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Hunting strategies by Siberian Jays *Perisoreus infaustus* on wintering small rodents

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Abstract. The Siberian Jay *Perisoreus infaustus*, the smallest of west Palearctic corvids, is year-round resident, territorial and stores food prior to the winter. I studied the species' hunting strategies on small rodents from November through March during 2004–2015 in a subalpine mixed forest in central Norway. Along a fixed track of ca. 5 km, I recorded where a flock of Siberian Jays was first observed. In years when small rodents (mainly bank voles *Myodes glareolus*) were abundant, the birds were most often seen in trees near open areas with numerous tracks of rodents, and mainly within the forest in years with low rodent abundance. In cold days, i.e. with ambient temperature below –10 °C, very few tracks of small rodents were registered in the snow despite high rodent abundance, and the birds then stayed within the forest. Siberian Jays apparently often stay near open areas hunting for small rodents running in the snow in years with a high rodent abundance, but keep more within the forest in years with low rodent abundance or in cold weather when the rodents live below the snow surface.

Key words: Siberian Jay; winter ecology; small rodents

INTRODUCTION

The Siberian Jay *Perisoreus infaustus*, the smallest of west Palearctic corvids (30 cm), is one of the few passerines that are year-round resident of boreal forests in the Palearctic. The birds are territorial and form small social flocks around a mated pair (Blomgren 1964, Ekman et al. 1994). The jays are omnivorous and prior to winter they scatter-hoard thousands of items in bark crevices, in lichen clumps and among conifer needle-clusters within the territory. The retrieval of stored food has been found to be for selfish use and not for mutualistic sharing among relatives (Ekman et al. 1996).

The energy consumption of Siberian Jays calculated from evening stomach content in mid-winter revealed a daily food requirement (3.5 hours daytime activity) of 12.7–18.1 g dry matter (Andreev 1982). Food availability in the form of caches may be critical to survival for Siberian Jays during winter, since only a few hours of daylight are available, severely restricting foraging time. The diet includes relatively small items such as berries, mushrooms, seeds and various insects (Cramp & Perrins 1994). However, earlier studies report that Siberian Jays may store small rodents such as field voles *Microtus agrestis* (Collett 1921), Norway lemmings *Lemmus lemmus* (Haftorn 1971) and bank voles *Myodes glareolus* (Bevanger 1974).

In an old forest dominated by pines in the Røros area (about 50 km from my study area in Budal), it was found that Siberian Jays mainly stored mushrooms (mostly *Amanita vaginata* and *Leccinum* sp.), berries (*Vaccinium myrtillus*, *V. vitis-idaea*, *V. uliginosum*) and animal food (snails and spiders), where mushrooms made about 60% of the items (Borgos1977). Although mushrooms made a large part of the variety of stored objects, it may reflect what was found in the area more than representing optimal food for the jays. As the Røros and Budal forests probably are of the same forest types with similar field layers, Siberian Jays in the Budal area are assumed to store much the same food as found for the birds in Røros. If so, small rodents, in addition to stored objects mentioned above, may represent an important and more energetically rich food source for the birds.

Although small rodents mainly live below the snow during the winter, they occasionally come out and run on the snow surface. In the Budal study area, most tracks of small rodents were registered in or close to open areas, and only a few tracks were registered within the forest. Although not quantified, also the number of rodent running paths in the field layer, after snow melting, were far more numerous in open areas than in the forest.

The Siberian Jays are rarely seen outside forests, probably due to increased predation risk. Due to their brown-grey and rufous body plumage and their secretive behaviour, little vocal and silent movements between trees, the birds may be hard to see. However, if they are actively hunting on small rodents on the snow, they may expose themselves more, and should be observed more frequently in or near open areas in

winters where the number of vole tracks were most often registered, but more frequently within the forest in years with none or few rodent tracks. Since small rodent tracks were rarely seen in the snow surface in cold weather, I also expected that the jays were less active and less frequently observed in cold weather.

Siberian Jays most often travel and forage as cohesive units consisting of 3–5 birds within their large territory, being 1–2 km^2 (Ekman et al. 1966). In the present study, I analyse data collected from apparently one such flock on which habitat (near open area or within forest) the birds were observed in winters in relation to the occurrence of small rodents.

MATERIAL AND METHODS

The field work was done from November through March during 2004–2015 in a subalpine mixed forest dominated by Scots pine *Pinus sylvestris* and downy birch *Betula odorata* interspersed with Norway spruce *Picea abies* and deciduous species such as rowan *Sorbus aucuparia* and *Salix* sp. in Budal, in central Norway (ca. 63 °N, altitude ca. 600 m). Winter conditions with permanent snow cover often begin in October and last through April, with extreme mid-winter temperatures falling below –25 °C.

Along a fixed track of ca. 5 km, I recorded where I first observed a flock of Siberian Jays. Although none of the birds were colour-ringed, I supposed it was the same flock consisting of three birds in the winters 2004–2012 and four birds in 2013–2014 and 2014–2015. Since there is probably only one territorial mated pair in the study area, the flock observations are assumed to be of the same pair over several years, whereas the additional member differs between years. To increase sample independence, I recorded the flock only once per day, most often with only a few observations per month each year. As only the first observation of the flock was recorded, the sum of these observations is expected to give a fair estimate of the habitat use of the birds (cf. Wiens et al. 1970).

The observations of the flock were divided into the following classes for habitat: (1) near open area, i.e. within a forest zone about 50 m from a bog or open clearing, and (2) within forest more than 100 m from open clearings. The habitat classes were chosen in order to avoid an intermediate forest area. Thus, the classes included were clearly differentiated. In total 276 surveys (yearly 12–44, mean 25) were made.

Ambient temperature was registered at the start of each trip.

The abundance of small rodents varied considerably from year to year, and I estimated the relative densities of rodents from tracks seen in the snow: 0, no tracks; 1, few tracks; 2, new tracks seen almost daily; 3, many tracks. The most common rodents were bank voles, but also field voles were observed, and in some years also Norway lemmings.

The tests are two-tailed, and were performed using SPSS 23. Data were analysed using nonparametric tests.

RESULTS

Records of jays related to rodent abundance

The flock of Siberian Jays was recorded most frequently in winters when small rodents were abundant (indices 2–3: median = 0.22 vs. indices 0–1: median = 0.11, Mann-Whitney U-test: $n_1 = 5$, $n_2 = 6$, $z = 2.74$, $p = 0.006$, Fig. 1, Table 1). Accordingly, the number of observations per survey was positively correlated with the yearly rodent index (Spearman correlation, $r_S = 0.85$, $p = 0.001$, $n = 11$).

Habitat use of jays related to rodent abundance

In winters with no or very few small rodent tracks in the snow (indices 0 and 1), the flock was observed mainly within the forest (Table 1). In winters with many tracks (indices 2 and 3), however, Siberian Jays were observed close to an open area on 24 occasions, more than twice the number of observations within the forest (11). The distribution pattern of records within the two habitats differed significantly with rodent indices ($\chi^2 = 10.50$, df = 3, $p = 0.015$, two-tailed). Thus, the birds

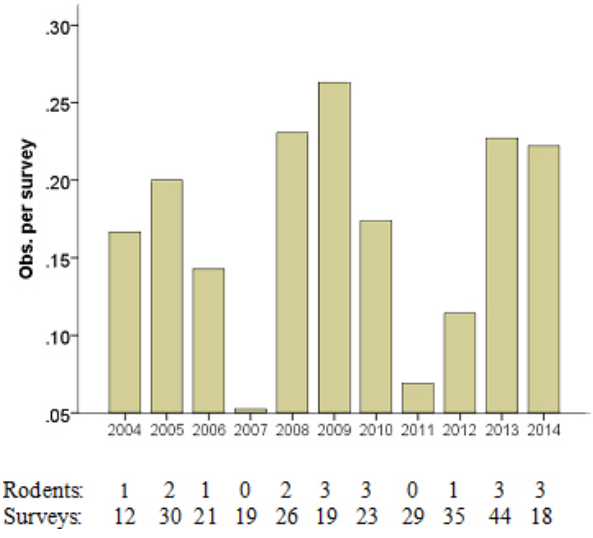

Figure 1. Mean number of observations of a flock of Siberian Jays per survey along a 5 km long fixed track during November – March in 2004–05 to 2014–15 in a subalpine mixed forest of pines and birches in central Norway. Small rodent index (0–3; no tracks – many tracks in the snow).

Table 1. Number of observations of a flock of Siberian Jays within different habitats (forest, open bog) related to small rodent abundances (indices 0–3) and different temperature intervals in a subalpine mixed forest in central Norway.

Habitat	Rodents	Temperature intervals (°C)			
		< –10	–10 – –6	–5 – 0	>0
Forest	0	0	1	2	0
	1	1	1	3	2
	2	0	2	1	0
	3	2	5	1	0
Open	0	0	0	0	0
	1	0	0	2	0
	2	0	0	7	2
	3	0	6	7	2

apparently stayed mainly within the forest in winters with few small rodents, but were seen more often near open clearings or bogs in years when small rodents were abundant.

Records of jays related to ambient temperature

In cold days, i.e. with ambient temperature below –10 °C, the few (n = 3) observations of the Siberian Jay flock were all within the forest (Table 1). When the temperature was –5 °C or higher, the birds seemed to be more frequently seen near clearings or bogs. However, the distribution pattern is not statistically significant (χ^2 = 7.34, df = 3, p = 0.062).

However, even in years with high abundance of small rodents (indices 2–3), few rodent tracks were registered in the snow when the temperature was below –10 °C, indicating that the rodents mainly stayed below the snow surface in cold days. The only two observations of the jay flock were then from the forest, revealing that Siberian Jays do not hunt for rodents in open areas when the chance to succeed is low.

Occasional observations

In winters with high abundance of small rodents (index 3) I observed a Siberian Jay with a small rodent in its bill in February 2011 and in March 2014, and three times in 2015 (February–March). One of these rodents (from 2011) was a bank vole placed in a bark crevice of pine, about six metres above ground. When I checked the locality a few days later, the vole had been removed.

Two unsuccessful attacks on small rodents running on the snow in an open area were observed during the study period. In both cases the jays were situated at a height of four to five metres in a pine close to a bog before diving towards the rodent.

DISCUSSION

The Siberian Jays travelled and foraged as a cohesive unit and single birds were never seen in the Budal study site. Since the number of flock observations increased with rodent abundance, it is suggested that the birds exposed themselves more due to increased hunting activity. In winters with few rodents, however, the jays apparently behaved more secretively and stayed more within the forest.

On the other hand, it may be argued that the increased number of observations of jays in years with high rodent abundance may be a result of more birds in the area, and that dominant flocks then force some birds from the forest to open areas. However, as Siberian Jays live in large, non-overlapping territories (e.g. Ekman et al. 1994), and I never observed aggressive encounters among jays, I consider such a possibility to be less likely.

Food hoarding provides a selfish, long-term benefit (Ekman et al. 1996). In a long-lived species with high territorial fidelity, such as the Siberian jay, stored food may provide survival and reproductive advantages.

Examples exist that show Siberian Jays as predators on small rodents. In northern Sweden, two Siberian Jays jointly attacked a small rodent, pecking at it alternately until it was dead (Cramp & Perrins 1994). In South-Norway, a Siberian Jay was observed with a bank vole in its bill in October, and a part of the vole was stored in the top of a pine, eight metres above ground (Bevanger 1974). Furthermore, when studying density variations in small rodents in an old spruce forest in southern Norway, Geir Sonerud (pers. comm.), found in October 1977 (a year with high abundance of rodents), that Siberian Jays removed rodents caught in snap traps. On one occasion he observed a jay leaving the ground with a rodent and the snap trap also.

It may therefore be supposed that small rodents make a substantial part of the winter diet of Siberian Jays. Thus, the content from wintering Siberian Jays in northeast Russia, revealed that 57% of 30 stomachs contained rodents (Andreev 1982). Other Russian studies showed that 45% of 20 stomachs from jays in autumn and winter contained rodents, and 22 stomachs collected in winter in the Irkutsk area contained 15% small mammals, and from Kola Peninsula 41% of the stomachs contained small rodents (Cramp & Perrins 1994).

Siberian Jays apparently kill small rodents for storing prior to the winter and for consuming in winter. However, the birds need to balance the costs of time, energy and safety in determining their foraging method during the few hours of daylight mid-winter.

Predation by hawks has been found to be substantial and is suggested as the main cause of mortality in adult Siberian Jays (Griesser 2008). Thus, jays generally chose to feed in cover, a pattern that becomes stronger toward late winter (Nystrand 2006). Adult Siberian Jays and their offspring feed more often at protected feeding sites containing high-quality food, but switch to more predator exposed sites when these sites offer higher quality food than the protected sites (Nystrand 2007). If the Eurasian Sparrowhawk *Accipiter nisus*, a common bird in my study site, is such a predatory factor on the jays, then the jays may face a conflict between gaining high-quality food and the risk of achieving it.

As I observed the jays most frequently within the forest in years with low abundance of small rodents, it may be suggested that the jay flock moves to the open areas most often when hunting for rodents when these mammals are abundant. If so, it may be suggested that the forest structure influences the foraging behavioural decisions of Siberian Jays, and furthermore, shows the bird's preferences for foraging sites focusing on how energy intake is traded against proximity to cover.

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