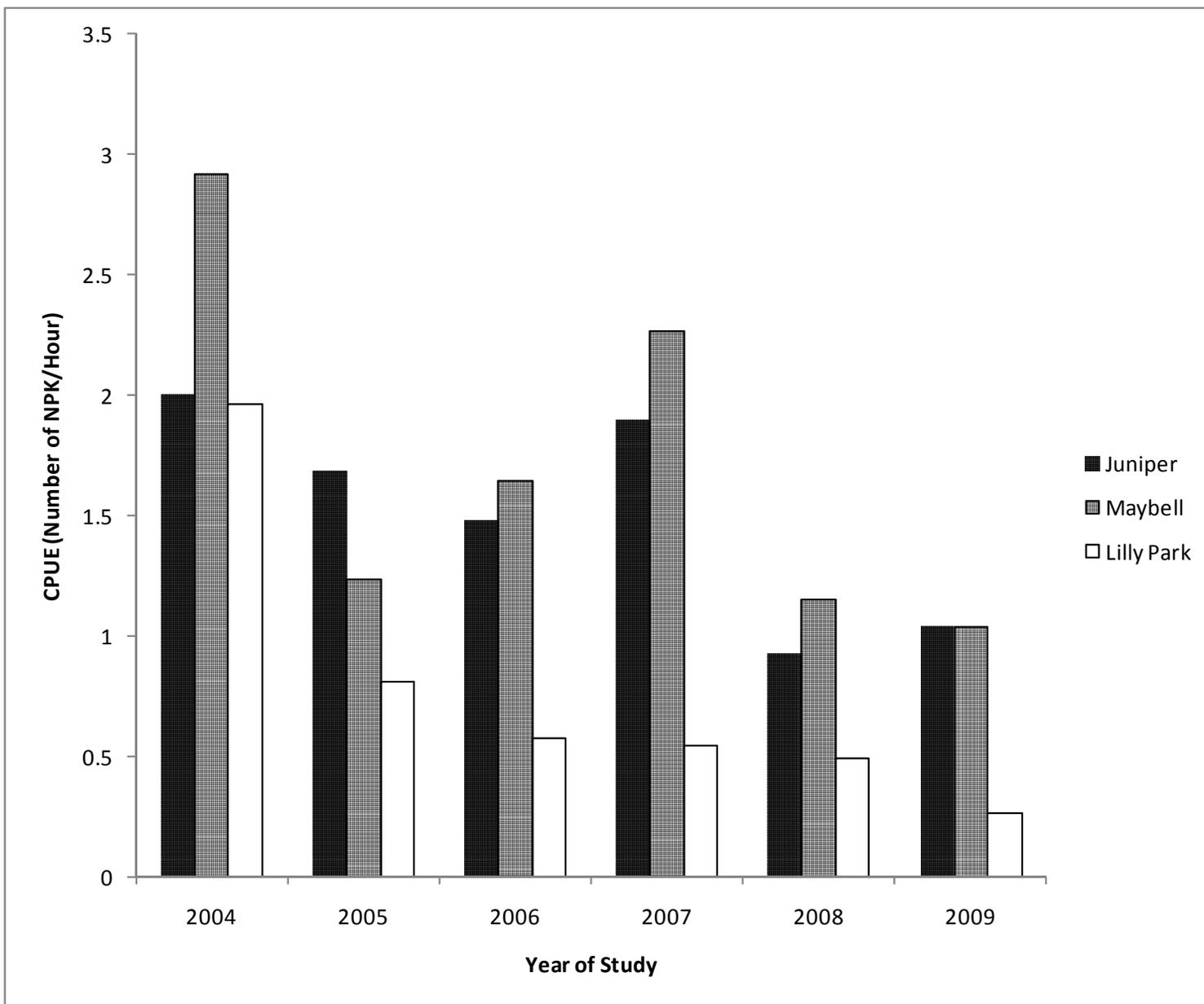


Figure 6. 2004 through 2009 Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) across three subsections of the middle Yampa River, Juniper (RM 134.2 – 91.0), Maybell (RM 88.7 – 60.6), and Lilly Park (RM 55.5 – 50.5).

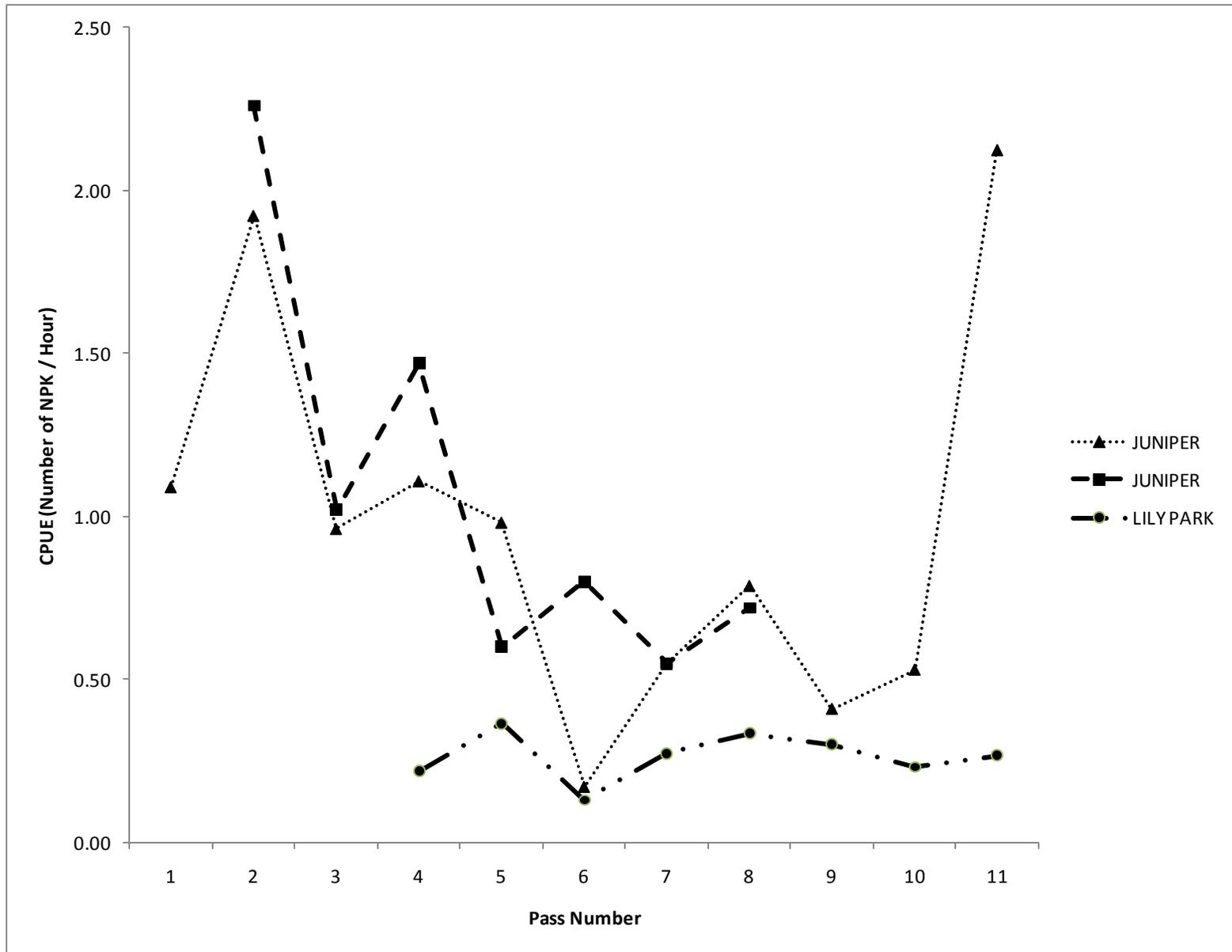


Figure 7. Northern pike electrofishing Catch Per Unit Effort (CPUE; # NPK/hour) for three sub-sections of the middle Yampa River across 11 passes in 2009.  
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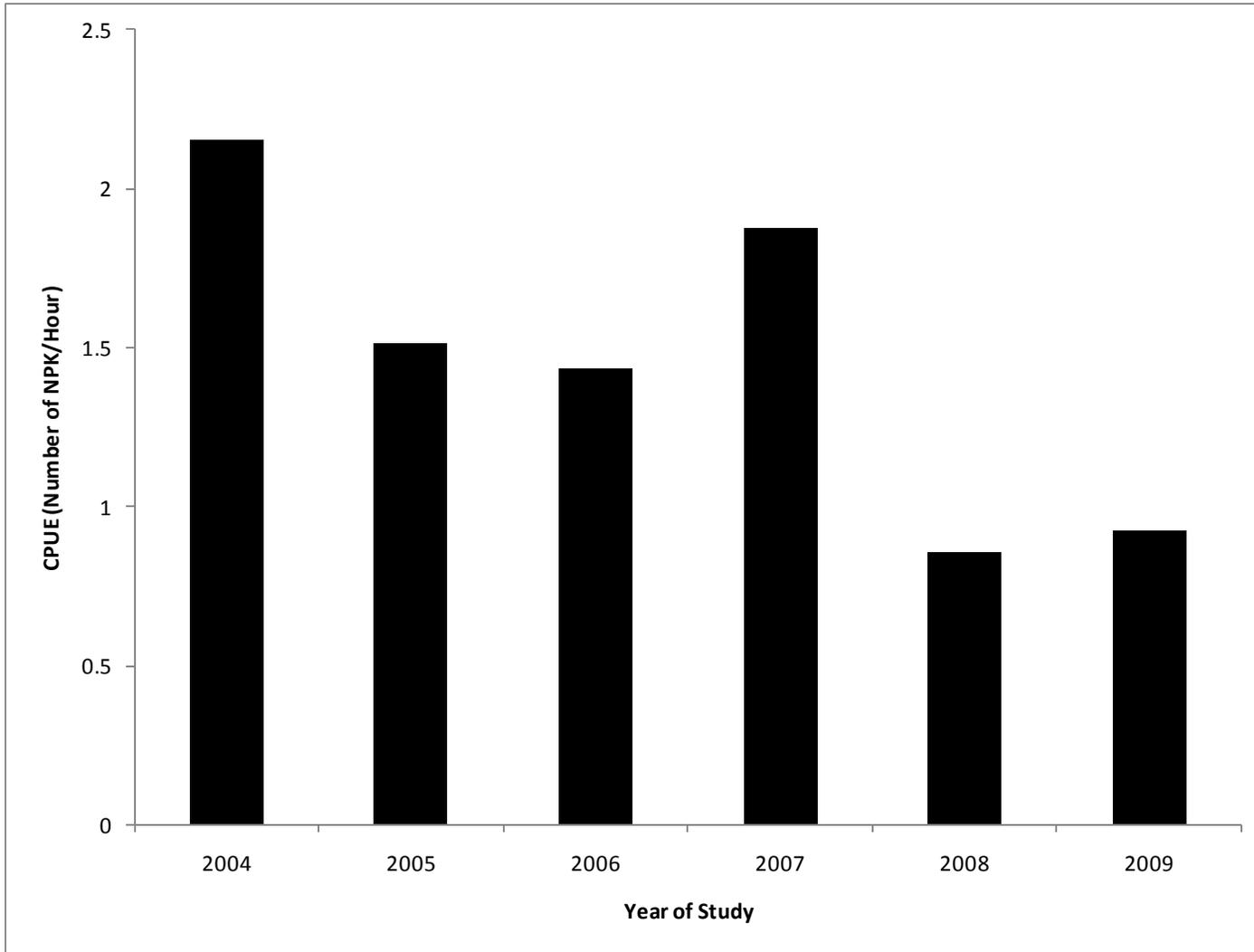


Figure 8. Northern pike Catch Per Unit Effort (CPUE; number of NPK/hour) across all passes in the entire study area sampled by CDOW and CSU, for 2004 through 2009.

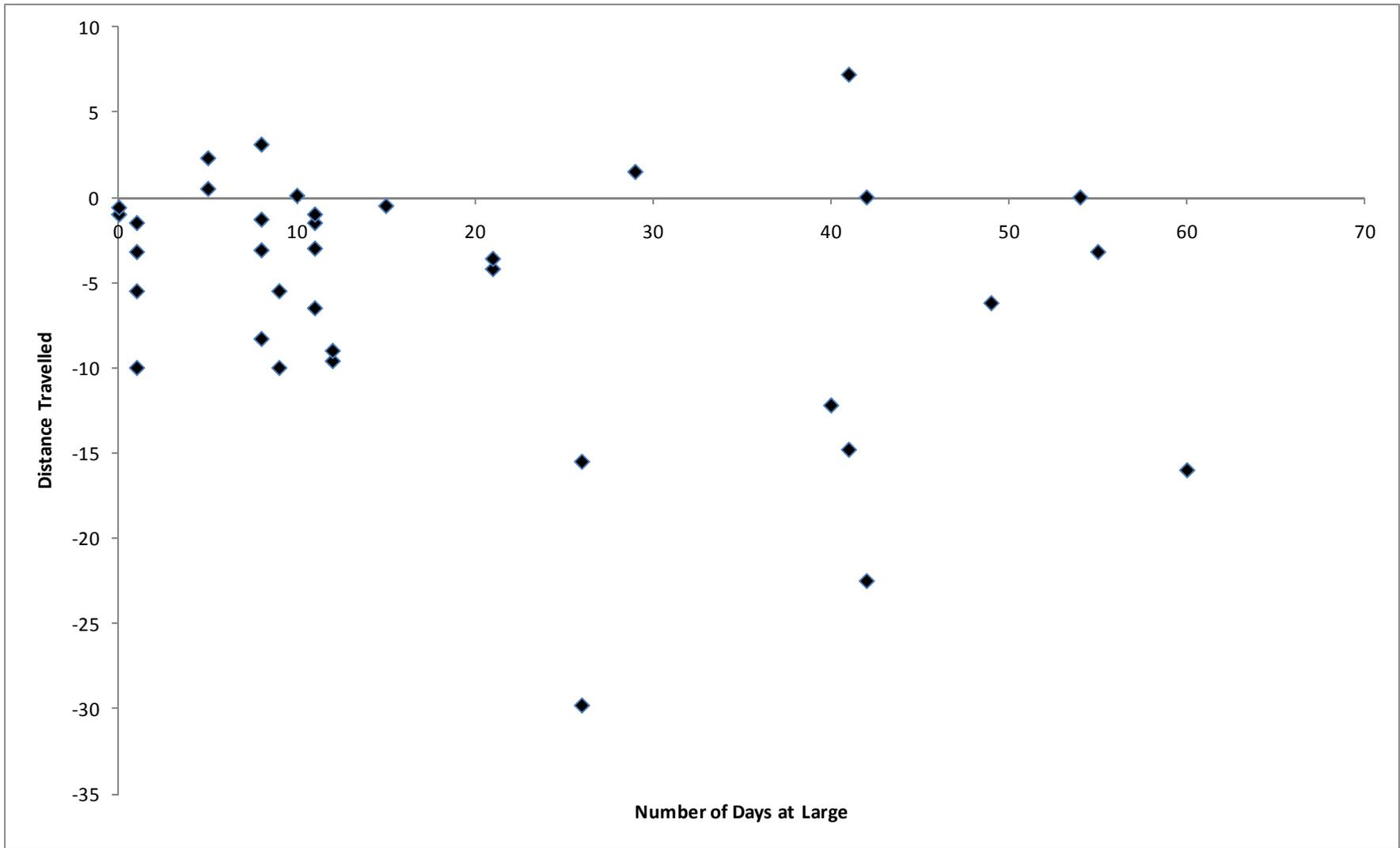


Figure 9. Movement distances of northern pike that were tagged and recaptured in the middle Yampa River in 2009, plotted against the number of days each fish spent at large between capture events. Negative values on the y-axis represent downstream movement and positive values represent upstream movement.

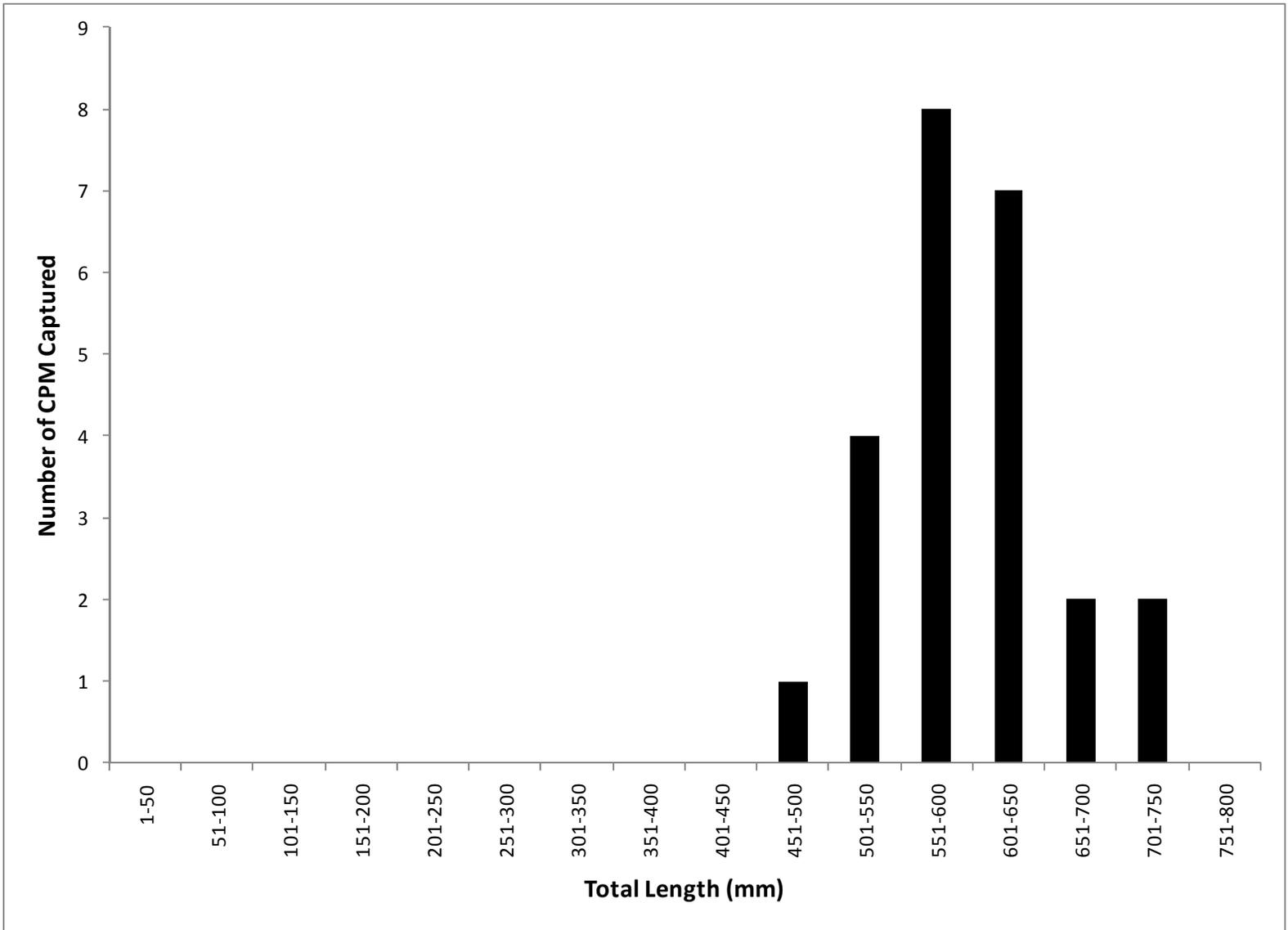


Figure 10. Colorado pikeminnow (CPM) total length (mm) frequency distribution, with size classes in increments of 50mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2009.

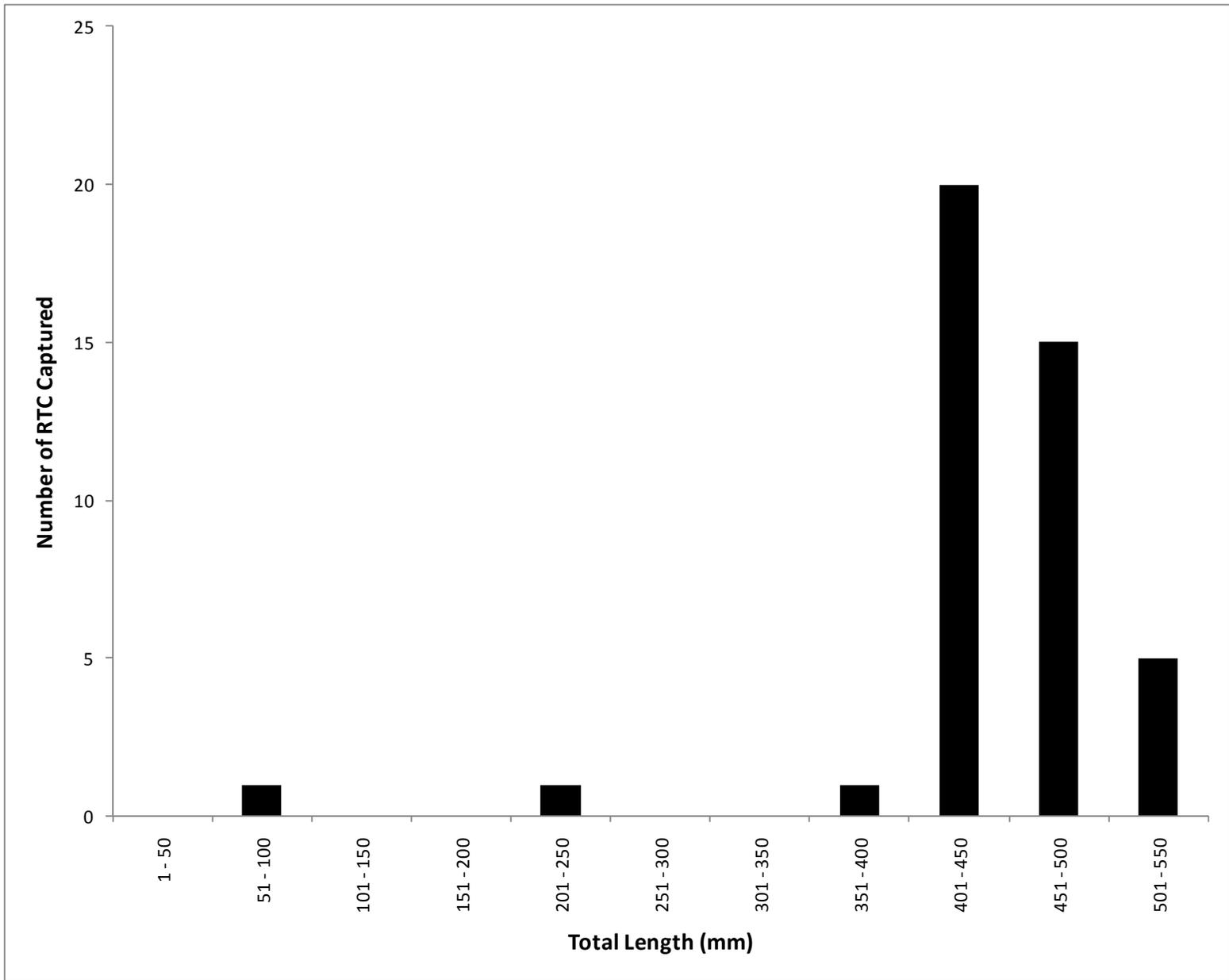


Figure 11. Roundtail chub (RTC) total length (mm) frequency distribution, with size classes in increments of 50 mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2009.

