Westslope Cutthroat Trout Restoration

in Muskrat Creek, Boulder River Drainage, Montana:

Progress Report for Period 1993 to 2002

Prepared by:

Bradley B. Shepard
Montana State Cooperative Fisheries Research Unit
Montana State University
Bozeman, Montana 59718

and

Lee Nelson
Montana Department of Fish, Wildlife and Parks
Townsend, Montana 59644

March 2003

Table of Contents

List of Figures

Executive Summary

Montana Fish, Wildlife and Parks (FWP), the Bureau of Land Management (BLM), and the Forest Service (FS) are collaborating in an on-going effort to conserve westslope cutthroat trout *Oncorhynchus clarki lewisi* (WCT) in Muskrat Creek, a tributary to the Boulder River, Montana in the Elkhorn Mountains. A wooden barrier (crib-type) was constructed near the Forest Service boundary (stream kilometer 12.7) in 1997. Since 1996 brook trout have been annually removed from Muskrat Creek from this constructed barrier up to a natural barrier, located about 2.4 km above this constructed barrier, using repeated electrofishing to conserve an extant WCT population in Muskrat Creek. This report summaries work completed in 2002.

A total of 589 brook trout were removed from the portion of Muskrat Creek from the constructed fish barrier upstream to the natural barrier in 2002. Twenty-seven brook trout were removed during April, 14 during June, 95 during July, 383 during August, and 27 during October. Almost all the brook trout captured during 2002 were age-1 fish, suggesting that past removal efforts have almost eliminated the adult population and that spawning by brook trout was not very successful in the fall of 2001 (2002 year-class). Brook trout removal has increased abundance of WCT in the portion of creek between the two barriers, despite the removal of age 1 and older WCT from this portion of the stream in 1997, 1998, and 2001. No adipose-clipped brook trout were captured above the constructed crib barrier in 2002 indicating that brook trout were not moving over the constructed barrier. Our intensive electrofishing efforts the past two years appears to have been effective at removing almost all of the adult brook trout and has severely depressed recruitment of brook as almost no age-0 brook trout were captured in 2002. We believe that it may be possible to totally remove all brook trout using electrofishing from the 2.4 km portion of Muskrat Creek between the two barriers. We suggest that one more year of intensive removal efforts to remove the successful 2001 year-class of brook trout (age-1 in 2002) when they are age-2 in 2003, and before they can spawn, could be successful in totally eliminating brook trout from this portion of the stream.

The WCT re-located above the natural barrier survived and reproduced in the upper basin and by 2002 these WCT had expanded upstream to the extreme headwaters (to about km 21.7 or 1.0 km above the release site) and downstream throughout the stream. Estimated densities of WCT in two sample sections near and below the original release sites were 20 and 27 WCT/100 m of stream. None of these re-located WCT had moved down below the natural barrier to their original capture sites until after 2000, when severe drought conditions reduced flows in the headwater portion of the stream leading to five individuals moving downstream in 2001. No additional adipose-clipped WCT were captured below the natural barrier in 2002. One adipose-clipped WCT was recaptured in 2002 above the natural barrier near where it had been released.

We have been successful in expanding the existing WCT population in both distribution and total population. We have increased their distribution above the Forest Service boundary (above stream kilometer 12.7), where the crib barrier was constructed, from 2.4 km to nearly 9.0 km. In addition, the removal of brook trout from the 2.4 km of stream between the constructed and natural barrier appears to be offering the existing WCT population some relief to increase their numbers in this portion of the stream. Our best estimate is that the WCT population (fish 75 mm and longer) has increased at least 10-fold, from less than 100 in 1997 to over 1,000 in 2002.

Introduction

Montana Fish, Wildlife and Parks (FWP), the Bureau of Land Management (BLM), and the Forest Service (FS) are collaborating in an on-going effort to conserve an extant population of westslope cutthroat trout *Oncorhynchus clarki lewisi* (WCT) in Muskrat Creek (Figure 1), a tributary to the Boulder River, Montana in the Elkhorn Mountains (Spoon and Shepard 1996; Canfield and Spoon 1999; Shepard et al. 1999; Shepard and Spoon 2000; Shepard et al. 2001; Shepard and Nelson 2002). Shepard and Spoon (2000), Shepard et al. (2001) and Shepard and Nelson (2002) provided a detailed description of the Muskrat Creek drainage and detailed efforts made to restore WCT in this drainage through 2001. Stream flows during 2000 and 2001 were extremely low due to drought conditions (Shepard and Nelson 2002); however, flows during 2002 were nearly average for the period of record (Figure 2). The tasks being implemented to conserve this WCT population include 1) construction of a barrier to upstream fish passage at stream kilometer 12.7, near the Forest Service boundary, to prevent further invasion of habitats above this barrier by exotic brook trout, 2) removal of brook trout from approximately 2.4 km of habitat between this constructed barrier and a natural barrier (located at stream kilometer 15.1) to eliminate competition and predation from brook trout on WCT and prevent the replacement or displacement of WCT by brook trout; and 3) movement of enough WCT upstream from the area between the two barriers to habitats above the natural fish barrier to establish a self-sustaining WCT population in the approximately 6.0 km of additional suitable habitat located above this natural barrier. This report details efforts made to remove brook trout, assess the effects of these removals on the existing WCT population between the two barriers, and evaluate the translocation success of WCT to the upper basin above the upper natural barrier during 2002.

Kulp and Moore (2000) suggested that conducting multiple electrofishing removals on at least three occasions within a year might be effective at removing exotic rainbow trout from Applachian Mountain streams, thus allowing native brook trout populations in these streams to expand. Thompson and Rahel (1996) indicated that this technique had merit in the Rocky Mountains for removing brook trout to conserve cutthroat trout, but did not completely remove brook trout from a Wyoming stream where they tested this technique. To test this technique for removing brook trout from mountainous streams of the Northern Rocky Mountains, we conducted multiple electrofishing efforts on two occasions during 2001 and on five separate occasions during 2002.

During 2001 all stream kilometer data were updated based on Montana FWP's GIS coverage of streams (1:100,000) being updated to an identification protocol with latitude/longitude at each stream's mouth (LLID) uniquely identifying each stream along with each stream routed by stream mile. Previously, stream kilometers had been calculated based on a fixed point above the stream's mouth. This resulted in increases for all stream kilometers by 2.4 km and slight changes in distances from previous reports. The distance from the constructed barrier to the natural barrier increased from 2.2 reported in last year's report (Shepard and Nelson 2002) to 2.4 km this year due to increased precision in locating barriers on GIS maps.

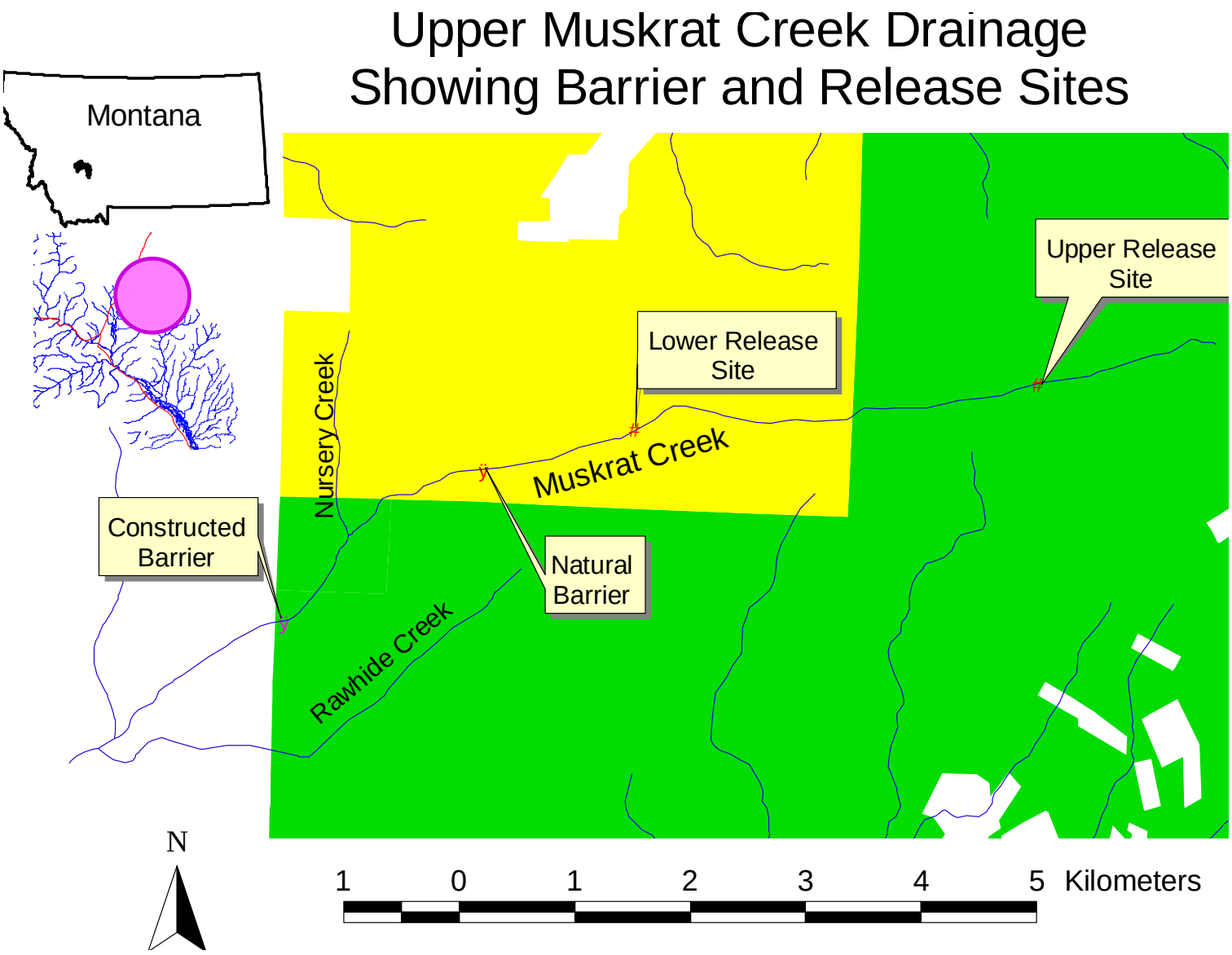

Figure 1. Map of Muskrat Creek showing land ownership, locations of constructed barrier, natural barrier (waterfall), and sites where westslope cutthroat trout were released in 1997 and 1998.

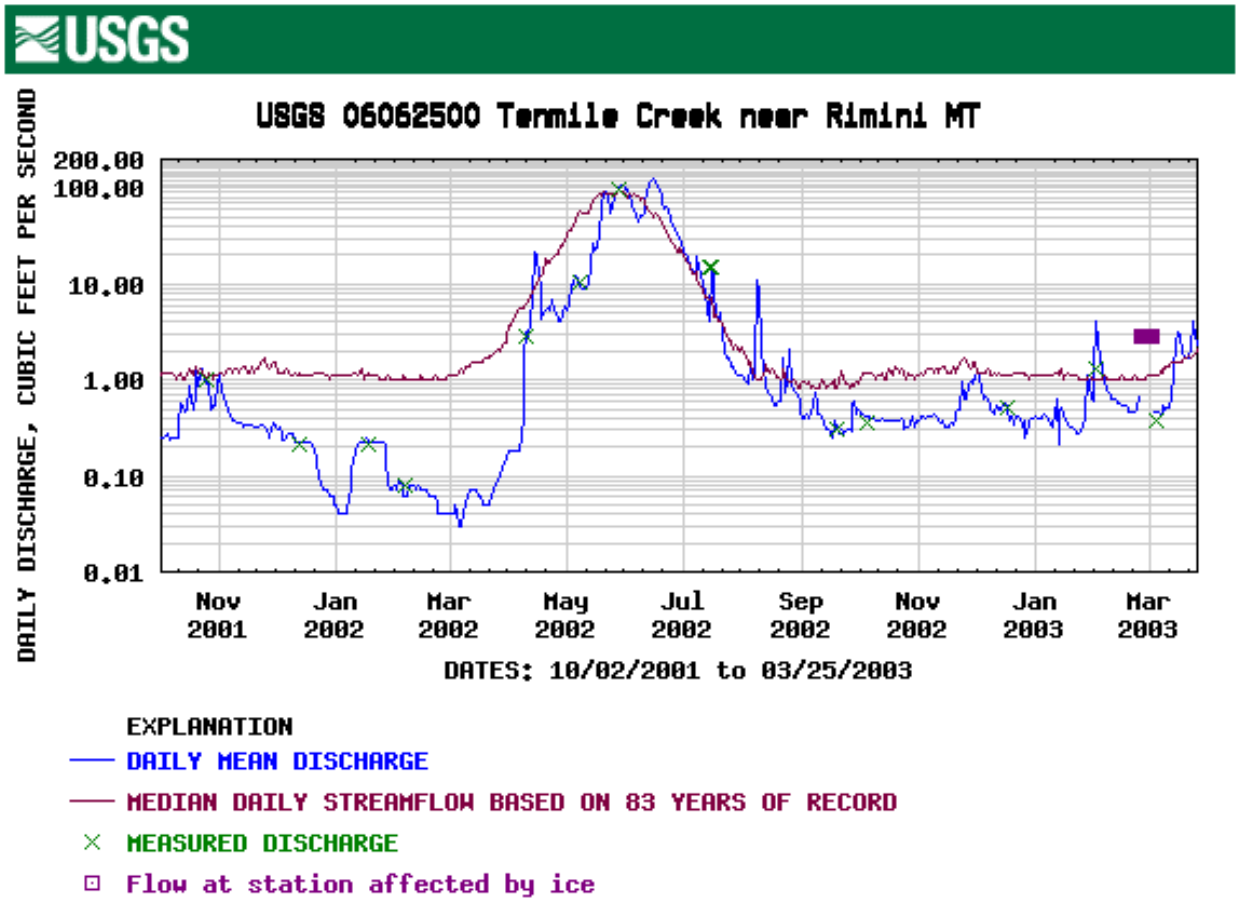

Figure 2. Provisional flow data for Tenmile Creek, the nearest flow-gauged stream, from November 2001 to March 2003 compared to long-term average (83 years) flows. Data are courtesy of the USGS via the web (http://mt.waterdata.usgs.gov/nwis/sw).

Methods

Single-pass and multiple-pass electrofishing were used to remove brook trout and estimate fish abundance. Multiple passes consisted of two or three consecutive electrofishing passes. Each section was blocked with 6.24 mm mesh nets at both its upstream and downstream boundaries prior to electrofishing. All captured fish were measured to the nearest mm (total length) and weighed to the nearest gram using either an electronic (O'Haus Scout®) or spring (Pesola®) scale. All captured brook trout were transported downstream below the constructed crib barrier where their adipose fins were removed prior to releasing them below this barrier. During 2002 we made a single electrofishing pass during the weeks of June 12 and October 1; a combination of single-pass and multiple-pass electrofishing during the week of July 10; and multiple-pass efforts during the weeks of August 26 and April 10. Electrofishing was conducted from the constructed fish barrier up to the natural fish barrier during all sampling efforts, except during April when electrofishing was only done from the constructed fish barrier up to Nursery Creek. During the April 2002 sampling effort all WCT captured were moved above Nursery Creek to the creek near the trailhead. These WCT did not have their adipose fins clipped. In addition, the 14 WCT captured during the June 2002 sampling from Nursery Creek up to the natural barrier were relocated above the natural barrier (between the natural barrier and the trail-crossing footbridge) and mistakenly did not have their adipose fins clipped.

Population estimates were made for the August sampling effort using the software program MICROFISH (version 3.0; Van Deventer and Platts 1989). Relative abundance, expressed as the number of fish captured per 100 m of stream length during a single electrofishing pass, was computed for all sampling efforts by stream kilometer. We plotted length frequencies for all captured fish by 10 mm size groups and species for each sample event.

Results and Discussion

A total of 589 brook trout were removed from the portion of Muskrat Creek from the constructed fish barrier upstream to the natural barrier in 2002. Twenty-seven brook trout were removed during April, 14 during June, 95 during July, 383 during August, and 27 during October. During August 2002 we estimated that the portion of Muskrat Creek from the natural barrier down to the constructed barrier supported an estimated 386 brook trout 75 mm and longer (SE: 2.7). Since only one brook trout captured during removal efforts was less than 75 mm we removed 382 of an estimated 386 brook trout from this reach of stream in August. However, in October we removed another 27 brook trout, so the August estimate was obviously an under-estimate. Regardless, we feel confident that we have removed most of the brook trout from this portion of the stream. We did not recapture any previously adipose-clipped brook trout in this reach of the stream, indicating that brook trout were not able to move upstream over the constructed barrier.

Length frequencies for captured brook trout indicated that age-0 brook trout were less than 90 mm for August and October sampling events, and less than 60 mm in April, June, and July sampling events (Figure 3). Based on length frequency data we partitioned ages based on length for the sample events in August and October 2002 as follows: age-0 – less than 90 mm; age-1 – 90 to 140 mm; and age 2+ - longer than 140 mm (Figure 3). For the April and June 2002 sampling events, ages were assigned as: age-0 - < 50 mm; age-1 – 50 to 120 mm; and age 2+

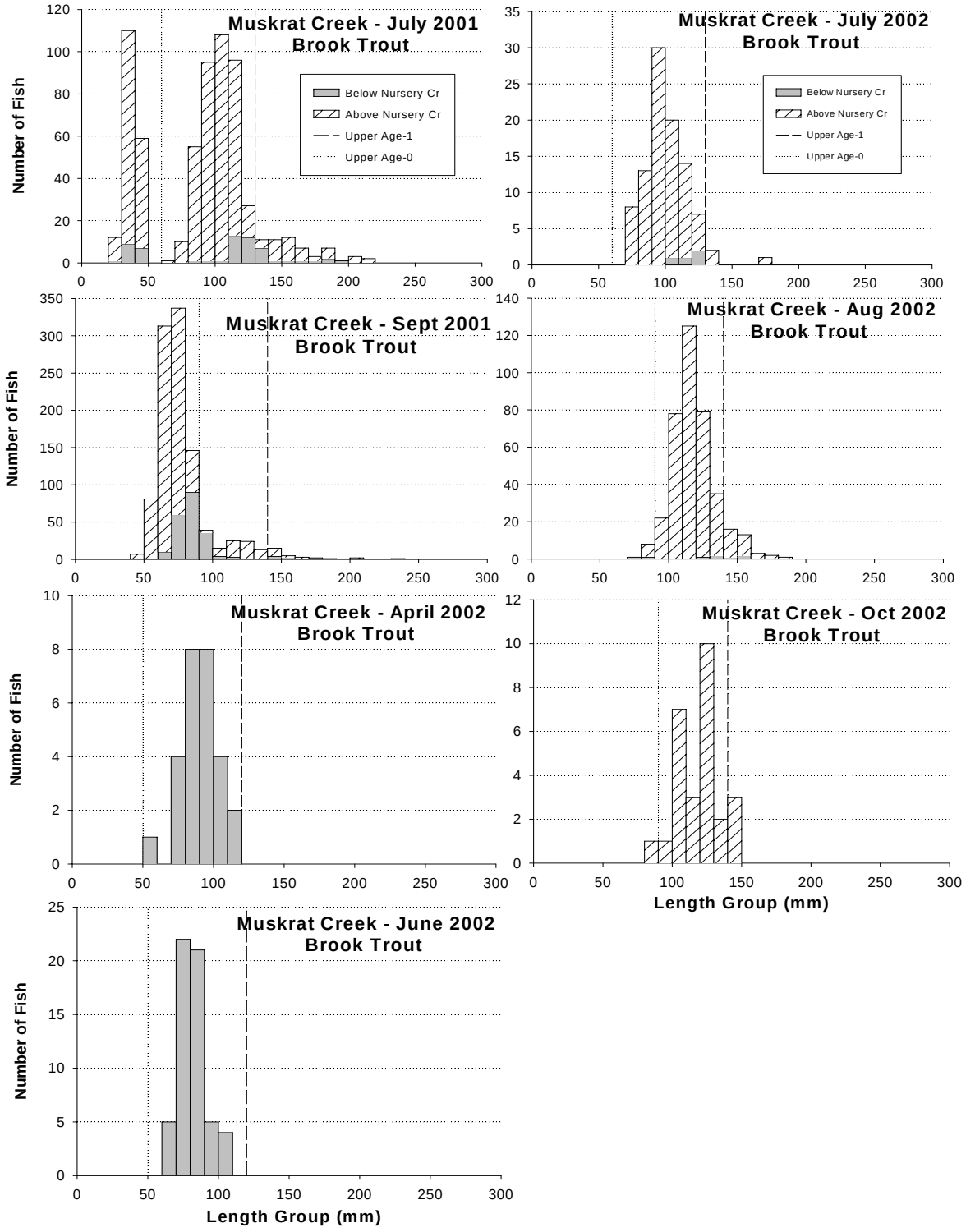

Figure 3. Length frequency histograms for brook trout captured in Muskrat Creek in 2001 and 2002. Vertical lines indicate assigned upper limits for age 0 (dotted line) and age 1 (dashed line) brook trout. September 2001 and August 2002 dates were very similar for comparing length frequencies since they occurred only three weeks apart.

- longer than 120 mm. For the July 2002 sampling events, ages were assigned as: age-0 - < 60 mm; age-1 – 60 to 130 mm; and age 2+ - longer than 130 mm. Length breaks for July not as clear as for other months, especially for the break between age-1 and age-2 fish, but still give a reasonable picture of age structure of captured fish.

Total catches of brook trout by age indicated that catch of age-0 brook trout declined from 1997 to 1999, increased between 1999 and 2001, and then declined dramatically between 2001 and 2002 (Figures 3 and 4). Almost all brook trout captured in 2002 were age-1 (Figure 3) and though their abundance was relatively high (Figure 4), we indicated that the 2001 year-class (age-1 in 2002) was a strong year-class based on last year's sampling of age-0 brook trout (Figure 3; Shepard and Nelson 2002). The September 2001 sample is comparable to the August 2002 sample since only three weeks separated these sampling dates in the two years (Figure 3).

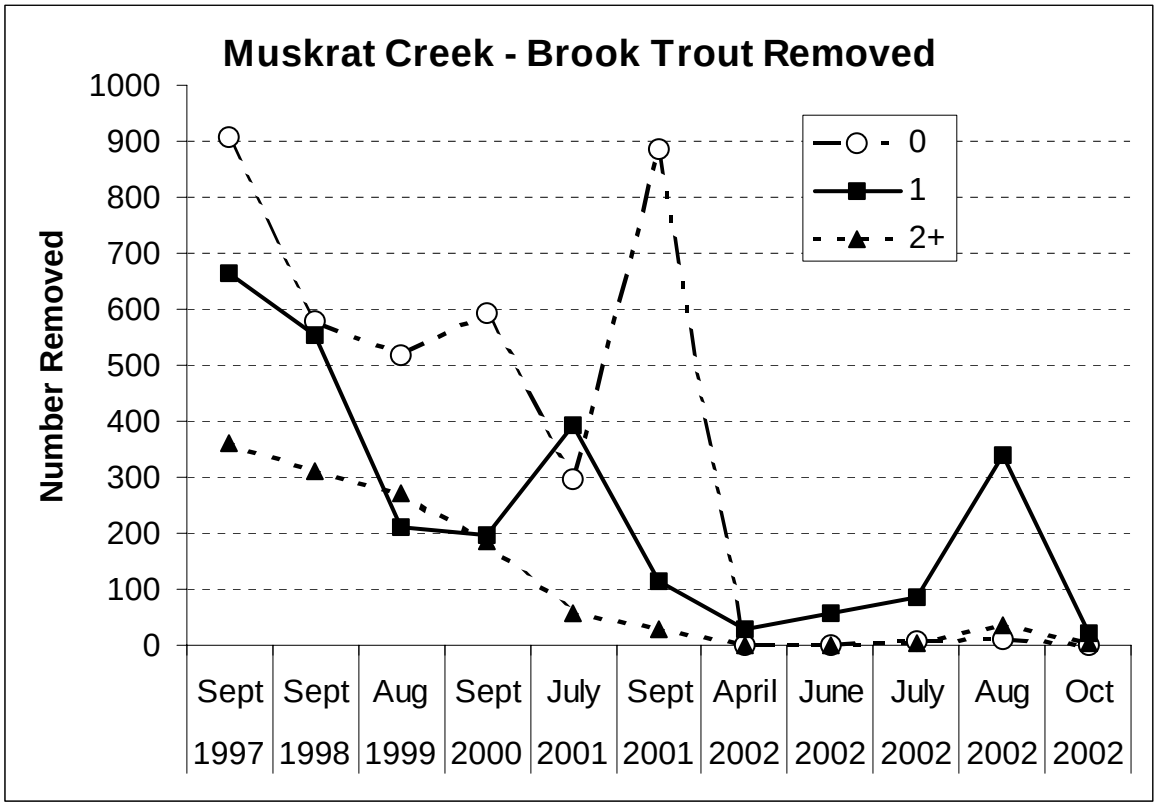

Figure 4. Number of brook trout age 0, age 1, and age 2 and older (see text for explanation of age assignments) removed from the portion of Muskrat Creek from the constructed fish barrier up to a natural fish barrier during each removal event from 1997 through 2002.

Our hope is that we can effectively remove this 2001 year-class by removing them as age-1 in 2002 and as age-2 in 2003 prior to their maturing. The extremely small numbers of both age-0 and age-2 and older brook trout that we found in the portion of Muskrat Creek from the constructed barrier upstream to the natural barrier was encouraging. We believe that if we can

effectively remove the 2001 year-class of brook trout before they mature and spawn, a total removal of all brook trout from this portion of Muskrat Creek will be accomplished. We have accomplished this in White's Creek, a nearby, smaller, less complex stream (Shepard et al. 2002).

We estimated that only 32 (SE: 1.1) WCT 75 mm and longer inhabited the reach of Muskrat Creek between the constructed and natural barriers during August 2002; however, it must be remembered that most WCT captured in this reach during July of 2001 were moved to the upper release site above the natural barrier (Figure 1). We did not recapture any previously adipose-clipped WCT in the portion of Muskrat Creek between the two fish barriers, indicating that WCT re-located above the natural barrier had not moved downstream into the portion of the creek below this barrier.

Two separate 100 m long sample sections located near the upper release site (Figure 1) supported an estimated 20 (SE: 1.9) and 27 (SE: 0.5) WCT 75 mm and longer during August 2002. We observed WCT in the very headwaters (at about stream km 21.7; where the uppermost two first order tributaries join to form Muskrat Creek) of Muskrat Creek during August 2002. WCT were also found immediately above the trail-crossing footbridge at stream km 16.5 during a single electrofishing pass made in October, but at a relatively low abundance (Figure 5). A single adipose-clipped WCT was recaptured in this sample section.

Based on these findings we believe that WCT now occupy much of Muskrat Creek above the natural fish barrier. Expanding an average of the two population estimates (23.5 WCT per 100 m of stream) to a 4.0 km portion estimates that about 940 WCT now occupy the area of Muskrat Creek near the release site. If we assume that densities of WCT for the remainder of the Muskrat Creek above the natural barrier are at about one-fifth of the density of the estimate sections results in a total estimate of 230 WCT for the remaining 5.0 km of occupied stream habitat above the natural barrier. Adding these two rough estimates to the estimate of WCT from the constructed barrier to the natural barrier results in a total rough estimate of about 1,260 WCT 75 mm and longer currently inhabiting Muskrat Creek above the constructed barrier.

Length frequencies for westslope cutthroat trout captured during 2002, particularly in August, indicated that all age classes of WCT were present in most reaches of Muskrat Creek (Figure 6). The presence of numerous age-0 WCT during August 2002 in the portion of Muskrat Creek above the natural barrier, where they exist in allopatry, was very encouraging. This finding shows that WCT are successfully reproducing in the upper basin and supports other work suggesting that young brook trout, particularly age-0 fish, may compete with young WCT and displace or replace them (Griffith 1972; Cummings 1987; Cowley 1987; Strach and Bjornn 1989; Behnke 1992; Thomas 1996; Sabo and Pauley 1997; Shepard et al. 2002).

Relative catches of WCT and brook trout during 2002 indicated that the portion of Muskrat Creek immediately below the natural barrier (near stream km 15.0) supported higher abundances of fish than found elsewhere in Muskrat Creek, while the portion of the stream immediately above the constructed barrier (stream kilometer 12.7) supported lower abundances (Figure 5). In addition, relative abundances of WCT in the portion of stream near the release site (km 19.6 and

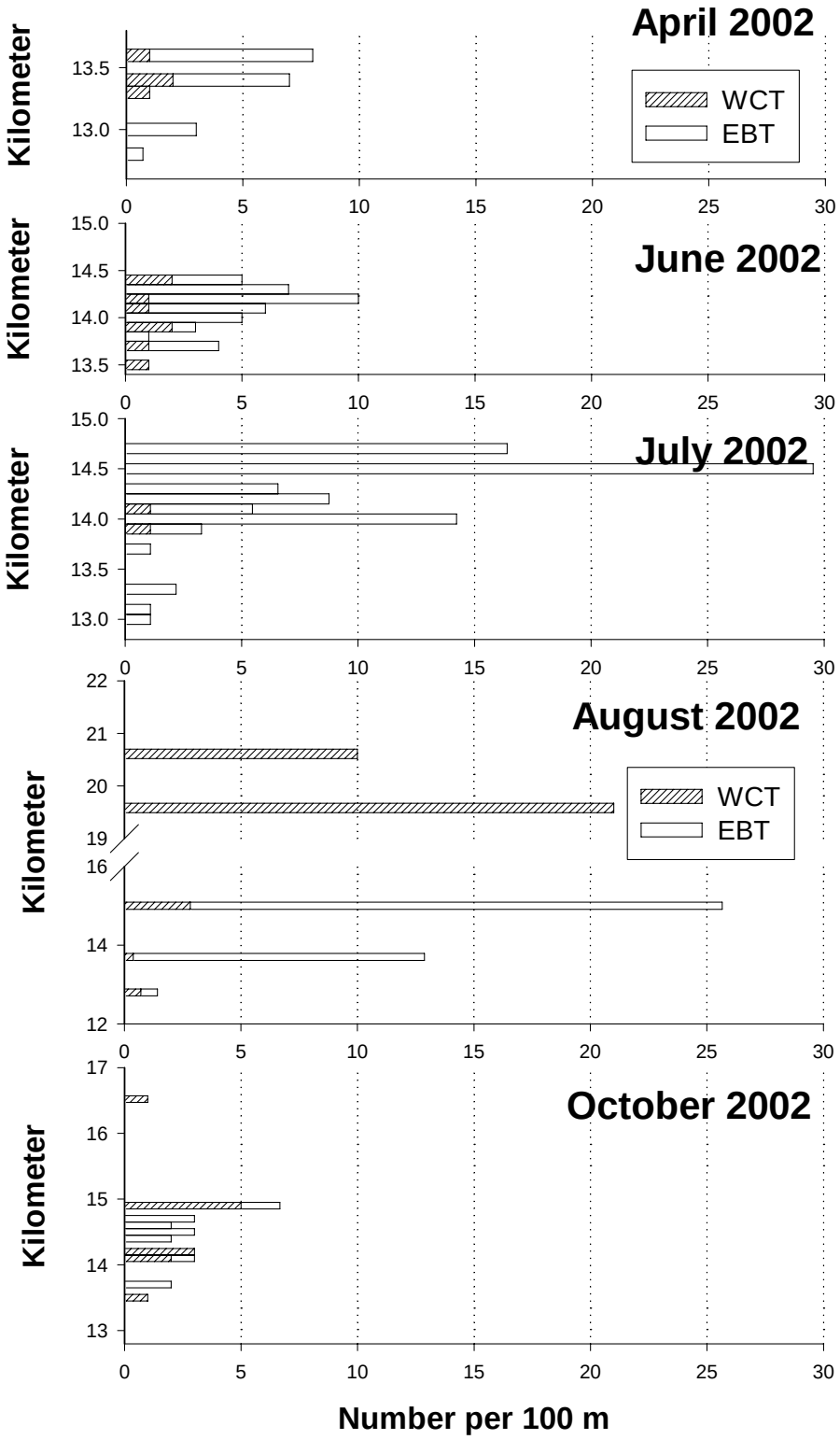

Figure 5. Relative abundance (catch of fish 75 mm and longer in first electrofishing pass standardized to number per 100 m of stream length) of westslope cutthroat trout (cross-hatch bars) and brook trout (open bars) in Muskrat Creek by stream kilometer in April, June, July, August, and October of 2002.

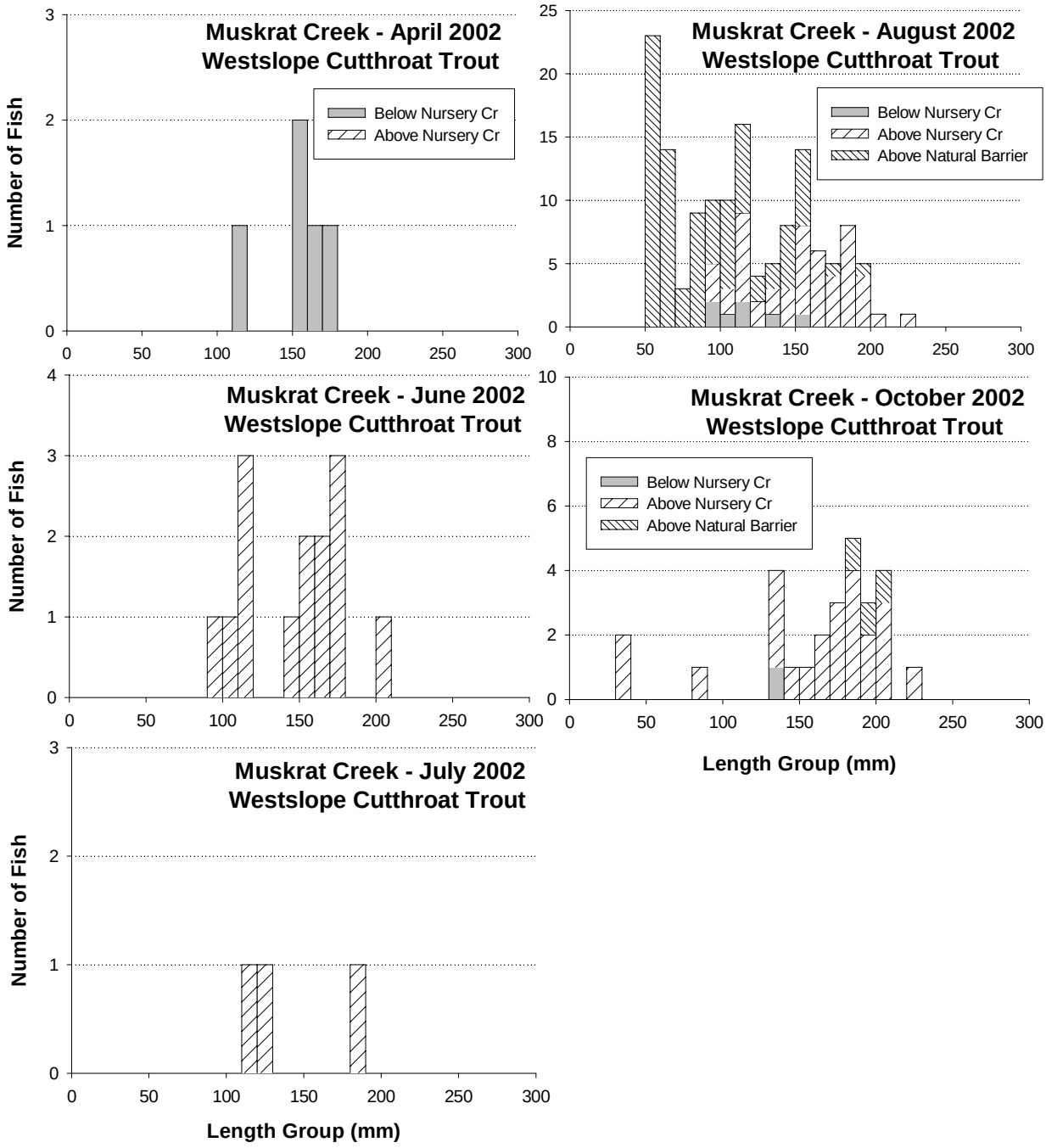

Figure 6. Length frequency histograms for westslope cutthroat trout captured during April, June, July, August, and October 2002 in Muskrat Creek below Nursery Creek (constructed barrier to Nursery Creek), above Nursery Creek (Nursery Creek up to natural barrier), and above the natural barrier (portion of creek where WCT were relocated).

20.6) during August were similar to the higher abundances observed immediately below the barrier in 2002. The observed distributions of higher abundances in the upper portion of the reach between the two barriers during the period after 2000 is in contrast to our observations of relative abundances prior to 2001 when relative abundances were higher in the lower portion of this reach (Figure 7). We are uncertain why this apparent shift in relative abundances occurred, but it may have been related to movements associated with drought conditions experienced during 2000 and 2001. Relative catches have yet to rebound to levels originally observed in 1997 when removals began, but this result is not surprising since we have been annually removing brook trout and periodically removing WCT from this reach of stream.

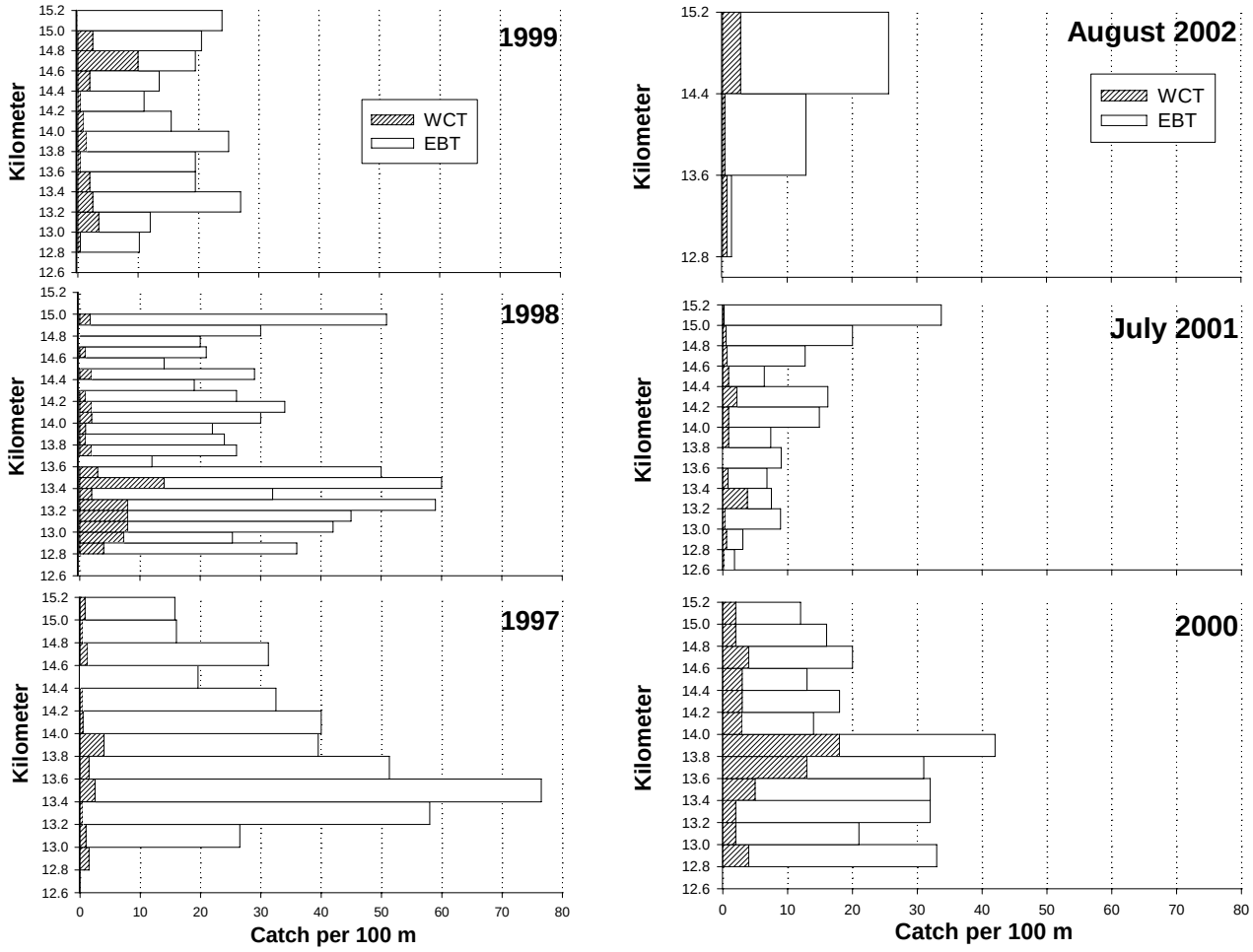

Figure 7. Relative abundance of westslope cutthroat trout (cross-hatched bars) and brook trout (open bars) in Muskrat Creek from the constructed barrier (km 12.7) up to the natural barrier (km 15.1) by stream kilometer from 1997 to 2002.

Total estimated numbers of brook trout 75 mm and longer indicated that after initially declining from 1997 to 1999, brook trout numbers stabilized from 1999 to 2001, in spite of our attempts to remove all captured and re-locate them below the constructed barrier (Figure 7; bottom graph).

As detailed above, the abundance of younger brook trout increased sharply due to the strong 2000 and 2001 year-classes and these strong year-classes carried through to 2001 and 2002. In 2001 the estimated number of brook trout 75 mm and longer did not decline very much between July and September, even though all brook trout captured in July were removed and relocated below the constructed barrier. However, the number of brook trout declined slightly in 2002 and, as mentioned above and illustrated by the length frequency distributions for captured brook trout, age-0 and age-2 and older brook trout were very scarce in 2002. The bulk of brook trout captured in 2002 were age-1, resulting from the strong 2001 year-class, and we believe we were successful in removing most of these age-1 brook trout from this reach of stream in 2002.

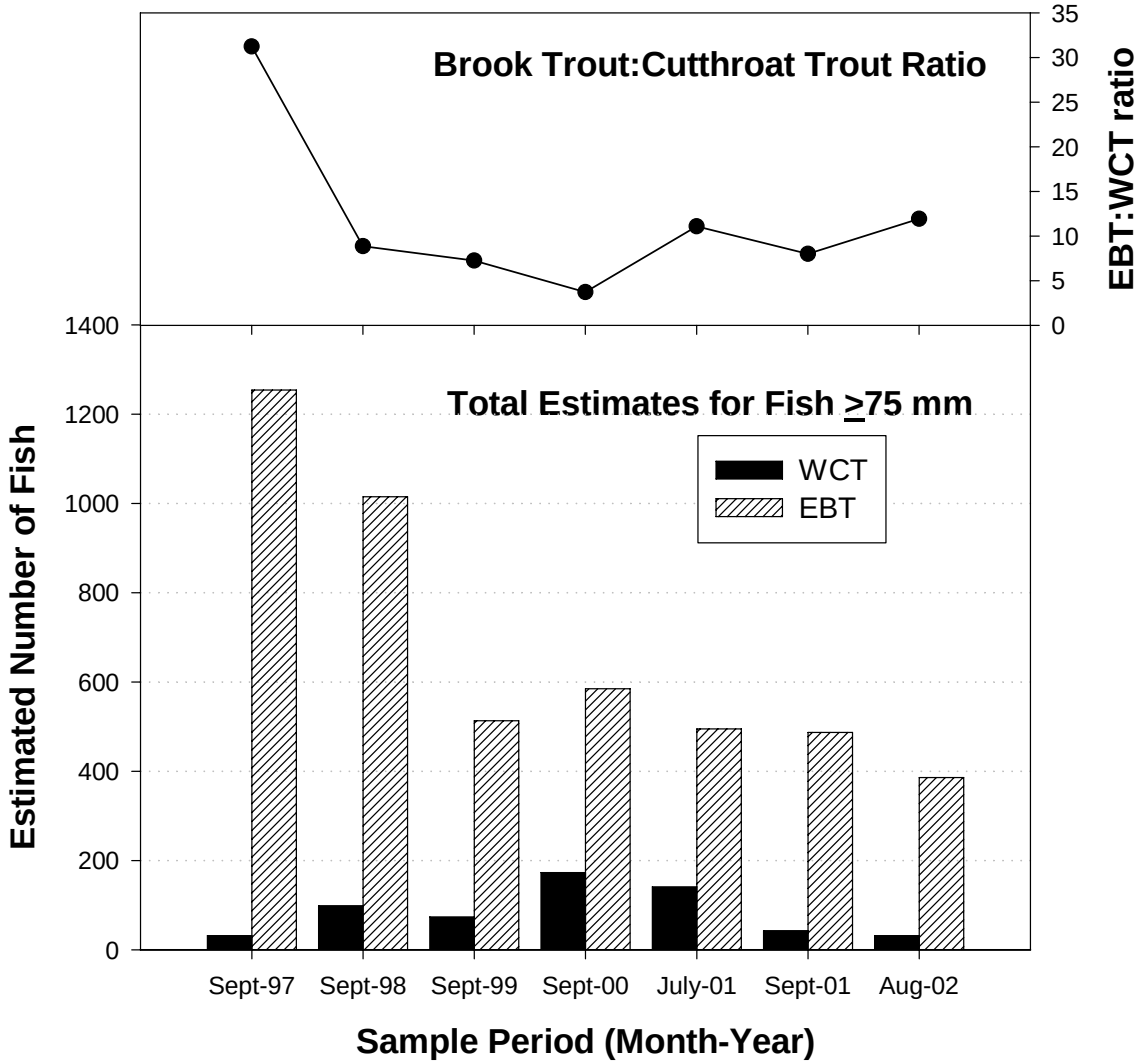

Figure 7. Total estimated number of westslope cutthroat (solid bars) and brook trout (cross-hatch bars) 74 mm and longer in Muskrat Creek between the constructed fish barrier (kilometer 12.7) and a natural fish barrier (kilometer 15.1) from 1997 to 2002 by sample month (bottom graph) and ratio of brook trout to westslope cutthroat trout based on average catch of fish 75 mm and longer on a single electrofishing pass standardized to number per 100 m of stream length (top graph).

We caution that depletion estimates for WCT may not be very accurate due to the small numbers of fish sampled. In addition, we know that depletion estimates have under-estimation bias (White et al. 1982; Riley and Fausch 1992), thus estimated numbers of both brook trout and WCT are probably slightly under-estimated. Regardless of these shortcomings, the evidence suggests that brook trout have been severely depressed in the reach of stream between the two barriers and that the WCT population, particularly in the upper basin, has increased dramatically and has expanded to fill most available habitats.

Conclusions and Recommendations

Based on information summarized to date, it appears that electrofishing removals of brook trout have provided some relief to the WCT population, especially for recruitment of young age classes into the population. While electrofishing removal of brook trout has not yet been 100% effective, it appears that we may be close to total removal of brook trout from the reach of Muskrat Creek from the constructed barrier upstream. We base this conclusion on the fact that almost no age-0 or age-2 and older brook trout were captured during 2002 and our relative high efficiency at removing the remaining age-1 brook trout that resulted from the strong 2001 year-class. We appeared to have effectively removed the strong 2000 year-class during the past two years of effort, as evidenced by the very low numbers of age-2 brook trout encountered during 2002, so we believe we have a realistic chance of removing the 2001 year-class with one more year of effort.

We did not recapture any previously adipose-clipped brook trout or WCT in the portion of Muskrat Creek between the constructed and natural fish barriers. This result indicates that brook trout did not pass upstream over the constructed fish barrier, nor did WCT that were re-located above the natural barrier move downstream past this natural barrier during 2002. We recaptured a single WCT that had been previously adipose-clipped near the trail-crossing footbridge over Muskrat Creek in October 2002.

The WCT that were re-located to the upper portion of Muskrat Creek above the natural fish barrier appear to be doing very well. This upper WCT population is obviously reproducing, as indicated by the age-0 WCT captured during 2002, and has expanded both up and downstream. We estimate that the upper 9.0 km portion of the drainage likely supported over 1,000 WCT 75 mm and longer during 2002. This estimate was based on expansion of a couple population estimates and the documented distribution and relative abundance of WCT throughout this upper reach of stream. While this population expansion formula has limitations, we believe this WCT population estimate is reasonable and represents a success in conservation of this population since our best estimate of the total WCT population in 1997 was about 100 fish 75 mm and longer.

We recommend that several additional brook trout removal efforts be conducted during 2003 in the portion of Muskrat Creek between the two fish barriers. We believe that if enough effort is expended in 2003, we can effectively eliminate the brook trout in this reach of stream. We also recommend that additional fish sampling be conducted in upper Muskrat Creek, above the natural barrier, to better estimate the total WCT population that inhabits this portion of the stream and better document the size structure of this population.

Acknowledgements

This work was supported by the USDA Forest Service (FS), Beaverhead-Deerlodge National Forest, the "Bring Back the Natives" program, USDI Bureau of Land Management's Butte District (BLM), the Montana Cooperative Fishery Research Unit at Montana State University (MSU), the Montana Youth Conservation Corps (MYCC), and Montana Department of Fish, Wildlife and Parks (FWP). We appreciate the assistance of staff from MSU, FWP, BLM, FS, and MYCC to complete field removals of brook trout. Brian Sanborn and Jim Brammer of the Beaverhead-Deerlodge Forest and Sally Sovey, Bill Dean, and Sara LaMarr of the BLM's Butte Field Office assisted with funding and fieldwork.

References

Behnke, R.J. 1992. Native trout of Western North America. American Fisheries Society Monograph 6, Bethesda, Maryland.

Canfield, J. and R. Spoon. 1999. Environmental assessment: westslope cutthroat trout restoration project in the Elkhorn Mountains. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Cowley, P.C. 1987. Potential for increasing abundance of cutthroat in streams by stocking fry and remvoal of brook trout. Master's Thesis. University of Idaho, Moscow, Idaho.

Cummings, T.R. 1987. Brook trout competition with greenback cutthroat trout in Hidden Valley Creek, Colorado. Master's Thesis. Colorado State University, Fort Collins.

DeStaso, J. I. and F. J. Rahel. 1994. Influences of water temperature on interactions between juvenile Colorado River cutthroat trout and brook trout in a laboratory stream. Transactions of the American Fisheries Society 123: 289-297.

Griffith, J.S. 1972. Comparative behavior and habitat utilization of brook trout (Salvelinus fontinalis) and cutthroat trout (Salmo clarki) in small streams in northern Idaho. Journal of the Fisheries Research Board of Canada 29: 265-273.

Kulp, M. A. and S. E. Moore. 2000. Multiple electrofishing removals for eliminating rainbow trout in a small southern Appalachian stream. North American Journal of Fisheries Management 20:259-266.

Riley, S.C. and K.D. Fausch. 1992. Underestimation of trout population size by maximum-likelihood removal estimates in small streams. North American Journal of Fisheries Management 12: 768-776.

Sabo, J.L. and G.B. Pauley. 1997. Competition between stream-dwelling cutthroat trout (Oncorhynchus clarki) and coho salmon (Oncorhynchus kisutch): effects of relative size and population origin. Canadian Journal of Aquatic Sciences 54: 2609-2617.

Shepard, B. B. and L. Nelson. 2002. Westslope cutthroat trout restoration in Muskrat Creek, Boulder River drainage, Montana: progress report for period 1993 to 2001. Report to BLM, Headwaters Field Office by Montana, Fish, Wildlife and Parks, Helena, Montana

Shepard, B. B. and R. Spoon. 2000. Westslope cutthroat trout restoration in Muskrat Creek, Boulder River drainage, Montana: progress report for period 1993 to 1999. Report to BLM, Headwaters Field Office by Montana, Fish, Wildlife and Parks, Helena, Montana

Shepard, B. B., R. Spoon, and B. Sanborn. 1999. Progress report for "Bring Back the Natives": westslope cutthroat trout restoration in Muskrat Creek. Report to BLM, Headwaters Field Office by Montana, Fish, Wildlife and Parks, Helena, Montana.

Shepard, B. B., R. Spoon, and L. Nelson. 2001. Westslope cutthroat trout restoration in Muskrat Creek, Boulder River drainage, Montana: progress report for period 1993 to 2000. Report to BLM, Headwaters Field Office by Montana, Fish, Wildlife and Parks, Helena, Montana.

Shepard, B. B., R. Spoon, and L. Nelson. 2002. A native westslope cutthroat trout population responds positively after brook trout removal and habitat restoration. Intermountain Journal of Sciences 8(3):193-214.

Spoon, R. and B. Shepard. 1996. Environmental assessment: introduction of westslope cutthroat trout into upper Muskrat Creek. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Strach, R. M. and T. C. Bjornn. 1989. Brook trout removal, stocking cutthroat trout fry, and tributary closures as means for restoring cutthroat trout in Priest Lake tributaries. Job completion report for Project F-71-R-12, Subproject III, Job 1, Federal Aid in Fish Restoration, Idaho Fish and Game, Boise.

Thomas, H.M. 1996. Competitive interactions between a native and exotic trout species in high mountain streams. Master's Thesis. Utah State University, Logan.

Thompson, P. D. and F. J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain streams. North American Journal of Fisheries Management 16:332-339.

Van Deventer, J. S. and W. S. Platts. 1989. Microcomputer software system for generating population statistics from electrofishing data - User's guide for Microfish 3.0. General Technical Report INT-254. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

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, LA-8787-NERP, Los Alamos, New Mexico.