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Black-backed woodpecker (*Picoides arcticus*) detectability in unburned and recently burned mature conifer forests in north-eastern North America

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Presence–absence data is often used to determine the preferred habitat of a given organism. However, with presence–absence datasets there is a problem associated with the comparison between habitats when there is an inter-habitat variation in the proportion of false zeros. Using conspecific playbacks and time of reaction of black-backed woodpeckers in burned and unburned forests, the present study determined whether detection probabilities were similar. The period of time required to detect this species was shorter in recently burned sites than in mature forest stands ($F_{2,235} = 22.1$, df = 2, $P < 0.0001$). To accurately compare these habitats it is important to assure the same proportion of presence and false zeros in each habitat during the census. To achieve this, we propose a time corrected method. Because inter-habitat differences in detectability exist for black-backed woodpeckers, and probably many other organisms, caution is needed when interpreting presence–absence data in the context of habitat comparisons or when monitoring biodiversity in different habitats.

Introduction

In landscape ecology, conservation biology and biodiversity monitoring studies, presence–absence data are often used to determine the preferred habitat of a given organism (Rosenstock *et al*. 2002, Kery & Schmid 2004). This method allows: (1) a large area to be covered, (2) the monitoring of a large number of individuals, and (3) a reduction in the time invested per sampling plot. During a binomial census (e.g., point counts for birds) in a given habitat, the species of interest is recorded as either present (one) or absent (zero). However, in the latter case there is a problem: is the species really absent? A true zero occurs when the species is not present at the site and a false zero occurs when the species is present at the site but is not detected (e.g., in the case of a bird not singing). Therefore, in a theoretical case, it is possible to have the following result: presence = 20 (49%), true zero = 11 (27%) and false zero = 10 (24%). In this example the species is in fact present at 73% of the stations visited. If the sampling stations are distributed in the same habitat in a given region, the probability of detecting a false zero may be assumed to be similar and, therefore, it remains possible to compare stations (e.g., different degrees of fragmentation or different concentrations of a given predator) in order to attempt to explain the presence or absence of the species being studied.

Studies comparing different habitats using datasets based on presence–absence data are common. Such studies assume that the detection probability remains similar between habitats (Majewski & Rolstad 1993, Kery & Schmid 2004). However, what happens when the proportion of false zeros varies from one habitat to another? In such cases, certain authors use the term 'imperfect species detectability' (Kery & Schmid 2004, Royle *et al.* 2005). In the example presented in Fig. 1, the species of interest is present at 73% of the stations in both habitats (i.e., the sum of the sites where the species is present and detected and present but not detected; false zeros). However, since the proportion of false zeros is not the same in both habitats, the observer would have recorded a higher proportion (51%) of stations as having the species in habitat B than in habitat A. In the context of a rare species, the conservation of habitat B would be promoted. However, both habitats could be of equal interest (73% occupied) for the species in question.

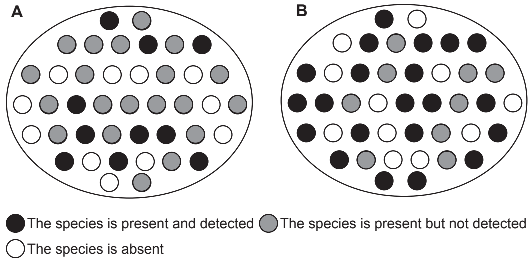

Fig. 1. Theoretical case of repartition of a species between two habitats (**A** and **B**). In both cases the species is present at 73% of stations, but in habitat **A** 48.8% of stations register a false zero (the species is present but not detected) whereas in habitat **B** this occurs at only 21.9% of stations. For the observer, habitat **B** shows more sampling stations with positive response.

In order to better illustrate this problem, we present a case study using the black-backed woodpecker. This species is limited to the boreal conifer forest of North America and it is perceived as rare throughout its range. Based on presence–absence data, it seems to be closely associated with recently burned sites (< three years old; Dixon & Saab 2000). In such areas, it can occur at particularly high densities (0.2 ind. ha^{-1}; Murphy & Lehnhausen 1998) due to the presence of larvae of wood-boring insects (e.g., white-spotted sawyer *Monochamus scutellatus*), which rapidly colonize the trunks of recently dead conifers (Wilson 1962). However, very few studies have investigated the ecology of black-backed woodpeckers in unburned forests (Dixon & Saab 2000). In those studies that have, the frequency of occurrence of this species, based on presence–absence data, seemed to be low in comparison with that in burned forests (Bock and Lynch 1970, Heinselman 1973, Apfelbaum & Haney 1981, Hutto 1995, Caton 1996, Murphy & Lehnhausen 1998, Hoyt & Hannon 2002). However, this species breeds and produces healthy nestlings at unburned sites (Dixon & Saab 2000). In a study by Hutto (1995), who did presence–absence censuses of many species of birds in different habitats, the author suggested that for black-backed woodpeckers: "*the relatively low numbers in unburned forests may be sink populations that are maintained by birds that emigrate from burns when conditions become less suitable*…". At the landscape scale, it has even been proposed that the long-term persistence of black-backed woodpeckers depends upon a regular presence of recently burned sites (Hutto 1995, Dixon & Saab 2000). This has, in turn, led to many ecologists considering this species to be dependent on recently burned areas, without further verification of Hutto's hypothesis.

In the present study, we aimed to: (1) verify whether it is possible to compare recently burned and unburned mature forests for the presence of black-backed woodpeckers based on the detection probability in the two habitats, and (2) if necessary, to provide corrections to the census method to enable comparison between the two habitat types.

Methods

We conducted roadside playbacks of calls and drumming of black-backed woodpeckers (taken

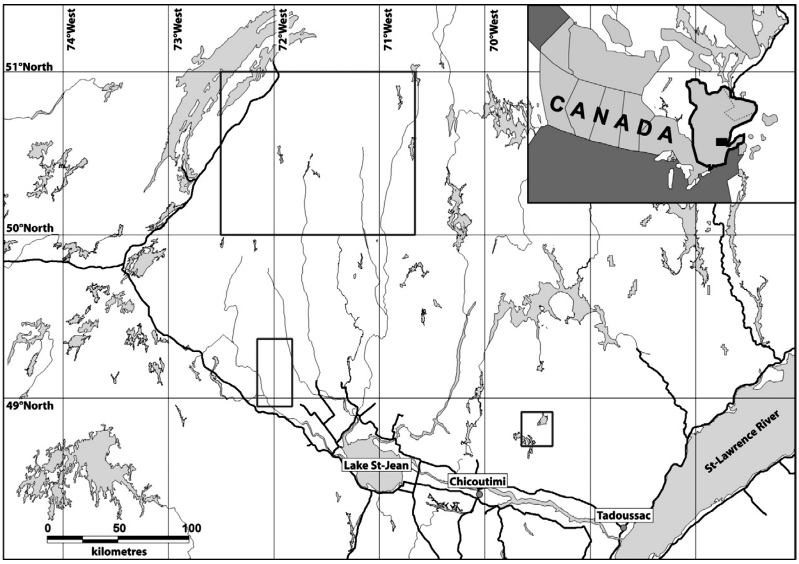

Fig. 2. Location of the study area in northern Québec (Canada).

from Elliot *et al.* 1997) at stations situated along a network of logging roads in northern Québec (Canada; Fig. 2) in 2003 and 2004. For both habitats (recently burned and unburned areas) site selection was limited by availability and accessibility. The dominant tree species at both burned and unburned stations were black spruce (*Picea mariana*) and jack pine (*Pinus banksiana*), with the occasional balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*) as companion species. In 2003 the playbacks (duration: 15 min) were done between 14 May and 24 June, and in 2004 between 1 May and 17 June. Initial analysis of 2003 data showed that a good percentage of responses occurred after about 15 min; therefore, in order to increase the possibility of recording a positive response, we increased the duration of that playback to 20 min in 2004. Playbacks were done between 5:00 and 15:00 in the absence of heavy rainfall and strong winds. A total of 409 stations were monitored in 2003 and 255 in 2004. The playbacks were done using a portable system comprising a compact disc player, an amplifier (40 watts) and two loudspeakers (25 watts). During playbacks, the speakers were placed perpendicular to the road and at 2 m above ground level. In the field, the maximum carrying distance was estimated to be 500 m through forest cover and up to 1 km along the road. Therefore, the minimal distance between stations was 1 km. The two observers stood between 50 m and 100 m from the loudspeakers to facilitate detection of responding birds. For each station, the time to first hearing or sighting of a black-backed woodpecker was noted (hereafter referred to as detection time). In order to reduce the possibility that an individual bird was recorded at more than one station, stations were separated by at least 2 km on a given survey round.

Data analysis

Three habitat types were sampled: (1) recently burned areas (younger than two years old), (2) mature conifer forest < 2 km from a recently burned area, and (3) mature conifer forest > 2 km from a recently burned area. A one-way analysis of variance was used to compare mean detection time between habitats for those stations where black-backed woodpeckers were detected. The black-backed woodpecker detection time was modelled for burned and unburned mature forests by fitting nonlinear regressions to cumulative presence data for both habitats. Data were analyzed using Jump 5.1 (SAS Institute Inc. 2003). Means ± SE are presented and results were considered significant at the 0.05 level. The curve fitting was done using Sigma plot 8.0 (SPSS Inc. 2002).

Results

Black-backed woodpeckers occurred in 34.5% of the stations in 2003 and in 42.2% of the stations in 2004 ($\chi^2 = 4.58$, df = 1, $P = 0.032$). The time at which playbacks were done was similar in both years ($t = 1.106$, df = 657, $P = 0.288$). In 2003, the period between the ordinal dates 134 and 175 (14 May to 27 June) was covered; by contrast, in 2004 the period between the ordinal dates 118 and 169 (27 April to 17 June) was covered ($X_{2003} = 152.3$, $X_{2004} = 150.0$, $t = 2.395$, df = 593, $P = 0.0169$). In 2004, a greater proportion of the stations were in recently burned areas than in 2003 ($\chi^2 = 8.77$, df = 1, $P = 0.012$).

Detection by habitat

Of the stations monitored, 85 were in recently burned forest sites, 46 were < 2 km from a recently burned site and 533 were > 2 km (31.5 ± 21.2 km) from a recently burned site. Stations in the latter two categories were either situated in a virgin or mature managed forest where fire events had not occurred within the last 120 years (trees aged by growth rings; own unpubl. data). Black-backed woodpeckers were detected in 80.0% of stations at recently burned sites, in 39.1% of stations < 2 km from a recently burned site and in 30.8% of stations > 2 km from a recently burned site ($\chi^2 = 75.73$, df = 2; $P < 0.0001$). After accounting for homogeneity of the variance (Bartlett: $F = 1.88$, $P = 0.152$), we found inter-habitat category differences in the time taken to detect black-backed woodpeckers ($F_{2,235} = 22.1$, df = 2, $P < 0.0001$). Detection time was shorter at the stations from recently burned forest sites (3.4 min ± 0.62) than at the stations either < 2 km from a recently burned site (9.3 min ± 1.2) or > 2 km from a recently burned site (8.1 min ± 0.40, Tukey-Kramer HSD; Fig. 3). The cumulative percentage of presence as a function of the duration of playback shows a tendency to reach an asymptote after between 5 and 8 min in recent burns; however, this was not so in both categories of mature forest habitat (Fig. 4). The model developed exhibited an exponential curve with an asymptote at $y = a[1 - \exp(-bx)]$, where y is the cumulative number of stations with woodpeckers, x is the duration of playback (min), a is the asymptote value, and b is the form of the curve. The R^2 values for the curves were high for both sets of data (0.99 in recent burns and 0.98 in mature forest) and the regressions were highly significant ($P < 0.0001$). According to the regressions (Table 1), 90% of responding black-backed woodpeckers were recorded in recently burned sites after 6.9 min and in mature forest after 55.5 min (Fig. 5).

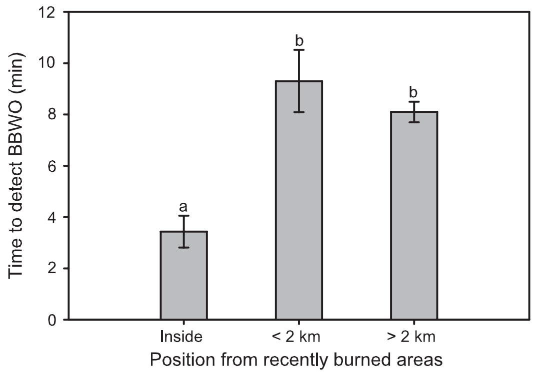

Fig. 3. Mean time allocated for the first detection of black-backed woodpeckers at stations in recently burned areas, mature conifer forest at < 2 km from a recently burned area and mature conifer forest at > 2 km from a recently burned area. Stations with no detection were not considered. Means ± SE are presented. Different letters indicate statistically significant differences ($P < 0.05$).

Discussion

Detection by habitat

Black-backed woodpeckers were recorded in a greater proportion at the recently burned sites

Table 1. Parameters of the regressions for recent burns and mature forest with the model $y = a[1 - \exp(-bx)]$, where y = cumulate number of stations with woodpeckers, x = duration of playback (min), a = asymptote value and b = curve form.

Parameter	Coefficient	SE	t	$P <$
Unburned forests				
a	320.87	44.7598	7.17	0.0001
b	0.04	0.0079	5.24	0.0001
Burned forests				
a	62.54	0.3939	158.79	0.0001
b	0.34	0.0099	34.15	0.0001

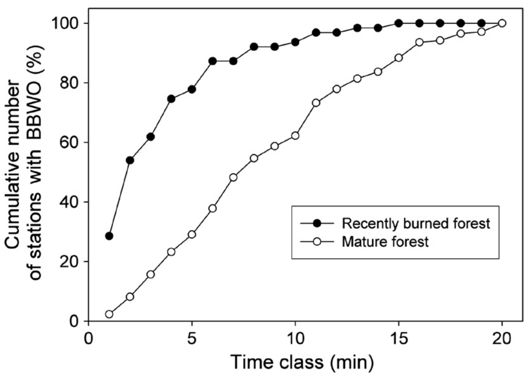

Fig. 4. Cumulative percentage of stations with black-backed woodpecker as a function of time for stations in recently burned areas and unburned mature conifer forest.

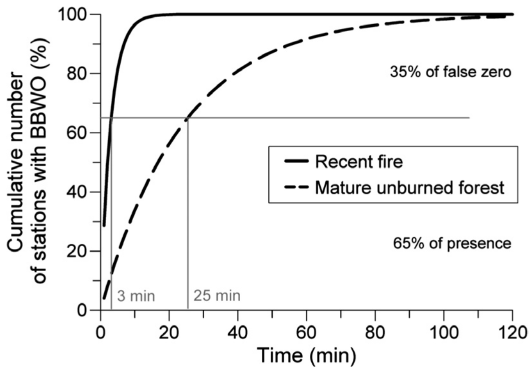

Fig. 5. Model fitting cumulative percentage of stations with black-backed woodpeckers as a function of time for stations in recently burned areas and unburned mature conifer forest. The figure shows the different times necessary to conduct playback censuses in the two habitats when the level of presence is fixed at 65% and level of false zeros at 35%.

than in mature forest. This is in keeping with the results of a number of studies (Goggans *et al*. 1988, Hutto 1995, Murphy & Lehnhausen 1998), which suggest that this species is dependent on recently burned sites. Nevertheless, in the present study, black-backed woodpeckers were recorded at the stations in mature forest, irrespective of their distance from recently burned sites. This observation contradicts the results of Hoyt and Hannon (2002), who found black-backed woodpeckers to be almost exclusively linked to recently burned sites or old growth stands at > 50 km from burned sites. During their study, Hoyt and Hannon (2002) determined the presence or absence of black-backed woodpeckers at stations situated in recently burned forest stands and in unburned forests situated 50, 75 and 100 km from a burned stand. The authors suggested that the absence of black-backed woodpeckers in unburned old growth forest stands at < 50 km from burned sites could be due to emigration towards burned forest stands.

The fact that black-backed woodpeckers were recorded at a higher proportion of stations in 2004, highlights the effect of using a five-minute longer playback period than in 2003. The present results also show that when black-backed woodpeckers are present, the period of time required to detect them is shorter in recently burned sites than in mature forest stands (Fig. 3). That the black-backed woodpecker exhibits a different detection time for the two habitat types has important implications for the interpretation of presence–absence data when playback periods of the same duration are used in two different habitats. To accurately compare these habitats it is important to assure the same proportion of presence and false zeros in each habitat during the census (Fig. 5). For example, if the detection level is fixed at 65% when black-backed woodpeckers are present in a given habitat, the false zero level must be 35% (Fig. 5). Based on the results of the present study, an observer in the field must use a time corrected method for playback duration, with a 3-min playback period at stations in recently burned areas and a 25-min playback period at stations in unburned forests (Fig. 5).

Again using the data from the present study but without accounting for false zeros, the results obtained after a two-minute-long playback (a length commonly reported in the literature), showed that black-backed woodpeckers were recorded in 40% of all stations in recently burned area, but in less than 4% of stations in forested area. On the other hand, using the same dataset, but with the detection level fixed at 90%, 67% of stations in recently burned areas had black-backed woodpeckers compared with 50% of stations in mature forest.

Inter-habitat difference

We suggest four hypotheses that might help explain this inter-habitat difference in the detection level of black-backed woodpeckers.

Individual time of reaction hypothesis

It is possible that in a population of black-backed woodpeckers, certain individuals are quicker to react to playbacks. If this is the case, in a recently burned area where it is possible to encounter up to 20 individuals per km^2 (Murphy & Lehnhausen 1998), more individuals could hear the playbacks, and the chance of encountering an individual that responds rapidly would be greater than at stations in mature forest. Thus, there is the possibility of a bias caused by the density of black-backed woodpeckers at stations in recently burned sites. However, this hypothesis implies that the territorial limits of black-backed woodpeckers are permeable. However, while this possibility exists for those species of birds that use communal habitat areas, woodpeckers of the genus *Picoides* generally seem to respect stricter territorial limits (Dixon & Saab 2000, Jackson *et al*. 2002).

The non-breeder hypothesis

It is possible that even if good numbers of black-backed woodpeckers are detected at unburned forest sites, that many of these individuals may be solitary non-breeders, which may exhibit erratic responses to conspecific playbacks. Such individuals may take more time to answer the playback and may create a bias inducing longer detection times at stations in unburned areas. However, mist-net data from these sites show that nearly 85% of black-backed woodpeckers caught at playback stations in unburned forests have a well-developed brood patch (n = 65) as compared with 91% in burned areas (n = 114; own unpubl. data).

The conspecific density hypothesis

It is possible that the response time is a social behaviour linked to density (Penteriani *et al*. 2002). That is, individuals with small territories at stations in recently burned areas (Murphy & Lehnhausen 1998) could react quicker to their conspecifics than those occupying larger territories (approx. 100 ha; Dixon & Saab 2000) in mature forest. This might be due to the fact that at higher densities individuals need to communicate rapidly and more often with their neighbours during territorial disputes (Penteriani *et al*. 2002).

The distance to protected resources hypothesis

Following a fire, every remaining dead tree becomes a potential food source due to their rapid colonization by large numbers of insect larvae. In such sites, territories are relatively small and this possibly explains why black-backed woodpeckers are quick to respond to potential intruders at stations in recently burned areas. In unburned mature forest, telemetry studies have shown that black-backed woodpeckers (like many other bird species) only forage in certain parts of their territory (J. A. Tremblay & J. Ibarzabal unpubl. data). Thus, individuals may respond rapidly to defend food resource areas, but less rapidly in areas that are not considered as a food resource. Therefore, if the playback station is situated away from a potential food resource, individual black-backed woodpeckers could take longer to respond.

However, in this study, it is not important to know which hypothesis or hypotheses explain the observed results. What is important is the fact that inter-habitat differences in the detectability of black-backed woodpeckers (and probably many other organisms) exist. For this reason, caution is needed with the interpretation of presence–absence data in the context of comparison of habitat or biodiversity monitoring (Majewski & Rolstad 1993). However, it must be borne in mind that the present study did not allow us to control for the real proportion of false zero. Thus, it is possible that some sites were recorded as not having black-backed woodpeckers when, in fact, the species was present. To correct for this in future studies, playbacks should be done at locations where black-backed woodpeckers are known to be present and the time to detection determined. For a variety of reasons, including the logistics and the difficulty of capturing individuals, this study only estimates the proportion of false zeros. Thus, the correction for the detectability of black-backed woodpeckers during the breeding period that we propose can only be an approximation. In spite of this, a better interpretation of presence–absence data in different habitats will be achieved using the correction that is purposed, rather than, as is the case in many studies, directly comparing data without taking into account the often important differences in detectability between the habitats in question. In conclusion, this study highlights the fact that it is unwise to assume the existence of similar behaviour and similar time to detection patterns for a given species in different habitats.

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References

Apfelbaum, S. & Haney, A. 1981: Bird population before and after wildfire in a Great Lakes pine forest. — *Condor* 83: 347–354.

Bock, C. E. & Lynch, J. F. 1970: Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. — *Condor* 72: 182–189.

Caton, E. L. 1996: *Effects of fire and salvage logging on the cavity-nesting bird community in northwestern Montana*. — Ph.D. dissertation, University of Montana, Missoula.

Dixon, R. D. & Saab, V. A. 2000: Black-backed woodpecker (*Picoides arcticus*). — In: Poole, A. & Gill, F. (eds.), *The birds of North America* No. 509. The Birds of North America, Inc., Philadelphia, PA.

Elliott, L., Stokes, D. & Stokes, L. 1997: *Stokes field guide to bird songs: eastern region*. — Time Warner AudioBook.

Goggans, R., Dixon, R. D. & Seminara, L. C. 1988: *Habitat use by three-toed and black-backed woodpeckers*. — Nongame Report No. 87-3-02, Oregon Dept. Fish and Wildl.

Heinselman, M. 1973: Fire in the virgin forests of the boundary waters canoe area. — *Q. Res*. 3: 329–382.

Hoyt, J. S. & Hannon, S. J. 2002: Habitat associations of black-backed and three-toed woodpeckers in the boreal forest of Alberta. — *Can. J. For. Res*. 32: 1881–1888.

Hutto, R. L. 1995: Composition of bird communities following stand-replacement fires in northern Rocky Mountain (U.S.A.) conifer forest. — *Conserv. Biol*. 9: 1041–1058.

Jackson, J. A., Ouellet, H. R. & Jackson, B. J. S. 2002: Hairy woodpecker (*Picoides villosus*). — In: Poole, A. & Gill, F. (eds.), *The birds of North America* No. 702. The birds of North America, Inc., Philadelphia, PA.

Kery, M. & Schmid, H. 2004: Monitoring programs need to take into account imperfect species detectability. — *Basic Appl. Ecol*. 5: 65–73.

Majewski, P. & Rolstad, J. 1993: The detectability of black woodpecker — implications for forest bird censuses. — *Ornis Fennica* 70: 213–214.

Murphy, E. C. & Lehnhausen, W. A. 1998: Density and foraging ecology of woodpeckers following a stand-replacement fire. — *J. Wildl. Manage*. 62: 1359–1372.

Penteriani, V., Gallardo, M. & Cazassus, H. 2002: Conspecific density biases passive auditory surveys. — *J. Field Ornithol*. 73: 387–391.

Pulliam, H. R. 1988: Sources, sinks, and population regulation. — *Am. Nat*. 132: 652–661.

Rosenstock, S. S., Anderson, D. R., Giesen, K. M., Leukering, T. & Carter, M. F. 2002: Landbird counting techniques: Current practices and an alternative. — *Auk* 119: 46–53.

Royle, J. A., Nichols, J. D. & Kéry, M. 2005: Modelling occurrence and abundance of species when detection is imperfect. — *Oikos* 110: 353–359.

SAS Institute Inc. 2003: *Jmp in, 5.1. The statistical discovery software*.

SPSS Inc. 2002: *Sigma plot 8.0*. — Chicago.

Wilson, L. F. 1962: *White-spotted sawyer*. — U.S.D.A. For. Serv. Lake States For. Exp. Stn. Forest insect and disease. Leaflet no. 74.