Chapter 9

EFFECT OF AMBIENT TEMPERATURE ON THE SELECTION OF REST STRUCTURES BY FISHERS

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Abstract: We examined the effect of ambient temperature on the selection of rest structures by 20 radio-tagged fishers in two areas of central British Columbia during 1991–1993 and 1996–2000. Fishers rested in tree cavities, on rust brooms or tree branches, under pieces of large coarse woody debris (CWD), and in burrows or rock crevices. We located fishers at 86 rest structures and recorded the local ambient temperature at nearby climate stations while these structures were occupied. The type of rest structure selected by fishers varied with local ambient temperature ($P = 0.005$). Temperatures were colder when fishers used CWD structures than when they used branch or cavity structures ($P < 0.05$). Large pieces of CWD may be important habitat elements for fishers during long periods of extremely low temperatures because they likely provide a more favorable thermal microenvironment than that found at other types of rest structures. Our results have implications for habitat management and conservation of old-forest structures for fishers in regions with cold climates.

1. INTRODUCTION

Fishers (*Martes pennanti*) use rest sites for a variety of purposes, including refuge from potential predators and thermoregulatory cover (Kilpatrick and Rego 1994). Fishers have been reported to use a wide variety of structures at rest sites: tree nests and cavities, logs (hollow or solid), root wads, willow (*Salix* spp.) thickets, ground burrows, and rock falls (Raine 1981, Arthur et al. 1989, Jones 1991, Powell 1993, Kilpatrick and Rego 1994, Gilbert et al. 1997).

Little is known about the factors that affect selection of rest structures by fishers. American martens (*M. americana*) are ecologically similar to fishers and utilize many of the same types of structures for resting (e.g., Buskirk et al. 1989, Martin and Barrett 1991, Gilbert et al. 1997, Raphael and Jones 1997).

Much of the selection for rest sites by martens has been attributed to ambient temperature; martens tend to select subnivean rest sites during periods of cold weather (e.g., Buskirk et al. 1989, Martin and Barrett 1991). The lower critical temperature (i.e., the lowest ambient temperature at which they can passively maintain normal body-core temperature, Harlow 1994) of martens when they rest is relatively high and therefore they select microenvironments that are energetically favorable for resting during periods of low temperature.

The effect of ambient temperature on the selection of rest sites by American martens is relatively well understood, but the relationship between temperature and selection of rest structures by fishers has not been examined thoroughly enough to determine if the same relationship holds true for fishers. Because fishers have a greater body mass than do martens, Buskirk and Powell (1994) hypothesized that thermal losses while resting are probably not as important to fishers. Indeed, Powell (1979) estimated that the lower critical temperature of resting fishers was -60°C for females and -120°C for males. According to this estimate, fishers are not exposed to temperatures that approach their lower critical temperature while resting throughout much of their range.

However, data suggests that fishers may select different structures for resting depending on ambient temperature. Raine (1981), Arthur et al. (1989), Jones (1991), and Kilpatrick and Rego (1994) all noted that fishers tend to use subnivean rest sites more frequently during winter and arboreal rest structures (i.e., tree nests and cavities) more frequently during spring, when temperatures are warmer. This evidence suggests that although ambient temperatures may be above their estimated lower critical temperature, fishers may make behavioral changes to reduce thermal losses above this critical limit.

In the northern portion of their range across Canada, arctic high-pressure weather systems can persist for several weeks during winter with ambient temperatures consistently below -25°C. The objective of our research was to perform an exploratory analysis to determine if a relationship exists between the local ambient temperature near the rest structure (i.e., coarse-scale ambient temperature) and the type of structures that fishers select. We hypothesized that fishers modify their selection of rest structures and use different structures during periods of cold temperature. This information may be useful for directing forest management practices that will aid in the conservation of fisher populations in areas with long periods of extreme cold.

2. STUDY AREAS

Our 1,800-km² northern study area (Williston) was centered 75 km northwest of Mackenzie, British Columbia (55° 30'N, 123° 02'W) and within the moist-cool and wet-cool subzones of the Sub-Boreal Spruce Biogeoclimatic (SBSmk and SBSwk) zone (Meidinger et al. 1991) to the west of the Williston Reservoir. Our 1,500-km² southern study area (Beaver Valley) was centered 65 km north-east of Williams Lake, British Columbia (52º 10'N, 122º 10'W) and entirely within the dry-warm subzone (SBSdw) of the SBS zone. Both study areas were ecologically similar; mean annual temperatures in Williston and Beaver Valley areas were from 1.2 to 3.6ºC respectively, with mean annual precipitation between 585 (SBSdw) and 690 mm (SBSmk) (MacKinnon et al. 1990, Steen and Coupé 1997). The SBS zone is a heavily forested, coniferous, montane zone that dominates the landscape of the central interior of British Columbia and generally occurs from valley bottoms to about 1,200 m above sea level (Meidinger et al. 1991). The climate of the SBS zone is continental and characterized by severe, snowy winters and relatively warm, moist, and short summers. During the study, local ambient temperatures in the Beaver Valley study area ranged between -29 and 34°C, while in the Williston study area temperatures typically ranged between -32 and 33°C. Consistent snow cover persisted in both study areas from mid-November through until mid-April, with maximum accumulations reaching approximately 90 cm in the forest interior.

Forests in both study areas were dominated by lodgepole pine (*Pinus contorta* var. *latifolia*), hybrid white spruce (*Picea engelmannii* x *glauca*), and subalpine fir (*Abies lasiocarpa*), with minor deciduous components of trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and black cottonwood (*Populus balsamifera trichocarpa*). Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) was a common mid- to late-successional species in the Beaver Valley study area. Common understory shrubs were prickly rose (*Rosa acicularis*), black huckleberry (*Vaccinium membranaceum*), black twinberry (*Lonicera involucrata*), kinnikinnick (*Arctostaphylos uva-ursi*), and black gooseberry (*Ribes lacustre*).

The dry and moist subzones of the SBS zone had a natural disturbance regime of frequent, large-scale fires on a cycle of about 150 years, with most stands burning every 100 years, while the wet subzone had typical fire return intervals of greater than 250 years (British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands and Parks 1995). Forest harvesting, using a variety of techniques, has occurred over the past 25 to 40 years and created a mosaic of seral stages and stand types throughout both of the study areas. Land clearing for cultivation and cattle grazing occurred along the valley bottom in the Beaver Valley study area.

3. METHODS

We captured and monitored 20 fishers (3 M, 17 F) as part of 2 larger studies on the ecology of fishers in British Columbia (Weir 1995, 2000). We live-trapped resident fishers in each area using baited wire cage traps (24.5 × 31 × 81 cm; Havahart Model 1081, Lititz, Pennsylvania, USA). We placed traps on beds of hybrid spruce or subalpine fir boughs and covered the top and sides of the traps with wax-coated cardboard boxes. Traps were also lined with hay and covered with more boughs so that snow or wind would not penetrate the trap. We baited each trap with approximately 500 g of meat from salmon (*Oncorhynchus* spp.), galliform or anseriform birds, or moose (*Alces alces*) and scented nearby trees with commercial trapping lure.

Upon capture, we immobilized each fisher with either a 10:1 mixture of ketamine:xylazine (Ketaset®, Ayerst Veterinary Laboratories, Guelph, Ontario, Canada; Rompun®, Bayer Inc., Toronto, Ontario, Canada) administered at 18 mg/kg or a 1:1 mixture of tiletamine:zolazepam (Telazol®; Fort Dodge Animal Health, Fort Dodge, Iowa, USA) administered at 8 mg/kg for radiotagging. We affixed radiocollars to healthy adult fishers captured in the Beaver Valley area. In the Williston area, we either affixed radiocollars or had intra-abdominal radiotransmitters surgically implanted by a wildlife veterinarian.

We monitored 9 fishers (1 M, 8 F) during 1991–1993 in the Beaver Valley study area and 11 fishers (2 M, 9 F) during 1996–2000 in the Williston study area. In both study areas, we identified resting structures used by radio-tagged fishers throughout the year by homing-in (White and Garrott 1990) on signals of stationary fishers to their rest sites (i.e., area surrounding a rest structure) and locating the structure with which the fisher was associated. Rest structures were identified throughout the year, but we did not include locations of female fishers with kits in natal or maternal dens in this analysis.

Within 0.5 hr of identifying the rest structure, local ambient temperature was recorded at either manual or automatic recording stations located within 20 km of each resting structure. In the Beaver Valley area, we recorded temperature at thermometers located in forest interior conditions located throughout the study area. In the Williston area, we recorded temperatures at either permanent thermometers or from remote temperature data loggers (Optic Stowaway®, Pocasset, Massachusetts) that recorded hourly temperatures. In both study areas, temperature stations were placed under normal forest canopy at least 10 m from the forest edge in well-ventilated, shaded locations approximately 2 m above the ground. These stations provided us with representative data on the local ambient temperature of the area near the rest structures.

We assessed the effect of local ambient temperature on the selection of rest structures by fishers using an Analysis of Variance. Because we occasionally recorded individual fishers using one type of resting structure more than once, we used each fisher as a replicate and performed the analysis of variance procedure on mean ambient temperatures for each fisher for each type of rest structure. We identified significant differences in mean ambient temperatures among the different types of rest structures using Tukey multiple comparison tests. We set the acceptable Type I error at 0.05.

4. RESULTS

We identified resting fishers associated with 4 distinct types of structures: branch, cavity, coarse woody debris (CWD), and ground. Branch rest structures were arboreal sites that typically involved abnormal growths (i.e., witches brooms) on live spruce trees (caused by spruce broom rust [*Chrysomyxa arctostaphyli*]) or on subalpine fir trees (caused by fir broom rust [*Melampsorella caryophyllacearum*]). We occasionally observed branch rest sites that were associated with exposed large limbs of black cottonwood and spruce trees. Cavity rest structures were chambers in decayed heartwood of the main bole of black cottonwood, aspen, or Douglas-fir trees that were declining in vigour, but still alive. Cavities were accessed by fishers through branch-hole entrances into heart-rot (black cottonwood, aspen, or Douglas-fir trees) or using excavations made by primary-cavity nesting birds (aspen trees only). Coarse woody debris rest structures were located inside, amongst, or under pieces of CWD. The source of the CWD was natural tree mortality, logging residue, or man-made piling. Coarse woody debris rest structures were usually comprised of a single large (>35 cm diameter) piece of debris, but occasionally involved several pieces of smaller diameter logging residue. Ground rest structures were those that involved large-diameter pieces of loosely arranged colluvium (e.g., rock piles) or burrows into the soil that were likely excavated by another animal.

We located 86 rest sites of 20 radio-tagged fishers over 6 years. We located fishers using structures for resting in both winter (59 locations) and non-winter seasons (27 locations). We recorded fishers using branch rest structures most frequently (57.0%), followed by cavity (19.8%), CWD (18.6%), and ground (4.6%) rest structures. We did not detect a significant difference in the frequency of selection of each type of rest structure by fishers between the Beaver Valley and Williston study areas ($\chi^2 = 3.32$, df = 3, $P = 0.34$). The simultaneous local ambient temperature near the rest sites ranged between -29.4 and 21.1ºC. The frequency at which we located rest structures with respect to temperature did not appear to be different than that of local ambient temperatures in a typical year (Fig. 9.1), although we intentionally collected data at cold temperatures.

Fishers did not use each type of rest structure independently of local ambient temperature ($F_{3,37} = 7.45$, $P \leq 0.001$). Local ambient temperatures were significantly colder when fishers used CWD rest structures compared to when they used branch and cavity structures ($P < 0.05$; Table 9.1). We did not detect a significant difference in local ambient temperature among the use of branch, cavity, and ground rest structures, nor were they different between the use of ground and CWD rest structures ($P > 0.05$).

5. DISCUSSION

Fishers in our study used structures for resting in a pattern similar to that reported elsewhere. Fishers used arboreal branch and cavity sites most frequently, but used CWD sites when temperatures were colder. In Maine (Arthur

Figure 9.1. Sampling distribution of rest structures of radio-tagged fishers with respect to local ambient temperature in the Sub-Boreal Spruce Biogeoclimatic zone of British Columbia, 1991–1993 and 1996–2000. The bars represent the number of rest structures obtained in each temperature interval. The solid line represents the proportion of hourly temperature recordings that occurred in each temperature interval throughout a typical year (data from 1999, Williston area).

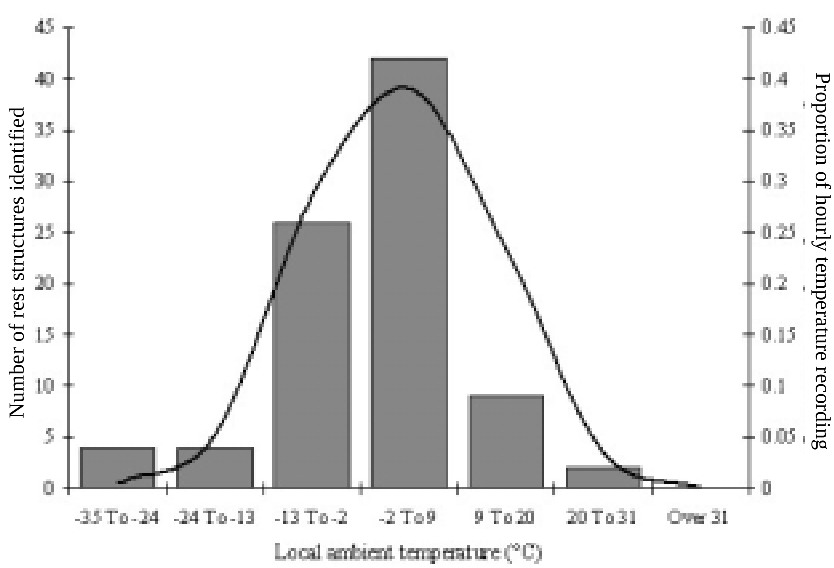

Table 9.1. Mean local ambient temperatures (ºC) at which radio-tagged fishers used each type of rest structure in the Sub-Boreal Spruce Biogeoclimatic zone of British Columbia, 1991–1993 and 1996–2000. The local ambient temperatures for structures with the same letter were not significantly different. The local ambient temperature when fishers used CWD structures was significantly lower than when they used branch or cavity structures.

Type of structure	Mean (ºC)	SE	Range (ºC)	n	Contrast of means
Branch	2.4	1.1	-13.1–20.9	49	A
Cavity	1.3	2.0	-14.2–21.1	17	A
Ground	-5.7	2.2	-10.9–0.3	4	A B
CWD	-10.7	3.1	-29.4–3.2	16	B

et al. 1989), Idaho (Jones 1991), and Connecticut (Kilpatrick and Rego 1994), fishers also used arboreal sites most frequently and CWD or subnivean sites only on very cold days. Our data support the hypothesis that a relationship exists between local ambient temperature and the selection of rest structures by fishers.

Previous research has illustrated that each type of rest structure has differing thermal properties. Taylor and Buskirk (1994) measured and calculated the thermal attributes of branch, cavity, and CWD sites used by American martens in high-elevation forests of southern Wyoming. They found that CWD sites provided the warmest microenvironments only during periods of cold temperatures (<-5ºC), deep snow pack (>15 cm), and high wind speed. Branch or cavity sites were warmer during all other combinations of ambient temperature, snow pack, and wind. In Manitoba, Raine (1981) measured the ambient temperature at a subnivean rest site of a fisher and found that, while the ambient temperature was -26ºC, the temperature inside the subnivean cavity was -11ºC.

The thermal attributes of the 4 types of rest structures may have affected the selection by fishers and helped to explain the patterns that we observed. Fishers probably used branch and cavity structures for resting during most of the year because these sites were relatively common and provided an adequate thermal environment for most combinations of ambient temperature, snow depth, and wind speed.

Although it is unlikely that fishers in our study areas encountered temperatures that were near their estimated lower critical temperature for resting, our data suggests that fishers modified their selection of rest structures during cold temperatures. Like American martens, fishers probably used CWD rest structures because they provided the warmest thermal environments during periods of cold temperatures. The mean temperature at which fishers used subnivean structures for resting (-10.7ºC) was considerably lower than that reported for martens in Wyoming (-5.5ºC, Buskirk et al. 1989). This finding is not unexpected because the lower critical temperature for fishers while resting is estimated to be substantially lower than that estimated for martens (fishers: female = -60ºC, male = -120ºC, Powell 1979; martens: 16ºC, Buskirk et al. 1988).

In our study areas, we did not observe fishers using arboreal or ground sites for resting when temperatures were below -14.2ºC; 6 of the 6 rest sites that we documented at temperatures <-14.2ºC were in subnivean sites with CWD structures. The exclusive use of subnivean CWD structures at temperatures <-14.2ºC suggests that fishers may select CWD structures for energetic benefits. It is unclear if this result represents a challenge to Powell's (1979) estimate of lower critical temperature for resting fishers, but this finding suggests that fishers modify their behavior during bouts of cold temperatures.

The reasons for selecting a specific rest structure probably change over time and thermoregulation is not the only factor that affects the selection of rest sites by fishers. Several authors have suggested that fishers rest close to food sources (de Vos 1952, Coulter 1966, Powell 1993). The resting sites in trees are generally more numerous than ground sites (Martin and Barrett 1991), hence, fishers may select tree sites opportunistically. Raphael and Jones (1997) speculated that arboreal structures offer greater protection from predators than do ground sites. Because of their elevated position, the detection of potential predators would probably be enhanced in tree sites that afford earlier olfactory or visual discovery of approaching predators. Similarly, elevated sites may provide greater detection of potential prey. In the absence of restrictive thermoregulatory demands (i.e., most of the year), we expect that fishers would select structures based upon factors other than temperature.

Local ambient temperature was not the best measure by which to assess the thermal environment facing fishers in our study. Our measurement methods likely ameliorated the fine-scale differences in ambient temperature among stands and patches of habitat. Site-specific abiotic factors, such as wind convection, solar radiation, and precipitation also affect the standard operative temperature that an animal experiences at any point in time (Taylor and Buskirk 1994) and examination of these factors would likely provide more insight into the effect of the thermal environment on rest structure selection by fishers. Also, the thermal attributes associated with each type of structure can change over time; Taylor and Buskirk (1994) showed that snow depth greatly affects the insulative capabilities of CWD sites. Habitat features, such as overhead cover surrounding the various rest structures undoubtedly affected the thermal properties of each respective structure. However, our research illustrated that a relationship existed between local ambient temperature and the selection of rest structures by fishers. Future research should be directed towards assessing these more detailed spatial- and temporal-specific attributes and determining their effects on the selection of rest structures by fishers.

6. MANAGEMENT IMPLICATIONS

Fishers use a variety of structures for resting, and most of these structures result from the natural processes of disease, death, and decay of trees. These structures accumulate over time and reach the greatest densities in mature- and late-successional forests (Cline et al. 1980). In regions where extended periods of extreme cold (<-15ºC) occur, fishers, like American martens, probably rely upon the CWD component that is characteristic of later successional forests to provide thermal cover while resting. As mentioned by Raphael and Jones (1997), rest sites are important microhabitats that contribute to the overall fitness of an animal because the selection of rest structures affects an individual's thermoregulation and vulnerability to predators.

The boreal and sub-boreal forests of British Columbia are prominent timber-producing areas. The harvesting of mature and late-successional forests may have a detrimental effect on fisher populations by reducing the availability and recruitment of large CWD that is suitable for thermal cover. Silvicultural prescriptions that retain large CWD, and the ecological processes that create it, will be important components of forest management plans that encourage the persistence of fisher populations, especially in regions that experience extreme cold. However, before these silvicultural prescriptions can be implemented, we need to determine the appropriate size, density, and arrangement of the structures that fishers use for resting. This information could be used to identify targets for the retention and generation of resting structures in managed forests.

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