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Brief report

Ground checks — an efficient and reliable method to monitor holes' fate

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1. Introduction

Holes in trees constitute an important resource for birds and the retention of an adequate supply of holes in exploited woods constitutes a major challenge for managers. Crucial to the evaluation of the efficiency of any hole management program is information on the fate of holes in the forest, and for how long they remain useable for occupation (reviews in Newton 1994, Günther & Hellmann 1995, Gibbons & Lindenmayer 1996). Hole monitoring is not an easy task; though some cases of hole non-useability can be easily recorded from the ground, like felling a hole tree, others can be only detected by checking the hole interior. Obtaining this information, especially on holes high above the ground is time-consuming and often physically dangerous. This severely limits the possibility of large scale hole monitoring in the field, as witnessed by the scarcity of such studies (see references above). Finding a more cost effective method would help in overcoming this restriction.

In an attempt to find such a solution, I carried out an eight year study aimed at answering the question of whether or not inspections from the ground could provide an alternative. Here I show that in a primaeval temperate forest, ground checks can serve adequately; as they produce hole useability estimates consistent among years and with a small margin of error.

2. Material and methods

2.1. Study area

Data were gathered in the strictly protected part of Białowieża National Park (eastern Poland, ca. 52°42′N, 23°52′E), in which the last surviving fragments of the European primaeval lowland temperate forest are preserved. The tree stands of the reserve have never been cut and its whole area has been strictly protected since 1921. Hence, one can still observe holes and hole nesters in conditions free of direct anthropogenic disturbance. The forest consists of several types of old-growth stands, both of deciduous and coniferous character (more detailed descriptions of study areas are given in Tomiałojć & Wesołowski 1990, Tomiałojć 1991, Wesołowski & Tomiałojć 1995), but the majority of data were gathered in two types of chiefly deciduous stands. These were riverine, composed mostly of alder *Alnus glutinosa*, ash *Fraxinus excelsior* and Norway spruce *Picea excelsa*, and upland deciduous, composed of more than 12 species of trees, mainly hornbeam *Car-*

pinus betulus, small-leafed linden *Tilia cordata*, continental maple *Acer platanoides*, pedunculate oak *Quercus robur* and spruce.

2.2. Methods

All holes used by birds for nesting within four large study plots (33–55 ha each, described in Wesołowski 1998), and accessible from a ladder (up to 5 m above the ground, in living trees), were marked in the field. From 1993 to 2000 holes were checked every year, twice within a breeding season, first from the ground, then the hole interior was inspected from the ladder. For checking the interior a small bulb on a bendable wire and a small mirror were used. The first inspection was done in the second half of April before the majority of birds commenced breeding, the second in late May, after all the birds started their first broods. Such timing permitted detecting all cases of hole occupancy by birds, as well as changes in hole interior occurring within a season.

The holes were classified as useable (entrance undamaged or only slightly enlarged, bottom dry to moist, covered with mould, rotten wood or with a thin layer of seeds, leaves or remnants of the previous year nest) or non-useable. The non-useable holes were classified as follows: 1) torn down — tree or its fragment with hole fallen, or some of hole wall removed (mostly by woodpecker activity); 2) compartmentalised — entrance diameter decreased to a size too small to be used even by the smallest hole nesters (< 18 mm; Wesołowski 1995, 1996); 3) bottomless — hole deepened to > 50 cm (Walankiewicz 1991, Wesołowski 1996, Wesołowski, unpublished data); 4) choked up — packed with plant material up to a level ≤ 5 cm below lower edge of hole entrance; 5) filled up — filled with rotten wood debris up to a level ≤ 5 cm below lower edge of hole entrance; and 6) flooded — bottom filled with semi-liquid mud or water filling hole.

During the ground checks only the two first categories of hole loss could be detected. Other categories were recognisable only during the hole interior checks. Torn down and compartmentalised holes were considered permanently damaged and were not checked again. Other holes were rendered temporarily non-useable and their inspections continued.

Table 1. Number of holes classified as useable according to the ground checks, interior inspections, and percentage overestimate of the number of useable holes by the ground checks, in relation to year.

Year	N holes checked	N useable		Overestimate (%)
		Ground	Interior	
1993	25	25	22	13.6
1994	91	88	80	10.0
1995	138	129	113	14.1
1996	147	138	130	6.1
1997	166	159	140	13.6
1998	173	164	142	15.4
1999	188	174	149	16.7
2000	203	197	163	20.9

3. Results

282 different holes were monitored over a period of 2–8 years giving a total of 1133 observations. Woodpecker-made holes constituted only 6% of the sample, others were formed by processes of tree decay. The holes were situated most often in hornbeam (59%), linden (28%) and alder (6%). The remaining 21 holes were found in eight other tree species.

As expected, the ground checks correctly identified only part of non-useable holes. In different years they overestimated the number of useable holes by 6–21% (Table 1). In reality this error was slightly less, as some holes classified as non-useable during April checks of the hole interior turned suitable still in the same season (see below). The errors in assessing the hole status from the ground (135 cases) were mostly due to their filling in (31%) or inundation (28%). Bottomless (22%) and choked up (19%) holes were less frequent. The frequency of different sources of misjudgement varied widely among years; in 1997–2000, the years with the largest number of errors (Table 1), filled in holes were responsible for 23–44, inundation for 14–32, choked up for 4–42, and bottomless for 9–32% of mistakes.

The holes were accessible only for small animals, up to the size of Starling *Sturnus vulgaris* or Great Spotted Woodpecker *Dendrocopos ma-*

jor. Besides three cases of hole occupation by hymenopterans and seven by mammals all the remaining holes were used by birds. However, in any single year, the birds occupied only a fraction of the useable holes. Except 1993 with a small sample, the occupancy rate amounted to 36–52% (Table 2). The species involved were most frequently *Ficedula albicollis* (34%) and three tits (*Parus palustris* 25%, *P. caeruleus* 13%, *P. major* 11%). Seven other species occurred with frequency < 5% each (Table 2).

The suitability of holes could change even within a season; of 135 holes classified as non-useable in April, 11 (two bottomless, two flooded, two choked up, five filled in) were actually occupied by birds still in the same season. Similarly a hole non-useable in one year could become useable the next. The frequency of such transitions depended on the factor causing non-useability; while the bottomless holes appeared almost permanently non-useable, the choked up holes regularly became suitable the next season (ten of 14 cases, in which such a comparison could be made). The flooded and filled in holes were intermediate in this respect (13 of 31 and 12 of 18 cases respectively).

4. Discussion

Long-term studies of hole availability, though badly needed for management purposes, are very rarely undertaken (reviews in Newton 1994, Günther & Hellmann 1995, Gibbons & Lindenmayer 1996). This is probably due to their prohibitive costs — checking the interior of a single hole situated in a large tree, 25–30 m above the ground, would demand climbing a tree with the use of specialised equipment (at least an hour, often more, own experience). Assessing the status of the same hole from the ground, using binoculars, can be done almost instantly. Thus, provided that the ground checks produce adequate results, one can save an enormous amount of time and effort. The results of this study clearly show the validity of using the ground checks to monitor hole useability as an alternative to tree climbing. Ground inspections produced correct results in 80 or more percent of cases; moreover, as the assessment error was consistent and varied little among years a correction factor could be introduced, to reduce error to about 10% of the actual numbers. This level of accuracy should be adequate in the large-scale monitoring of resource availability for the secondary hole nesting birds, though it might not be sufficient in the monitoring of hole availability for rare or endangered species, when ascertaining the exact status of every hole would be critical. The latter, however, can be achieved only at a cost of increasing the amount of field work by orders of magnitude.

How far can the Białowieża results be generalised? The study was limited to holes situated in living trees, low above the ground. While it is hard to imagine how height above the ground could affect the results, there could be some difference between holes in living trees and in snags. It seems reasonable to suppose that the filling in of holes with rotten wood could be more frequent in snags, but even if such cases were twice as frequent, it

Table 2. Number of useable holes (according to the interior checks) actually used by different birds and the overall occupancy rate, in relation to year.

Year	Species					Total	% useable occupied
	Ficedula albicollis	*Parus palustris*	*Parus caeruleus*	*Parus major*	Other		
1993	3	7	2	2	0	14	63.6
1994	1	22	4	0	2	29	36.3
1995	19	14	9	5	8	55	48.7
1996	19	15	9	7	18	68	52.3
1997	30	7	5	4	17	63	45.0
1998	28	11	4	5	10	58	40.8
1999	25	14	9	11	7	66	44.3
2000	23	17	13	15	16	84	51.5

would not increase the assessment error substantially. Additionally, as flooding could be less frequent in snag holes (flooding is often due to the changing geometry of a growing trunk), the overall error would be similar to that recorded above. Assessing the relevance of the results to other areas is more difficult, it seems that they should be directly applicable within the temperate European zone, as forests in this region are to a large extent composed of the same tree species and are inhabited by the same hole-using organisms as observed in this study. However, the situation could be dissimilar in regions with totally different flora and fauna, thus carrying out a separate validating study would be advisable, before relying on the ground checks to monitor the cavities' fate.

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Selostus: **Tehokas ja luotettava menetelmä kolopesijöiden pesimämenestyksen arviointiin**

Koloissa pesivien lintulajien pesimämenestyksen arviointi ei ole helppoa. Kolon käyttö pesintään voidaan varmistaa useimmiten vain tutkimalla kolon sisältö. Kolot kuitenkin sijaitsevat varsin usein korkealla puissa ja niiden tarkistaminen vie paljon aikaa. Korkealla sijaitseville koloille kiipeäminen voi lisäksi olla jopa vaarallista. Edellä mainitut tekijät vaikeuttavat laaja-alaisten kolopesintäinventointien tekemistä. Kirjoittaja esittää artikkelissaan tulokset Puolan Białowieżan kansallispuiston metsissä vuosina 1993–2000 tehdystä tutkimuksesta, jonka avulla yritettiin löytää tehokas ja luotettava kolontarkistusmenetelmä. Kirjoittaja kartoitti kaikki lintujen käyttöön sopivat kolot neljältä, 33–55 hehtaarin koealalta. Kolot tarkistettiin kaksi kertaa vuodessa. Ensimmäinen tarkistus tehtiin maasta käsin. Toinen kolojen tarkistus tehtiin tikapuita ja peiliä apuna käyttäen. Myöhemmin arvioitiin, kuinka luotettavan tuloksen maasta käsin suoritettu pesien tarkistus antoi. Kolot määritettiin joko käyttökelpoisiksi tai käyttökelvottomiksi. Käyttökelvottomat kolot ryhmiteltiin kuuteen eri luokkaan, joista kaksi voitiin todeta maasta käsin. Koloja oli seurannassa kaikkiaan 282 kappaletta 2–8 vuoden ajan. Havaintoja kertyi 1133. Käyttökelpoisista koloista oli vuosittain käytössä 36–52 %. Useimmiten koloissa pesivät sepelsieppo (34 %), viitatiainen (25 %), sinitiainen (13 %) ja talitiainen (11 %). Valtaosa koloista oli syntynyt puiden kaatumisen ja oksien katkeilun seurauksena. Löydetyistä koloista 6 % oli tikkojen tekemiä. Suurin osa koloista sijaitsi valkopyökeissä (59 %) ja lehmuksissa (28 %). Maasta käsin suoritettu kolojen tarkistus yliarvioi käyttökelpoisten kolojen määrän vuosittain 6–21 %:lla verratuna kolon sisätilan tarkistukseen. Yliarvio johtui lähinnä kolon täyttymisestä kasvimateriaalilla, mudalla tai vedellä. Näitä tilanteita ei voitu havaita maasta käsin suoritettavalla tarkistuksella.Kolojen käyttökelpoisuus muuttui myös pesintäkauden kuluessa. Huhtikuussa pesintään soveltumattomista 135 kolosta oli myöhemmin tehdyn tarkistuksen mukaan käytössä 11 koloa. Vastaavasti tiettynä vuonna käyttökelvoton kolo voi jonain toisena vuonna olla käyttökelpoinen.Erityisesti tämä koskee kasvimateriaalilla täyttyneitä koloja. Syventyneet kolot (kolon syvyys >50 cm) näyttivät olevan pysyvästi käyttökelvottomia. Yli 80 %:ssa tutkituista tapauksista maasta käsin tehty tarkistus antoi oikean kuvan kolon käyttökelpoisuudesta. Tutkimuksen mukaan maasta käsin tehtävällä kolojen tarkistuksella voidaan luotettavasti ja tehokkaasti arvioida kolojen käyttökelpoisuutta.

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