Westslope Cutthroat Trout Restoration

in Muskrat Creek, Boulder River Drainage, Montana:

Progress Report for Period 1993 to 2001

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December 2001

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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. This report summaries work completed in 2001. A total of 747 brook trout were removed in July of 2001 and another 1,029 were removed in September of 2001. A total of 78 WCT were moved into the upper drainage in 2001. Monitoring suggests 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 and 1998. The WCT re-located above the natural barrier apparently survived and reproduced in the upper basin. None of these re-located WCT had moved down below the natural barrier to their original capture sites until 2000 and 2001, when severe drought conditions reduced flows in the headwater portion of the stream leading to a few individuals moving downstream. Five WCT that had been previously fin-clipped and moved above the natural barrier were recaptured below that natural barrier in 2001. One of these fish was recaptured twice. One adipose fin-clipped brook trout was recaptured in July 2001 above the constructed crib barrier. A total of five adipose-clipped brook trout have been captured above the constructed crib barrier. At this time we are uncertain if the adipose-clipped brook trout actually were re-located below the barrier and made it upstream (either by jumping the barrier or being moved by human intervention), or if these brook trout had had escaped from a holding pen located just above the mouth of Nursery Creek. 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 12.75), where the crib barrier was constructed, from 2.2 km to over 8.0 km. In addition, the removal of brook trout from the 2.2 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 this WCT population (fish 75 mm and longer) has more than doubled, from less than 100 in 1997 to over 200 in 2001. However, we doubt that multiple electrofishing removals will ever totally eradicate brook trout from the portion of Muskrat Creek between the constructed and natural barriers. We recommend that chemical de-population of the brook trout between these two barriers be completed after multiple electrofishing efforts have been done to salvage as many brook trout and WCT as possible.

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 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 and Spoon 2000; Shepard et al. 2001). Shepard and Spoon (2000) and Shepard et al. (2001) provided a detailed description of the Muskrat Creek drainage and efforts made to restore WCT in this drainage through 2000. 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. 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 plan to conduct another effort in early 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.

Expansion of the WCT population from a weak population occupying about 2.2 km (this distance was calculated from 1:100,000 hydrography and the 2.5 km reported in earlier reports is likely a more accurate figure because it was estimated from 1:24,000 maps; however, we will be consistent in using the 2.2 km to correspond to GIS coverages), in sympatry with brook trout that were apparently driving them to extinction, to occupy an additional 6.0 km of habitat above a natural barrier appears to be working. In addition, removal of brook trout from the 2.2 km of habitat immediately above the Forest Service boundary appears to be offering the existing WCT population some relief, allowing them to increase their numbers in this portion of the stream. This report summarizes efforts made during 2001. Stream flows during the summers of 2000 and 2001 were extremely low due to drought conditions (Figure 2).

Methods

Multiple electrofishing passes were used to remove brook trout and catch WCT for re-location to the upper portion of the basin. Two to four consecutive electrofishing passes were made within each section. 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 most were 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. Most WCT captured during July also had their adipose fin removed and were transported by helicopter to the upper portion of the drainage to the upper release site (Figure 1).

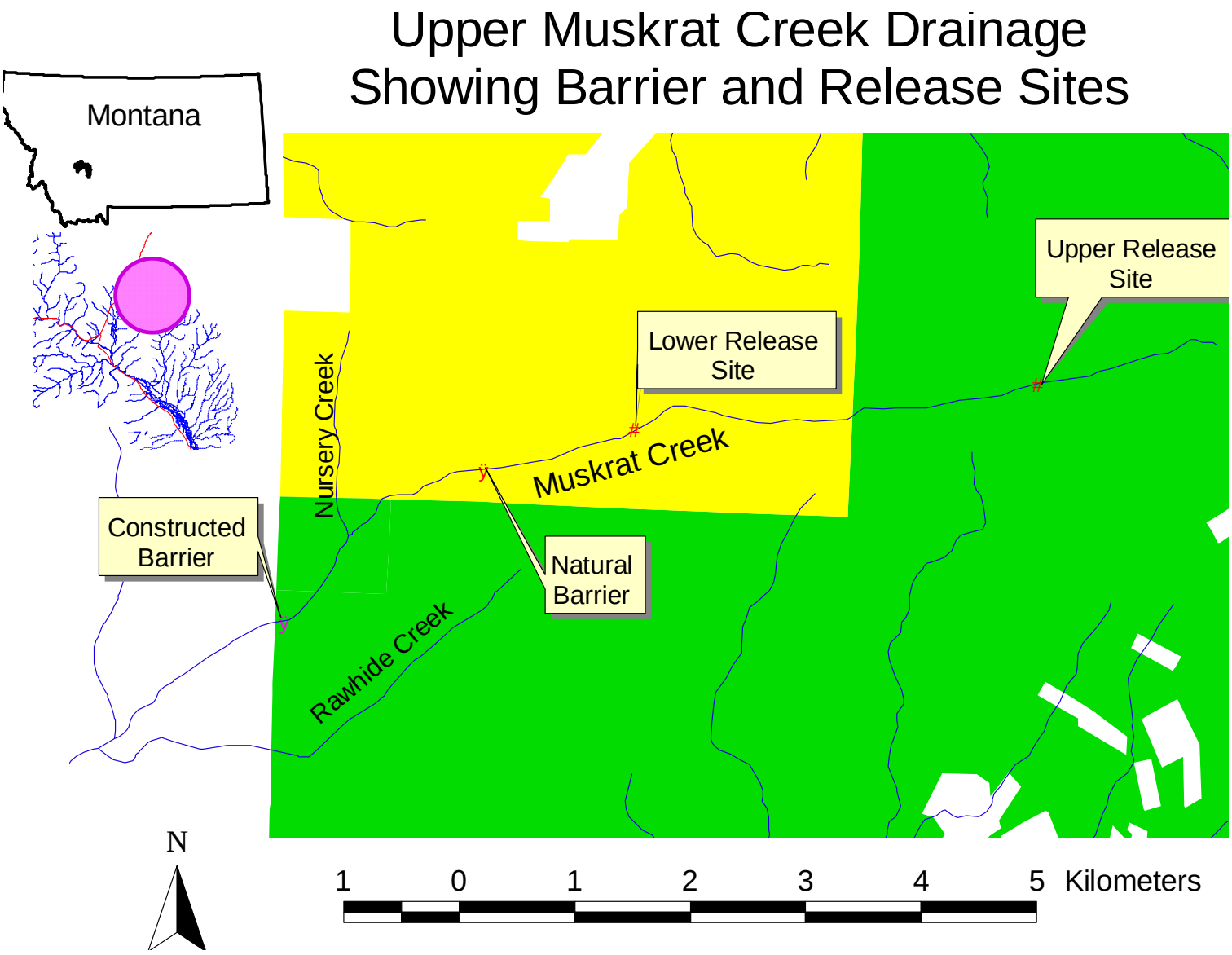

Figure 1. Map of Muskrat Creek showing land ownership, locations of constructed barrier, natural barrier (waterfall), and sites where westslope cutthroat trout were released in 1997 and 1998.

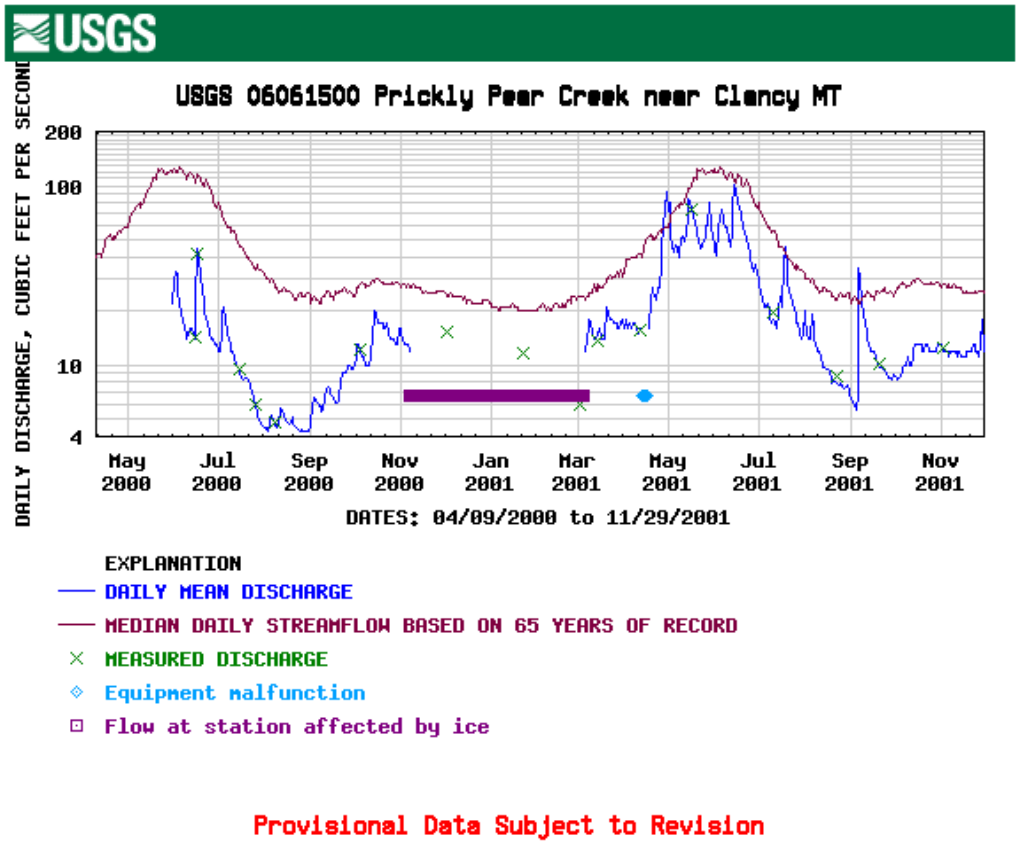

Figure 2. Provisional flow data for Prickly Pear Creek, the nearest flow-gauged stream, from May 2000 to November 2001 compared to long-term average (65 years) flows. Data courtesy of the USGS via the web (http://mt.waterdata.usgs.gov/nwis/sw).

In a few sections not all young-of-the-year (YOY) brook trout were measured, but they were enumerated by pass. During 2001 we conducted these multiple electrofishing pass efforts on two separate occasions, during the week of July 9 and again during the week of September 9. Population estimates were made using the software program MICROFISH (version 3.0; Van Deventer and Platts 1989). Length frequencies were plotted for each sample event by 10 mm size groups

Results and Discussion

During 2001, 747 brook trout were removed in July and another 1,029 were removed in September. Length frequencies for captured brook trout indicated that age 0 (young-of-the-year; YOY) brook trout were less than 90 mm for all sample events except for July of 2001, when they were less than 50 mm (Figure 3). Based on length frequency data we partitioned ages based on length for all sample events except July 2001 as follows: age 0 – less than 90 mm; age 1 – 90 to 140 mm; and age 2+ - longer than 140 mm (Figure 2). For the July 2001 sampling event, ages were assigned as: age 0 - < 50 mm; age 1 – 50 to 130 mm; and age 2+ - longer than 130 mm.

Total catches of brook trout by age indicated that catch of age 0 brook trout declined from 1997 to 1999; however, it appears that the 2000 and 2001 year-classes were very strong (Figure 4). The strong 2000 year-class carried through to 2001, as shown by the increase in catch of age 1 fish from 2000 to July 2001. Catches of age 1 brook trout generally followed, with a year delay, trends in catches of age 0 fish. Catches of age 0 brook trout in 2001 indicate that the 2001 year-class is also a relatively strong year-class. We are unsure exactly why the 2000 and 2001 year-classes were so strong, but speculate that enough adults were left in these sections to reproduce and that drought conditions in 2000 and 2001 led to lower spring flows which allowed for higher survival of newly emerged brook trout. We also speculate that since our efforts to remove brook trout have been moderately successful for larger brook trout, the reduction in densities of these larger brook trout may have allowed for much higher survival of young brook trout. Since age 0 brook trout are difficult to capture via electrofishing, these strong year classes will likely remain relatively strong during subsequent years, reducing the likelihood that we will effectively eliminate brook trout from this portion of Muskrat Creek.

Trends in the catch of age 2+ brook trout present a slightly more optimistic picture in that catches of these larger, mature fish have steadily declined. In 2001 we caught 57 age 2+ brook trout in July and only 29 in September. Unfortunately, any age 2+ brook trout remaining in this portion of the stream will probably lead to at least some successful reproduction in 2002.

A total of 78 WCT were moved to the upper portion of the drainage (Upper Release Site; Figure 1) in July 2001. Not all WCT captured during electrofishing in July were held and transported to the upper portion of the drainage. A few (about 12) of the WCT held in live cars died during the time they were held, so we quit adding more to live cars to reduce crowding and mortality. Many of the WCT captured during July were age 2 and older (> 110 mm; Figure 5).

The relative numbers of age 1 WCT between 50 and 110 mm (10 fish) in July 2001 declined from the relative numbers captured in 2000 (106), 1999 (32), and 1998 (58). We suspect that the increased numbers of YOY brook trout produced in 2000 might have led to more competition between YOY brook trout and WCT during 2000, resulting in fewer age 1 WCT during 2001.

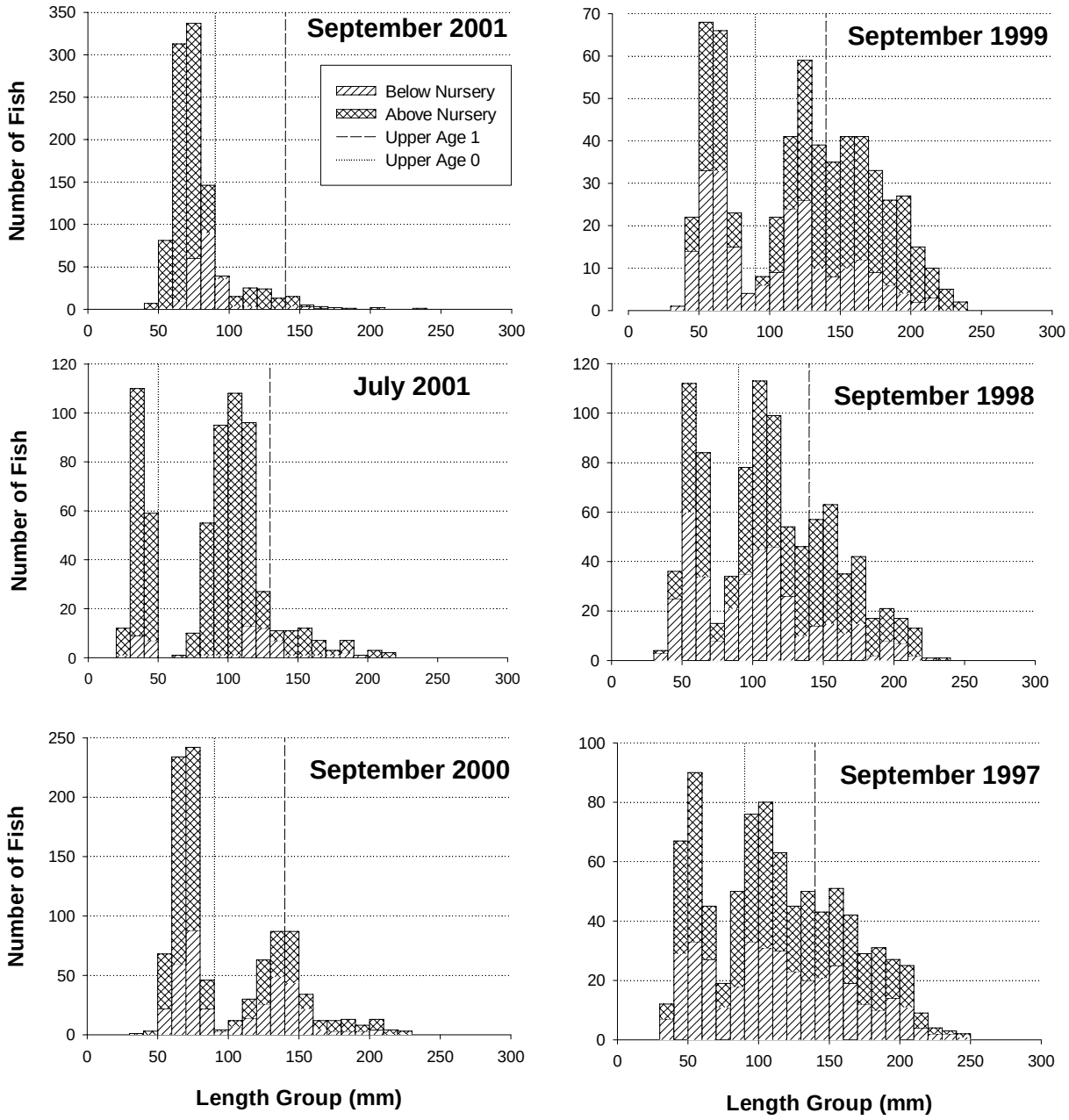

Figure 3. Length frequency histograms for brook trout captured in Muskrat Creek from 1997 to 2001. Vertical lines indicate assigned upper limits for age 0 (dotted line) and age 1 (dashed line) brook trout.

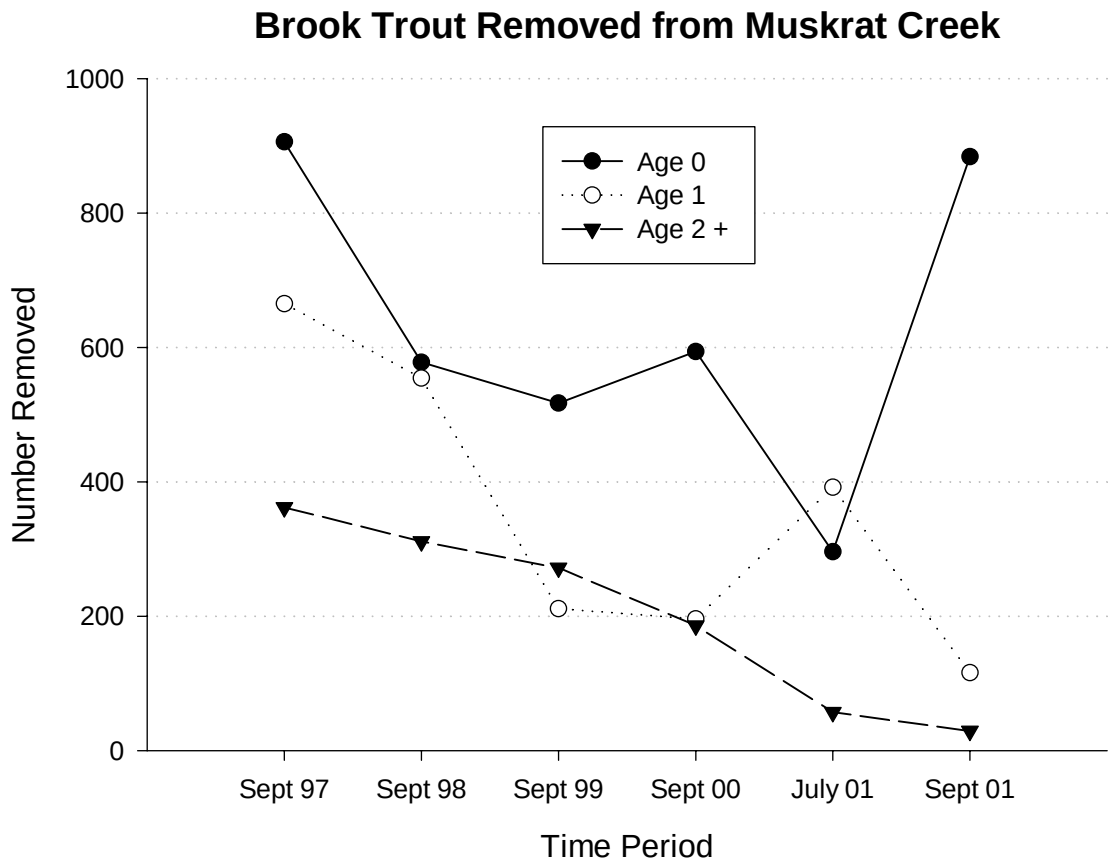

Figure 4. Number of brook trout age 0, age 1, and age 2 and older (see text for explanation of age assignments) removed during each removal event from 1997 through 2001.

We note that few brook trout over 140 mm (approximately age 2+) were present in 2001, indicating that the mechanism for suppression of young WCT is likely competion with young brook trout rather than predation by older brook. We postulated this mechanism previously (Shepard 2000), but now have data to better support this speculation.

All age 1 WCT captured during 2001 were captured above Nursery Creek. While few age 1 WCT were moved to the upper portion of the drainage in July, sampling during September still found few age 1 WCT, with a similar number captured (Figure 5). As expected, the number of WCT longer than 110 mm declined in September due to the relocation of most fish of this size during July.

Relative catches of WCT and brook trout indicated that the during July 2001 the portion of Muskrat Creek immediately below the natural barrier (near stream km 15.0) supported relatively higher abundances of fish than in past years, while the portion of the stream immediately above the constructed barrier (stream kilometer 12.75) supported relatively lower abundances (Figure 6). 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 the past two years.

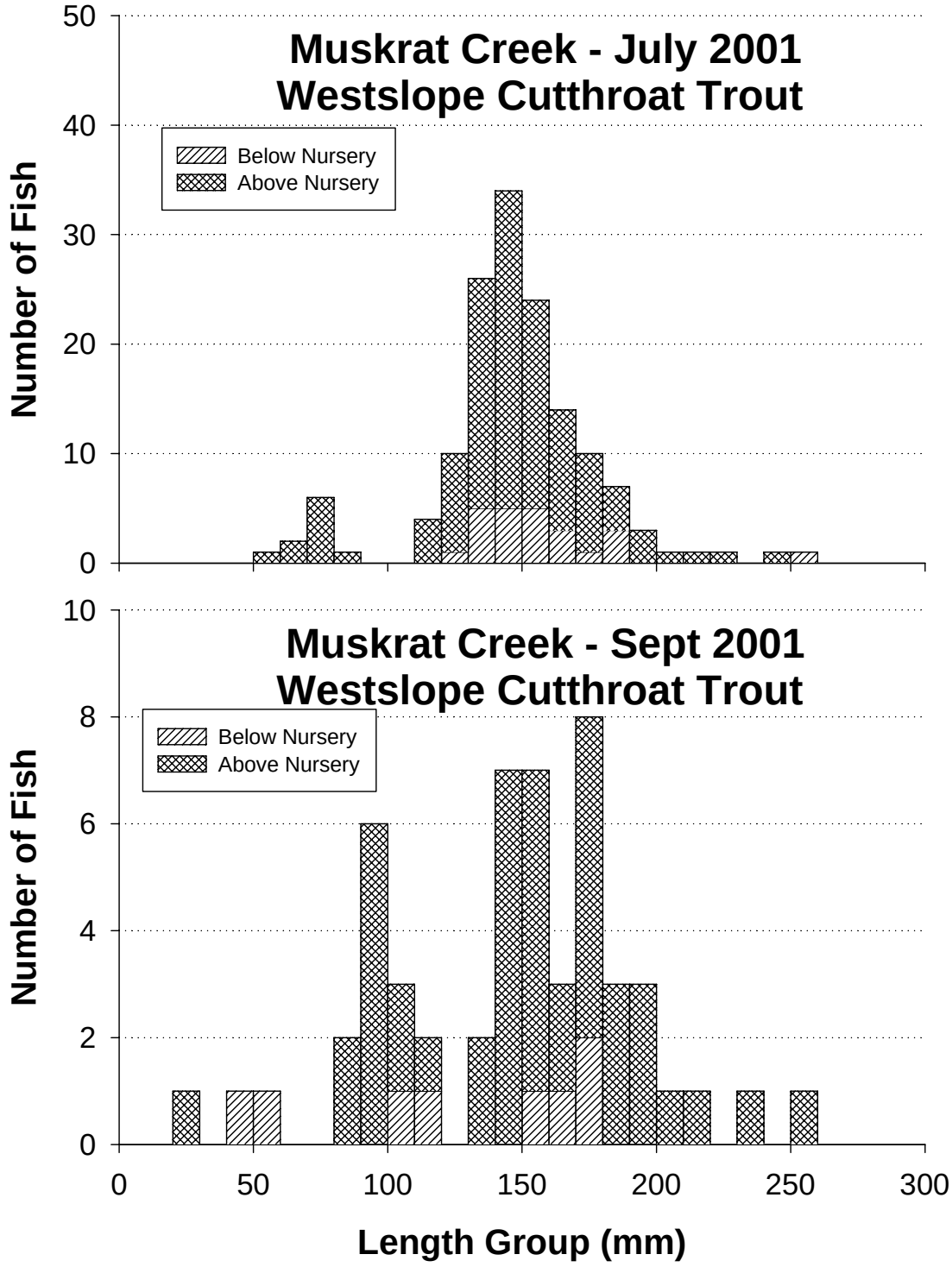

Figure 5. Length frequency histograms for westslope cutthroat trout captured during July (top) and September (bottom) 2001 in Muskrat Creek above and below Nursery Creek.

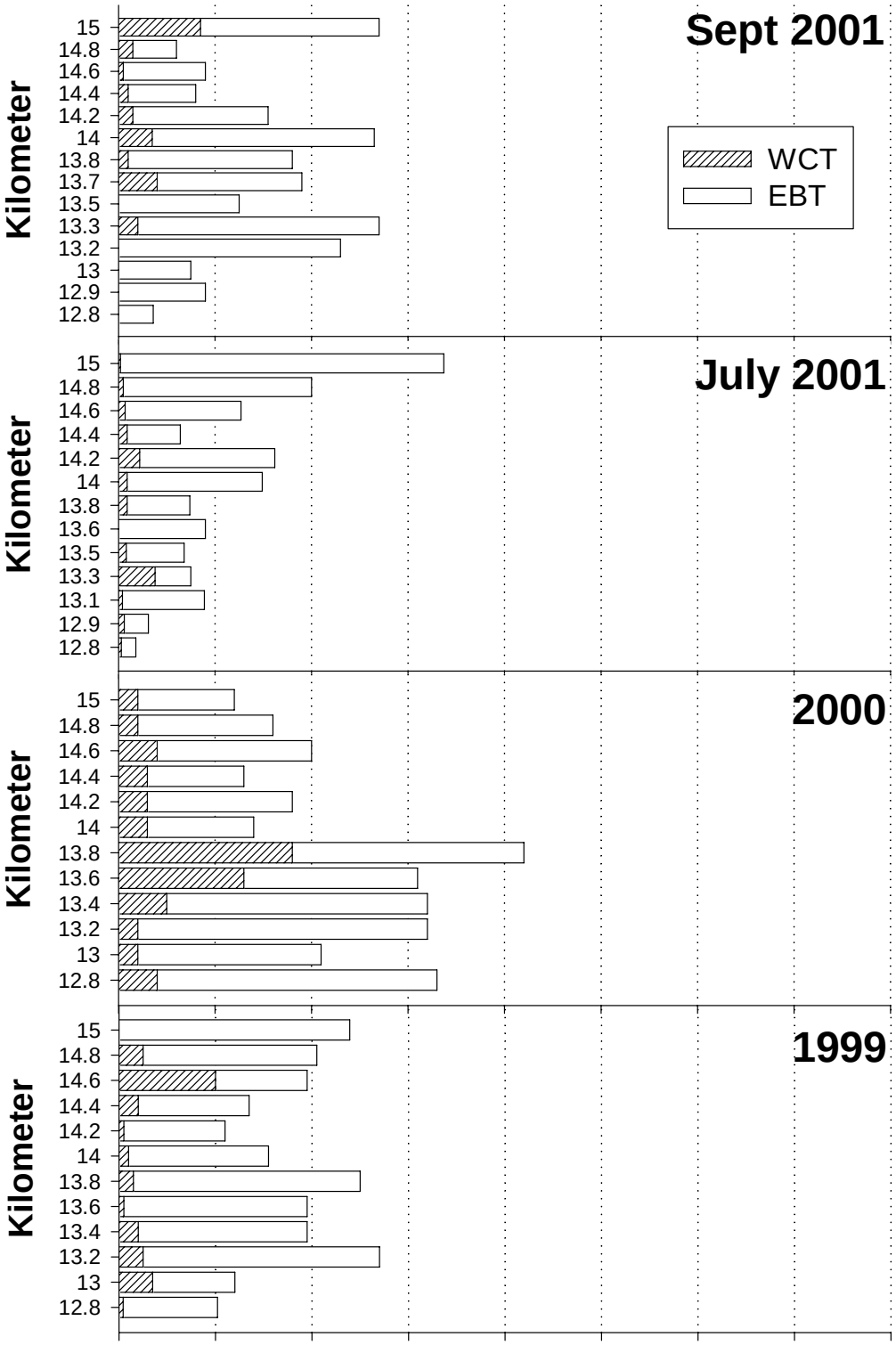

Figure 6. Relative abundance (catch of fish 75 mm and longer in first electrofishing pass standardized to number per 100 m of stream length) of westslope cutthroat trout (solid bars) and brook trout (cross-hatch bars) in Muskrat Creek by stream kilometer in 1999, 2000, and July and September of 2001.

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 year-class and this strong year-class carried through to 2001. 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. As mentioned above, and illustrated by the length frequency distributions for captured brook trout, the YOY brook trout were less than 50 mm in July and then grew so that by September many of the YOY's were 75 mm and longer.

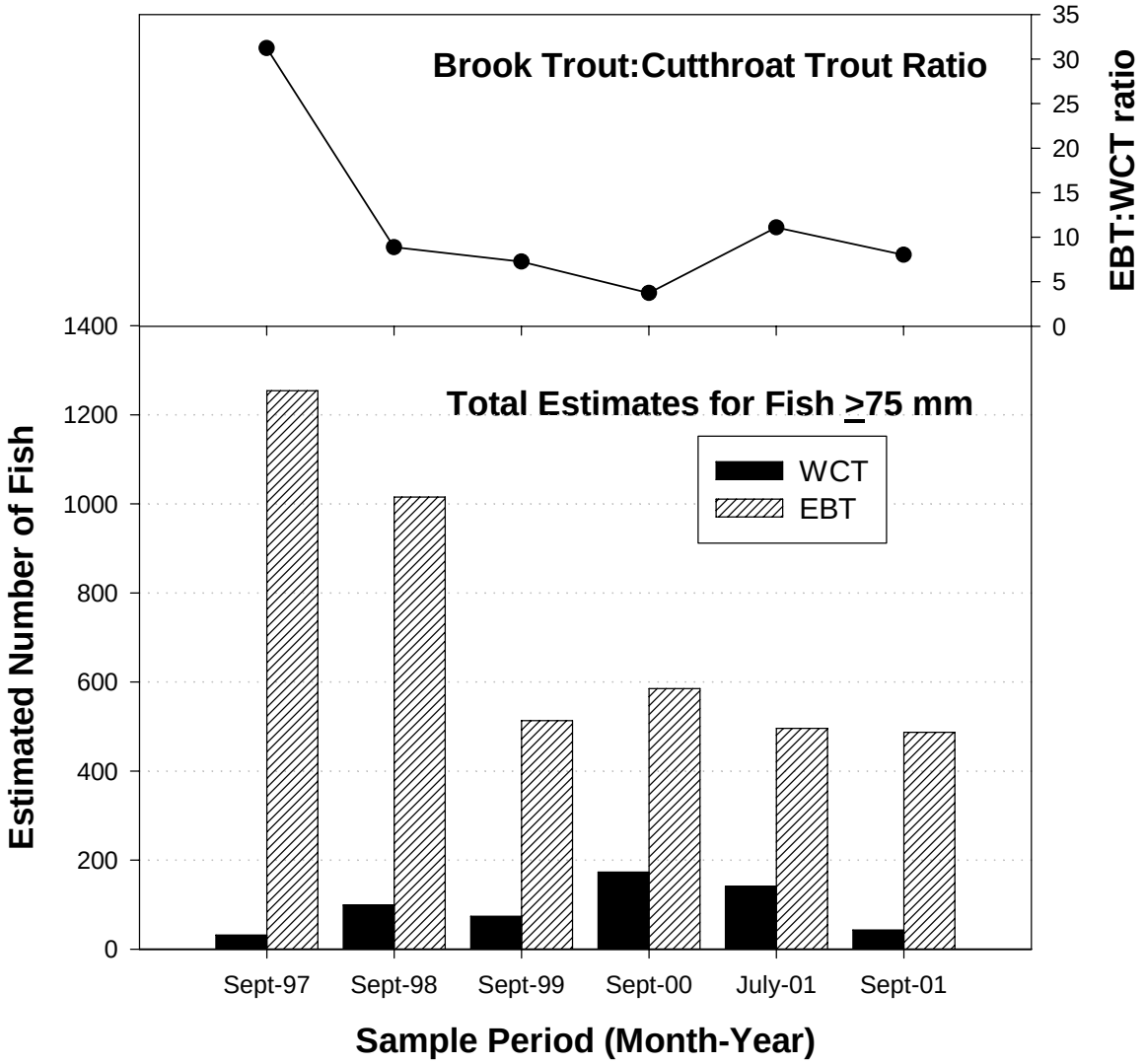

Figure 7. Total estimated number of westslope cutthroat (solid bars) and brook trout (cross-hatch bars) 74 mm and longer in Muskrat Creek between the constructed fish barrier (kilometer 12.75) and a natural fish barrier (kilometer 15.0) from 1997 to 2001 by sample month (bottom graph) and ratio of brook 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 must caution that depletion estimates for WCT may not be very accurate due to the small numbers of fish sampled. In addition, the numbers of WCT in the upper portion of the basin, above the natural barrier, have not been estimated to reduce handling stress on these fish. Thus, total estimates provided in Figure 7 are only for the portion of Muskrat Creek between the constructed crib and natural barriers (Figure 1) and do not include WCT above the natural barrier. A total of 148 WCT had been re-located to the upper basin prior to 2001. Total estimated numbers of WCT 75 mm and longer within Muskrat Creek between the constructed and natural barriers indicated that following the re-location of most WCT captured in 1997, estimated numbers of WCT rebounded in 1998 (Figure 7; bottom graph). This immediate rebound was probably related to higher survival of young WCT from 1997 to 1998 following brook trout removal. In 1999 populations of WCT declined, but then rebounded in 2000, before declining slightly in July 2001, at which time many of the captured WCT were re-located to the upper portion of the drainage. The ratio of brook trout to WCT steadily declined from 1997 to 2000 (from 31.2:1 to 3.7:1), but increased slightly, to about 10:1, in 2001 (Figure 7; top graph).

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. However, electrofishing removal of brook trout has not been 100% effective and probably would need to be repeated at intervals of two to three year to keep brook trout populations low enough to increase survival of young WCT. The 2000 and 2001 year-classes of brook trout both appeared to be strong year-classes, in spite of annual efforts to remove brook trout. The presence of these strong year-classes indicates that even when adult numbers have been severely reduced, recruitment of YOY brook trout can be high, probably in relation to ideal incubation and emergence flow conditions related to higher than normal winter temperatures during incubation (Figure 8) and lower than average flows during emergence (Figure 2).

We recommend that some type of piscicide treatment be conducted in Muskrat Creek between the waterfall and constructed barrier, and in Nursery Creek, to permanently eliminate brook trout from this portion of the drainage. Prior to the treatment, as many WCT as possible should be captured by electrofishing and temporarily moved and held out of the treated area. Brook trout captured during this electrofishing could also be moved below the constructed barrier prior to treatment. This recommendation was formally proposed in the Environmental Assessment for the westslope cutthroat trout restoration project in the Elkhorn Mountains (Canfield and Spoon 1999).

At least some of the WCT moved into upper Muskrat Creek have remained near their release site and have reproduced successfully. Only one relocated WCT has moved back down below the waterfall where it was originally captured. This WCT moved during the drought year of 2000 and its movement was probably related to low stream flows. To date, four fin-clipped brook trout have beeen found above the constructed barrier, but we are uncertain at this time if these brook trout had actually been transported below the barrier. They may have escaped from a holding facility located above the constructed barrier.

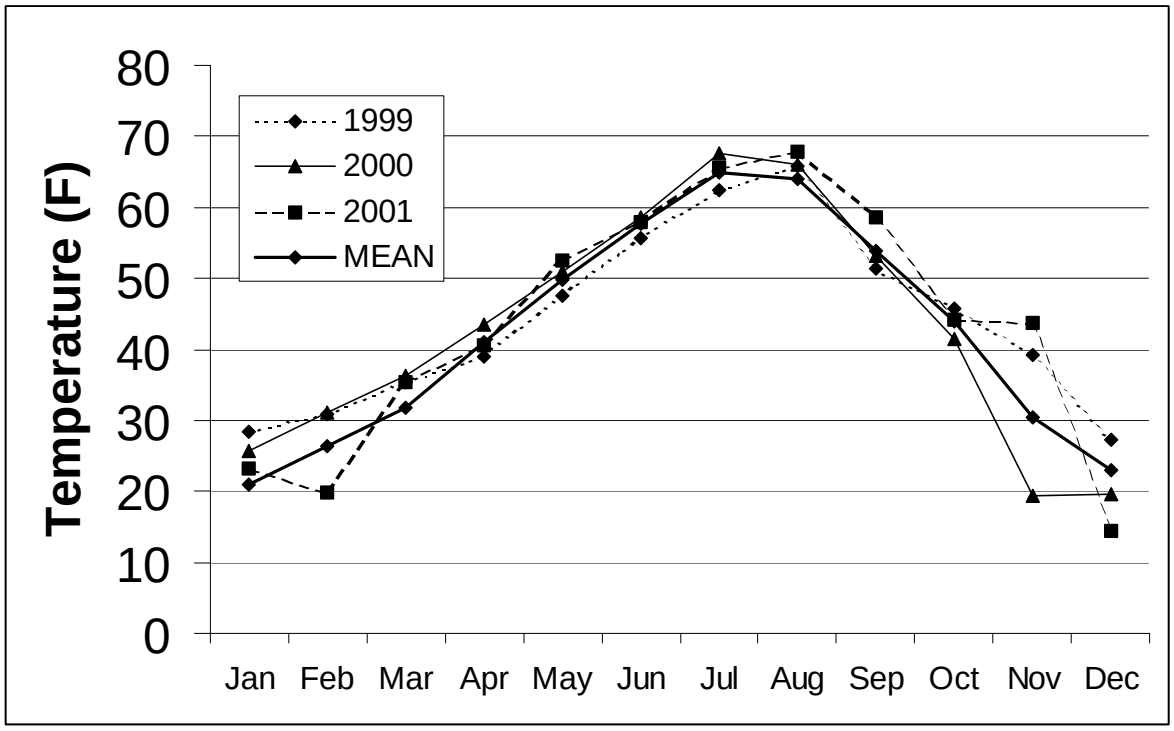

Figure 8. Average monthly air temperatures (F) at Boulder, Montana from 1999 to 2001 along with long-term mean average monthly temperatures for the period of record (1948 – 2001).

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 of the Beaverhead-Deerlodge Forest and Sally Sovey and Bill Dean of the BLM's Butte District assisted with funding and fieldwork.

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Appendix A

Fish Population Estimates in Muskrat Creek 1997-2001

Table A1. Population estimates and standard errors (SE) made in Muskrat Creek from 1997 through 1999 by stream kilometer, date, species (EBT = brook trout; WCT = westslope cutthroat trout), and length group. Section lengths, estimator (number of passes to compute maximum likelihood depletion estimates), minimum and maximum length ranges of captured fish, total estimate (for fish 75 mm and longer), and estimated number of fish 75 mm and longer per 100 m of stream length and per hectare are also shown. Blank estimates indicate an estimate could not be made because because catches did not decrease on subsequent capture passes.

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
MUSKRAT CR											
10.30	07/21/2000	60.0	EBT 2	60 (6.8)	21 (4.7)	50 (1.9)	103	247	72 (4.2)	120 (7.0)	
10.40	09/08/1998	100.0	EBT 3	186 (17.1)	33 (1.1)	19 (3.2)	77	212	53 (2.9)	53 (2.9)	1514
10.40	09/08/1998	100.0	WCT 3	0 (0.0)	12 (4.2)	1 (0.0)	80	167	14 (5.6)	14 (5.6)	400
10.40	08/23/1999	140.0	EBT 2	83 (8.7)	25 (1.2)	2 (0.0)	75	157	27 (1.1)	19.2 (0.8)	
10.40	09/18/2000	140.0	WCT 2	0 (0.0)	0 (0.0)	5 (0.0)	201	245	5 (0.0)	3.57 (0.0)	198
10.40	09/18/2000	140.0	EBT 2	5 (0.0)	32 (0.2)	11 (0.3)	76	173	43 (0.3)	30.7 (0.2)	1706
10.50	09/02/1997	200.0	EBT 2	44 (4.4)	73 (10.1)	24 (11.3)	76.19	228.	100 (15.8)	50 (7.9)	1667
10.50	09/02/1997	200.0	WCT 2	0 (0.0)	0 (0.0)	--	180.3	215.	--	--	
10.50	09/08/1998	150.0	EBT 3	38 (9.7)	33 (2.6)	9 (0.5)	92	202	42 (2.4)	28 (1.6)	800

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
10.50	09/08/1998	150.0	WCT 3	0 (0.0)	16 (0.9)	0 (0.0)	81	149	16 (0.9)	10.6 (0.6)	305
10.50	09/18/2000	200.0	WCT 2	0 (0.0)	1 (0.0)	3 (0.7)	147	215	4 (0.6)	2 (0.3)	111
10.50	09/18/2000	200.0	EBT 2	--	39 (1.8)	9 (0.8)	75	210	49 (2.4)	24.5 (1.2)	1361
10.60	09/08/1998	100.0	WCT 2	1 (0.0)	10 (0.7)	0 (0.0)	80	131	10 (0.7)	10 (0.7)	286
10.60	09/08/1998	100.0	EBT 2	41 (2.8)	71 (26.6)	8 (0.4)	87	195	72 (16.2)	72 (16.2)	2057
10.70	09/02/1997	200.0	EBT 2	104 (18.9)	114 (4.8)	39 (1.8)	80	218	154 (5.3)	77 (2.6)	2567
10.70	09/02/1997	200.0	WCT 2	5 (0.0)	1 (0.0)	0 (0.0)	87	87	1 (0.0)	0.5 (0.0)	17
10.70	09/08/1998	100.0	EBT 2	60 (17.9)	77 (21.3)	4 (0.0)	76	173	75 (14.7)	75 (14.7)	2143
10.70	09/08/1998	100.0	WCT 2	1 (0.0)	10 (0.8)	0 (0.0)	75	135	10 (0.8)	10 (0.8)	286
10.70	08/23/1999	200.0	WCT 2	0 (0.0)	2 (0.0)	6 (0.5)	136	175	8 (0.4)	4 (0.2)	
10.70	08/23/1999	200.0	EBT 2	--	19 (6.9)	10 (0.7)	108	219	29 (5.2)	14.5 (2.6)	
10.70	09/18/2000	200.0	EBT 2	12 (1.1)	55 (0.4)	8 (0.0)	75	200	63 (0.4)	31.5 (0.2)	1750

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
10.70	09/18/2000	200.0	WCT 2	0 (0.0)	2 (0.0)	2 (0.0)	136	200	4 (0.0)	2 (0.0)	111
10.80	09/08/1998	100.0	EBT 2	48 (10.0)	53 (1.7)	9 (0.8)	79	210	62 (1.8)	62 (1.8)	1771
10.80	09/08/1998	100.0	WCT 2	0 (0.0)	12 (2.7)	1 (0.0)	78	205	13 (2.6)	13 (2.6)	371
10.90	09/02/1997	200.0	WCT 2	1 (0.0)	5 (0.0)	--	78	197	6 (0.5)	3 (0.2)	94
10.90	09/02/1997	200.0	EBT 2	108 (10.7)	135 (3.6)	45 (0.7)	80	239	183 (3.4)	91.5 (1.7)	2859
10.90	09/08/1998	100.0	EBT 2	17 (1.2)	38 (3.6)	--	88	223	50 (6.7)	50 (6.7)	1429
10.90	09/08/1998	100.0	WCT 2	0 (0.0)	3 (0.8)	0 (0.0)	78	93	3 (0.8)	3 (0.8)	86
10.90	08/23/1999	200.0	WCT 2	0 (0.0)	4 (0.0)	1 (0.0)	125	154	5 (0.0)	2.5 (0.0)	114
10.90	08/23/1999	200.0	EBT 2	122 (7.7)	36 (0.7)	19 (0.5)	100	214	55 (0.9)	27.5 (0.5)	1250
10.90	09/18/2000	200.0	WCT 2	0 (0.0)	6 (0.0)	3 (0.0)	107	206	9 (0.0)	4.5 (0.0)	250
10.90	09/18/2000	200.0	EBT 2	22 (2.0)	58 (2.5)	12 (1.1)	75	225	72 (3.5)	36 (1.8)	2000
11.00	09/08/1998	100.0	WCT 2	0 (0.0)	16 (1.2)	2 (0.0)	78	157	18 (1.1)	18 (1.1)	514
11.00	09/08/1998	100.0	EBT 2	36 (14.5)	53 (5.6)	14 (0.6)	84	212	66 (4.9)	66 (4.9)	1886
11.10	09/03/1997	265.0	WCT 2	-- (1.1)	6 (0.0)	0 (1.1)	76	149	6 (0.4)	2.26	71

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
11.10	09/03/1997	265.0	EBT 2	278 (19.5)	137 (6.9)	39 (0.3)	80	245	173 (5.1)	65.2 (1.9)	2040
11.10	09/08/1998	100.0	EBT 2	32 (7.4)	56 (3.3)	--	82	213	74 (6.9)	74 (6.9)	2114
11.10	09/08/1998	100.0	WCT 2	0 (0.0)	--	0 (0.0)	77	140	--	--	
11.10	08/23/1999	200.0	EBT 2	147 (32.4)	28 (2.0)	17 (0.8)	76	215	46 (2.5)	23 (1.3)	
11.10	08/23/1999	200.0	WCT 2	0 (0.0)	2 (0.0)	2 (0.0)	135	162	4 (0.0)	2 (0.0)	
11.10	09/19/2000	158.0	EBT 3	75 (3.9)	38 (1.7)	5 (0.0)	75	211	43 (1.5)	27.2 (1.0)	1512
11.10	09/19/2000	158.0	WCT 3	0 (0.0)	30 (1.7)	0 (0.0)	83	116	30 (1.7)	18.9 (1.1)	1055
11.20	09/08/1998	116.0	EBT 2	10 (0.8)	--	--	90	215	--	--	
11.20	09/08/1998	116.0	WCT 2	0 (0.0)	--	0 (0.0)	136	136	--	--	
11.20	09/19/2000	200.0	WCT 3	0 (0.0)	47 (0.9)	0 (0.0)	83	139	47 (0.9)	23.5 (0.4)	1469
11.20	09/19/2000	200.0	EBT 3	37 (1.8)	44 (0.3)	10 (0.1)	75	210	54 (0.3)	27 (0.2)	1688
11.30	09/09/1998	100.0	EBT 2	7 (0.0)	23 (2.0)	9 (0.8)	89	199	32 (2.1)	32 (2.1)	1067
11.30	09/09/1998	100.0	WCT 2	0 (0.0)	3 (0.8)	0 (0.0)	107	145	3 (0.8)	3 (0.8)	100

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
11.30	08/24/1999	200.0	EBT 2	108 (14.2)	24 (0.7)	20 (0.8)	110	221	44 (1.0)	22 (0.5)	
11.30	08/24/1999	200.0	WCT 2	0 (0.0)	0 (0.0)	1 (0.0)	155	155	1 (0.0)	0.5 (0.0)	
11.40	09/03/1997	200.0	WCT 3	5 (1.2)	10 (4.7)	5 (0.4)	76.19	238.	14 (2.5)	7 (1.2)	212
11.40	09/03/1997	200.0	EBT 3	169 (43.0)	105 (11.3)	32 (0.8)	78.69	223.	133 (7.8)	66.5 (3.9)	2015
11.40	09/09/1998	100.0	EBT 2	39 (5.4)	36 (6.9)	5 (1.2)	91	177	44 (9.4)	44 (9.4)	1467
11.40	09/09/1998	100.0	WCT 2	0 (0.0)	--	--	126	158	--	--	
11.40	09/19/2000	200.0	WCT 3	0 (0.0)	14 (3.8)	1 (0.0)	86	152	14 (2.4)	7 (1.2)	438
11.40	09/19/2000	200.0	EBT 3	42 (31.9)	39 (6.1)	8 (0.5)	75	208	46 (4.8)	23 (2.4)	1438
11.50	08/05/1993	79.5	EBT 2	11 (0.3)	109 (24.1)	13 (2.6)	75.75	224.	124 (24.1)	155. (30.3)	4727
11.50	08/05/1993	79.5	WCT 2	0 (0.0)	4 (1.4)	2 (0.0)	104.0	179.	6 (1.1)	7.54 (1.4)	229
11.50	09/09/1998	100.0	WCT 2	0 (0.0)	1 (0.0)	0 (0.0)	130	130	1 (0.0)	1 (0.0)	33
11.50	09/09/1998	100.0	EBT 2	23 (0.5)	17 (1.2)	16 (5.6)	100	220	34 (4.8)	34 (4.8)	1133
11.50	08/24/1999	200.0	WCT 2	0 (0.0)	1 (0.0)	2 (0.0)	144	177	3 (0.0)	1.5 (0.0)	

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
11.50	08/24/1999	200.0	EBT 2	--	42 (6.2)	31 (2.8)	108	217	74 (6.9)	37 (3.5)	
11.60	09/03/1997	200.0	EBT 2	350 (51.9)	116 (15.7)	20 (0.5)	77	212	130 (10.8)	65 (5.4)	2167
11.60	09/09/1998	100.0	WCT 2	0 (0.0)	2 (0.0)	0 (0.0)	130	139	2 (0.0)	2 (0.0)	67
11.60	09/09/1998	100.0	EBT 2	60 (5.2)	27 (8.4)	17 (0.5)	83	207	42 (4.3)	42 (4.3)	1400
11.60	09/19/2000	200.0	EBT 3	28 (2.7)	41 (1.5)	2 (0.0)	75	156	42 (1.1)	21 (0.5)	1313
11.60	09/19/2000	200.0	WCT 3	0 (0.0)	12 (2.5)	0 (0.0)	91	145	12 (2.5)	6 (1.3)	375
11.70	09/09/1998	100.0	WCT 2	0 (0.0)	1 (0.0)	1 (0.0)	125	208	2 (0.0)	2 (0.0)	67
11.70	09/09/1998	100.0	EBT 2	9 (0.4)	28 (1.1)	11 (0.7)	87	202	40 (1.8)	40 (1.8)	1333
11.70	08/24/1999	200.0	EBT 2	37 (3.7)	17 (1.2)	22 (2.0)	102	231	40 (2.8)	20 (1.4)	
11.70	08/24/1999	200.0	WCT 2	0 (0.0)	0 (0.0)	2 (0.0)	156	196	2 (0.0)	1 (0.0)	
11.80	09/03/1997	200.0	EBT 2	23 (0.2)	81 (5.3)	11 (1.1)	76	210	93 (5.7)	46.5 (2.9)	1409
11.80	09/03/1997	200.0	WCT 2	1 (0.0)	1 (0.0)	0 (0.0)	78	78	1 (0.0)	0.5 (0.0)	15
11.80	09/09/1998	100.0	WCT 2	0 (0.0)	1 (0.0)	0 (0.0)	140	140	1 (0.0)	1 (0.0)	33

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
11.80	09/09/1998	100.0	EBT 2	--	24 (0.7)	6 (1.1)	87	175	30 (1.1)	30 (1.1)	1000
11.80	09/19/2000	200.0	WCT 3	0 (0.0)	14 (3.8)	6 (0.1)	111	222	19 (2.0)	9.5 (1.0)	594
11.80	09/19/2000	200.0	EBT 3	18 (4.7)	30 (3.6)	8 (1.1)	75	188	39 (4.2)	19.5 (2.1)	1219
11.90	09/09/1998	100.0	EBT 2	8 (3.2)	17 (1.2)	7 (0.4)	100	172	24 (1.2)	24 (1.2)	800
11.90	08/24/1999	200.0	EBT 2	18 (0.8)	14 (0.9)	12 (0.7)	94	214	26 (1.1)	13 (0.6)	
11.90	08/24/1999	200.0	WCT 2	0 (0.0)	0 (0.0)	1 (0.0)	170	170	1 (0.0)	0.5 (0.0)	
12.00	09/09/1998	100.0	WCT 2	0 (0.0)	2 (0.0)	0 (0.0)	90	126	2 (0.0)	2 (0.0)	67
12.00	09/09/1998	100.0	EBT 2	2 (0.0)	24 (1.9)	10 (0.3)	95	204	34 (1.7)	34 (1.7)	1133
12.00	09/20/2000	200.0	EBT 3	71 (5.9)	39 (2.5)	10 (0.1)	75	225	48 (1.7)	24 (0.9)	1500
12.00	09/20/2000	200.0	WCT 3	0 (0.0)	23 (30.1)	3 (0.0)	110	161	17 (5.1)	8.5 (2.5)	531
12.10	09/09/1998	100.0	WCT 2	1 (0.0)	--	0 (0.0)	141	141	--	--	
12.10	09/09/1998	100.0	EBT 2	-- (2.3)	15 (0.5)	5 (2.2)	93	206	20 (2.2)	20	571
12.10	08/25/1999	200.0	EBT 2	6 (0.5)	10 (0.3)	22 (3.3)	104	223	31 (2.1)	15.5 (1.1)	

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
12.20	09/09/1998	100.0	EBT 2	--	16 (3.9)	13 (0.6)	94	215	29 (2.9)	29 (2.9)	967
12.20	09/09/1998	100.0	WCT 2	0 (0.0)	0 (0.0)	1 (0.0)	162	162	1 (0.0)	1 (0.0)	33
12.20	09/20/2000	200.0	EBT 3	67 (1.7)	37 (3.4)	9 (0.5)	75	198	46 (3.1)	23 (1.6)	1438
12.20	09/20/2000	230.0	WCT 3	0 (0.0)	2 (0.0)	3 (0.3)	115	242	6 (0.4)	2.60 (0.2)	163
12.20	09/20/2000	200.0	WCT 3	0 (0.0)	3 (0.7)	3 (0.7)	112	185	6 (1.1)	3 (0.5)	188
12.20	09/20/2000	230.0	EBT 3	73 (2.2)	28 (2.9)	12 (0.5)	75	225	40 (2.5)	17.3 (1.1)	1087
12.30	09/09/1998	100.0	WCT 2	1 (0.0)	0 (0.0)	0 (0.0)	75		0 (0.0)	0 (0.0)	0
12.30	09/09/1998	100.0	EBT 2	4 (0.0)	72 (76.1)	5 (0.5)	88	177	62 (34.5)	62 (34.5)	2067
12.30	08/25/1999	200.0	EBT 2	4 (0.6)	10 (0.3)	11 (0.3)	102	209	21 (0.5)	10.5 (0.3)	
12.30	08/25/1999	200.0	WCT 2	--	44 (15.1)	1 (0.0)	75	193	44 (13.4)	22 (6.7)	
12.40	09/09/1998	100.0	EBT 2	5 (1.2)	26 (3.2)	16 (0.9)	93	218	43 (3.5)	43 (3.5)	1433
12.50	09/04/1997	200.0	WCT 2	0 (0.0)	0 (0.0)	1 (0.0)	231	231	1 (0.0)	0.5 (0.0)	14
12.50	09/04/1997	200.0	EBT 2	--	120 (200.1)	27 (8.4)	83	215.	127 (88.7)	63.5 (44.3)	1764

Stream km	Date	Section length (m)	Species Estimator	Estimate (SE) by Length Group < 75 mm	75-150 mm	150 + mm	Length Range (mm) Min	Max	Total estimate (SE)	Estimated number/ 100 m	Hectare
12.50	09/09/1998	112.0	WCT 2	0 (0.0)	0 (0.0)	3 (0.7)	150	225	3 (0.7)	2.67 (0.7)	89
12.50	09/09/1998	112.0	EBT 2	1 (0.0)	44 (13.5)	46 (2.5)	102	236	87 (7.7)	77.6 (6.9)	2589
12.50	08/25/1999	200.0	WCT 2	1 (0.0)	5 (0.5)	1 (0.0)	79	153	6 (0.5)	3 (0.3)	
12.50	08/25/1999	200.0	EBT 2	24 (7.3)	19 (2.3)	24 (0.2)	102	227	42 (1.1)	21 (0.6)	
12.60	08/05/1993	68.9	EBT 2	0 (0.0)	21 (2.1)	3 (0.7)	75.75	169.	24 (2.2)	34.8 (3.2)	917
12.70	09/04/1997	235.0	EBT 2	--	--	30 (2.9)	82	243	161 (124.)	68.5 (53.1)	1903
12.70	09/04/1997	235.0	WCT 2	0 (0.0)	0 (0.0)	3 (0.7)	185	265	3 (0.7)	1.27 (0.3)	35
12.70	08/25/1999	230.0	EBT 2	14 (0.6)	23 (3.2)	54 (3.2)	76	235	78 (4.8)	33.9 (2.1)	