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Early season arboreal behaviour in Yellow-Bellied Marmots (*Marmota flaviventris*)

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Abstract. We observed Yellow-bellied Marmots using aspen and spruce trees as forage during a spring with later than usual snow cover. Marmots were seen climbing vertical trees of 10-20 cm in diameter and eating buds and branches. Following snowmelt, tree use declined abruptly. We believe that marmots use trees as an alternative source of forage during years with high spring snow pack. If marmots are emerging earlier and through greater spring snow pack then trees may be an important, but previously neglected, resource.

Key words: marmot, behaviour,

Introduction

Yellow-bellied Marmots (*Marmota flaviventris*) are semi-fossorial rodents, living and raising young in burrows; primarily they eat grasses and forbs (Armitage 1979). Use of trees as substitutes for underground burrows by yellow-bellied marmots has been documented only once before (Garrot and Jenni 1978). We provide novel observations of marmots using trees both for alternative sources of food as well as for resting places while all rocks were snow-covered following emergence from hibernation.

Methods

Our study site was located in and around the Rocky Mountain Biological Laboratory in Gothic, Colorado, 38˚ 57' 29"N, 106˚ 59' 06"W. This site has been the focus of continued marmot research since 1962. In the Spring of 2005, we studied five colony sites and observed arboreal behavior in only one of them, the Picnic colony. From 21 April to 31 May 2005, we recorded 57 hours of observations at the Picnic colony (typically 2.5-3 h per day on days when weather permitted observations) during the morning activity period from 0700 - 1200 h. Marmots had been marked for individual recognition the year before with fur dye; most, but not all, subjects were individually identifiable. We noted all occurrences of arboreal behavior and took detailed notes on what marmots did while in trees.

Results

In 2005 the Picnic colony consisted of four distinct social groups, which were determined by space use overlap patterns (Nanayakkara and Blumstein in press). We observed both male and female yearlings and adults participating in arboreal behavior before snowmelt (Table 1). We noted 77 instances of marmots in trees. Individuals were seen in both spruce (*Picea engelmanni)* and aspen (*Populus tremuloides*) trees, either sitting and looking, or feeding on buds, needles, or cones.

	Age : Sex Class				
Area	**AF**	**AM**	**Y**	**UNK**	**Grand Total**
1	16	15	22	15	68
2	3	1	-	-	4
3	3	1	-	1	5
Grand Total	22	17	22	16	77

Table 1. Number of adult females (AF), adult males (AM), yearlings (Y), and individuals of unknown age and sex (UNK) seen in trees for each of three spatial locations at the colony site.

Marmots climbed relatively short spruce trees (< 4 m tall) by ascending branches whereupon they were observed eating needles and cones. Marmots climbed aspens by ascending vertical trunks with a diameter of 10-20 cm to reach the branches where they were observed sitting and foraging. Marmots appeared to have difficulty descending vertical tree trunks and we observed approximately 20 instances of individuals falling while attempting to climb down. Previously, we have seen marmots occasionally climb short fence posts and trees that form an angle of less then 90° with the ground, but we have never before observed marmots climbing vertical tree trunks of this large a diameter.

We also observed marmot tooth marks on the branches and trunks of aspens; in some instances the trees were completely ringed with marmot tooth-marks. We observed marmots eating bark, as well as collecting it for probable bedding material. This supposition is supported by the fact that we observed some individuals tearing bark off trees and carrying it into their burrows, much as they would normally carry dried grasses used for bedding (Armitage 2003).

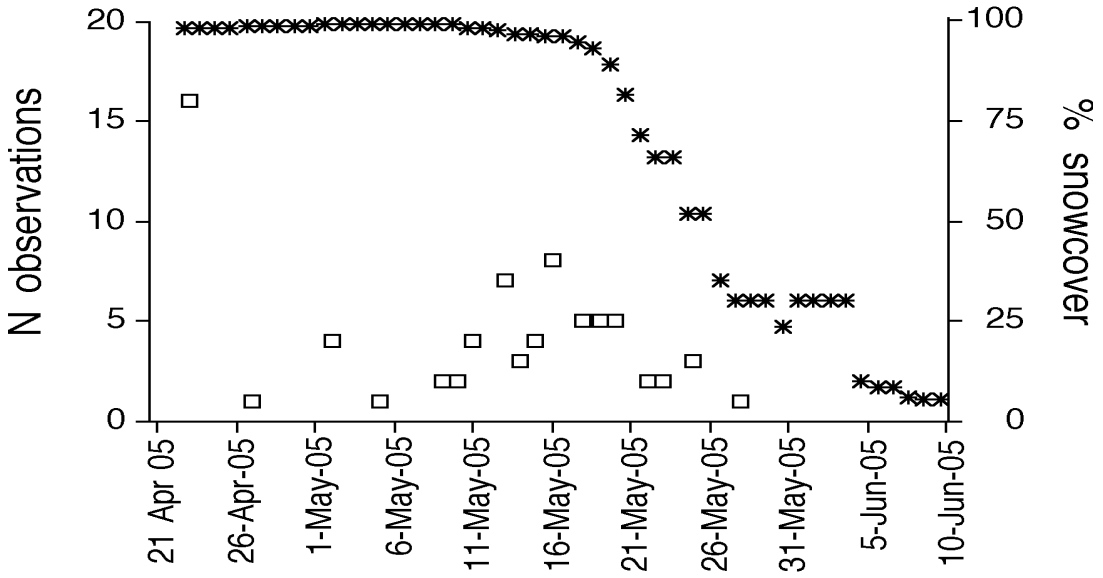

Fig. 1. Number of observations of arboreal behavior ( ) as a function of date and percent snow cover (*) at the Picnic yellow-bellied marmot colony site.

We estimate that snow at the Picnic colony was ca. 2 m deep over the entire site, except for two small areas in which avalanches had exposed bare ground. When the site was snow-covered there was no available forage, and it was during this time that we saw marmots use trees (Fig. 1). The number of marmots sitting or feeding on trees dropped precipitously as snow melted; we saw only 1 instance of marmots using trees after 50% of the snow had melted.

Discussion

There are several reasons for marmots to emerge from hibernation as early as possible, and thus potentially through deep snow pack. The end of the growing season influences juvenile over-winter survival (Armitage *et al.* 1976), thus, marmots must reproduce as soon as possible to ensure adequate time for juveniles to gain sufficient mass to survive hibernation (Armitage *et al.* 1976; Armitage *et al.* 2003). Additionally, males typically terminate hibernation first to initiate spermatogenesis (Christian *et al.* 1972; Barnes *et al.* 1986), maintain territories established in the previous autumn (Armitage 1974), and breed (Armitage 1965; Armitage 1998; Blumstein *et al.* 2004). Thus, individuals that emerged from their hibernacula and did not find green grasses and forbs might have to make use of marginal forage as they prepared for the mating season. Yearlings, in particular, might be unable to return to torpor because of limited fat reserves. In such instances, it may be a better strategy for marmots to rouse early and forage on inferior foods, rather than risk death during hibernation (Humphries *et al.* 2003).

We evaluate three possible explanations for the use of trees by marmots in the early season. First, marmots may use the high vantage point offered by trees to increase their ability to detect predators. If so, the use of trees would be expected to continue throughout the season, whereas we observed a sharp drop off in the behavior as soon as snowmelt stimulated the growth of herbaceous vegetation.

Second, thermoregulatory benefits may partly explain this behavior. We have previously observed marmots sitting on rocks when the ground was snow-covered, which we believe allows the marmot to get off wet ground and take advantage of the greater thermal absorbency of dark rocks as opposed to snow. If rocks are covered, trees may be a substitute. The fact that marmots went back to sitting on rocks when snow melted is consistent with this hypothesis.

Third, marmots could have used trees as early season forage, and this is the hypothesis that seems most likely. The suggestion that food was severely limiting is supported by three main observations. Adult females forced the dispersal of at least 12 of the previous year's juveniles one month earlier than normal; the yearlings were forced out of the colony and into sub-optimal burrows. We observed adult females aggressively chasing yearlings 13 times from 23 April to 29 May, followed by the relocation of those yearlings to new burrows; dispersal of yearlings usually occurs in June and July (Van Vuren 1990). In one instance the yearlings moved into unprotected burrows from which we later witnessed coyote (*Canis latrans*) predation. On 9 June, when the colony area was 93% snow-free, the surviving yearlings moved back to their natal burrow areas.

We also observed exceptionally high early season mortality among yearlings, apparently from starvation. In one instance, a litter of seven yearlings

emerged from hibernation on 16 May. While not trapped, we estimated them to weigh between 600-1000 g (based on observed body size). Two of these yearlings were visibly distressed on 18 May, staggering and falling when walking; these two yearlings were not seen after 19 May. In another instance, three yearlings emerged on 22 May, were seen for 6 days and were largely inactive, and then vanished. Finally, we observed one adult male actively push two yearlings out of a tree in which they were foraging and forage in their place.

We believe that the opportunistic use of spruce and aspen trees by marmots in the early season provides a way for marmots to survive when there is substantial snow pack following emergence. Spruce needles, though low in protein, have a fair caloric content (Dittberner and Olson 1983). Aspen leaves have protein content between 13.4 - 20.9% in the spring, also making them a viable source of alternate forage early in the year (Tew 1970; Dittberner and Olson 1983). While this strategy may be effective for adult marmots in good condition, it does not appear to be as useful an option for yearlings. Yearling yellow-bellied marmots have been shown to remain in hibernation until food becomes available or they succumb to starvation (French 1990). We believe that the early emergence of some yearlings was due to impending starvation, leaving yearlings with no choice but to emerge and attempt to find enough forage to survive. If this is true, it is unlikely that aspen buds would be an abundant or easily obtainable resource to prevent starvation.

Alternative spring forage may become increasingly important if continued changes in the climate cause an increase in early spring snow, a documented trend at our study site (Inouye *et al.* 2000). For example, in 1999, there was 57 cm more snow on the ground when marmots emerged than there was 23 years ago (Inouye *et al.* 2000). Given this, we may see more marmot populations turning to alternate sources of forage during early spring, before the beginning of the growing season.

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