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MINK PREDATION ON RADIO-TAGGED TROUT DURING WINTER IN A LOW-GRADIENT REACH OF A MOUNTAIN STREAM, WYOMING

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Key words: mink, *Mustela vison*, brook trout, *Salvelinus fontinalis*, cutthroat trout, *Oncorhynchus clarki*, predation, natural mortality, stream, winter.

Sources of natural mortality among fluvial salmonids are poorly understood, and contributions by predators to natural mortality rates have not been measured. Mink (*Mustela vison*) are effective fish predators (Dunston 1978, 1983, Linscombe et al. 1982, Eagle and Whitman 1987) that can contribute to natural mortality of salmonids in streams (Erlinge 1969, Alexander 1976, Melquist et al. 1981, Whitman 1981). Evidence that mink predation is a significant source of natural mortality among fluvial salmonids has been observed. For example, Heggenes and Borgstrom (1988) reported that mink presence led to a marked increase in mortality of juvenile Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) in streams. However, Burgess and Bider (1980) concluded that mink predation on brook trout (*Salvelinus fontinalis*) was not a significant source of mortality in a stream improved to enhance brook trout.

Winter is considered a time of stress among fluvial salmonids. Causes of overwinter mortality are poorly understood, but evidence exists that mortality can be associated with dynamic ice conditions, starvation, predation, or an interaction of these factors (Simpkins and Hubert 2000, Simpkins et al. 2000). Predation by mink can be a source of winter mortality because mink remain active during winter (Marshall 1936, Sealander 1943), and fishes may be more susceptible to mink predation because low water temperatures reduce the metabolic rates and abilities of fish to escape attacks (Gerrell 1967). Predation by mink on rainbow trout (*Oncorhynchus mykiss*) during winter was observed during a telemetry study in a regulated

river downstream from a large reservoir in Wyoming (Simpkins 1997). Similarly, Jakober (1995) reported the loss of radio-tagged bull trout (*Salvelinus confluentes*) to mink predation in late autumn after ice formed in a stream in Montana. Mountain streams can provide good habitat for mink and support substantial populations, particularly along low-gradient segments with abundant willows (*Salix* spp.) in riparian areas and beaver (*Castor canadensis*) ponds along the stream (Liscombe et al. 1982, Eagle and Whitman 1987).

We conducted a study that provided insight into the possible contribution of mink predation to winter mortality of salmonids in mountain streams. It was part of a larger study to assess habitat use and movements of cutthroat trout (*Oncorhynchus clarki*) and brook trout from fall through winter (Lindstrom 2003). The study was conducted on a 7-km reach of South Cottonwood Creek in the Green River watershed on the Wyoming Range in western Wyoming at an elevation of 2460–2530 m above mean sea level. Mean wetted width of the study reach was 7 m, mean channel slope was 0.9%, late summer discharge was 0.6–0.8 m³ · s⁻¹, and minimum winter discharge was 0.2–0.3 m³ · s⁻¹. Beaver were common throughout the study reach. Dominant riparian vegetation was willow. Conifers and deciduous trees were absent from the riparian zone, and large woody debris was rare in the channel. Habitat improvements had been conducted between 1984 and 1994 on a 2-km segment of the stream in the middle of the study reach to stabilize the stream channel and increase pool habitat (Binns 1999).

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Table 1. Species, total length, date of last observation of live fish, and date of observation following predation by mink for 9 of 50 cutthroat trout and brook implanted with radio transmitters in South Cottonwood Creek, Wyoming, in autumn 2002 and monitored throughout the winter.

Species	Total length (mm)	Date last observed alive	Date observed to have been predated by mink
Brook trout	280	11 November	18 November
Brook trout	235	18 November	25 November
Brook trout	260	18 November	25 November
Brook trout	280	25 November	10 December
Brook trout	250	18 December	2 January
Brook trout	245	2 January	15 January
Brook trout	280	15 January	30 January
Cutthroat trout	300	15 January	30 January
Cutthroat trout	255	12 February	26 February

We captured 25 adult cutthroat trout (mean total length [TL] = 333 mm, mean weight = 406 g) and 25 adult brook trout (mean TL = 264 mm, mean weight = 236 g) by electrofishing during autumn (25 September–1 October 2002) over the length of the study reach. We then surgically implanted the fish with radio transmitters (Model F170, Advanced Telemetry Systems, Isanti, MN; mean weight = 3.1 g) using the shielded-needle technique (Ross and Kleiner 1982) and released them into the pool from which they were captured upon their recovery (0.5–1.0 hour). Fish were tracked from the ground during daylight hours using a directional loop antenna and scanning receiver (Challenger R2000, Advanced Telemetry Systems, Isanti, MN), and locations of transmitters were determined to within a 2-m radius (Simpkins and Hubert 1998). Fish were located at 1-week intervals during October and November and biweekly from December to mid-March.

During the study period we attributed fish losses to mink predation, transmitter failures, movements out of the study reach, spawning behavior, or unidentified causes. Predation by mink was inferred when transmitter locations were over land and below ground and there were mink signs (tracks or scat) in the immediate vicinity of the transmitter locations. Transmitters were considered to have failed if weakened signals or slowed pulse frequencies had been observed during previous location efforts.

We tracked 14 cutthroat trout and 8 brook trout to the end of the study in mid-March 2003. Among 11 cutthroat trout losses, 6 were attributed to transmitter failures, 2 to mink predation, and 3 to unknown causes. Among

17 brook trout losses, we attributed 7 to mink predation, 4 to transmitter failures, 1 to spawning behavior, 1 to movement out of the study area, and 4 to unknown causes. Among the fish identified as losses to mink predation (Table 1), the 2 cutthroat trout (255 and 300 mm TL) were shorter than the mean length (333 mm TL) of cutthroat trout tagged, but the 7 brook trout (mean TL = 261) were similar in length to those tagged (mean = 264 mm TL). Predation by mink on tagged fish occurred throughout the winter from the middle of November through February, but the first 5 fish lost to mink predation were all brook trout (Table 1). We commonly observed mink sign in the riparian area throughout the study reach in the vicinity of tagged fish. Fish believed to have been killed by mink were found in both beaver ponds and lateral scour pools prior to their loss. Locations of radio tags from fish identified as having been killed by mink were generally within 100 m of the last recorded location of the fish. On each of 2 sampling dates (25 November and 30 January), 2 fish were determined to have been predated by mink, and in both cases the fish were found in the same beaver pond when previously located.

Mink predation was an important source of mortality among tagged trout during our study. We believe mink killed at least 8% of tagged cutthroat trout and 28% of tagged brook trout. Several factors may have contributed to this high level of predation by mink. Three areas of groundwater inflow prevented surface ice from totally covering 3 different 250- to 1000-m segments of the study reach (Lindstrom 2003). This may have enabled enhanced predatory behavior by mink in these reaches with open water, but fish were also lost from segments of

the stream that had total ice cover throughout the study. It is possible that surgical implantation of radio transmitters made the study fish more vulnerable to mink predation than other fish in the stream; however, the body burden created by the transmitters (maximum 1.6% of weight) was substantially less than the 2% maximum recommended for radiotelemetry studies with fish (Winter 1996). Brook trout may have been more vulnerable to predation by mink than were cutthroat trout due to their fall spawning behavior and smaller sizes. Observations from our study and other recent studies (Jakober 1995, Simpkins 1997) suggest that mink may have a substantial effect on natural mortality rates of fluvial salmonids during winter in the Rocky Mountain region. Further research is needed to identify the extent to which mink predation may contribute to winter mortality rates in mountain streams.

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