

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 source 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 sportfish, 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 provide results from the 2010 field season and 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 2010, for the second year in a row, 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 2010 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 2010 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2010 Tasks and Deliverables

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

Schedule: March 2010

Deliverable: **Task Completed**

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

Schedule: February-April, 2010

Deliverable: **Task Completed**

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

Schedule: April 14 – July 1, 2010

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, 2010

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 2010 marks the second consecutive 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 2010 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 5. Five total sampling passes (1 mark/release, 4 removal) were performed in Reach 2 and Reach 4. Eight total sampling passes (1 mark/release and 7 removal) were performed by CDOW in Reach 1 and Reach 3. This marked a significant increase in effort from previous years' sampling. The CDOW's sampling occurred from April 13, 2010 to June 17, 2010.

In CSU's study area, 6 total sampling (1 mark/release; 5 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 13, 2010 to June 27, 2010.

In addition to standard sampling within the study area, CDOW and CSU also participated in a cooperative effort with USFWS. The focus of this effort was concentrated removal and disturbance of spawning adult smallmouth bass in river reaches with relatively high concentrations of adult smallmouth bass, and is referred to here as the Surge and also featured northern pike removal. During the Surge, which lasted from June 22 to July 10, an additional four (4) removal passes were conducted in Reach 1 and Little Yampa Canyon. An additional three (3) removal passes were conducted in Reach 2, and one (1) additional removal pass was conducted in Reach 3. Thus, 12 total passes were performed in Reach 1 (1 mark, 11 removal), 10 total passes were performed in Little Yampa Canyon (1 mark, 10 removal), 8 total passes were performed in Reach 2 (1 mark, 7 removal), and 9 total passes in Reach 3 (1 mark, 8 removal).

In past study years the first pass constituted the mark/release pass and all subsequent passes constituted removal efforts. In 2010 the marking pass was postponed, as was the case in 2009, in an effort to increase the number of smallmouth bass tagged by tagging bass when catch rates are highest. It made the most logistical sense to combine northern pike and smallmouth tagging. Such practice resulted in northern pike removal passes that occurred prior to the mark/release pass on most sample reaches.

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 1954 to 1988, but not continuously. Northern pike that were tagged by the CDOW ranged from 4101 to 4506. Northern pike captured during the removal passes were removed from the river and were either marked and transported alive to Yampa State Park Headquarters West Pond, or were euthanized for age and growth and diet analysis. The 2010 study marked the first year that no northern pike were translocated to Loudy Simpson Pond in Craig. All translocated northern pike were released at the State Park Headquarters West Pond. If northern pike that were translocated were not already tagged, they received a new, grey FLOY tag, with tag numbers ranging from 1854 to 1900, 2213 to 2596, and 3328-7599 for CSU, and from 4137 to 4150, 4395 to 4577, 4656 to 4675, and 4733-4747 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 2010, 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 2010 and (2) an estimate spanning the reach from Hayden (RM 171) to Lily Park (RM 50.5). This is the second 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 Mark (White et al. 1982) was used to generate these estimates using the Huggins closed estimator. 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 over the entire study area.

### *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, as well as movement that occurred within the study area from 2008 to 2010.

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**

Ten (10) different fish species were collected within the Colorado Division study reaches. Summary data for all species handled is presented in Table 2.

### Northern Pike

#### *Overview*

Overall, the CDOW and CSU captured 662 individual northern pike and a total of 697 capture events occurred (includes recapture events). Total number of northern pike capture events in 2010 (697) increased from the total number of northern pike capture events in 2009 (587). However, with the addition of the Surge, effort increased considerably in 2010, which increased capture numbers. Six-hundred and twenty-three (623) northern pike were removed in 2010, 94% of the northern pike individuals handled (Table 3). Four-hundred and eighty-two (482) pike were translocated to State Park Headquarters West Pond. One-hundred and thirty-three (133) northern pike were euthanized and preserved for Viral Hemorrhagic Septicemia (VHS) testing, age and growth analysis, and diet analysis (Table 4). Eight (8) northern pike died during sampling and handling.

Fifty six (56) northern pike  $\geq 300$  mm TL were marked and released during the marking effort. Fifty-four (54) of these fish were marked by CDOW and CSU in 2010, while the remaining 2 had been marked in previous years by the USFWS, CSU, and CDOW. Eleven (11) of the 56 northern pike greater than 300 mm (20%) that were tagged on the marking pass were recaptured on the subsequent recapture pass. An additional 20 northern pike that were tagged and released on the marking pass were recaptured across all subsequent passes. Thus, 46% of the northern pike of all size classes initially tagged and released during the marking pass were recaptured during all subsequent passes; 54% of the northern pike handled and released during the marking pass were never recaptured (Table 3).

#### *Population Size Structure*

Northern Pike total length frequency histograms for the entire section of the river sampled by CDOW and CSU from 2007 to 2010 are presented in Figure 2. Multiple age classes are represented in the 2010 length frequency histogram. The predominant size range of northern pike was 151 to 651 mm in Total Length. Fifty (50; 7%) of the northern pike captured were less than 150 mm in total length. Two-hundred and ninety four (294; 42%) of the northern pike captured fell within the 151 – 400 mm size range. Three

hundred (300; 43%) of the northern pike captured fell within the 401 – 650 mm size range. Fifty-three (53; 8%) of the northern pike captured were greater than 650 mm in total length.

Northern pike growth rates, based on capture history of fish recaptured in 2010 that were tagged and released during previous years, were relatively high and ranged from 0.11 to 5.88 mm/week (Table 5). Thus, it is safe to assume that the prevalent cohort of northern pike in the 51 to 200 mm TL range in 2009 are represented in the 2010 length-frequency as the prevalent cohort ranging from 251 to 450 mm TL. Likewise, the prevalent cohort of northern pike in the 201 to 450 mm TL range in 2009 are represented in the 2010 length-frequency distribution as a prevalent cohort ranging from 451 mm TL to 655 mm TL. In previous years, such as 2007, influx of distinct cohorts of northern pike was documented, which were presumed to have originated from upstream source populations. Conversely, given that 85% of the northern pike captured in 2010 fell within the 150 to 650 mm TL range, which can be accounted for by the previous 2009 length-frequency histogram, it is concluded that relatively limited influx of adult northern pike from upstream source habitats occurred subsequent to the 2009 study period in the middle Yampa River.

The calculated growth rates of northern pike (Table 5) based on capture history of recaptured northern pike, were corroborated by back-calculated length at age data based on aging of cleithra from northern pike taken in 2009 (Figure 3). Using these growth analyses, it appears the majority of northern pike captured in our study area in 2010 were  $\leq$  Age 3. The northern pike population in 2010 was weighted toward younger fish when compared to previous years.

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

The population estimate for northern pike in the middle Yampa River in 2010 suggests that northern pike numbers remained relatively stable between 2009 and 2010, 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 2010 was 664 (317-827 95% C.I.; SE=124.3; p-hat=0.196), and was not significantly different than the 2009 estimate of 765 (553-1160 95% C.I.; SE=149.2; CV=0.20; p-hat=0.15) though the point estimates suggest a decrease in the population size. In 2010, 72.4% of the northern pike population  $\geq$  300 mm TL (estimate of 664) was removed (481 NPK  $\geq$  300 mm TL), which was nearly 10% higher than any rate of exploitation achieved during previous years.

This increase in removal can be attributed to the increase in electrofishing effort expended in 2010 in the upstream portion of the study area, where northern pike catch rates have typically been highest. Although the overall electrofishing effort increased slightly from 637 hours in 2009 to 658 hours in 2010, the amount of effort in the Juniper Section (most upstream section) increased from 406 hours in 2009 to 447 hours in 2010. Conversely, electrofishing effort in Lily Park (most downstream portion of study area), where northern pike catch rates are typically lower, decreased from 97 hours in 2009 to



71 hours in 2010. The increase in effort in the Juniper section is a result of the addition of the Surge effort in 2010. Catch rates for pike also increased during the Surge, which is discussed in greater depth in the *Catch Per Unit Effort* section of this report. Northern pike removal during the Surge accounted for 30% of the northern pike removed in 2010.

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. In 2008, abundance had decreased to levels reflective of the 2006 estimate. In 2009 and 2010, 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, but increased slightly in 2010 to 0.20. It has been demonstrated that postponing the marking pass, as was done in 2009 and 2010, decreased capture probability because catch rates are highest during the first few passes. Capture probability is positively correlated with number of fish tagged and released (Robson and Rieger 1964). The increase in capture probability from 2009 to 2010 can be explained by better coordination between the CSU and CDOW crews, which resulted in better synchronization between the marking and subsequent recapture pass.

Over the course of 7 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 combined with growth rate calculations 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.

Starting in 2008, the Colorado Division of Wildlife has been engaged in northern pike control projects in several of the presumed source populations located in the upper Yampa River basin, near Steamboat Springs. The lack of large influxes of adult northern pike into the study area since 2007 may be attributed to such control efforts; however it may also be a matter of time before another massive influx is observed.

The increase in electrofishing effort on the descending limb of the hydrograph in prime pike habitat, resulting from the Surge, also enabled a higher rate of exploitation. It will be most interesting to see if the upcoming 2011 abundance estimate correlates with the higher rate of exploitation achieved in 2010.

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

Two thousand and ten (2010) marks the second 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). There were no statistically significant trends in estimated northern pike abundance for this section of river between 2009 and 2010, though the point estimate did increase from 1260 (929-1803 95% C.I.; SE=217.5; CV=0.17;  $\hat{p}=0.13$ ) to 1406 (997-1563 95% C.I.; SE=142.4;  $\hat{p}=0.215$ ), respectively. It should be noted that capture probability increased considerably, from 13% in 2009 to 21% in 2010. This increase can be attributed to markedly improved capture probability in the Hayden to Craig reach in 2010 (see Project 98b. 2010 Annual Report).

### *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 increased slightly between 2009 and 2010 across all three sections (Figure 6). However, in 2010, the Surge resulted in an increase in effort that was shifted to later in the season when discharge was lower and northern pike catch rates increased (Figure 7).

CPUE was also calculated for each pass across the entire study area (Table 8; Figure 7). CPUE generally showed a decreasing trend as discharge increased on the ascending limb of the hydrograph. When discharge peaked, CPUE was at its lowest. On the descending limb of the hydrograph CPUE increased with decreasing discharge. The 2010 study featured increased effort on the descending limb of the hydrograph when compared to previous years, due to the Surge which sought to target spawning adult smallmouth in late June and early July. Incidentally, the Surge also resulted in higher catch rates of northern pike, because northern pike are most vulnerable to our sampling techniques at relatively lower flows when they are confined to smaller, less expansive habitats. Additionally, the majority of Surge activity occurred in the upper reaches of the study area where northern pike catch rates have typically been highest. The Surge accounted for 30% of the removed northern pike in 2010.

Overall CPUE for all passes across the entire study area in 2010 increased by 13% from 2009 (Figure 8). However, it is re-emphasized that the increase in effort in 2010 was focused in reaches where northern pike catch rates have typically been highest, and occurred during environmental conditions (i.e. decreased discharge) that are favorable for catching northern pike. 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*

Fourteen (14) northern pike were recaptured that were tagged and released by project 98b in 2009 or previous years. Six (6) northern pike were recaptured that were tagged and

translocated to Loudy Simpson Pond in previous years. Five (5) of the presumed Loudy Simpson escapees were released in Loudy Simpson in 2009, 1 was released there in 2007. Nineteen (19) northern pike were recaptured that were tagged during this study in 2006 through 2009. One (1) of those fish was tagged and released in 2006, 2 were tagged and released in 2007, 3 were tagged and released in 2008, and 13 were tagged and released in 2009. Thirty-one (31) northern pike were recaptured that were tagged by CDOW and CSU in 2010 (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 2010 sampling year (Figure 9). Twenty-six (26) northern pike that were tagged and recaptured in 2010 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 2010 moved distances as great as 30 miles, while the greatest distance moved in an upstream direction was 22 miles, although the other three northern pike that travelled upstream moved less than 10 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 movement between 2010 and previous years also demonstrated a similar trend (Figure 10). Fifteen (15) northern pike that were tagged in 2009 and recaptured in 2010 moved more than one mile in a downstream direction, while only 2 northern pike moved more than a mile upstream. The 2010 movement results underscore a trend similar to what has been observed in previous years. Northern pike generally move downstream, rather than upstream, in the Yampa River drainage, and it is likely that discharge is a key factor in the observed downstream movement.

### *Escapement*

Six (6) northern pike were recaptured in the Yampa River in 2010 that were translocated to Loudy Simpson Pond during previous years. Of the six presumed escapees, 1 was translocated to Loudy Simpson Pond in 2007, and five were translocated in 2009; only 100 northern pike were translocated to Loudy Simpson Pond in 2009. One (1) of the five northern pike escapees that were translocated in 2009 was recaptured in the river at river mile 130, on April 22, 2010. Thus, this fish would have had to be physically transferred back to the river by a person, since translocation of northern pike to Loudy Simpson in 2009 occurred well after peak runoff when some connectivity to the river may have occurred, and the fish was recaptured in the river prior to 2010 peak runoff. The remaining 4 Loudy Simpson escapees that were translocated in 2010 were recaptured in the Yampa River between river miles 123.0 to 136.0 during the month of June. It is most likely that these four northern pike escaped during the 2010 peak runoff, when connectivity with the river occurred.

Northern pike were not translocated to Loudy Simpson Pond in 2010. Independent sampling conducted by the CDOW in the fall of 2009 and spring of 2010 confirmed that limited natural reproduction of northern pike has occurred in Loudy Simpson Pond, but the lack of northern pike greater than Age 1 in the sample suggests that periodic winter kill and/or high harvest rates occur.

In 2010, State Park Headquarters Pond was the only receiving water used for northern pike translocation. This study has not documented any escapement from State Park Headquarters Pond, which is isolated from the Yampa River floodplain.

### Colorado Pikeminnow

Overall, 30 Colorado pikeminnow individuals were captured and handled by CDOW in 2010, eight more than were captured and handled in 2009 (Table 10). Five (5) Colorado pikeminnow were captured during Pass 1, 3 were captured during Pass 2, 3 were captured during Pass 3, 4 were captured during Pass 4, 5 were captured during pass 5, 8 were captured during Pass 6, and 2 were captured during Pass 7. Two (2) of the Colorado pikeminnow that were handled by CDOW in 2010 were captured twice by CDOW in 2010. Colorado pikeminnow capture locations ranged from river mile 58.5 to river mile 99.2. A total length frequency histogram was developed for all Colorado pikeminnow captured (Figure 11). Mean total length of Colorado pikeminnow captured by CDOW in 2009 was 601 mm. Thirteen (25) Colorado pikeminnow capture events occurred in the main channel, and 5 were captured in backwaters. None of the Colorado pikeminnow displayed evidence of presumed northern pike attacks that had healed, but 7 featured lesions, for which the cause is unknown. Most notable is that 7 of the Colorado pikeminnow captured were not recaptures, and are presumed to be “new” fish.

### Roundtail Chub

Overall, 28 roundtail chub individuals were captured and handled by CDOW (Table 11). One (1) roundtail chub was captured during Pass 1, 2 were captured during Pass 2, 4 were captured during Pass 3, 4 were captured during Pass 4, 8 were captured during Pass 5, and 9 were captured during Pass 6. No roundtail chub were captured subsequent to Pass 6. A total length frequency histogram was developed for all roundtail chub individuals (Figure 12). The mean total length of roundtail chub captured was 447 mm.

## VII. Recommendations:

- A. Repeat 2010 standard northern pike removal effort and consider shifting more effort from the peak of the hydrograph, when northern pike catch rates have been shown to be lower, to the descending limb of the hydrograph, when northern pike catch rates have been shown to be higher. The highest catch rates of northern pike occur prior to and after peak runoff.
- B. Consider the merits of repeating the 2010 Surge effort in future years, as the Surge accounted for 30% of removed northern pike in 2010, and was complimentary to northern pike management objectives in the Yampa River.



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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 2. A summary of the total number of individuals captured for all species of interest in the Middle Yampa River in 2010, including incidental non-natives that were lethally removed: black bullhead, black crappie, bluegill, green sunfish, white crappie, brook stickleback, and creek chub.

<u>Species</u>	<u>Number of Individuals Captured</u>
Northern Pike	662
Smallmouth Bass	1217
Colorado pikeminnow	28
Roundtail Chub	28
Black Bullhead	0
Black Crappie	2
Bluegill	0
Green Sunfish	3
White Crappie	0
Brook Stickleback	1
Creek Chub	2

Table 3. Number of northern pike  $\geq 300$  mm TL tagged on the marking pass, number northern pike  $\geq 300$  mm TL that were tagged on the marking pass and recaptured on the recapture pass, number of northern pike in all TL classes that were tagged on the marking pass and removed during all subsequent passes, % of northern pike of all size classes 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 2010.

<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 to Marking Pass</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	71%
2005	195	NA	83	43%	526	410	78%
2006	214	NA	79	37%	520	384	74%
2007	181	NA	93	51%	878	775	88%
2008	154	41	72	47%	503	417	83%
2009	92	13	16	17%	558	495	89%
2010	67	11	31	46%	662	623	94%

Table 4. Disposition totals for northern pike removed from the middle Yampa River in 2010. Northern pike were either moved to the State Park Headquarters Pond or euthanized for Viral Hemorrhagic Septicemia (VHS) testing, age and growth analysis, or diet analysis. In 2010 there were no northern pike moved to the Loudy Simpson pond.

<u>Disposition</u>	<u>Number of Northern Pike</u>
State Park Headquarters Pond	482
Loudy Simpson	0
Euthanized for VHS testing, Age and Growth, and Diet Analysis	133
Incidental Mortality	7
Unknown	3
<b><u>Total</u></b>	<b>623</b>

Table 5. Growth rate calculations based on capture history of northern pike that were recaptured in 2010, but initially tagged and released in previous years. For each fish fitting such description, the table includes TL (mm) at first capture, date of first capture, TL (mm) at recapture, date of recapture, length difference between the two capture events, growth rate expressed in mm/week, and growth rate expressed in mm/day.

<u>TL @ first Capture(mm)</u>	<u>Date of First Capture</u>	<u>TL @ Second Capture(mm)</u>	<u>Date of Second Capture</u>	<u>Change in TL(mm)</u>	<u>Growth Rate(mm/week)</u>	<u>Growth Rate (mm/day)</u>
256	4/23/09	555	4/14/10	299	5.88	0.84
258	4/23/09	548	6/10/10	290	4.92	0.70
314	5/3/09	400	4/21/10	86	1.71	0.24
346	4/19/07	605	4/21/10	259	1.65	0.24
354	4/26/06	581	4/27/10	277	1.09	0.16
366	4/18/07	692	4/27/10	326	2.07	0.30
366	4/21/09	490	5/27/10	124	2.16	0.31
370	4/21/09	485	4/20/10	115	2.21	0.32
390	5/1/09	625	5/1/10	235	4.51	0.64
401	5/2/09	494	4/16/10	93	1.87	0.27
523	5/1/09	580	5/25/10	57	1.03	0.15
533	4/27/09	540	4/21/10	7	0.14	0.02
550	4/23/09	596	4/22/10	46	0.88	0.13
572	4/22/08	740	5/11/10	168	1.57	0.22
575	4/22/08	725	6/2/10	150	1.36	0.19
590	4/22/08	760	4/12/10	170	1.65	0.24
630	4/21/09	636	4/28/10	6	0.11	0.02
698	4/21/09	790	6/9/10	92	1.56	0.22

Table 6. Northern pike  $\geq 300$  mm TL population estimate and the 95% confidence interval, generated using Program MARK Huggins closed estimate, p-hat, number of northern pike  $\geq 300$  mm removed, and exploitation rate of northern pike in terms of percent of the abundance point estimate removed for 2004 through 2010 in the middle Yampa River.

<u>Year</u>	<u>NPK <math>\geq 300</math> mm Population Estimate and 95% Confidence Interval</u>	<u>P-Hat</u>	<u>Number NPK <math>\geq 300</math> mm Removed</u>	<u>NPK <math>\geq 300</math> mm Exploitation Rate</u>
2004	981 (774-1288)	0.23	560	57.1%
2005	678 (555-861)	0.22	380	56.0%
2006	623 (517-780)	0.22	328	52.6%
2007	1073 (825-1321)	0.23	679	63.3%
2008	633 (518-806)	0.28	384	60.7%
2009	765 (553-1160)*	0.15	378	49.4%
2010	664 (492-1002)**	0.20	481	72.4%

\*137 northern pike were removed prior to conducting the abundance estimate and were added to the point estimate and upper and lower confidence limit for comparison with previous years

\*\*175 northern pike were removed prior to conducting the abundance estimate and were added to the point estimate and upper and lower confidence limits for comparison with previous years.

Table 7. Northern pike Catch Per Unit Effort (CPUE) from 2004 to 2010 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>Maybe 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
2010	1.13	1.07	0.41

Table 8. 2010 northern pike Catch Per Unit Effort (CPUE, number of northern pike captured per hour via electrofishing only) during each pass across the entire study area of the middle Yampa River (South Beach to Lily Park).

	<u>Pass 1</u>	<u>Pass 2</u>	<u>Pass 3</u>	<u>Pass 4</u>	<u>Pass 5</u>	<u>Pass 6</u>	<u>Pass 7</u>	<u>Pass 8</u>	<u>Pass 9</u>	<u>Pass 10</u>
NPK Captured	96	74	81	115	71	33	26	82	82	26
Effort (hours)	68.75	34.03	68.53	76.89	86.4	87.96	58.22	84.29	71.1	31.4
CPUE (NPK/hour)	1.40	2.17	1.18	1.50	0.82	0.38	0.45	0.97	1.15	0.83

Table 9. Movement of recaptured northern pike among study areas in 2004 through 2010. 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’. Northern pike that were translocated to State Park Headquarters Pond are indicated in parenthesis as ‘SP’.

<u>Year</u>	<u>Into USFWS from Upstream</u>	<u>Upstream Into USFWS from CDOW/CSU</u>	<u>Into CDOW/CSU from USFWS &amp; 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)	?	?
2010	3 (2 Catamount, 1 SP?)	10	20 (6 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 2010 by the Colorado Division of Wildlife (CDOW).

<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	5	0	5	5	0	0
2	3	0	3	3	0	0
3	3	1	2	3	0	0
4	4	1	3	4	0	0
5	5	3	2	5	0	0
6	8	2	6	8	0	0
7	2	0	2	2	0	0
<u>Total</u>	30	7	23	30	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 6 in 2010 by the Colorado Division of Wildlife(CDOW).

<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	1	1	0	1	0	0
2	2	2	0	2	0	0
3	4	3	1	4	0	0
4	4	3	1	4	0	0
5	8	6	2	8	0	0
6	9	7	2	9	0	0
<u>Total</u>	28	22	6	28	0	0

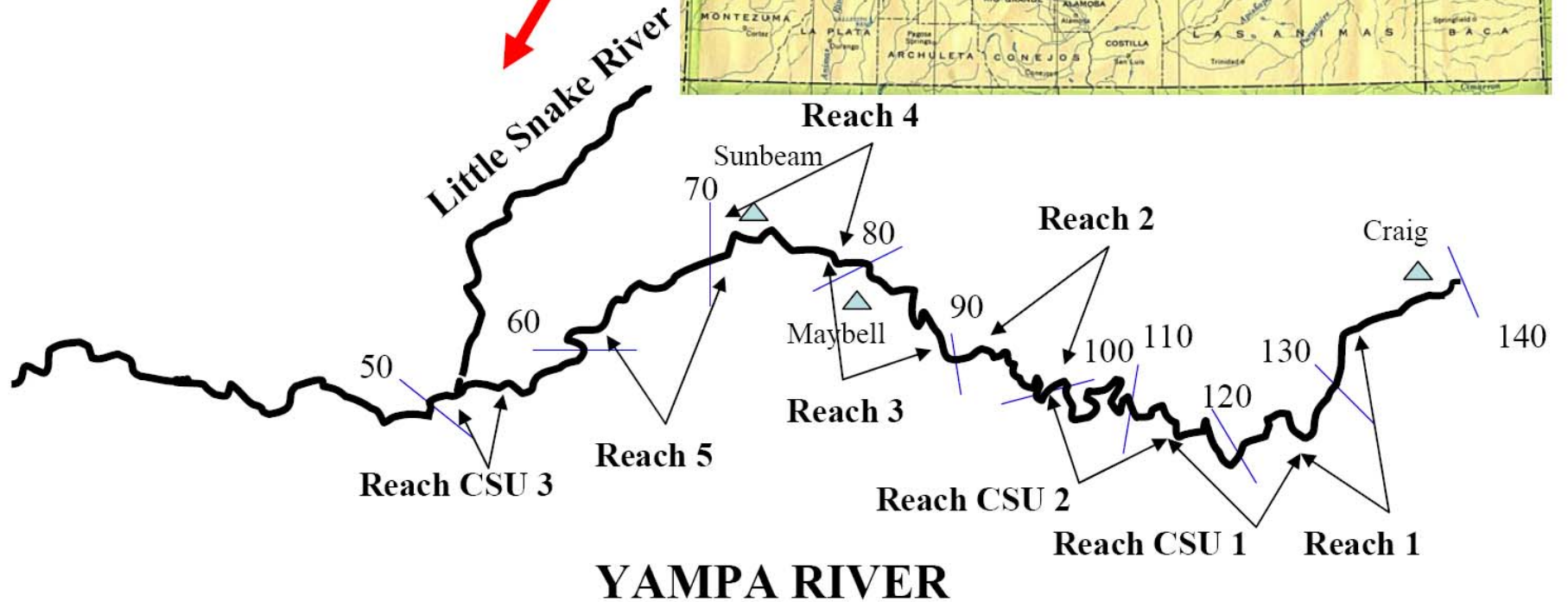
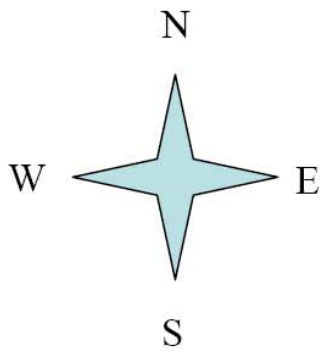


Figure 1. River reaches of the middle Yampa River sampled by the CDOW and CSU (Graphics courtesy of P. Martinez and R. Anderson)

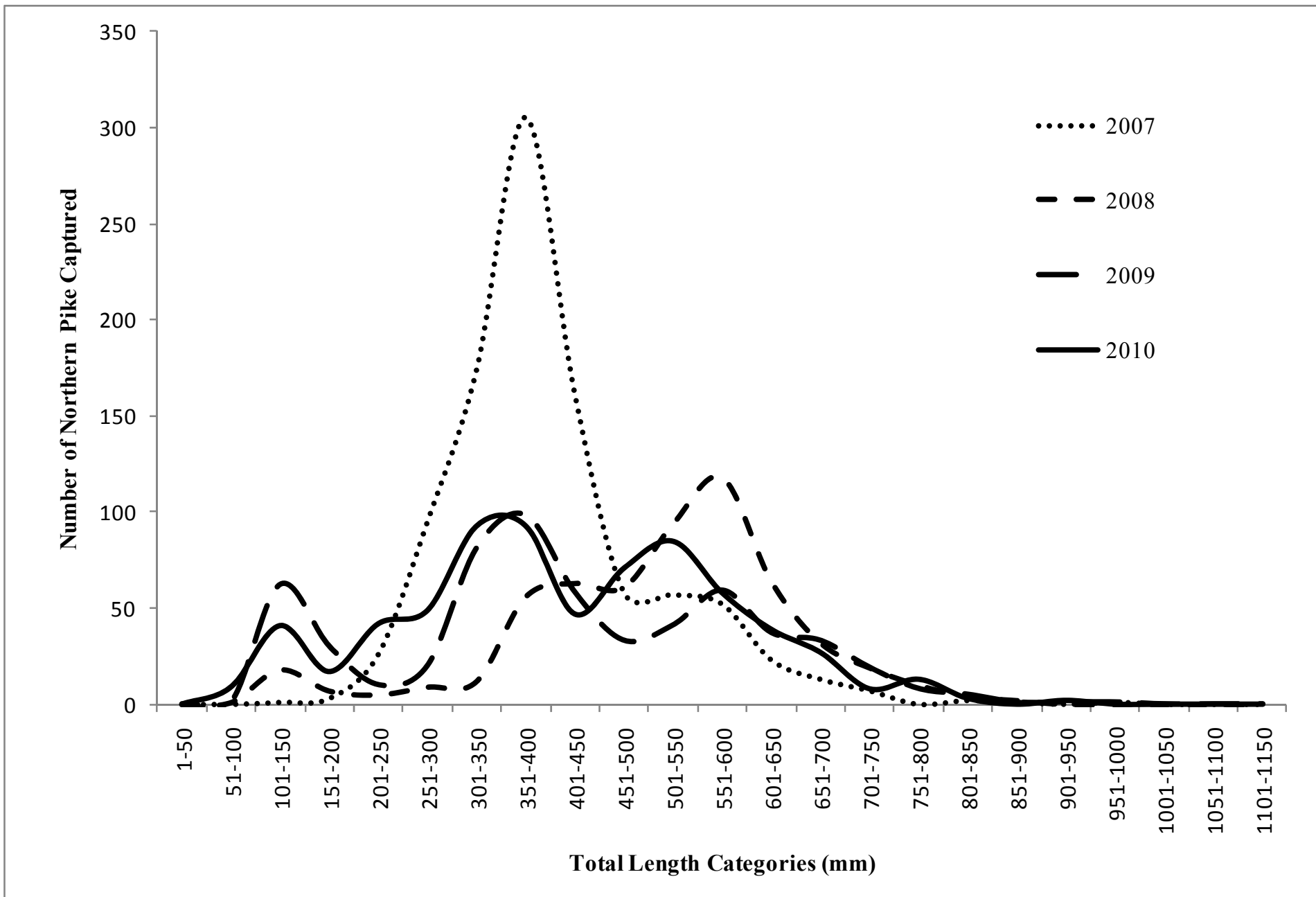


Figure 2. Northern pike total length frequency distributions in increments of 50 mm, from 2007 to 2010, in the middle Yampa River, from South Beach (RM 134.2) to Lily Park (RM 50.5). 2010 is depicted as a solid line, 2009 is depicted as a large dashed line, 2008 is depicted as a small dashed line, and 2007 is depicted as a dotted line.

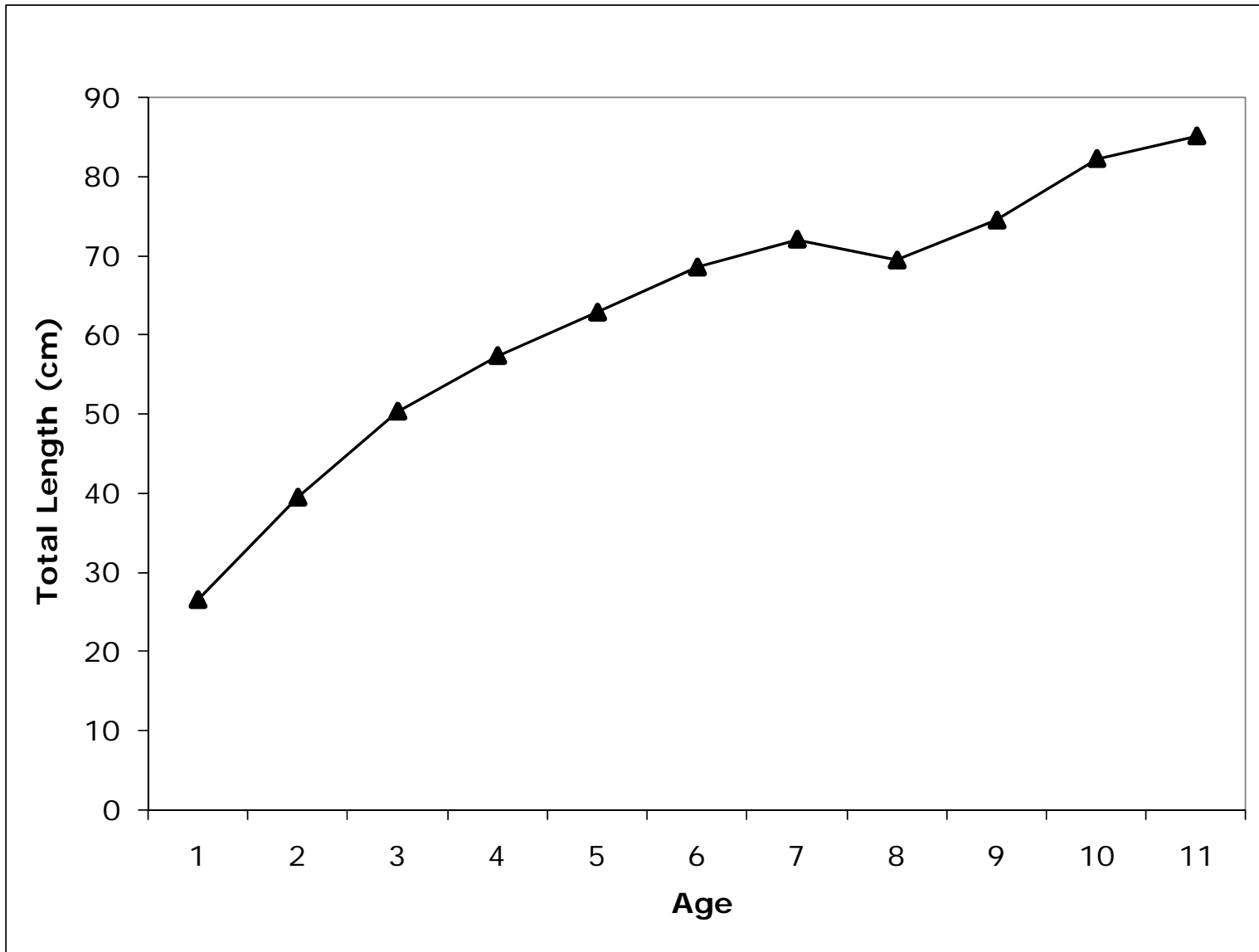


Figure 3. Northern pike length (cm) at age based on ageing of northern pike cleithra taken during the 2009 field season.

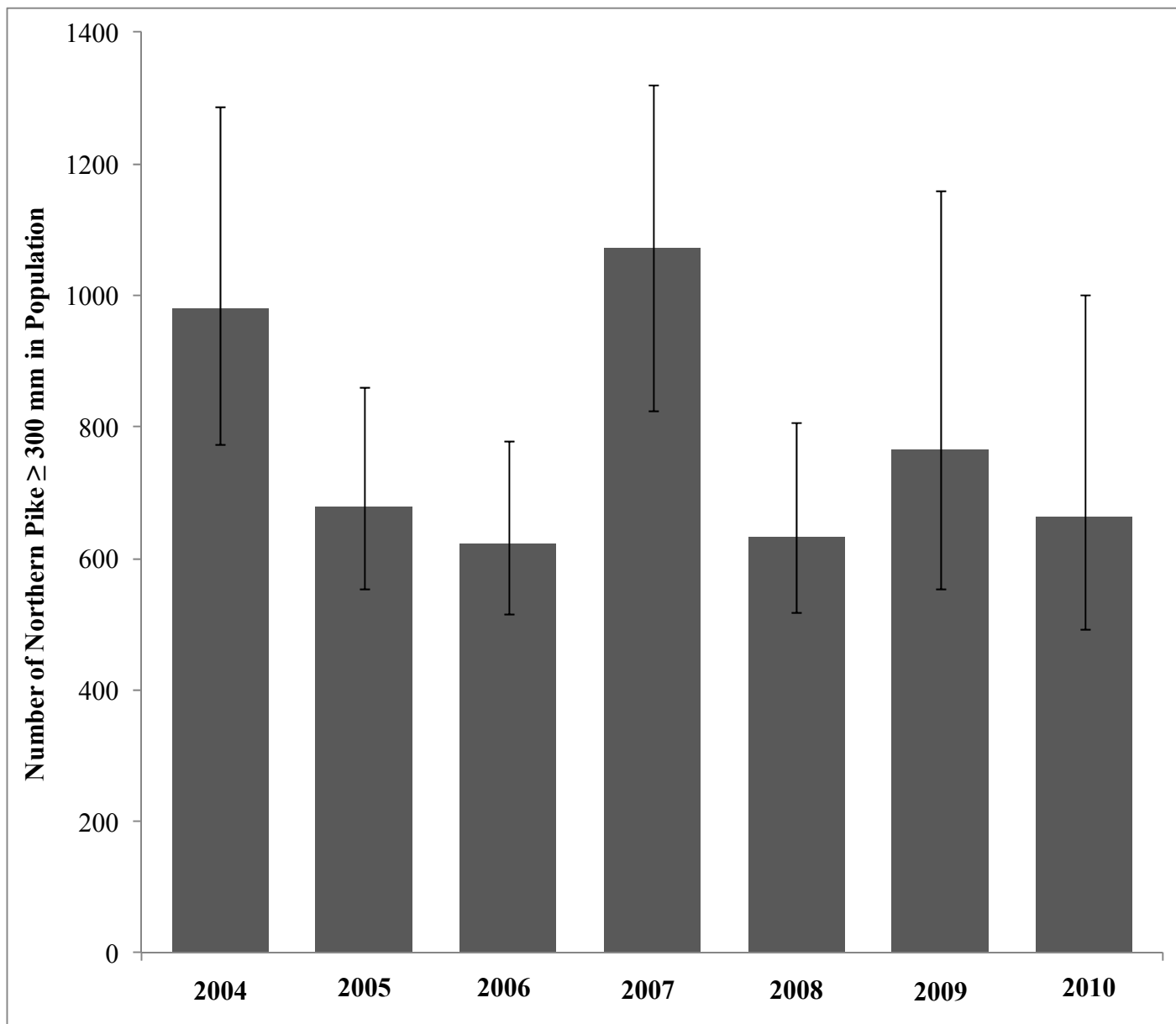


Figure 4. Northern pike  $\geq 300$  mm population estimates and the 95% confidence interval, generated using Program MARK Huggins closed estimate, for the middle Yampa River (RM 134.2- 50.5), from 2004 through 2010.

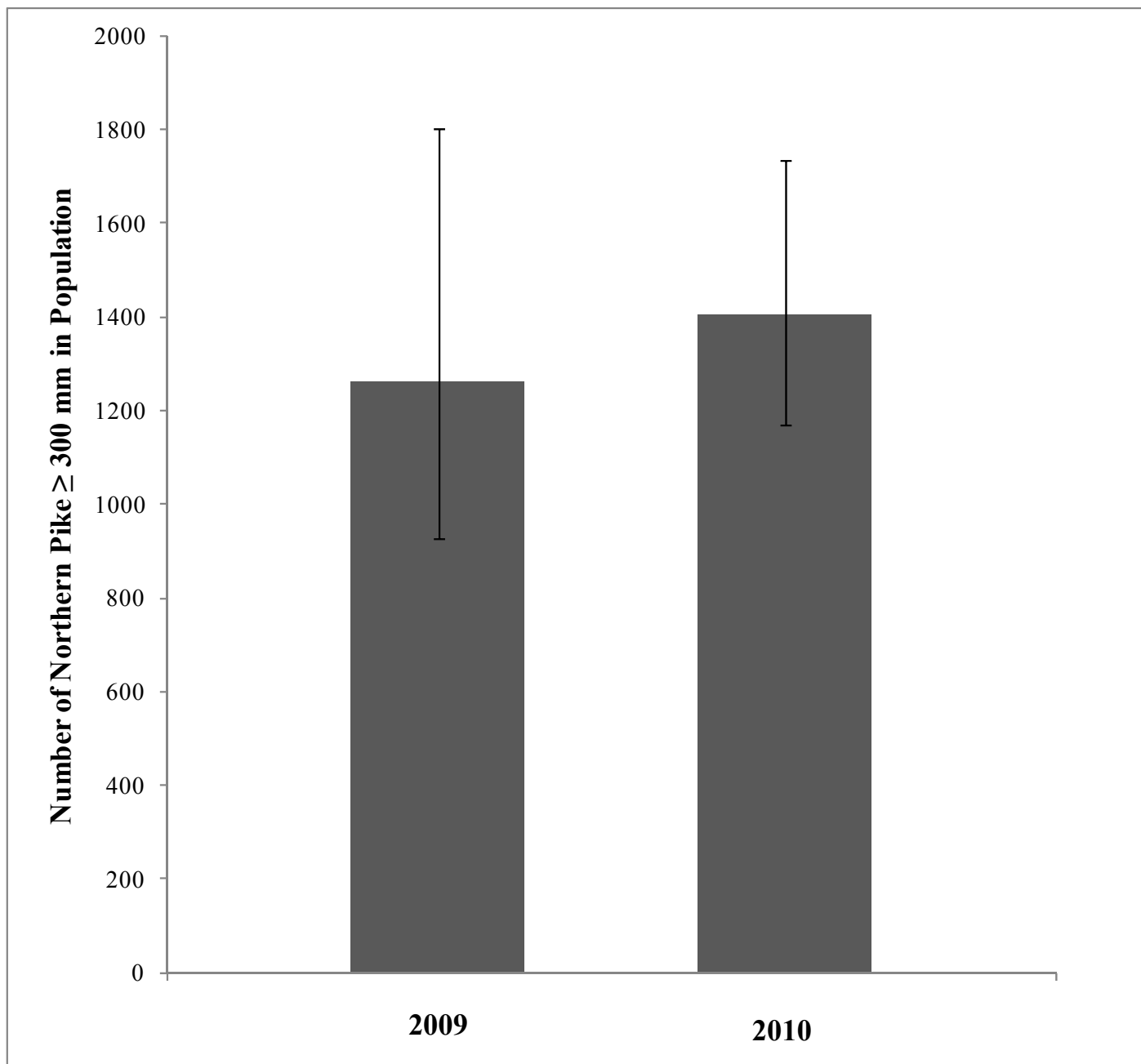


Figure 5. Northern pike  $\geq 300$  mm TL population estimates and the 95% Confidence Interval generated for projects 98a, 125, and 98b combined (Hayden to Lily Park), in 2009 and 2010.

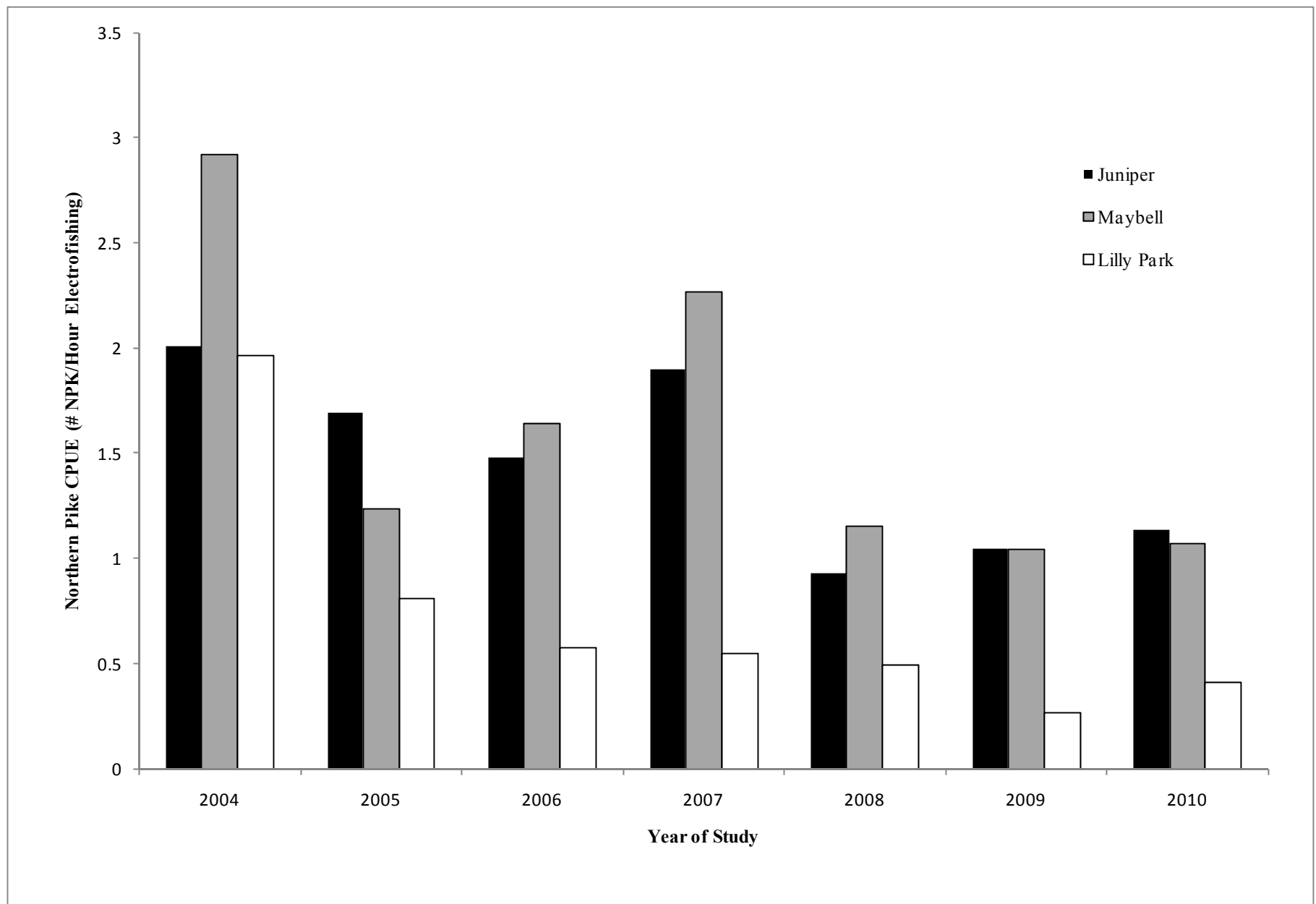


Figure 6. Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) across three subsections of the middle Yampa River, Juniper (RM 134.2 – 91.0), Maybell (RM 88.7 – 60.6), and Lilly Park (RM 55.5 – 50.5), from 2004 to 2010.



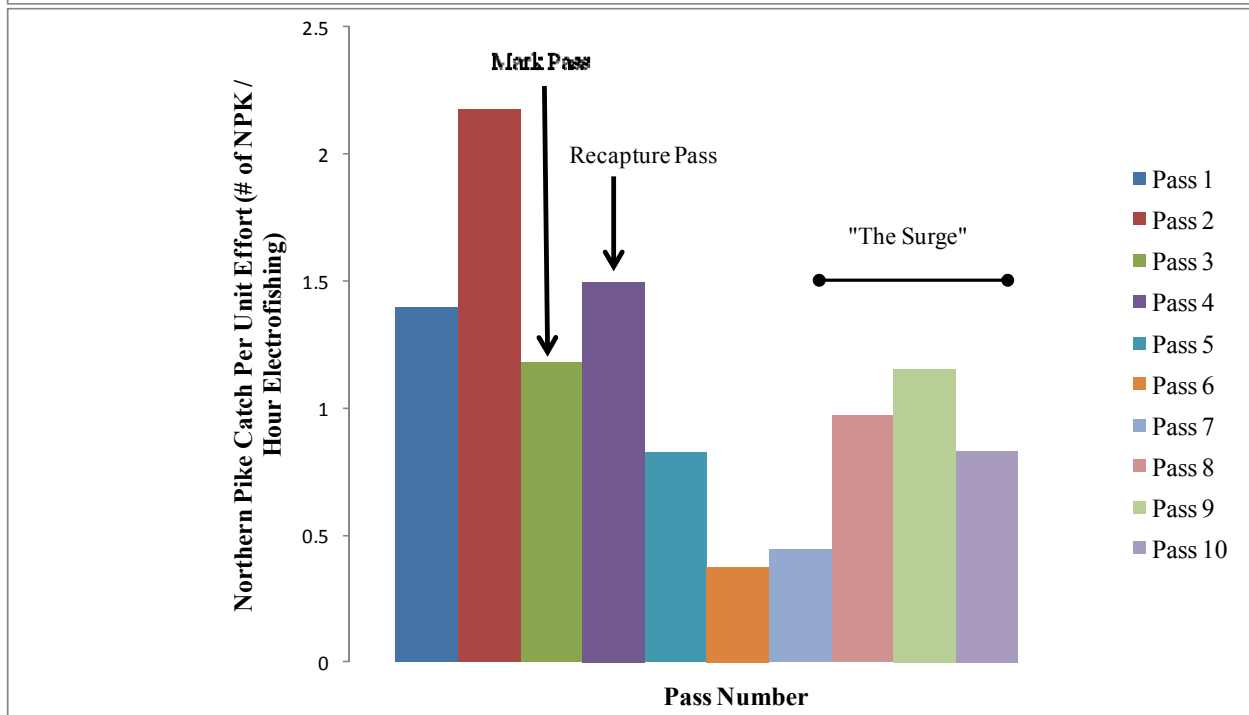
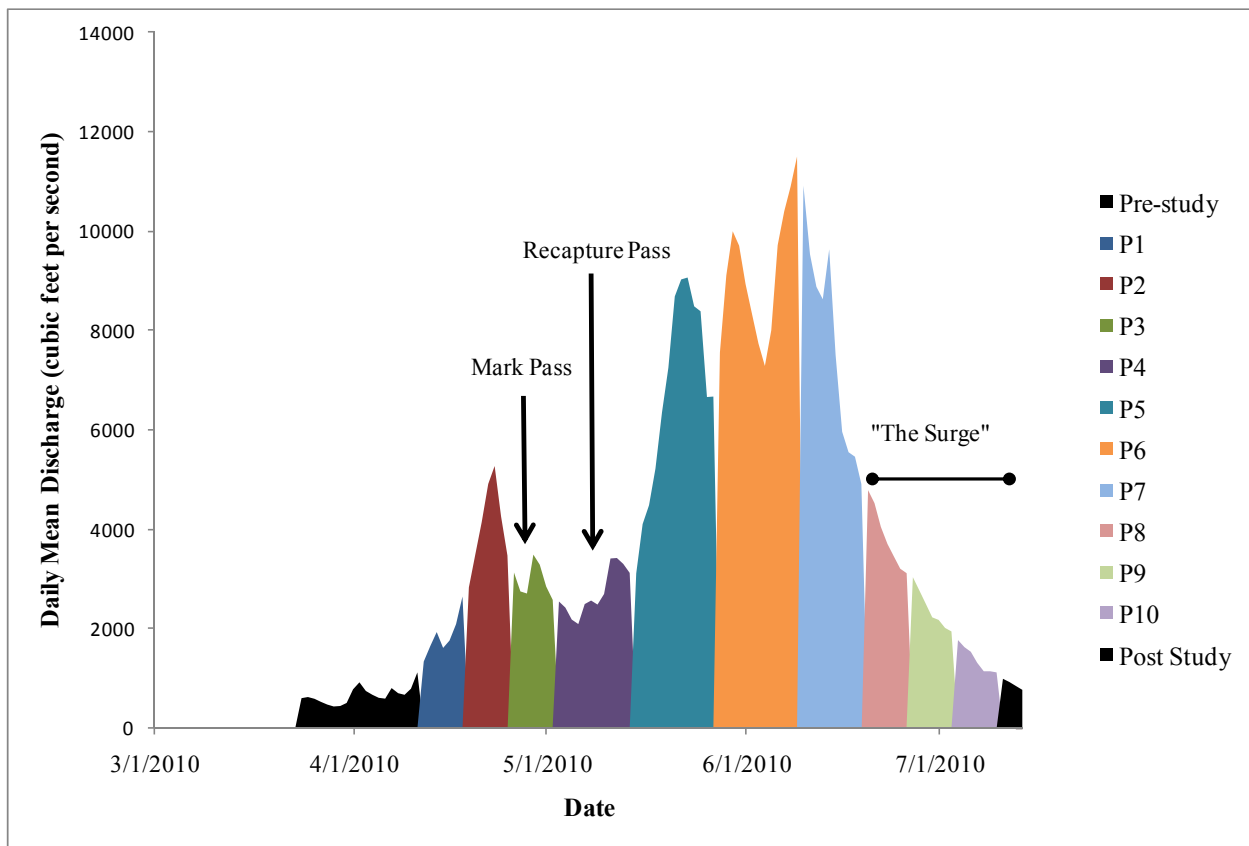


Figure 7. Northern pike electrofishing Catch Per Unit Effort (CPUE; # NPK/hour) across 10 passes in the middle Yampa River in 2010, displayed below the color coded hydrograph during the study period in 2010 to illustrate the timing of each pass relative to discharge stage. The marking pass, recapture pass, and Surge passes are all labelled. It should be noted that the color coded hydrograph depicts date ranges for when sampling occurred during each pass, but sampling did not occur on every date within the date range.

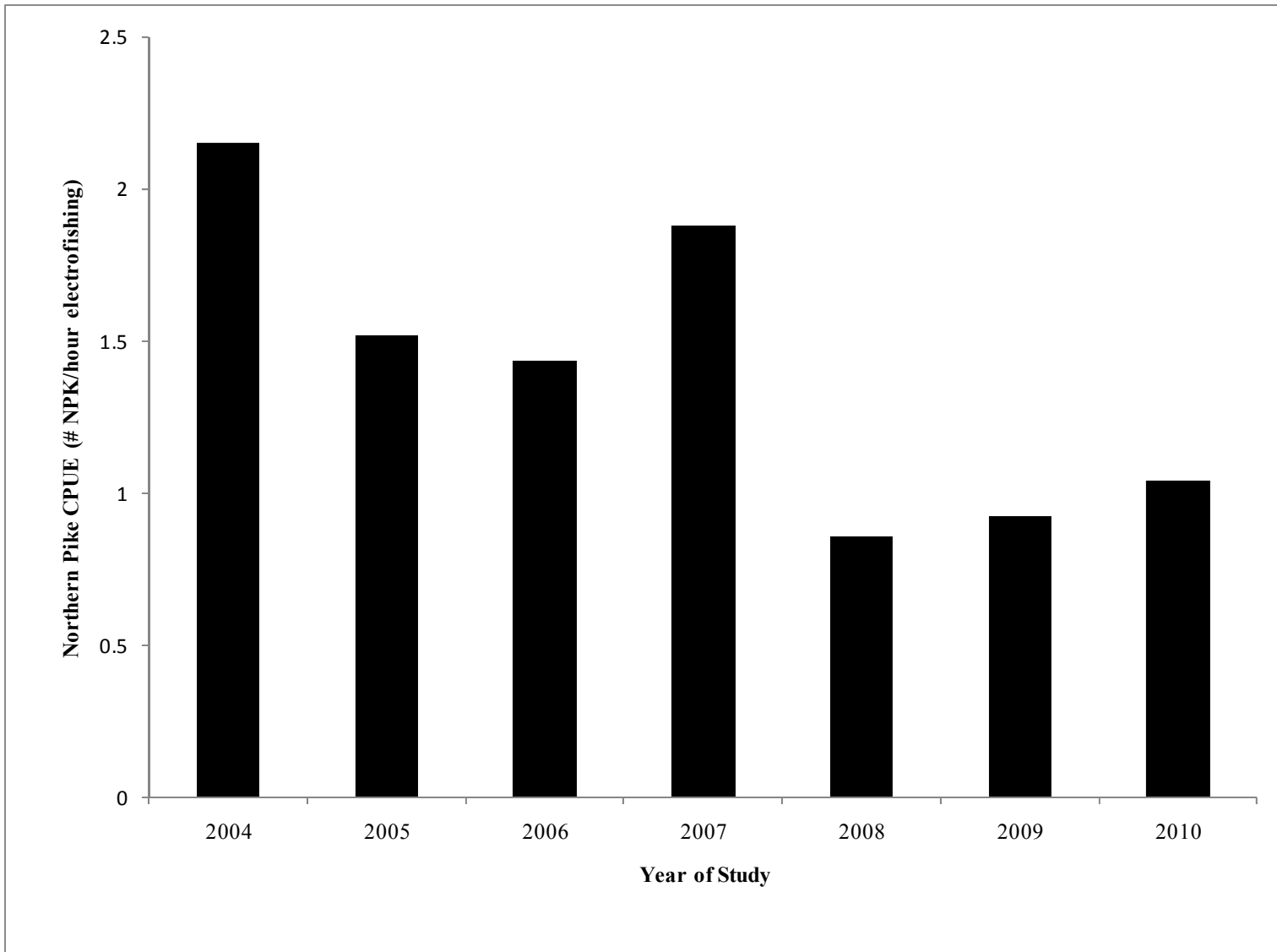


Figure 8. Northern pike Catch Per Unit Effort (CPUE; number of NPK/hour) across all passes in the entire study area sampled by CDOW and CSU, for 2004 through 2010.

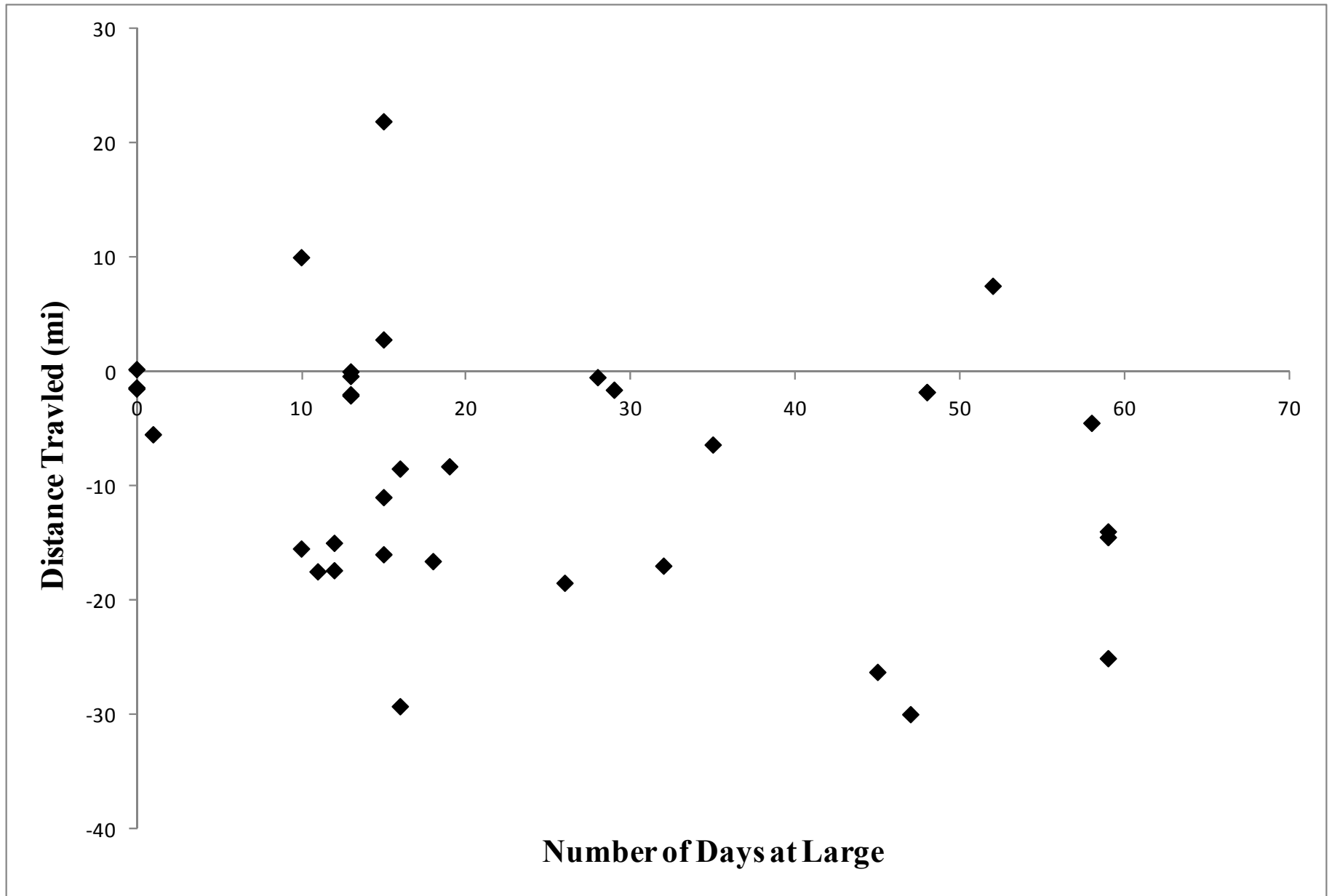


Figure 9. Movement distances of northern pike that were tagged and recaptured in the middle Yampa River in 2010, plotted against the number of days each fish spent at large between capture events. Negative values on the y-axis represent downstream movement and positive values represent upstream movement.



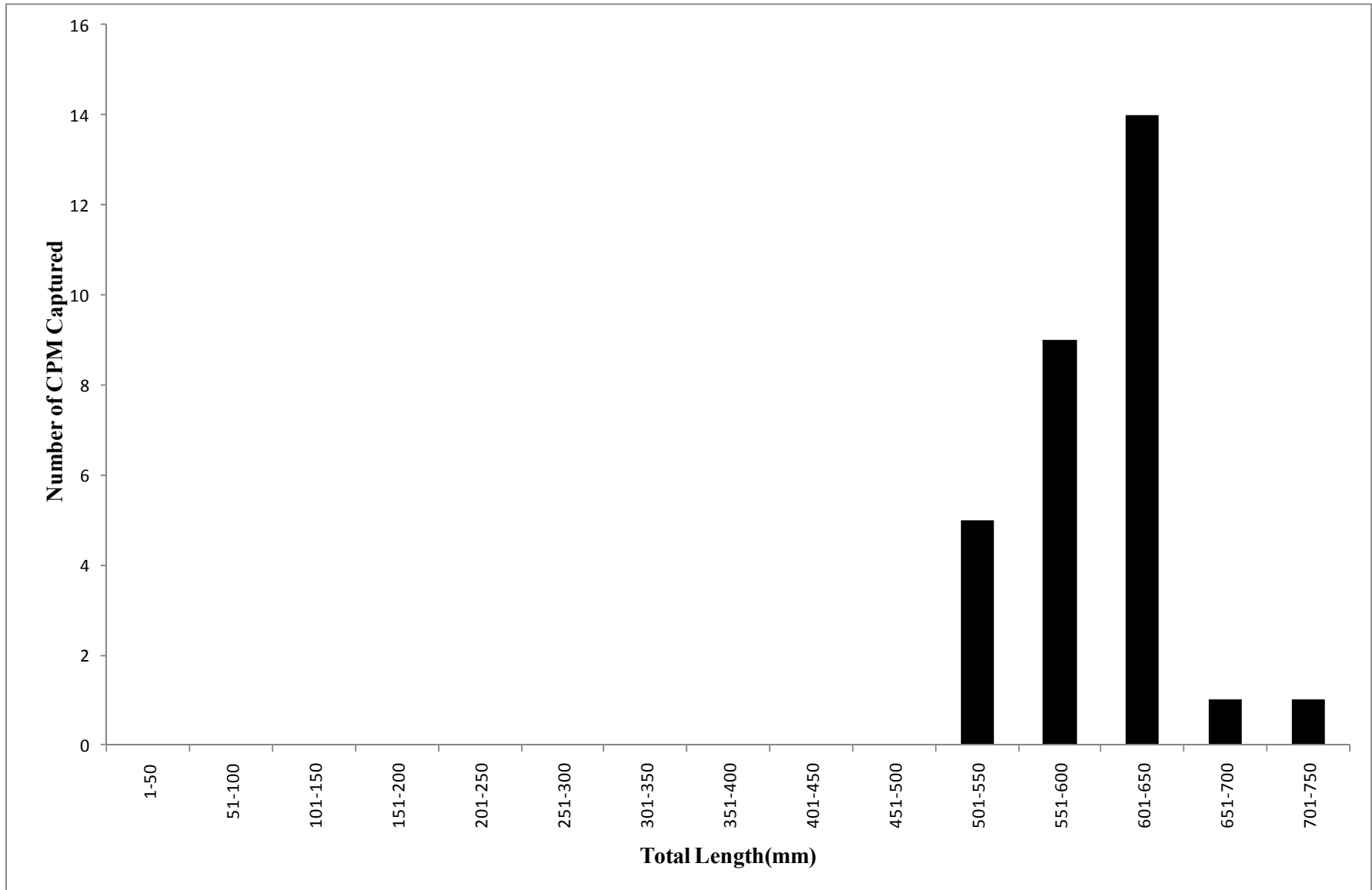


Figure 11. Colorado pikeminnow (CPM) total length (mm) frequency distribution, with size classes in increments of 50mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2010.

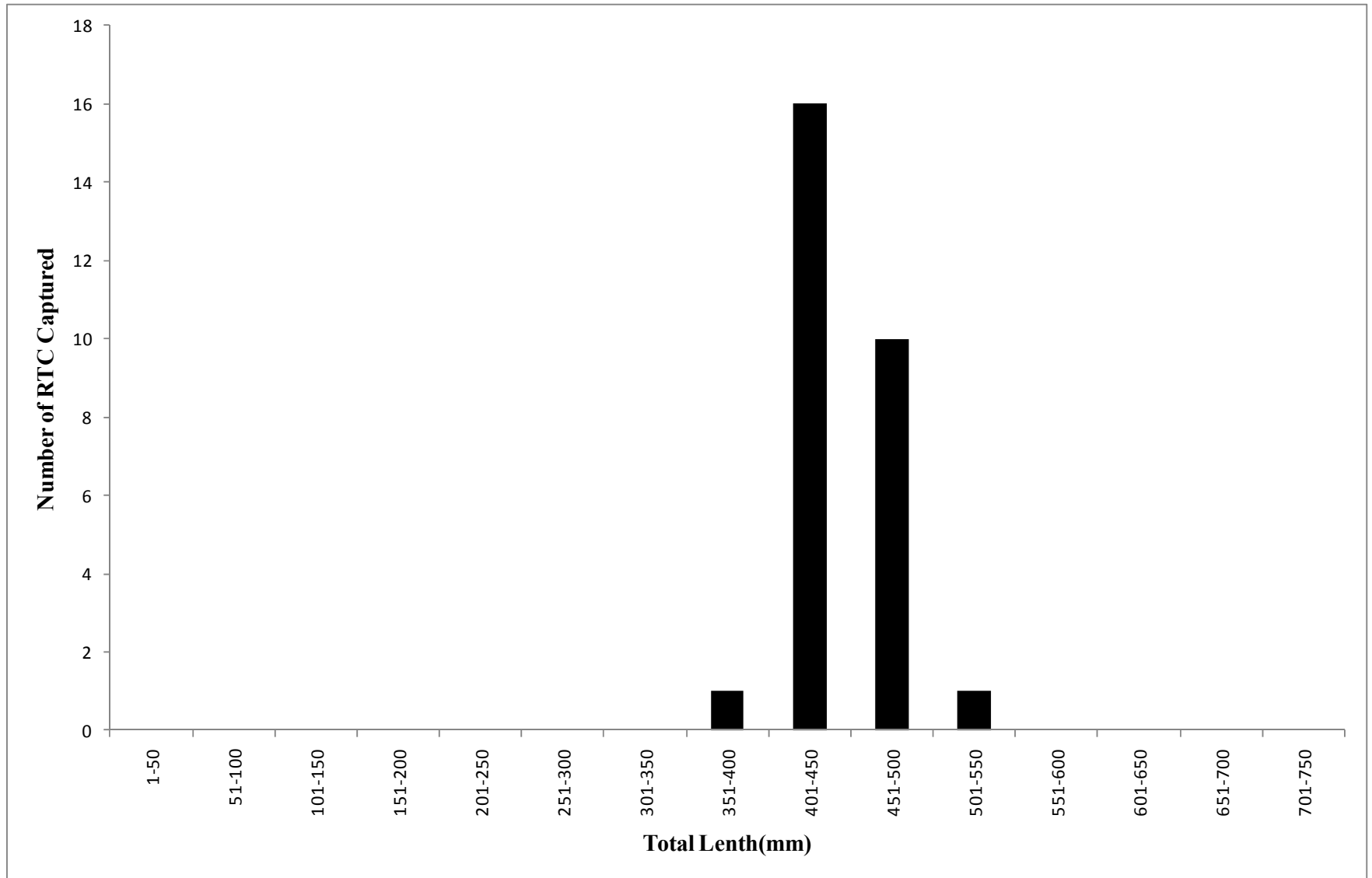


Figure 12. Roundtail chub (RTC) total length (mm) frequency distribution, with size classes in increments of 50 mm, for the five reaches in the middle Yampa River sampled by the CDOW in 2011.

