

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

II. Principal Investigator:

F. Boyd Wright  
Colorado Division of Parks and Wildlife  
317 West Prospect  
Fort Collins, CO Colorado 80526  
Phone: 970-472-4366  
FAX: 970-472-4458  
Email: [boyd.wright@state.co.us](mailto:boyd.wright@state.co.us)

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 prevention, removal, and exclusion. The Colorado Division of Parks and Wildlife (CPW) 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 (UCRRIIP 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 2011 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). Thus, 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 2011 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 2011 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2011 Tasks and Deliverables

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

Schedule: March 2011

Deliverable: **Task Completed**

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

Schedule: February-April, 2011

Deliverable: **Task Completed**

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

Schedule: April 14 – Aug 1, 2011

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, 2011

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 CPW and CSU combined, from river mile (RM) 134.2 to 50.5 (Figure 1). CPW samples Reach 1 (RM 134.2 – 124.0), CSU samples Little Yampa Canyon (LYC; RM 124 – 100), CPW samples Reaches 2 through 5 (RM 110 – 60.6), and CSU samples Lily Park (RM 55.5 – 50.5) (Table 1).

### CDOW Study Methods/Approach

Fiscal Year 2011 marks the third consecutive year in which all smallmouth bass data collected by CPW were submitted to CSU for a combined analysis of smallmouth bass, as has been done by CPW with northern pike data since 2005. Thus, the focus of this report is on northern pike. See 2011 report # 125 for a detailed analysis of smallmouth bass data collected in the study area.

Five total sampling passes (1 mark/release, 4 removal) were performed by CPW in Reach 1 (RM 134.2 – 124.0). Nine additional removal passes were performed in this reach by CSU, CPW, and USFWS combined during the “Surge” effort, bringing the total to 14 total sampling passes (13 removal passes). Five total sampling passes (1 mark/release, 4 removal) were performed in Reach 2 (RM 100 – 91.0). Six total sampling passes (1 mark/release and 5 removal) were performed by CPW Reach 3 (RM 88.7 – 79.2). Four total sampling passes (1 mark/release; 3 removal) were conducted by CPW in Reach 4 (RM 97.2 – 71.0). Finally, 4 sampling passes (1 mark/release; 3 removal) were performed by CPW in Reach 5 (RM 71.0 – 60.6).

In CSU’s study area, 15 total sampling (1 mark/release; 14 removal) passes were conducted in Little Yampa Canyon (RM 124-100), and 6 total sampling passes (1

mark/release; 5 removal) were conducted in Lily Park (RM 58.9-55.5).

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. The Surge lasted from July 19 to August 22. Additional removal passes that were accomplished during the Surge are accounted for in the above paragraph describing effort.

In most study years the first pass constituted the mark/release pass and all subsequent passes constituted removal efforts. In 2011 the marking pass was postponed in an effort to increase the number of smallmouth bass tagged by tagging bass when catch rates are highest. As a result, in most reaches as many as three removal passes occurred prior to the mark/release pass for northern pike, which commenced on May 9, 2011.

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 5913 to 6307, but not continuously. Northern pike that were tagged by the CPW ranged from 7201 to 7232. Northern pike captured during the removal passes were removed from the river. All fish that were less than 20 inches in total length were euthanized, and the majority of those greater than 20" in total length were translocated to Yampa State Park Headquarters Pond. If northern pike that were translocated were not already tagged, they received a new, grey FLOY tag, with tag numbers ranging from 6101 to 6647 for CSU, and from 7301 to 7500 for CPW.

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 black bullheads were euthanized.

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

### *Population Estimates*

In 2011, one population estimate was conducted and included 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 2011. CPW 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). 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 (RM 134.2 to 91.0), (2) Maybell (RM 88.7 to 60.6), and (3) Lily Park (RM 55.5 to 50.5). For these three sub-section CPUE was broken down into three categories and reported for each pass. The three categories for which CPUE was reported were: (1) NPK < 300mm TL, (2) NPK > 299mm TL, (3) All NPK.

### *Movement*

Movement was broadly described in terms of the number of fish that were recaptured in the CPW 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 2011, as well as movement that occurred within the study area from 2008 to 2011.

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**

Six (6) different fish species were collected within the CPW study reaches. Summary data for all species captured and handled by CPW in 2011 is presented in Table 2.

### Northern Pike

#### *Overview*

Overall, the CPW and CSU captured 824 individual northern pike and a total of 849 capture events occurred (includes recapture events). The total number of northern pike capture events in 2011 (849) increased from the total number of northern pike capture events in 2010 (697). However, with the extended duration of the Surge allowed by sustained high flows, effort increased considerably in 2011, which increased capture numbers. Seven-hundred and sixty-five (765) northern pike were removed in 2011, 90% of the northern pike individuals handled (Table 3). Eighty-four (84) pike were translocated to State Park Headquarters West Pond, down substantially from the 482 that were translocated in 2010. Six-hundred and eighty-one (681) northern pike were euthanized (Table 4).

Seventy-five (75) northern pike  $\geq 300$  mm TL were marked and released during the marking effort. Seventy-two (72) of these fish were marked by CPW and CSU in 2011, while the remaining 3 had been marked in previous years by CSU and CPW. Eleven (11) of the 75 northern pike greater than 300 mm (14.7%) that were tagged on the marking pass were recaptured on the subsequent recapture pass. A total of 79 northern pike of all size classes were tagged and released, and 20 of those fish were recaptured and removed across all subsequent removal passes, resulting in an exploitation rate for tagged fish of 25.3% (Table 3).

#### *Population Size Structure*

Northern Pike total length frequency histograms for the entire section of the river sampled by CPW and CSU from 2007 to 2011 are presented in Figure 2. In 2011 the northern pike population featured fewer large fish when compared to previous years. The length frequency analysis yielded two predominant size ranges of northern pike in 2011. Three hundred and ten (310; 36.5%) of the northern pike were in the 0 to 300 mm size range and 444 (52.3%) were in the 301 to 550 mm size range. The remaining 95 (11.2%) northern pike were greater than 550 mm in total length. The largest northern pike captured was 1001 mm, and was a recaptured fish that was originally captured, tagged, and released by CPW in Elkhead Reservoir on April 21, 2011. The size structure of the northern pike population shifted from predominantly larger fish early in the study, prior to peak runoff, to predominantly smaller fish later in the study, after peak runoff (Figure 3).

Interestingly, more young of year (YOY) northern pike were captured than documented in previous years (Figure 4), and the majority of such fish were captured in the Juniper Section (RM 134.2 to 91.0). YOY northern pike first appeared in the sample during the June 23 to July 9 sampling period when they averaged 122 mm TL (n=2). Such fish continued to appear in the sample in increasing numbers on subsequent sampling events, and by the August 17 to August 22 sampling period averaged 228 mm TL (n=41), yielding a growth rate for YOY northern pike of 2.1mm/day in 2011.

Capturing such a high proportion of YOY northern pike was noteworthy, because it has been long believed that the majority of northern pike recruitment in the Yampa River is a tribute to off-channel recruitment source populations (Hill 2005, Wright 2010, Wright

2009). However, the increased presence of YOY in 2011 suggests that recruitment resulting in reproduction of Yampa River resident northern pike may account for more production in the river than previously recognized, when environmental conditions are favorable. The markedly high and sustained runoff observed in 2011 may have created favorable conditions for northern pike reproduction and recruitment in the river in 2011. Alternatively, the decreased abundance of large northern pike resulting from removal activities, may be releasing predatory pressure on YOY northern pike in the river. This observed increase in relative abundance of YOY may also be an artifact of an altered sampling regime, which has crews working later into the summer with increased effort specifically in the Juniper section, when compared to previous years. It is possible that recruitment of YOY northern pike has occurred in previous years, but was not documented to the degree it was in 2011 due to changed sampling regime, which featured sampling later into the summer.

Northern pike growth rates, based on capture history of fish recaptured in 2011 that spent at least 30 days at large between capture events were consistent with previous years (Wright 2010), ranging from 0.09 to 8.56 mm/week (Table 5). Generally, fish that were relatively small when initially captured exhibited higher growth rates than those that were relatively large when initially captured.

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

The population estimate for northern pike in the middle Yampa River in 2011 suggests that northern pike numbers remained relatively stable between 2010 and 2011, and that the population remains lower than when the study was initiated in 2004 (Table 6; Figure 5). The Program MARK Model (t) of Chao population estimate of northern pike in 2011 was 641 (505-912 95% C.I.; SE=99.15; p-hat=0.147), and was not significantly different than the 2010 estimate of 664 (492-1002 95% C.I.; SE=124.3; p-hat=0.196), though the point estimates suggest a decrease in the population size. The 2011 abundance estimate resulted in a density estimate of 7.7 NPK  $\geq$  300mm/mile. In 2011, 71.8% of the northern pike population  $\geq$  300 mm TL (estimate of 641) was removed (460 NPK  $\geq$  300 mm TL), which was similar to the exploitation rate in 2010 (72.4%), and nearly 10% higher than any rate of removal achieved prior to 2010.

In both 2010 and 2011, greater than 70% of the estimated population size was removed, which was markedly higher than what was achieved in previous years. Two changes in the sampling regime in 2010 and 2011 have increased removal numbers. First, in both years northern pike were removed on the first pass, rather than tagged and released as was previously done. As discussed in greater depth in the *Catch Per Unit Effort* section of the results, the first few passes routinely account for the greatest catch rates of northern pike. Thus, removing fish during those passes, as was done in 2010 and to a greater extent in 2011, enabled elevated removal numbers. Second, the Surge accounted for 47.7% of the northern pike that were removed in 2011 and 30% of northern pike removed in 2010. The Surge occurs later in the sampling season, on the descending limb of the hydrograph, when northern pike catch rates have been shown to increase. Moreover, the area targeted by the Surge, which has been determined to be a primary spawning area for

smallmouth bass, has also been shown to harbor relatively high northern pike concentrations within the study area. The Surge, which is a targeted smallmouth bass removal effort, is also complimentary to northern pike removal.

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

CPUE was calculated for the three sub-sections of the study area (Juniper, Maybell, and Lily Park) and compared to previous years (Table 7). Additionally, CPUE was calculated for three size categories (< 300mm TL, > 299mm TL, and all sizes of northern pike) across all passes conducted in three sub-sections (Juniper, Maybell, and Lily Park), and expressed as the number of northern pike captured per hour (# of NPK/hour) (Table 8). In the Juniper section (Figure 6) CPUE showed a stable decrease through the sixth pass (June 23 to June 26), and then increased across subsequent passes, largely due to the increase in CPUE of northern pike < 300mm TL. This increase was mostly due to the appearance of YOY northern pike in the sample. In the Maybell section, CPUE decreased steadily across four passes (Figure 7), and northern pike >299mm TL accounted for the majority of fish captured. In the Lily Park section, CPUE decreased steadily through the fourth pass, but increased on the fifth and sixth pass, on the descending limb of the hydrograph (Figure 8). In Lily Park, northern pike > 299mm TL accounted for all of the catch through the first five passes, but on the sixth pass northern pike CPUE was comprised solely of fish <300mm. As has been reported in greater detail in previous years (Wright 2010), CPUE was generally inversely correlated with discharge, such that lower flows result in higher catch rates of northern pike.

Overall CPUE for all passes across the entire study area in 2011 increased by 5.8% from 2010 (Figure 9). Slight increases in overall CPUE have been documented each year since 2008. However, it should be noted that effort in areas that are known to support relatively higher numbers of northern pike has also increased. Thus, overall CPUE is somewhat biased by the change in sampling regime. Nonetheless, 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*

Unlike previous years, we did not recapture any northern pike that were tagged and released by project 98b (Yampa River: Hayden to Craig) in 2011 or previous years. This is largely because in 2011 98b ceased conducting a tag and release pass for northern pike. One (1) northern pike was recaptured that was originally tagged and released by CPW in Elkhead Reservoir on April 20, 2011. Eight (8) northern pike were recaptured that were tagged by CPW and CSU in previous years, dating back to 2008 (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 2011 sampling year (Figure 10). Five (5) northern pike that were tagged and recaptured in 2011 moved more than one

mile in a downstream direction, while 5 northern pike moved distances greater than one mile upstream. Northern pike that demonstrated downstream movement within 2011 moved distances as great as 22.5 miles, while the greatest distance moved in an upstream direction was 4.3 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 2011 and previous years generally demonstrated greater degrees of upstream movement when compared to movement that occurred within 2011 (Figure 11). Three (3) northern pike that were recaptured 2010, but tagged in previous years, moved more than one mile in a downstream direction, while 5 northern pike moved more than a mile upstream. Movement in a downstream direction ranged up to 33 miles, while distance moved in an upstream direction ranged up to 27 miles. The northern pike that travelled 27 miles in an upstream direction was tagged at river mile 103.5 in 2010 and was recaptured at river mile 130.5 in 2011. The 2011 movement results underscore a trend similar to what has been observed in previous years, albeit with a greater proportion of fish that moved upstream between years. Northern pike generally move downstream, rather than upstream, in the Yampa River drainage.

### *Escapement*

Unlike 2010, in 2011 we did not recapture any fish that were previously translocated to Loudy Simpson Pond. In 2010 we did not translocate any northern pike to Loudy Simpson Pond, and translocation to Loudy Simpson Pond officially ceased in 2011. However, one northern pike was recaptured in the Yampa River in 2011 that was initially tagged and released in Elkhead Reservoir in 2011. This fish was tagged in Elkhead Reservoir on April 21, 2011, when it measured 998 mm TL. It was recaptured in the Yampa River during the Surge at river mile 110.6 on July 26, 2011, when it measured 1001 mm TL. CPW initiated a study in 2011, during which 420 northern pike were tagged and released in Elkhead Reservoir in April of 2011, prior to the reservoir spilling over. Escapement of translocated smallmouth bass from Elkhead Reservoir has been previously documented (Hawkins 2010), but prior to the study initiated by CPW in 2011 it was impossible to document escapement of resident northern pike and smallmouth bass from Elkhead Reservoir. The recapture of this northern pike marks the first such documentation and it will be informative to see if any further escapement of resident northern pike is documented in future years.

### Colorado Pikeminnow

Overall, 36 Colorado pikeminnow capture events occurred in the CPW study in 2011, six more than were captured and handled in 2010 (Table 10). Two (2) Colorado pikeminnow were captured during Pass 1, 9 were captured during Pass 2, 12 were captured during Pass 3, 8 were captured during Pass 4, and 1 was captured during pass 5. Colorado pikeminnow capture locations ranged from river mile 61.5 to river mile 128.0. A total

length frequency histogram was developed for all Colorado pikeminnow captured (Figure 12). Mean total length of Colorado pikeminnow captured by CPW in 2011 was 591 mm. Twenty-seven (27) Colorado pikeminnow capture events occurred in the main channel, and 9 were captured in backwaters. None of the Colorado pikeminnow displayed evidence of presumed northern pike attacks that had healed. Most notable is that 8 of the Colorado pikeminnow captured were not recaptures, and are presumed to be “new” fish.

### Roundtail Chub

Overall, 37 roundtail chub capture events occurred in the CPW study in 2011 (Table 11). Five (5) roundtail chub were captured during Pass 1, 11 were captured during Pass 2, 16 were captured during Pass 3, and 5 were captured during Pass 4. A total length frequency histogram was developed for all roundtail chub individuals (Figure 13). The mean total length of roundtail chub captured was 448 mm.

## VII. Recommendations:

- A. Repeat 2011 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. Prioritize sampling to occur later in the sampling season, which can be accomplished by the Surge, to document the presence or absence of YOY northern pike in future years.
- C. Consider the merits of repeating the 2011 Surge effort in future years, as the Surge accounted for 47.7% of removed northern pike in 2011, and was complimentary to northern pike management objectives in the Yampa River.
- D. Continue work to control potential northern pike source populations. Prioritize work schedule to focus on populations of immediate concern. Continue CPW study aimed at marking northern pike in Elkhead Reservoir and estimating abundance
- 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, CPW, for her leadership assistance in the field and Lori Martin, CPW, for her lead on this project from 2004 to 2007. The author also appreciates the assistance of numerous CPW 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 2012 may be adjusted per results from the 2011 Nonnative Fish Control Workshop.

X. FY 2011 Budget Status:

- A. Funds Provided: \$163,617, Funds Requested: \$163,617
- B. Funds Expended: \$163,617
- C. Difference: \$0.00
- D. Percent of the FY 2011 work completed: 100%
- E. Recovery Program funds spent for publication charges: \$0.00

X1. Status of Data Submission: Data for Colorado pikeminnow collected by the CDOW will be provided to the database Manager by March 1, 2012.

XII. Signed: F. Boyd Wright March 2, 2011  
Principal Investigator Date

XIII. Literature Cited:

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

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

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

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

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

Hawkins, J.A. 2010. Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Annual Report to the Colorado River Recovery and Implementation Program.

Hawkins, J.A. 2011. Evaluation of smallmouth bass and northern pike management in the middle Yampa River. Annual Report to the Colorado river Recovery and Implementation Program.

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

Martin L.M., and F.B. Wright. 2007. 2004-2007 Middle Yampa River Northern Pike Removal and Evaluation South Beach (RM 134.2) to Lily Park (RM 50.5); Smallmouth

Bass (Limited Removal) and Evaluation South Beach (RM 134.2) to Cross Mountain Canyon (RM 60.6). Synthesis Report to the Colorado River Recovery Implementation Program.

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

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

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

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

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

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

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

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

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

Wright, F.B. 2009. Middle Yampa River northern pike removal and evaluation. Annual Report to the Colorado River Recovery and Implementation Program.

Wright, F.B. 2010. Middle Yampa River northern pike removal and evaluation. Annual Report to the Colorado River Recovery and Implementation Program.

#### 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 2011, 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 Capture Events</u>
Northern Pike	849
Smallmouth Bass	792
Colorado pikeminnow	36
Roundtail Chub	37
Black Bullhead	1
Black Crappie	0
Bluegill	0
Green Sunfish	0
White Crappie	0
Brook Stickleback	0
Creek Chub	5

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 2011.

<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%
2011	79	11	20	25.3	824	765	90%

Table 4. Disposition totals for northern pike removed from the middle Yampa River in 2011. Northern pike were either moved to the State Park Headquarters Pond or euthanized.

<u>Disposition</u>	<u>Number of Northern Pike</u>
State Park Headquarters Pond	84
Loudy Simpson	0
Euthanized and Incidental Mortality	681
<b><u>Total</u></b>	765

Table 5. Growth rate calculations based on capture history of northern pike that were recaptured in 2011 and spent a minimum of 30 days at large between capture events. 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>
283	5/1/2009	608	5/14/2011	325	3.06	0.44
314	5/12/2011	411	8/9/2011	97	7.63	1.09
337	5/13/2011	402	7/15/2011	65	7.22	1.03
341	4/27/2010	524	5/4/2011	183	3.44	0.49
346	4/29/2010	618	7/19/2011	272	4.27	0.61
348	5/9/2011	452	8/2/2011	104	8.56	1.22
350	5/12/2011	385	7/8/2011	35	4.30	0.61
357	5/9/2011	445	8/2/2011	88	7.25	1.04
373	5/14/2011	430	7/8/2011	57	7.25	1.04
382	5/14/2011	445	7/8/2011	63	8.02	1.15
389	5/1/2010	637	7/19/2011	248	3.91	0.56
435	5/13/2011	495	7/8/2011	60	7.50	1.07
551	6/9/2009	743	4/26/2011	192	1.96	0.28
575	4/21/2009	637	4/27/2011	62	0.59	0.08
580	4/26/2010	585	5/10/2011	5	0.09	0.01
590	4/22/2008	787	5/10/2011	197	1.24	0.18
708	5/10/2011	713	7/10/2011	5	0.57	0.08
998	4/21/2011	1001	7/26/2011	3	0.22	0.03

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 2011 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%
2011	641 (505-912)***	0.15	460	71.8%

\*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.

\*\*\*246 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 2011 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
2010	1.13	1.07	0.41
2011	1.27	0.75	0.37

Table 8. Number of northern pike captured, electrofishing effort expended (hours), and northern pike catch per unit effort (CPUE; # NPK/ hour electrofishing) across each pass for each of the three sub-sections (Juniper: RM 134.2-91.0, Maybell: RM 88.7-60.5, and Lily Park: RM 55.5-50.5) in 2011.

	<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>	<u>Pass 11</u>	<u>Pass 12</u>	<u>Pass 13</u>	<u>Pass 14</u>
<b><u>JUNIPER</u></b>														
NPK Captured	137	89	59	34	8	4	31	42	56	59	73	57	38	42
Effort (hours)	48.02	46.03	48.01	40.85	34.83	34.58	42.85	44.74	52.38	36.38	42.28	39.95	28.59	32.52
CPUE (NPK/hour)	2.85	1.93	1.23	0.83	0.23	0.12	0.72	0.94	1.07	1.62	1.73	1.43	1.33	1.29
<b><u>MAYBELL</u></b>														
NPK Captured	5	17	14	7										
Effort (hours)	32.6	25.39	29.73	35.6										
CPUE (NPK/hour)	1.66	0.67	0.47	0.20										
<b><u>LILY PARK</u></b>														
NPK Captured	9	8	2	1	3	4								
Effort (hours)	12.35	10.0	11.94	12.66	17.4	8.72								
CPUE (NPK/hour)	0.73	0.80	0.17	0.08	0.17	0.46								

Table 9. Number of northern pike (NPK) 2011 recaptures that featured “foreign” tags, including those tagged and released by CPW and CSU in 2008, 2009, and 2010, as well as those tagged by project 98b in previous years and those tagged and released by CPW in Elkhead Reservoir in 2011.

<u>Source of “Foreign” Tags</u>	<u>Number of NPK Recaptured</u>
Tagged and Released by CPW and CSU in 2008	1
Tagged and Released by CPW and CSU in 2009	3
Tagged and Released by CPW and CSU in 2010	4
Tagged and Released by USFWS (98b) in Previous Years	0
Tagged and Released by CPW in Elkhead Reservoir in 2011	1

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 2011 by the Colorado Division of Parks and Wildlife (CPW).

<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	9	2	7	9	0	0
3	12	5	8*	12	0	0
4	12	1	9	12	0	0
5	1	0	1	1	0	0
<u>Total</u>	36	8	27	36	0	0

\*Includes 1 recaptured fish with old style tag that was given new style tag

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 2011 by the Colorado Division of Parks and Wildlife(CPW).

<u>CDO 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	5	5	0	5	0	0
2	11	6	5	11	0	0
3	16	12	4	16	0	0
4	5	2	2	5	0	0
<u>Total</u>	37	25	11	37	0	0

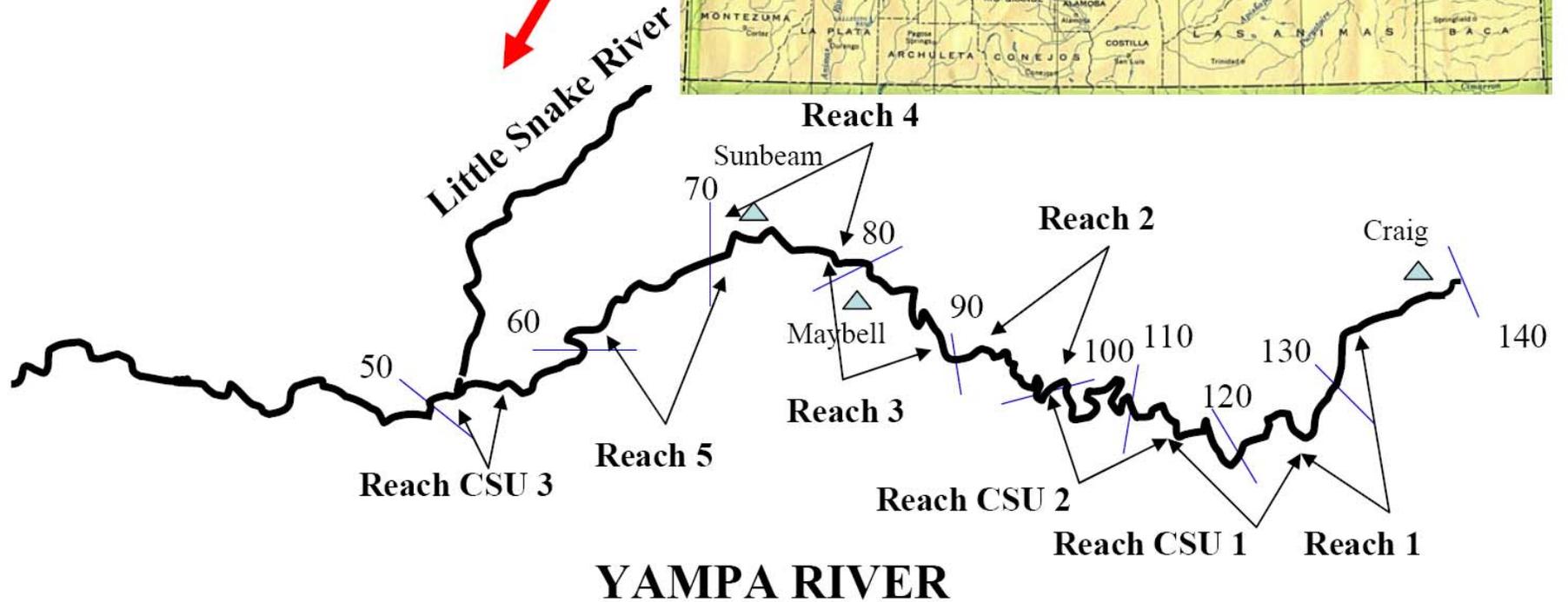
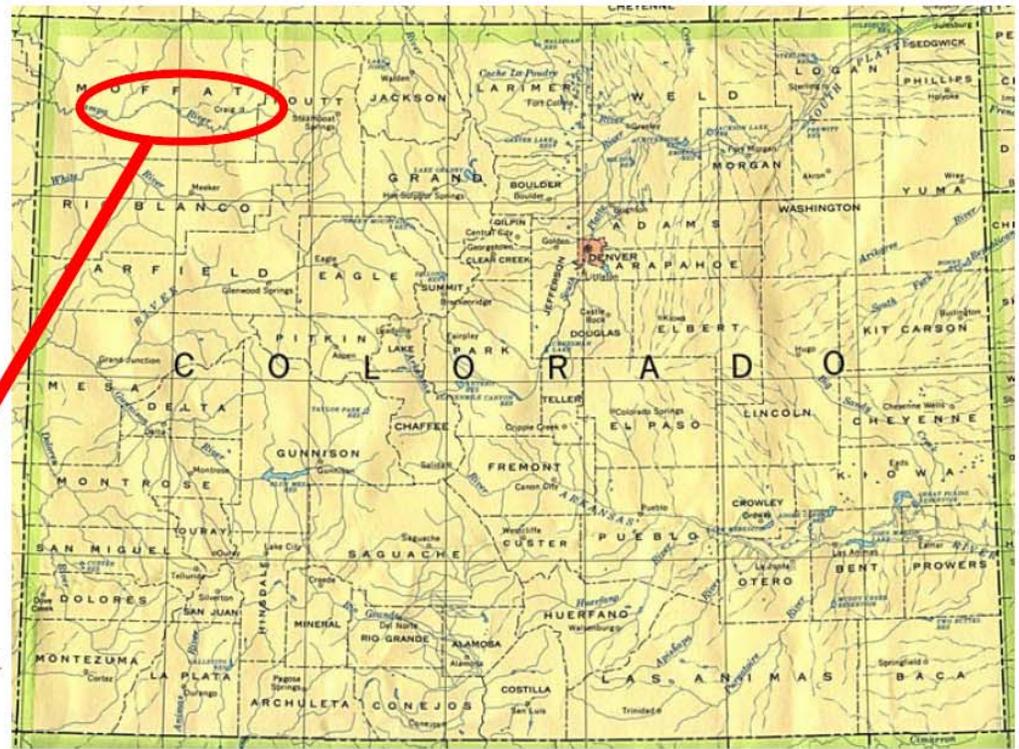
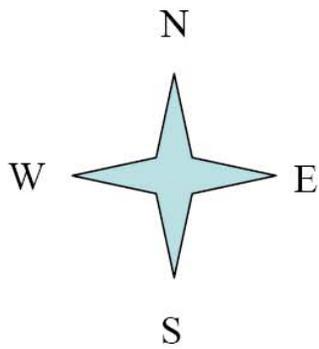


Figure 1. River reaches of the middle Yampa River sampled by the CDOW and CSU (Graphics courtesy of P. Martinez and R. Anderson)

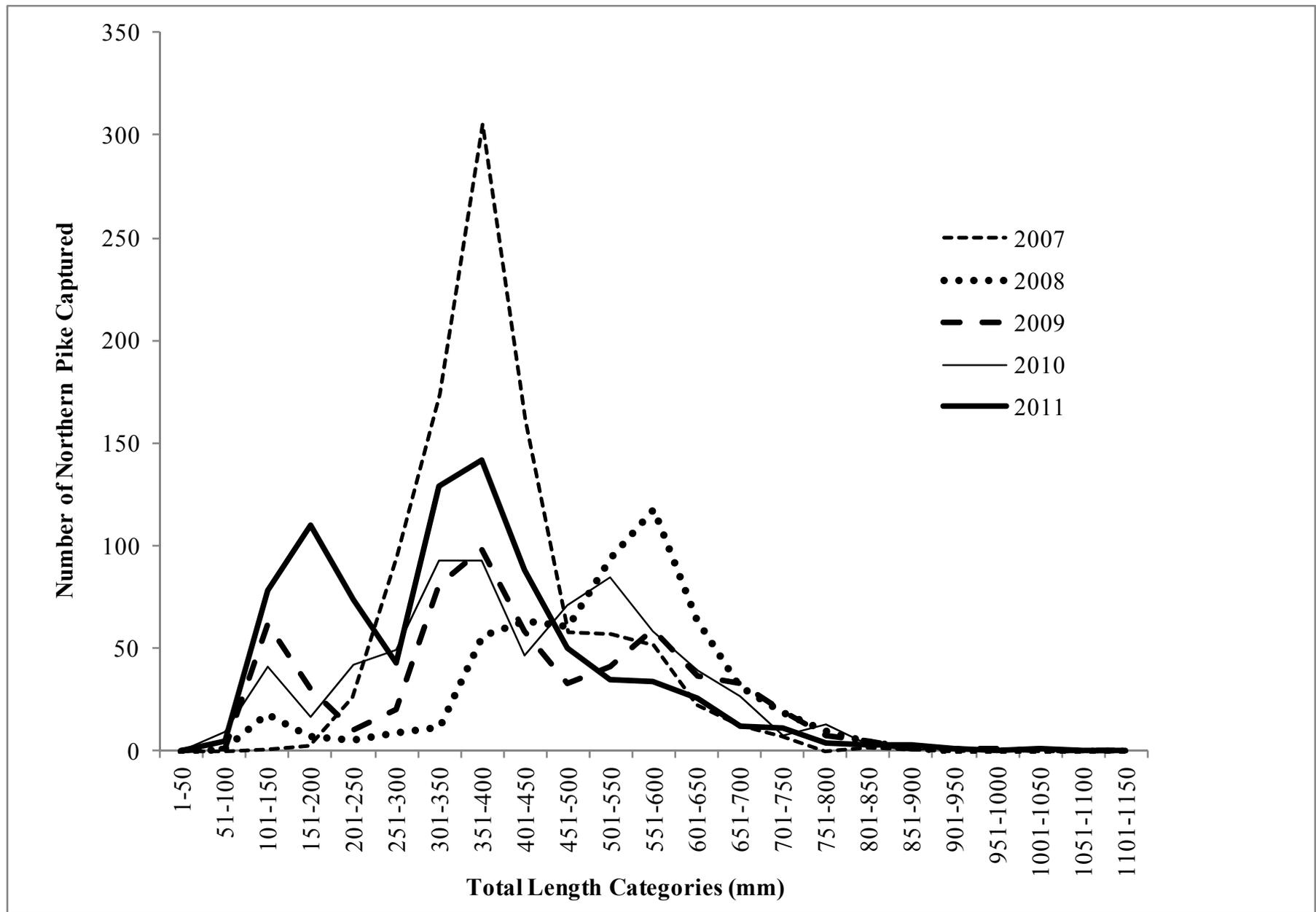


Figure 2. Northern pike total length frequency distributions in increments of 50 mm, from 2007 to 2011, in the middle Yampa River, from South Beach (RM 134.2) to Lily Park (RM 50.5). 2011 is depicted as a heavy weight solid line, 2010 is depicted as a light weight solid line, 2009 is depicted as a large dashed line, and 2008 is depicted as a dotted line, and 2007 is depicted as a small dashed line.

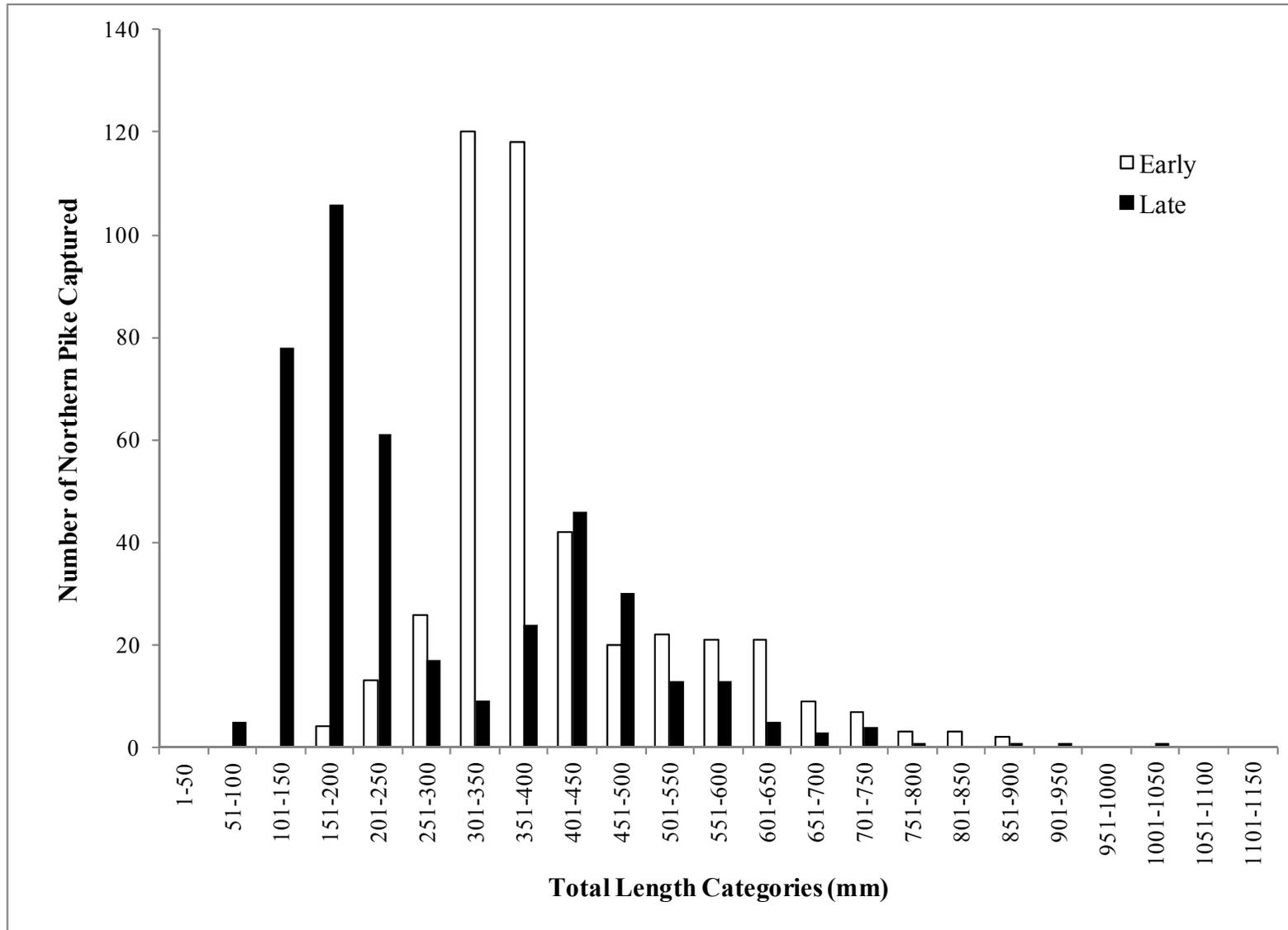


Figure 3. Northern pike length frequency distribution in increments of 50mm for early in the study (white bars), prior to peak runoff, and late in the study (solid bars) after peak runoff in 2011.

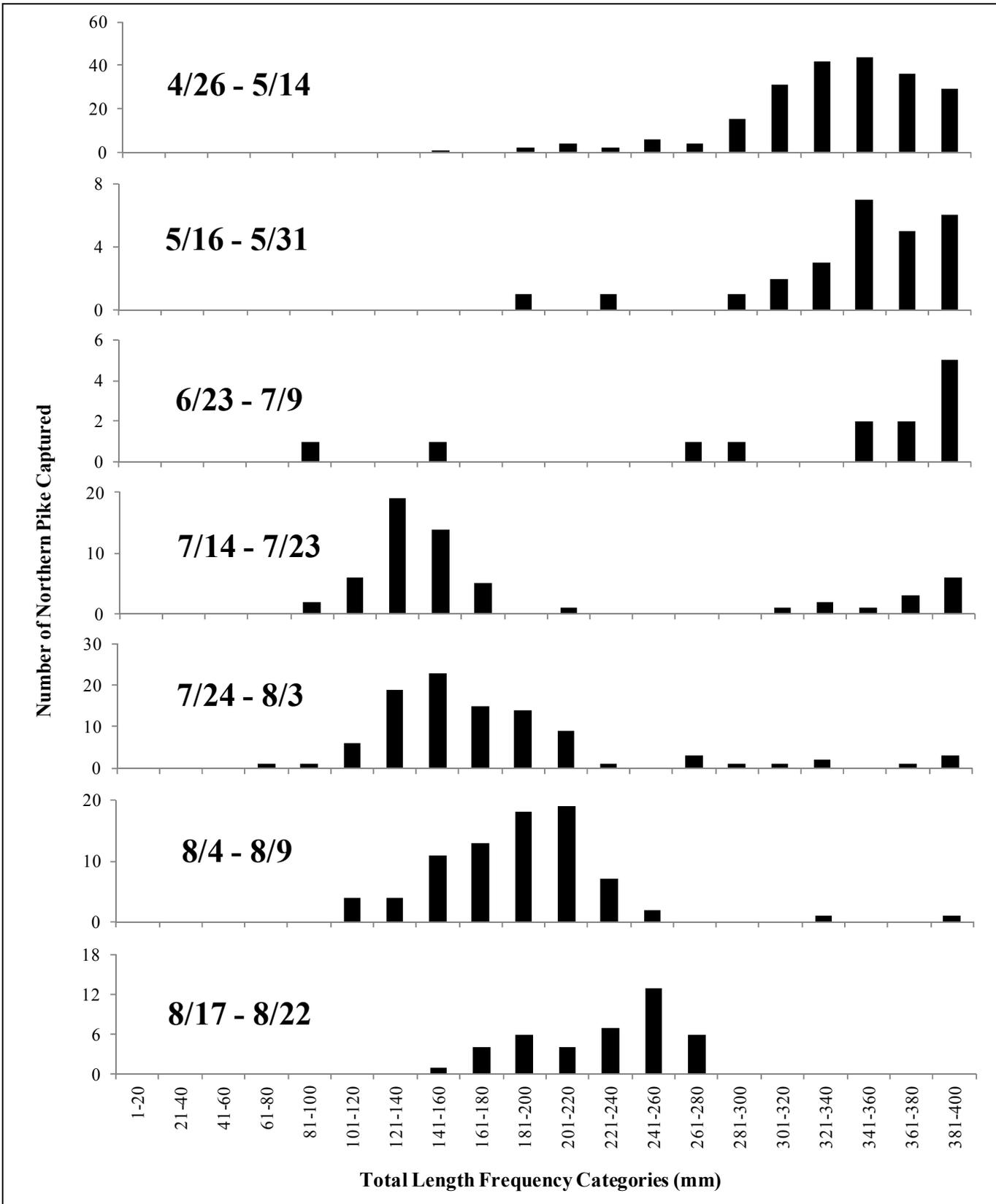


Figure 4. Length frequency distribution for northern pike < 400 mm TL, in increments of 20mm, across seven sampling periods in the Juniper section, in 2011.

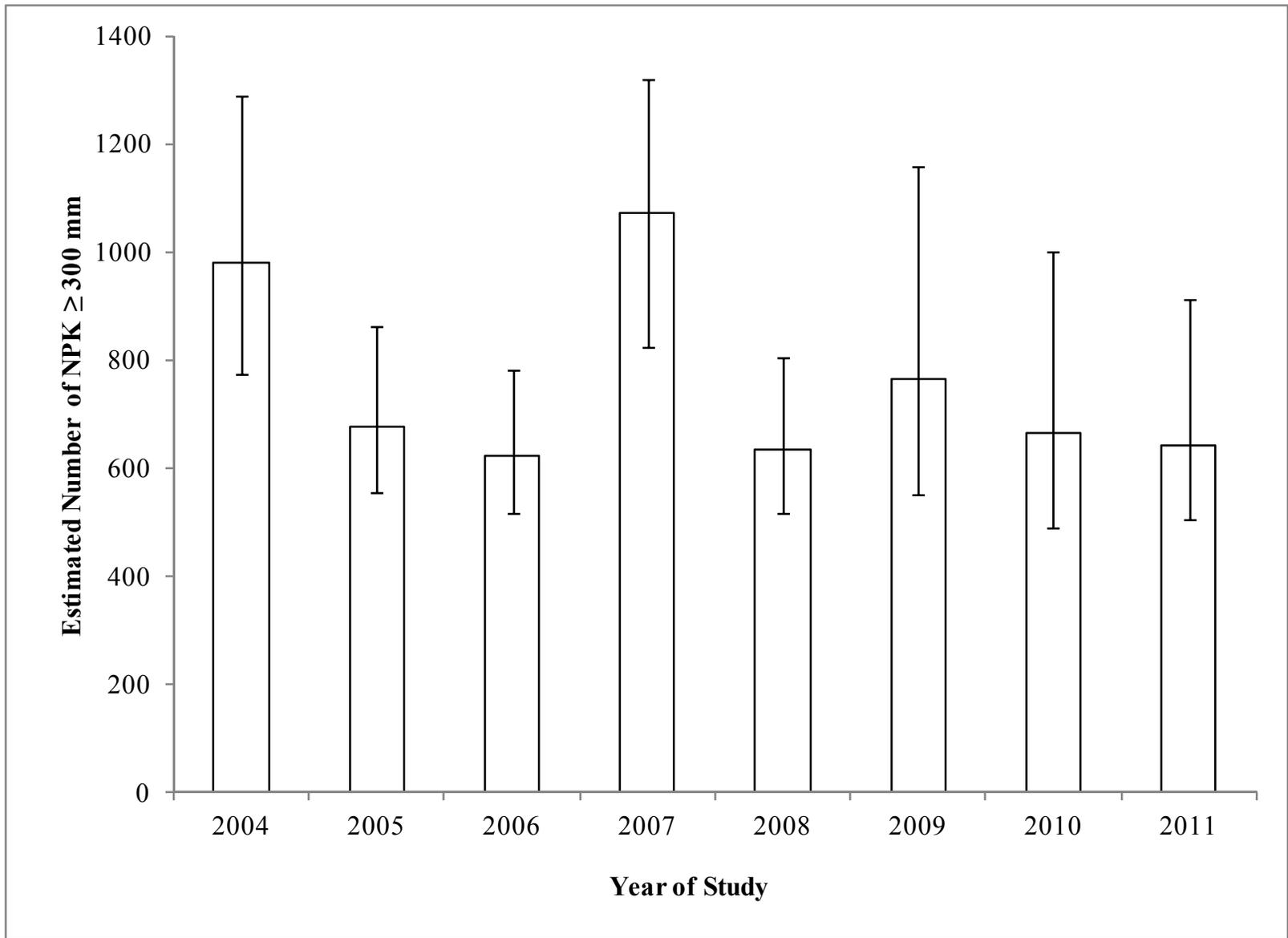


Figure 5. Northern pike  $\geq 300$  mm TL population estimates and the 95% Confidence Interval generated for the Yampa River from river mile 134.2 to 50.5. .

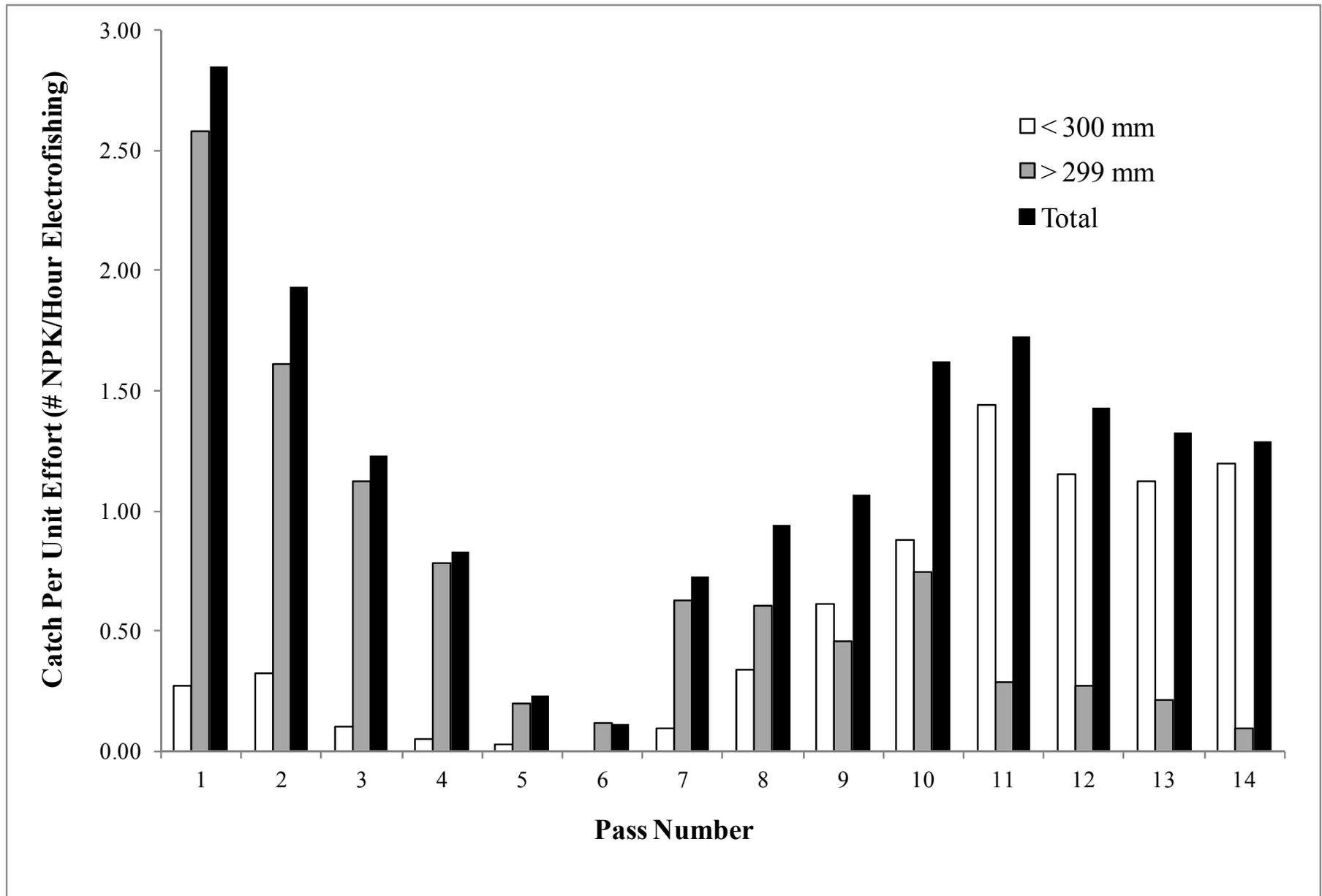


Figure 6. Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) for three categories (< 300 mm, > 299 mm, and all NPK) across 14 passes in the Juniper subsection in 2011.

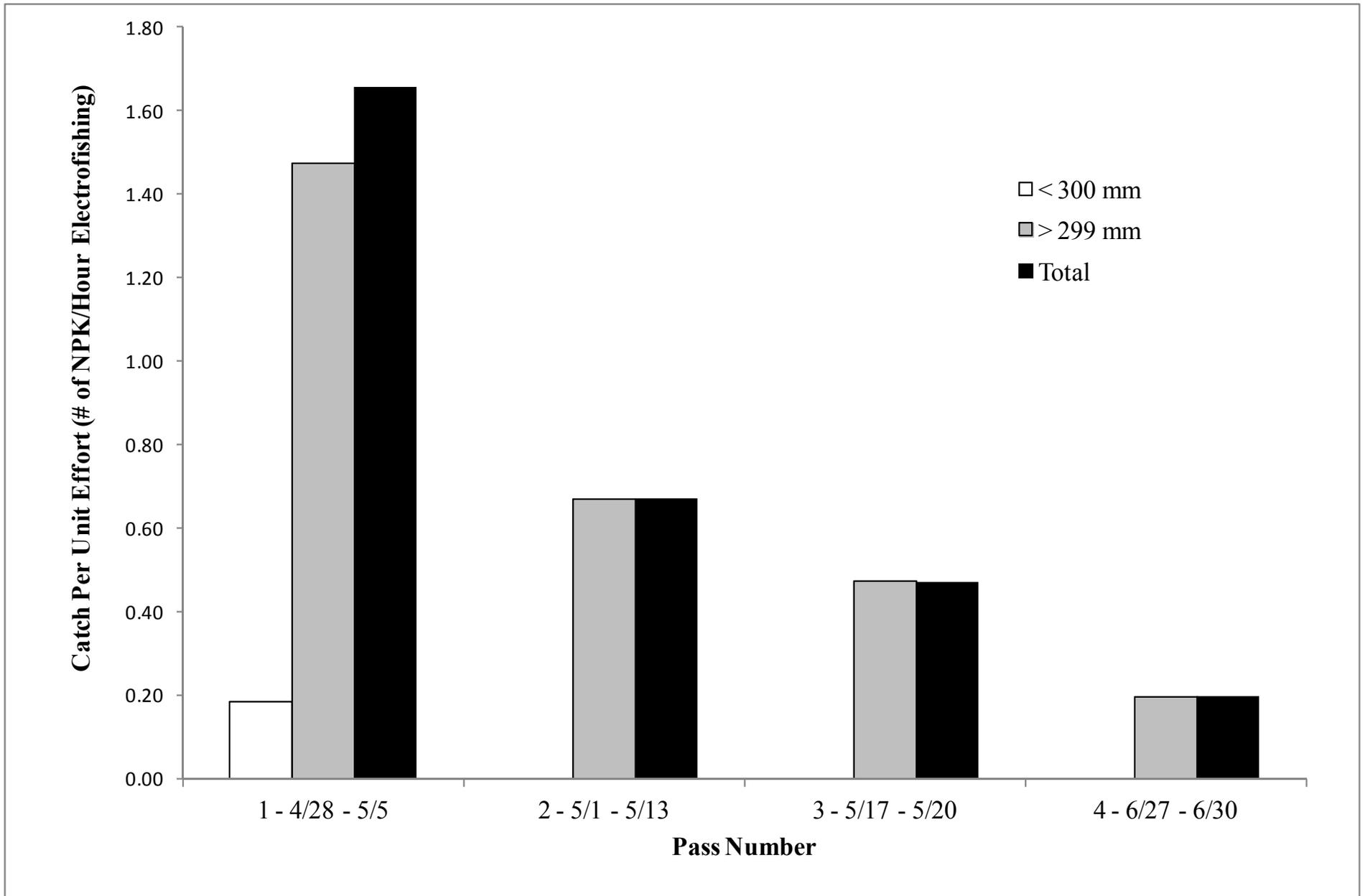


Figure 7. Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) for three categories (< 300 mm, > 299 mm, and all NPK) across 4 passes in the Maybell subsection in 2011. Associated dates for each pass are denoted next to the pass number.

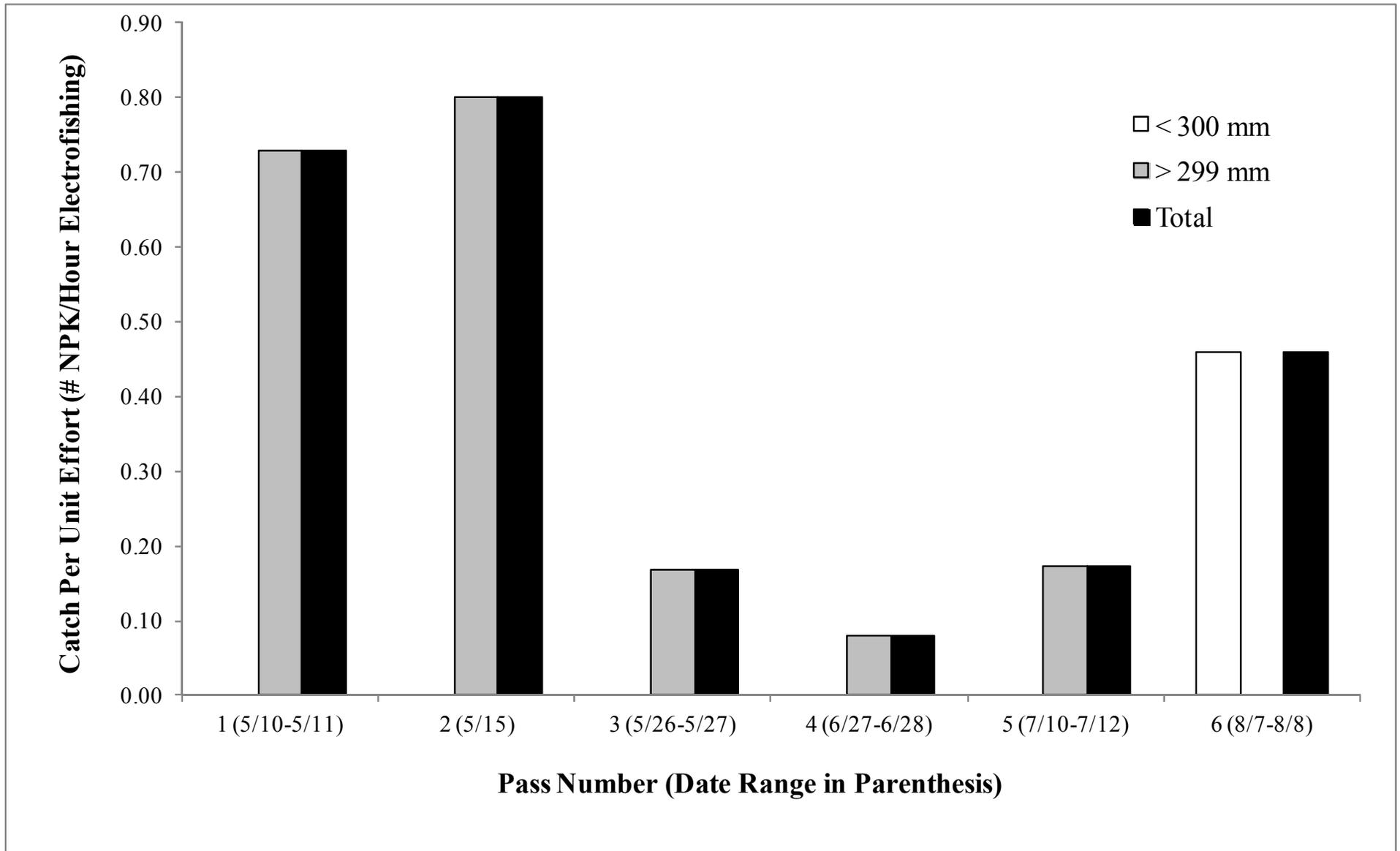


Figure 8. Northern pike (NPK) catch per unit effort (CPUE; # NPK/hour) for three categories (< 300 mm, > 299 mm, and all NPK) across 6 passes in the Lily Park subsection in 2011. Associated dates for each pass are denoted next to the pass number.

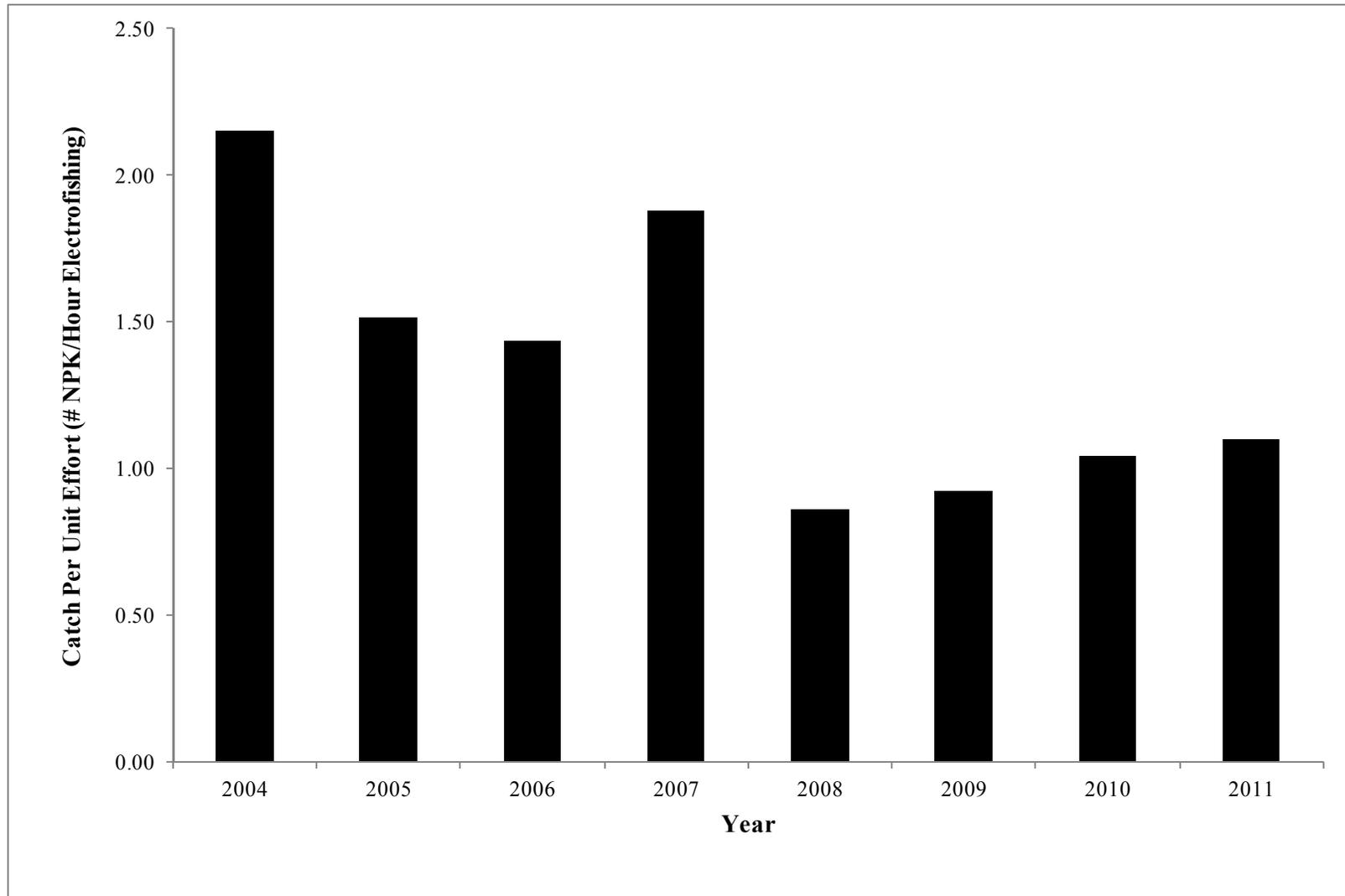


Figure 9. Northern pike Catch Per Unit Effort (CPUE; number of NPK/hour) across all passes in the entire study area sampled by CPW and CSU, for 2004 through 2011.

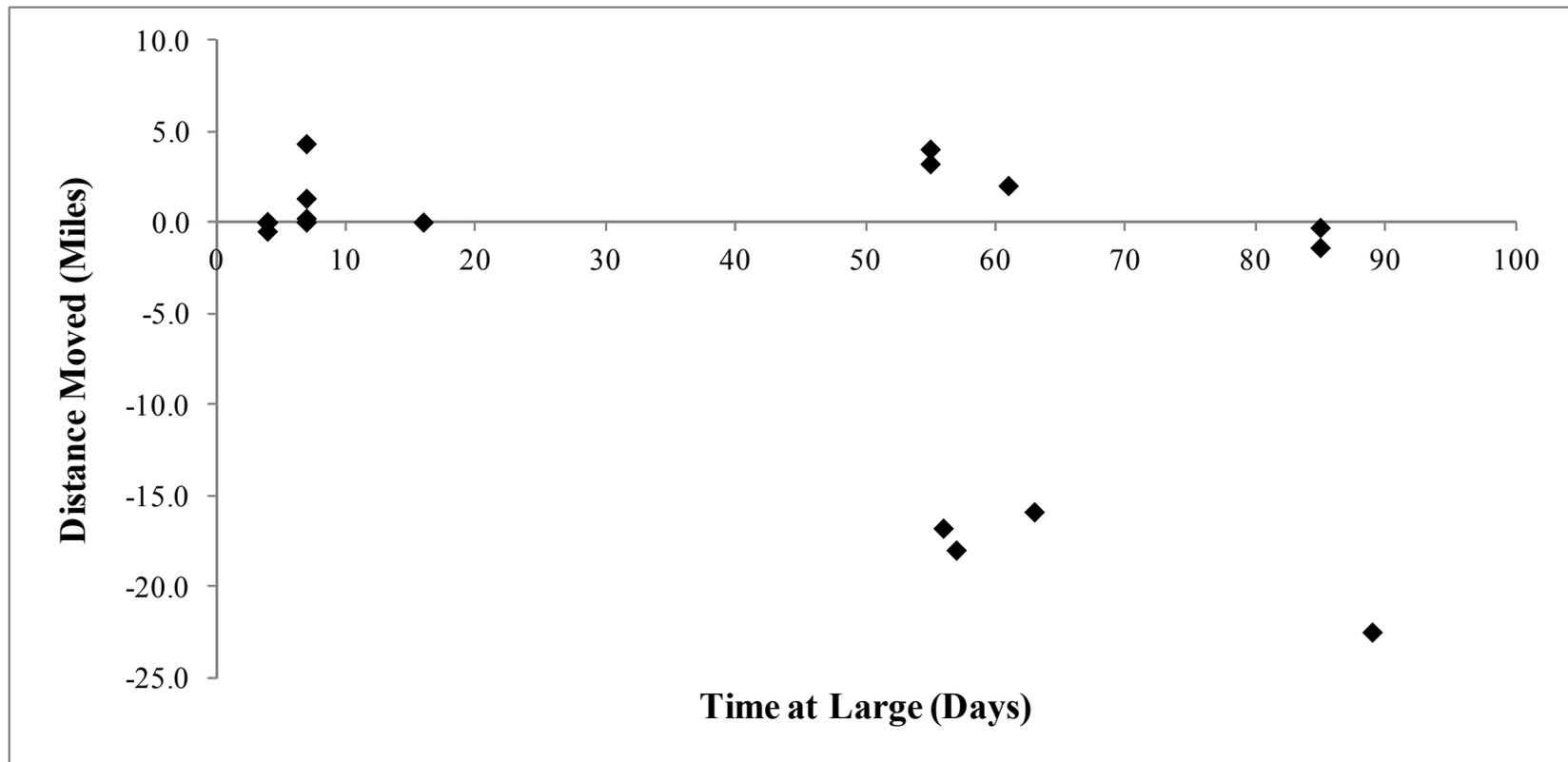


Figure 10. Movement distances of northern pike that were tagged and recaptured in the middle Yampa River in 2011, plotted against the number of days each fish spent at large between capture events. Negative values on the y-axis represent downstream movement and positive values represent upstream movement.

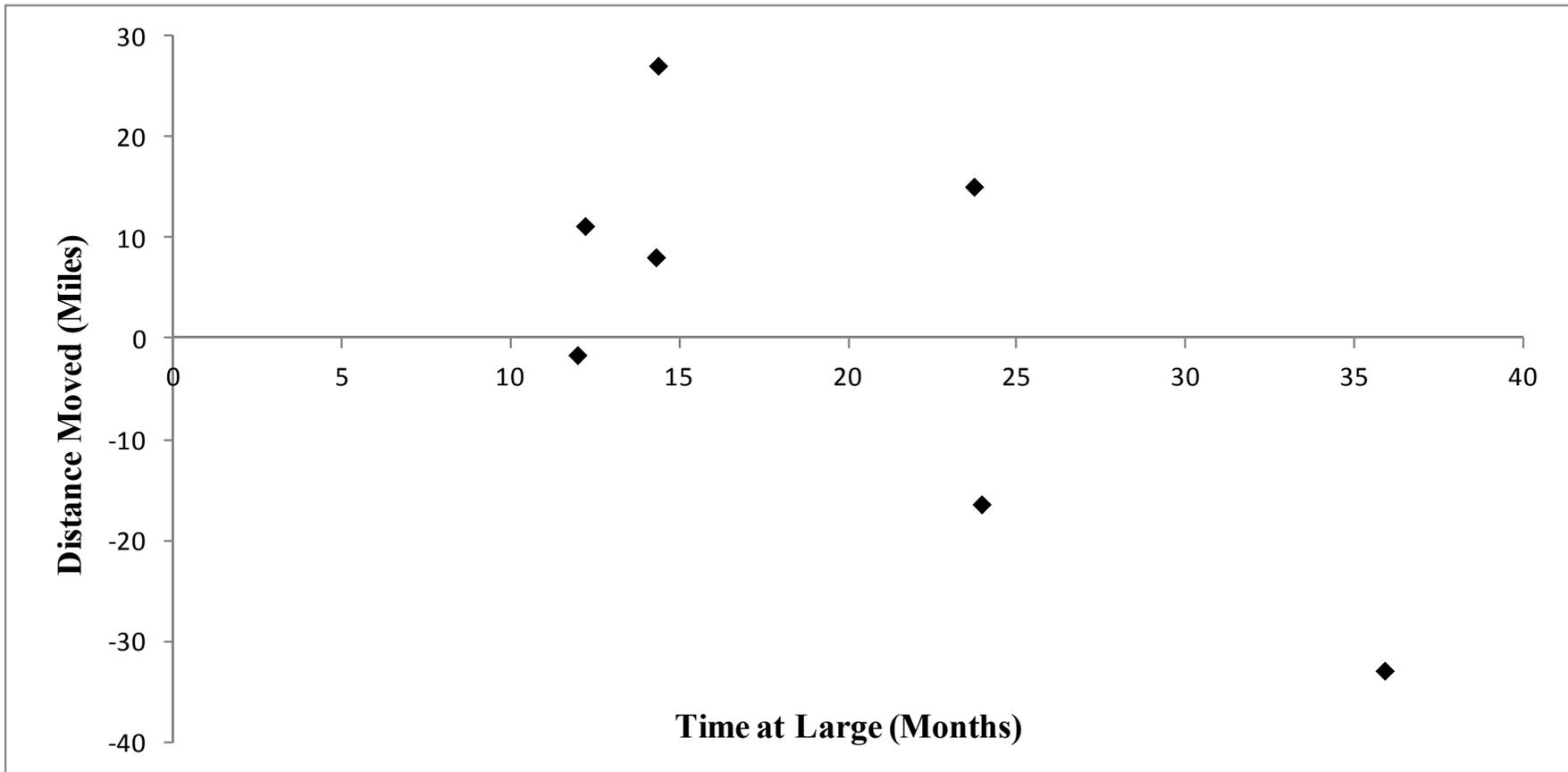


Figure 11. Movement distances of northern pike that were recaptured in the middle Yampa River in 2011, but that were initially tagged in previous years, plotted against the number of months each fish spent at large between capture events. Negative values on the y-axis represent downstream movement and positive values represent upstream movement.

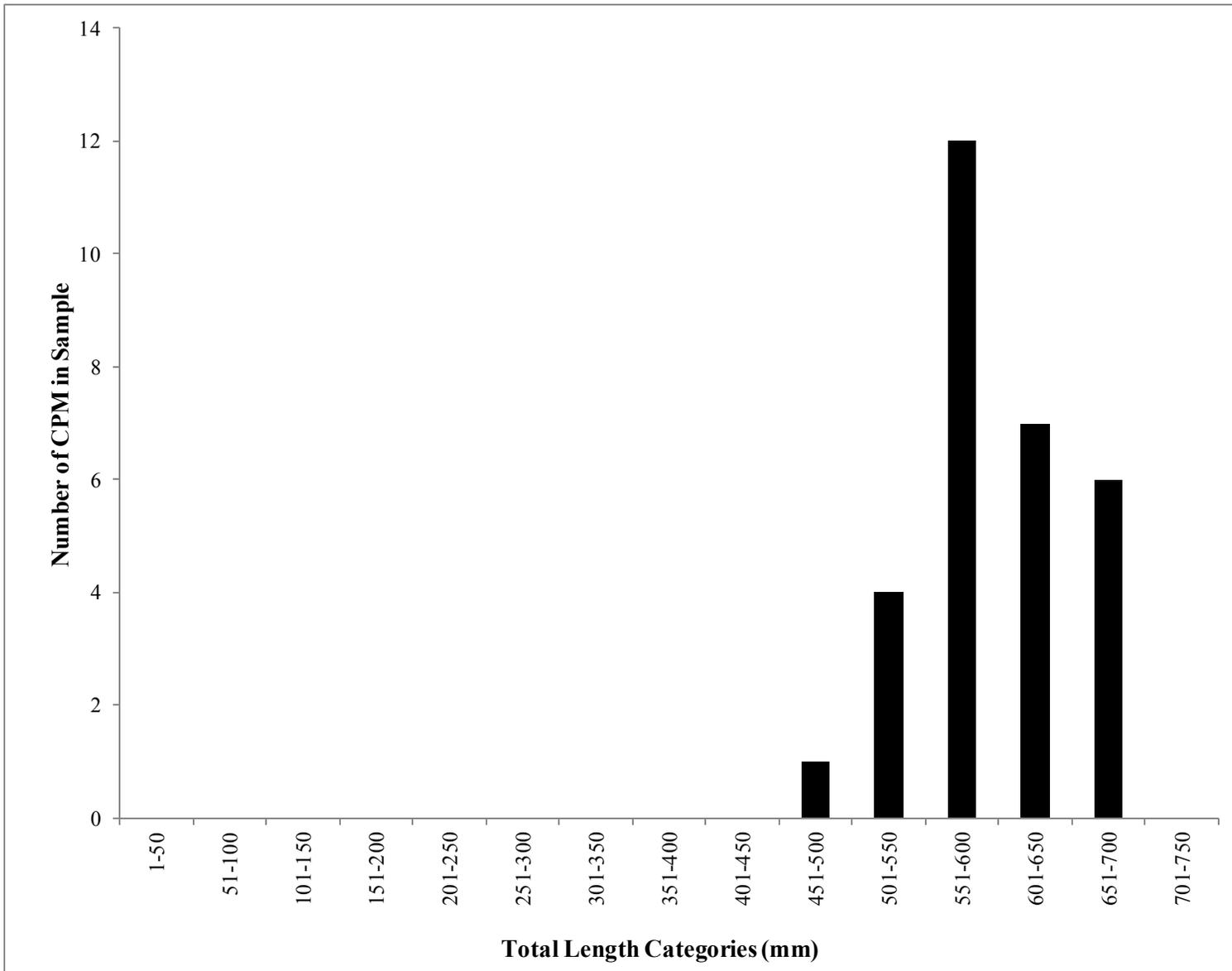


Figure 12. Colorado pikeminnow (CPM) total length (mm) frequency distribution, with size classes in increments of 50mm, for the five reaches in the middle Yampa River sampled by the CPW in 2011.

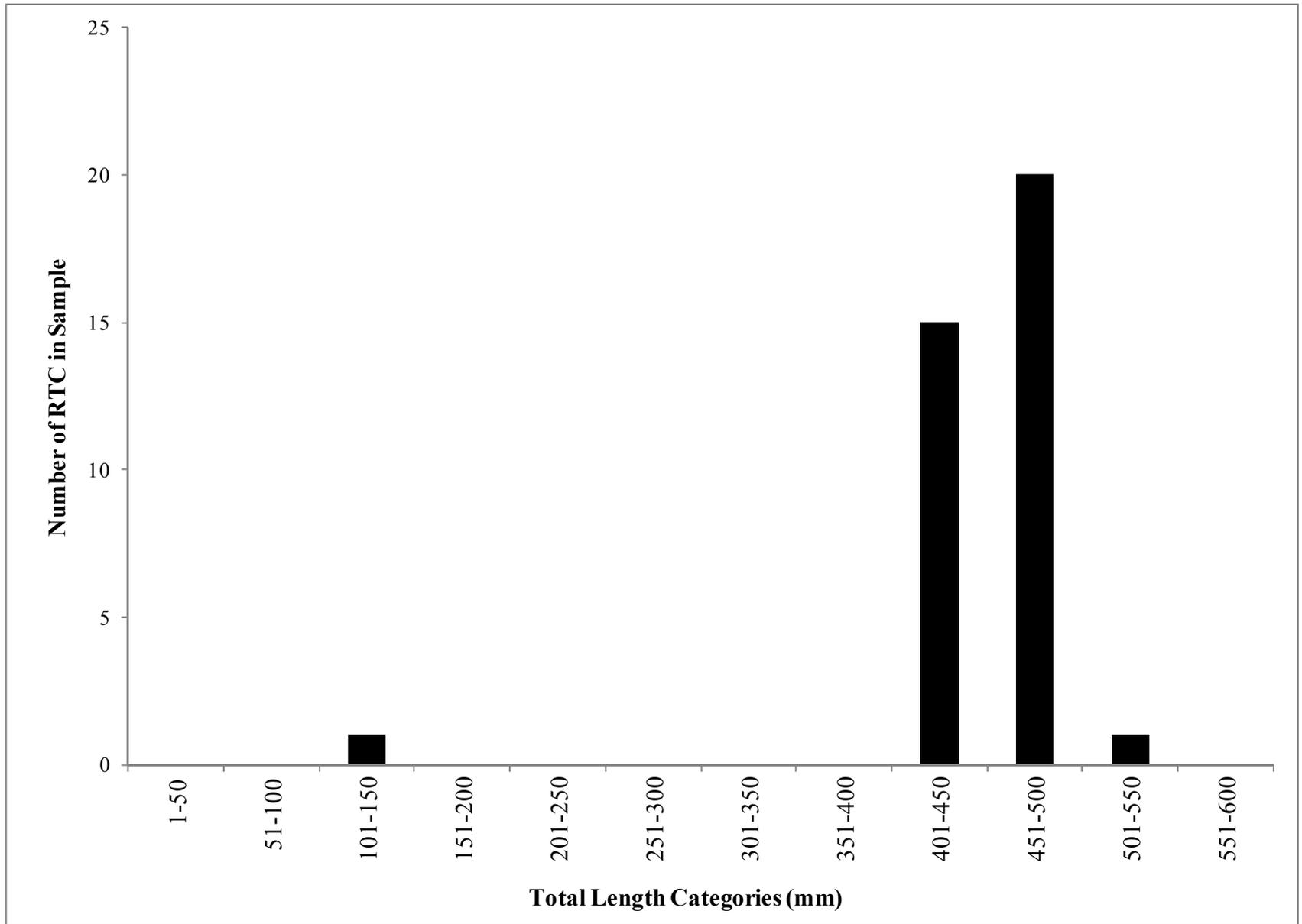


Figure 13. Roundtail chub (RTC) total length (mm) frequency distribution, with size classes in increments of 50 mm, for the section of the Yampa River sampled by CPW in 2011.

