

Seasonal Migration of Westslope Cutthroat Trout in the Middle Fork Salmon River Drainage, Idaho

Abstract

Additional information about the migratory behavior of westslope cutthroat trout may aid managers in making decisions regarding the long term conservation of the species. From September 2000 to September 2001, we used radio telemetry to track the movement of 30 adult westslope cutthroat trout that were collected from Bear Valley Creek a tributary to the Middle Fork Salmon River, Idaho. Downstream movement of the tagged fish began soon after they were released in late September and continued through December. By 22 February, the tagged fish were spread over more than 150 km of habitat, from Bear Valley Creek to the Salmon River. Fish movement diminished as temperatures stabilized during the coldest months of the winter. Upstream movement of the tagged fish began in March as water temperature and discharge increased and peaked in May. As of 30 May, 2 of the 8 fish that were in likely spawning and rearing areas were in tributaries that were downstream of the locations of capture. The longest total movement for a fish was 475 km. The longest downstream movement was 194 km. Of the fish that survived through March, the shortest downstream movement was 9 km. Our results suggest that westslope cutthroat trout in the study area have a wide winter habitat range and lack strong spring and summer habitat site fidelity. Our results also provide additional evidence that, when not constrained by barriers such as dams or impassable culverts, westslope cutthroat trout may migrate over long distances, and exhibit plasticity in seasonal habitat use. Conservation plans should account for the diversity in westslope cutthroat trout migratory behavior.

Introduction

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) exhibit a continuum of life history types. In some systems, fluvial westslope cutthroat trout will often migrate out of spawning areas soon after spawning and return to larger rivers. The amount of time the adults linger in specific areas between spawning and wintering habitats varies. In some systems, the adults return to the large rivers soon after spawning (Shepard et al. 1984, Behnke 1992) and in other systems they will spend much of the summer in the smaller tributaries where they spawned (Shepard et al. 1984). Westslope cutthroat trout in headwater streams may also be resident fish that spawn, rear, and live through adulthood in the same relatively short section of stream (Shepard et al. 1984, Behnke 1992, Brown and Mackey 1995).

Extensive spawning migrations have been documented for native stocks of westslope cutthroat trout in the Blackfoot River, Montana (Schmetterling 2001), and the Salmon River, Idaho (Bjornn and Mallet 1964). The Bear Valley Creek drainage, located on the Boise National

Forest, Idaho, flows directly into the Middle Fork of the Salmon River. We have little information specific to westslope cutthroat trout migration patterns and spawning habitat in the Bear Valley Creek and Middle Fork Salmon drainage. Natural resource managers will be able to more adequately assess the effects of land management activities on westslope cutthroat trout in the Bear Valley Creek and Middle Fork Salmon drainage if they have a more detailed understanding of the fish's migratory patterns and the location of spawning habitat. We used radio telemetry to track the annual movement of adult westslope cutthroat trout in the Bear Valley Creek drainage and the Middle Fork Salmon River.

Study Area

The study area is located within National Forest system lands in the Salmon River Mountains of West Central Idaho. The study focused on the Bear Valley Creek and the Middle Fork Salmon River drainage, which encompasses a drainage area of 7,485 km² (Figure 1). Bear Valley Creek converges with Marsh Creek in the Frank Church River of No Return Wilderness and forms the Middle Fork Salmon River. The entire length of the Middle Fork Salmon River lies within the Wilderness. The

Author to whom correspondence is to be addressed. E-mail: czurstadt@fs.fed.us

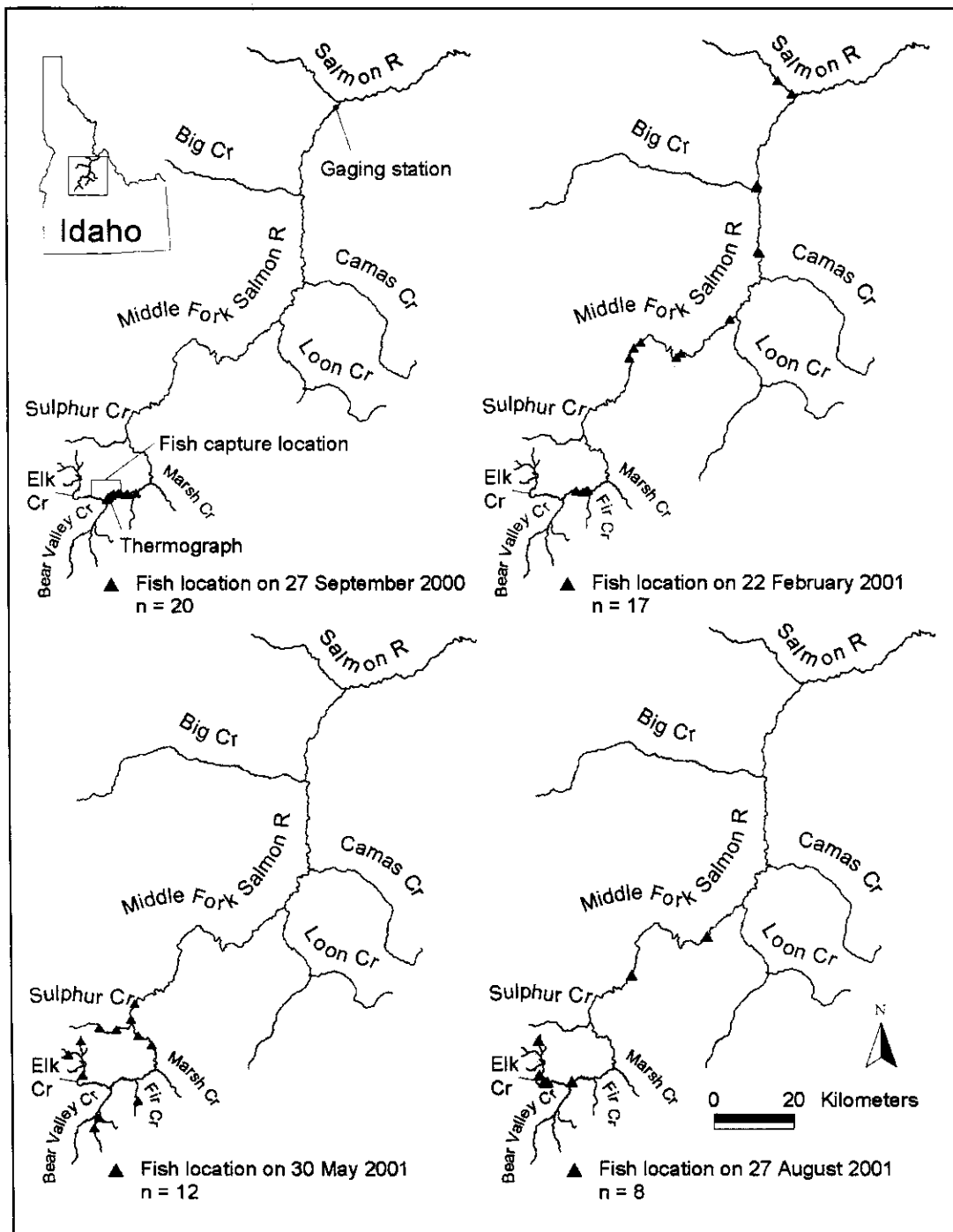


Figure 1. Map of study area and changes in radio tagged westslope cutthroat trout locations over the year. n = the number of fish located on the specific date.

geology underlying the study area is dominated by the Idaho Batholith Granitics and the Challis Volcanics. Glaciation, cryoplanation, plutonic intrusions, localized block faulting, and fluvial processes including mass wasting have shaped the landscape (Arnold 1975).

Wet winters and dry summers characterize the local climate. Most of the annual precipitation results from cyclonic storms from the Pacific Ocean that drop snow from November through March (Wendt et al. 1975). Depending on elevation and topography, mean annual precipitation in the area ranges from 370 to 820 mm and mean annual air temperatures range from 1.4° to 6.8°C (Western Regional Climate Center 1998). Peak stream flows correspond with spring and early summer snowmelt, which begins around March and can extend into early July. The streams that flow into the Middle Fork Salmon River originate in rolling hills and meander into deeply filled glacial valleys that often accumulate cold air.

In addition to westslope cutthroat trout, fish species found in the study area include mountain whitefish (*Prosopium williamsoni*), sculpin (*Cottus* spp.), spring/summer Snake River chinook salmon (*O. tshawytscha*), resident and anadromous forms of redband trout (*O. mykiss gairdneri*), bull trout (*Salvelinus confluentus*), and non indigenous brook trout (*S. fontinalis*). Anthropogenic disturbance in the area has historically focused on the Bear Valley Creek drainage and included intensive sheep and cattle grazing, road construction, dredge mining, logging, and fire suppression. Currently, the Forest Service allows limited logging and practices fire suppression. Recreational and Native American subsistence fishing have a long history in the drainage and continue today. Because it is located within a designated wilderness area, the Middle Fork Salmon River remains relatively pristine. Common predators found within the study area include river otters (*Lutra canadensis*), belted kingfisher (*Ceryle alcyon*), and osprey (*Pandion haliaetus*).

Methods

A continuously recording thermograph was deployed to measure water temperature in Bear Valley Creek for the duration of the study (Figure 1). Stream flow data were measured at a gaging station near the mouth of the Middle Fork Salmon River (USGS 2001) (Figure 1).

Between 14 September and 5 October 2000, hook and line was used to capture 30 adult westslope cutthroat trout in Elk Creek, and Bear Valley Creek (Figure 1). The Bear Valley Creek drainage was initially the focus of the study; therefore, fish capture was restricted to Bear Valley Creek and Elk Creek. Tagging occurred in the late summer to help insure that the fish were in good physical condition and because angling efficiency was known to be high at this time. Fish were anaesthetized with MS-222 and radio tags were surgically implanted using the shielded needle technique (Ross 1982). For each fish the trailing antenna was trimmed so that it did not project past the caudal fin. Following surgery the fish were allowed to recover in a holding tank, then released near their location of capture. Winter (1983) suggested that the weight of radio tags in the air should be less than 2% of the total weight of the fish. Because there is evidence that the 2% rule is conservative (Brown et al. 1999) we elected to follow that recommendation. Each radio tag had a dry weight of 7.8 g; therefore, all but two fish tagged were ≥ 390 g. The remaining two fish were 370 g each. The mean wet weight of the fish before tagging was 528.3 g (SE = 23.5 g) with a range of 370 - 850 g. The mean total length of tagged fish was 36.8 cm (SE = 0.49 g) with a range of 33 - 43 cm. Radio tags were equipped with a mortality function, which would cause the radio tag to double the transmitted pulse rate if the tag was stationary for 12 consecutive hours. The radio tags had an expected battery life of one year. On 27 and 28 September 2000, we tracked tagged fish from the ground using a wireless receiver and YAGI antenna. Between 16 October 2000 and 10 September 2001, we tracked at weekly or biweekly intervals from a fixed wing aircraft. The mean number of flights per month was 2.4, with a total of 29 flights. The frequency of flights depended on the amount of fish movement. For example, only two flights were made in February 2001 because fish movement was minimal. In contrast, five flights occurred in May 2001 when fish were swimming long distances (Figure 1). Due to US Forest Service administrative constraints, there were no flights in April 2001; therefore, there are no data for fish location during April. Once a radio signal was received the UTM coordinates of the fish location were recorded using a handheld GPS unit. In the Middle Fork Salmon River, where habitat units are large (e.g. pools >50 m in length separated by >5 km long

riffles) and easily identifiable during December - February, the observer tried to determine if the fish was in a pool or riffle (Hawkins et al. 1993). Once a mortality signal was received no further attempts were made to locate the fish from the air. After all 29 flights the mean percent success rate for locating tagged fish was calculated by dividing the number of flights in which a living fish was located by the total number flights that the fish was searched for and multiplying by 100. The mean was then taken of the percent success rate for all of the fish. The UTM coordinates of fish locations were plotted on a stream layer using geographic information system software. The distance between two consecutive fish locations was recorded as the length of the stream segment between the fish locations. In order to have a standardized comparison of fish travel distances per month the mean daily upstream and downstream travel distance per fish was calculated for each month.

Results

Water Temperature and Discharge

Temperature and discharge data came from two locations separated by over 100 km therefore, we consider the general trends as more representative of the drainage than actual values. Water temperature declined in the fall of 2000 and remained near 0°C from early November 2000 through mid March 2001 (Figure 2). Water temperature began to rise in late March 2001 and peaked at 18.9°C on 4 July 2001. Discharge, as measured at the USGS gage at the mouth of the Middle Fork Salmon River, remained relatively steady from the time of tagging in late September through March (Figure 2). Much of the Middle Fork Salmon River drainage was covered with ice from mid December through February. Flows began to rise in late April 2001, peaked on 16 May 2001, and began to recede in late May.

Fish Movement

In locations where radio tag transmissions were not blocked by canyon walls the maximum linear distance over which we could detect a radio tag transmission was ~1.6 km. In most cases the fish location was logged immediately after a transmission was received; therefore, the actual fish location could vary from the UTM coordinates by a maximum of 0.8 km. When possible we

would wait for the strongest signal before logging the location and in those cases the accuracy was significantly better than 0.8 km. The mean success rate for locating individual fish over the course of 29 flights was 93.6% (SE = 2.3%). Downstream movement of the tagged fish began soon after they were released in late September and continued through December (Figure 2). We observed that tagged fish generally moved quickly through the higher gradient sections of river that were dominated by riffles. During January and February, there was little movement and tagged fish tended to hold in sections of river where large pools existed. By 22 February, of the 17 surviving fish, 5 continued to hold in lower Bear Valley Creek, 10 were spread throughout the Middle Fork Salmon, and 2 were in the Main Salmon River (Figure 1). The longest downstream movement was 194 km. Of the fish that survived through March, the shortest downstream movement was 9 km and was completed by a fish that remained upstream of the Middle Fork Salmon River for the duration of the study. The mean downstream movement for 16 tagged fish that survived through mid February was 91.4 km (SE = 16.5 km). The mean total distance traveled (includes downstream and upstream movement) for 16 tagged fish that survived through February was 231.6 km (SE = 39.9 km).

Upstream movement of the tagged fish began in March and peaked in May (Figure 2). As of 30 May, 5 of the 12 surviving fish were upstream of the location of capture, and 8 of the surviving fish were in likely spawning and rearing tributaries. Of the fish that were in likely spawning and rearing areas two were in tributaries that were downstream of the locations of capture (Figure 1). Substantial downstream movement occurred during May through July (Figure 2) as tagged fish moved back downstream out of tributaries to Bear Valley Creek or the Middle Fork Salmon River. The longest total movement over the course of the year was 475 km. The longest total movement in the shortest time period occurred during June and consisted of 46 km covered in 8 days.

Over the course of the study 22 of the 30 fish tagged were probable mortalities. In 2001, after 9 May, two of the surviving fish could not be located, after 13 August, four of the surviving fish could not be located, and on 10 September, seven of the surviving fish could not be located, which indicates that radio tag

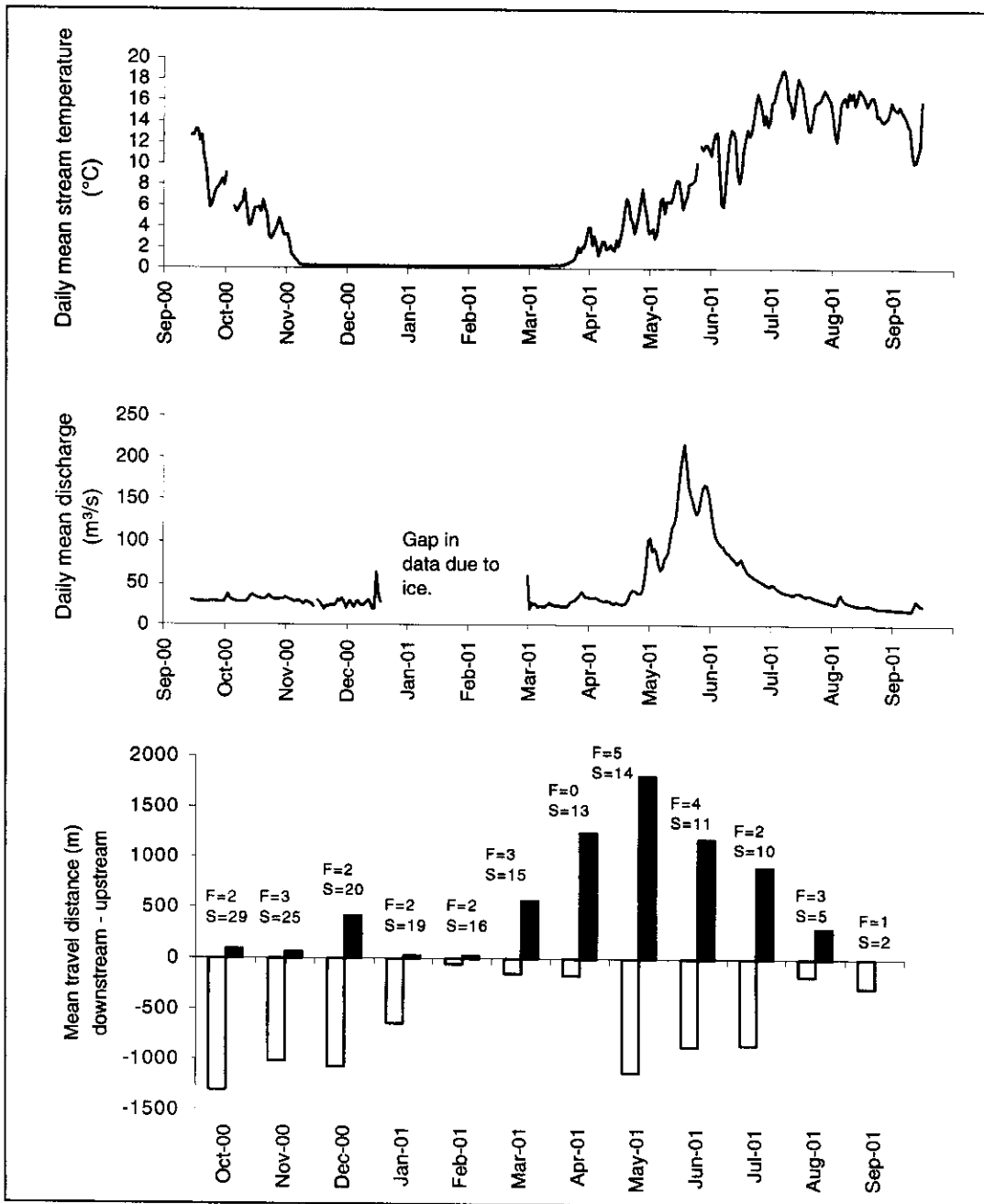


Figure 2. Top graph displays the daily mean water temperature in Bear Valley Creek. Middle graph displays daily mean discharge at the mouth of the Middle Fork Salmon River. Bottom graph displays the mean monthly up- and downstream movement per fish per day. Due to the method of sampling and analyzing fish movement mean travel distances for the month of October 2000 are likely biased toward the fish that swam shorter distances. No flights were conducted in April; therefore the mean travel distance for April was calculated using distances traveled between the 27 March and 3 May flights. F = the number of flights conducted during the month. S = the number of surviving fish as of the last flight of the month. For April, S = the number of surviving fish located on the 3 May flight.

batteries were beginning to fail. The greatest number of mortalities occurred during the months of November and December (Figure 2). Three of the spring mortalities occurred while the fish were in small streams with mean bank full widths < 7 m. Five tags that were transmitting mortality signals were retrieved.

Discussion

Our results suggest that westslope cutthroat trout in the study area are utilizing a wide range of habitat not just from one season to the next, but within seasons. As temperature and discharge fluctuate some individuals migrated long distances while others remained near the point of capture. There seems to be a lack of strong spring and summer habitat site fidelity. More specifically, our findings suggest that the population range for some westslope cutthroat trout that summer in the Bear Valley Creek drainage includes the Middle Fork Salmon River and portions of the Salmon River. Our findings will help provide natural resource managers with a better understanding of the extent and plasticity of westslope cutthroat trout migration behavior in the Bear Valley Creek and Middle Fork Salmon River drainage.

On average fish moved downstream as temperature decreased in the fall and winter then movement diminished as temperatures stabilized during the coldest months of the winter. As temperature and flows increased in the spring mean fish movement increased dramatically. Similar associations between temperature, flow, and movement of westslope cutthroat trout have been observed in other drainages (Shepard et al. 1984, McIntyre and Rieman 1995, Schmetterling 2001). However, not all of the fish we tagged fish moved long distances downstream. By the end of February the tagged fish were spread out over more than 150 km of habitat (Figure 1). We are unaware of other instances in which westslope cutthroat trout have been documented utilizing such an extensive range of overwintering habitat. From December - February the tagged fish tended to hold in lower gradient sections of river where large pools exist. The tendency for cutthroat trout to aggregate in pools during winter has been well documented (Jakober et al. 1998, Brown 1999). From the aircraft it was evident that during the winter the habitat in the Middle Fork Salmon River is dominated by very long riffles and large distinct

pools are relatively scarce. One explanation for extensive range of overwintering habitat is that adequate pools are limited and fish are forced downstream as pools fill up with fish (Cunjak and Power 1986). It should be noted that the snow pack for the Salmon River Basin for the winter of 2000-2001 was ~50% of the mean (USDA 2001), therefore, the flows in the Middle Fork Salmon River were less than average. We do not know if fish movement in a more typical water year would differ greatly from what we observed.

The movement of radio tagged fish into the small tributaries provides additional evidence that migratory westslope cutthroat trout in the Bear Valley and Middle Fork Salmon River drainage use small tributaries for spawning. Schmetterling (2000, 2001) documented westslope cutthroat trout spawning in 1-10 m wide tributaries to the Blackfoot River, Montana. In our study some of the tagged fish migrated into small headwater tributaries, while others remained in Bear Valley Creek or the Middle Fork Salmon River throughout the spring and summer. Alternate year spawning has been documented in some westslope cutthroat trout populations (Shepard et al. 1984, McIntyre and Rieman 1995). The tendency for alternate year spawning may help explain why more of the tagged fish did not migrate into small headwaters streams.

Only one fish died within a month of tag implantation. The absence of excessive mortalities immediately after the release of tagged fish indicates that westslope cutthroat trout are tolerant of the short-term effects of hook and line capture and tag implantation during late summer. The increases in mortalities during the coldest months of winter and just after spring indicate that the rigors of winter and subsequent migration and spawning activity are possible causes of mortality. Westslope cutthroat trout mortality from spawning can be high (Trotter 1992, McIntyre and Rieman 1995). Several of the mortalities occurred shortly after fish entered small first- or second-order tributaries in which they may have spawned. The high mortality rate may also have been due to a bias towards tagging older fish that were nearing the end of the normal life expectancy of westslope cutthroat trout. Other causes of mortality may have been due to predation and stress from the radio tag implants. There were no remains of the fish visible near the recovered tags and no obvious signs of predators, such as scat.

The long distance migrations exhibited by some of the tagged fish in this study are consistent with the findings from other work documenting migrations from westslope cutthroat trout (Bjornn and Mallet 1964, Schmetterling 2001). Schmetterling (2001) found that fluvial westslope cutthroat trout in the Blackfoot River, Montana, exhibited great plasticity in prespawning and postspawning movement. The movement of tagged fish into tributaries and sections of the Middle Fork Salmon River downstream of the location of capture in Bear Valley Creek (Figure 1), suggest a lack of strong spring and summer habitat site fidelity. One implication of a population that is widely distributed is that disturbances separated by long distances (e.g. 10 – 200 km) can have cumulative effects on the population. Management activities that affect stream habitat condition in an isolated part of a drainage may have effects on a westslope cutthroat trout population that is dispersed over a much larger area.

Due to low road densities (0.01 km ha⁻¹) and bridge placements at road crossings adult westslope cutthroat trout have unimpeded access to many of the tributaries in the Bear Valley Creek drainage. Similarly, the Middle Fork Salmon River drainage has few human caused barriers to fish. The results of this study add to the evidence in the literature that in a system without dams, and with few other human caused barriers, westslope cutthroat trout exhibit a wide range of migratory strategies and seasonal habitat use. It is unknown how restricting the full expression of westslope cutthroat trout migratory behavior and habitat use

may influence population persistence. Actions that isolate populations of westslope cutthroat trout are likely to threaten the long term persistence of those populations (McIntyre and Rieman 1995). Migratory behavior may aid in population persistence by spreading of the risk of extinction over a larger area. Localized disturbance is not likely to extirpate an entire population if the population is spread out over a large area (Den Boer 1968). In addition, migratory populations can provide colonizers to patches of suitable, but unoccupied habitat. To insure that this can happen, managers will need to strive to restore habitat connectivity, and prevent the creation of artificial barriers.

Acknowledgements

We would like to acknowledge the following for their contributions to the project: Ted Trueblood Chapter of Trout Unlimited, National Trout Unlimited, IDF&G (Dale Allen, Brian Flatter), Garden Valley Highschool Advanced Biology Class (Ralph Foote and class); Project sponsors A Rocky Mountain River Tour, Solitude River Trips, Dave Helfrich Outfitters, Hughes River Expeditions, Jim Classen, Rik Moran, ZofX Systems, and Forest Service technicians Thomas Edwards, Eric Esselstyn, Edward Fochtman, Joleen Kiesel, and Kristi Overberg. This work was supported in part by the USDA Forest Service Rocky Mountain Research Station. Dave Burns, Jeff Dillon, Jason Dunham, Steve Elle, Dona Horan, Rodger Nelson, and Michael Young provided helpful suggestions for improving the manuscript.

References

- Arnold, J. F. 1975. Appendix B of the Idaho Batholith source book: descriptions of sections and subsections of that portion of the northern rocky mountain physiographic province containing the Idaho Batholith. USDA Forest Service, Boise National Forest, Boise, Idaho.
- Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society, Monograph 6, Bethesda, Maryland.
- Bjornn, T. C., and J. Mallet. 1964. Movements of planted and wild trout in an Idaho river system. Transactions of the American Fisheries Society 93:70-76.
- Brown, R. S., J. Cooke, G. W. Anderson, and S. R. McKinley. 1999. Evidence to Challenge the "2% Rule" for Biotelemetry. North American Journal of Fisheries Management 19:867-871.
- Brown, R. S., and W. C. Mackay. 1995. Spawning ecology of cutthroat trout (*Oncorhynchus clarki*) in the Ram River, Alberta. Canadian Journal of Fisheries and Aquatic Sciences 52:983-992.
- Brown, R. S. 1999. Fall and early winter movements of cutthroat trout, *Oncorhynchus clarki*, in relation to water temperature and ice conditions in Dutch Creek, Alberta. Environmental Biology of Fishes 55:359-368.
- Cunjak, R. A., and G. Power. 1986. Winter habitat utilization by stream resident brook trout *Salvelinus fontinalis* and brown trout *Salmo trutta*. Canadian Journal of Fisheries and Aquatic Science 43:1970-1981.
- Den Boer, P. J. 1968. Spreading of risk and stabilization of animal numbers. Acta Biotheoretica (XVIII) 164-192.
- Hawkins, C. P., J. L. Kershner, P. A. Bisson, M. D. Bryant, L. M. Decker, S. V. Gregory, D. A. McCullough, C. K. Overton, G. H. Reeves, R. J. Steedman, and M. K. Young. 1993. A hierarchical approach to classifying stream habitat features. Fisheries 18:3-4, 6-12.
- Jakober, M.J., T. E. McMahon, R. E. Thurow, and C.G. Clancy, 1998. Role of stream ice on fall and winter movements and habitat use by bull trout and cutthroat trout in Montana headwater streams. Transaction of the American Fisheries Society 48:757-762.

- McIntyre, J. D. and B. E. Rieman. 1995. Westslope cutthroat trout. Pages 1-15 *In* M. K. Young, editor. Conservation assessment for inland cutthroat trout. USDA Forest Service General Technical Report RM-256. Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.
- Ross M. J. 1982. Shielded needle technique for surgically implanting radio frequency transmitters in fish. *Journal of Progressive Fish Culture* 44: 41-43.
- Schmetterling, D. A. 2000. Redd characteristics of fluvial westslope cutthroat trout in four tributaries to the Blackfoot River, Montana. *North American Journal of Fisheries Management* 20:776-783.
- Schmetterling, D. A. 2001. Seasonal movements of fluvial westslope cutthroat trout in the Blackfoot River Drainage, Montana. *North American Journal of Fisheries Management* 21:507-520.
- Shepard, B. B., K. L. Pratt, and P. J. Graham. 1984. Life histories of westslope cutthroat trout and bull trout in the upper Flathead River basin, Montana. Montana Department of Fish, Wildlife and Parks, Helena, Montana.
- Trotter, P. 1992. Cutthroat trout (*Oncorhynchus clarki*). Pages 236-265 *In* J. Stolz and J. Schnell, (editors), Trout. Stackpole Books, Harrisburg, Pennsylvania.
- United States Geological Survey. 2001. Water resources of the United States. Available online at www.water.usgs.gov.
- United States Department of Agriculture. 2001. Idaho NRCS snow survey. Available online at www.idsnow.id.nrcs.usda.gov/snow/snowpack_reports.htm.
- Wendt, G. E., R. A. Thompson, and K. N. Larson. 1975. Land systems inventory: Boise National Forest Idaho. USDA Forest Service. Boise National Forest, Boise, Idaho.
- Western Regional Climate Center. 1998. Historical climate information. Available online at www.wrcc.dri.edu/index.html.
- Winter J. D. 1983. Underwater biotelemetry. Pages 371-395 *In* L. A. Nielson and D. L. Johnson, (editors), Fisheries Techniques. Southern Printing Company, Blacksburg, Virginia.

Received 20 November 2003

Accepted for publication 27 July 2004