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Relationship between vegetation structure and abundance of Great-spotted Woodpeckers *(Dendrocopos major)* in a mosaic habitat

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Abstract This study was made in a postglacial relic bog in the Ócsa Protected Landscape Area in Hungary. Secondary succession of vegetation began after peat extraction and a grove-like forest evolved. Among the eight woodpecker species that occur in this area, the Great-spotted Woodpecker is the most abundant with the largest amount of data, it is for this reason we chose this species to study. The aims of this work were to detect changes in the abundance of the study species in relation to forest succession; to examine the seasonal patterns of these changes in abundance, and to identify any relationship between the height of the trees near the nets and the number of captured birds. We used the data from 1411 mist-netted Great-spotted Woodpeckers (1984–2010), which were captured at the Ócsa Bird Ringing Station (120 standard mist nets). The assessment of forest succession rates were based on aerial photos (1979–2010). We measured the height of the vegetation, at 12 points, near each 12 m long net. Population growth of Great-spotted Woodpeckers was significantly correlated with the rate of afforestation. The majority of birds occurred only during the dispersal period. The pattern of the captures correlated well with the vegetation structure, not just with height, but also with vegetation quality as well.

Keywords: forest fragmentation, arboreal vegetation characteristics, succession, habitat preference, population dynamics

Összefoglalás Vizsgálatainkat az Ócsai Tájvédelmi Körzet területén végeztük, egy posztglaciális reliktum lápszegélyen. A terület beerdősülése a tőzegbányászat befejeztével kezdődött el. Mára mozaikos, kis facsoportokból álló ligetes fás vegetáció alakult ki. A munka során az Ócsai Madárvártán 1984-2010-ig, 120 db függőnyhálóval befogott és meggyűrűzött nagy fakopáncsok adatait dolgoztuk fel. A nyolc eddig megjelent harkályfaj közül a nagy fakopáncs a leggyakoribb, erről a fajról gyűlt össze eddig a legtöbb adat, ezért lett ez a vizsgált faj. A következő kérdésekre kerestünk választ: az erdősülés üteme mentén hogyan változott a vizsgált faj éves egyedszáma? Milyen az egyedszámok szezonális mintázata? Korrelál-e a fogásszám a hálók melletti fák magasságával? A vizsgálati periódusban 1411 fogási adat gyűlt össze a vizsgált fajról. A szukcesszió ütemét 1979, 1992, 2000, 2005 és 2010-ben készült légifotók alapján becsültük meg. A vegetáció magasságát a 12 m-es hálók mentén, a háló mindkét oldalától 5 és 10 m-re, 4 m-es szakaszokban mértük meg. Az évenkénti egyedszám pozitívan korrelált az erdősülés ütemével. A legtöbb madár a júliustól októberig tartó diszperziós időszakban jelent meg, és csak rövid ideig tartózkodott a területen, mivel a revírek a rezidens egyedek által már telítettek voltak. A fogásszámok pozitívan korreláltak a vegetáció magasságával, de a vegetáció számos más jellemzője is befolyásolta az egyedek élőhely preferenciáját, pl. preferált fafajok, illetve táplálékban bővelkedő holtfák jelenléte.

Kulcsszavak: erdő fragmentáció, fásszárú vegetáció jellemzői, szekunder szukcesszió, élőhely-preferencia, populációdinamika

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Introduction

This study was carried out at the perimeter of a postglacial relic bog. This area is at the stage of early successional forest, such habitats are very important, because of their high biodiversity, complex food webs and ecosystem processes. Numerous opportunist and specialist species can settle there (Swanson *et al*. 2011). This area also has importance to species, because these kinds of habitats can be green corridors or stepping stones for them in a fragmented forest landscape, a common situation in Hungary.

These habitats are not preferred by most of the European woodpecker species, they are present, though at lower densities. The Great-spotted Woodpecker can reach higher densities than the other European woodpecker species can (Gorman 2004). Nine of the ten European woodpecker species live in Hungary (Gorman 2004). So far (1983–2010), eight woodpecker species have been recorded in the study area. Among them, the Great-spotted Woodpecker is the most common and most abundant. According to our ringing data, this is the only species with more than one breeding pair per year, and the other species don't breed yearly. The Great-spotted Woodpecker is a generalist species, and can inhabit various wooded habitats (Török in Csörgő *et al.* 2009). They can nest in closed or fragmented forests, and even in urban parks and orchards (Gorman 2004). As an opportunist, this species could be the first woodpecker species, to settle in an early stage succession forest. They help the other cavity-nester species, to settle (Carlson *et al.* 1998, del Hoyo 2002).

The number of birds occurring in an area varies seasonally (del Hoyo 2002). Every year, in summer, full-fledged young woodpeckers leave their parents' territory and disperse to occupy new territories (Kesler & Walters 2012). During this period, the density of woodpeckers can increase rapidly. They can cross tens of kilometres, to reach the appropriate woodlot, forest patch or closed forest (Howe 1984, Török in Csörgő *et al*. 2009). These dispersal movements finish in late autumn, and so the density of birds is stable in the other seasons.

During the study period from 1983 to 2010, succession was undisturbed, and the extent of the area, covered by arboreal vegetation increased steadily. The trees became older, providing better food sources for the Great-spotted Woodpeckers (del Hoyo 2002, Gorman 2004).

In this study, we examined through ringing records, if there are any seasonal patterns in the number of the Great-spotted Woodpeckers in the area. We also study if there is a relationship between the number of birds and the extent of tree coverage, and finally, we would like to determine, if there is a relationship between the height of the trees and the number of capturing occasions. Our aims were to examine the seasonal patterns of the species' abundances, to detect the changes in the abundance of the study species in relation to afforestation and to identify any relationship between the height of the trees near the nets and the number of captured birds in the five wooded blocks.

Material and methods

This research was carried out in Hungary, near Budapest (Ócsa, E 47° 29' N 19° 20') at the perimeter of a post-glacial relic bog in Ócsa Landscape Protection Area, which is the part of Duna-Ipoly National Park. There was intensive peat extraction in the area. In 1978, this area became protected, and that

Species	GSW	LSW	MSW	SW	GW	BW
All catches	1411	438	101	57	164	38
Ringed specimens	523	182	33	46	70	24
Recoveries	888	256	68	11	94	14
Recovered specimens	254	84	23	4	46	9

Table 1. The number of captures of each species in the study period
1. táblázat A különböző fajok fogási adatai a vizsgálati periódusban

extraction ceased. After this, secondary succession of wooded vegetation began. The size of the study area was approximately 30 hectares, of which tree coverage recently reached 20 hectares.

The canopy level is most provided by poplar (*Populus* spp.) and willow (*Salix* spp.) trees. There are also some other tree species, like Hungarian Narrow-leaved Ash *(Fraxinus angustifolia* ssp. *pannonica)*, Walnut *(Juglans regia)* and Hackberry *(Celtis occidentalis)*. In the shrub layer the most common species are Elder *(Sambucus nigra)*, Blackberry *(Rubus fruticosus)* and young specimens of willow species.

We used the data from woodpeckers caught using mist nets at the Ócsa Bird Ringing Station between 1983 and 2010. There are 120 standard Japanese-type mist nets in this area which are situated in standard net blocks according to the various vegetation types. Each mist net is 12 m long, 2.5 m high with 5 shelves. With this method, one can only catch woodpeckers that fly low through the area, but according to their foraging behaviour, it is common for birds to land on lower regions of trees and to climb upwards.

We assessed tree coverage by counting squares, which were covered by at least 50% by woody vegetation, on a grid of 10 m by 10 m. These were mapped on aerial photographs (which could be obtained from the years of 1979, 1992, 2000 and 2005) from the Institute of Geodesy, Cartography and Remote Sensing in Hungary and from Google Maps (2010). We studied and graphed the correspondence between number of caught specimens and the vegetation succession tendency. We fitted various lines on the points of the results, with GraphPad InStat (www.graphpad.com) and MS Excel (www.microsoft.com).

The mist nets are situated in standard net blocks representing various vegetation types. The first block is a willow-poplar woodlot next to a reedbed (6 nets). The second is also a willow-poplar woodlot, but with a numerous Elder bushes in the shrub layer (10 nets). The third is a willow-poplar-ash woodlot surrounded by reeds. There are young willow trees, Elders and Blackberries in the shrub layer (15 nets). The fourth is lining between bushes of Elder with Common Hop *(Humulus lupulus)* on them. At the end of the line, there are some large poplar and willow trees (10 nets). The fifth is on the bank of a channel. There are numerous large Hungarian Narrow-leaved Ashes all along the nets. There are some shorter willow, poplar and Walnut trees as well. There are Elders and Blackberries in the shrub layer (10 nets). We determined the specific location of the successful catches with the precision of 12 m, according to the standard numbered nets.

We measured the height of trees on transects lines running parallel with the nets,

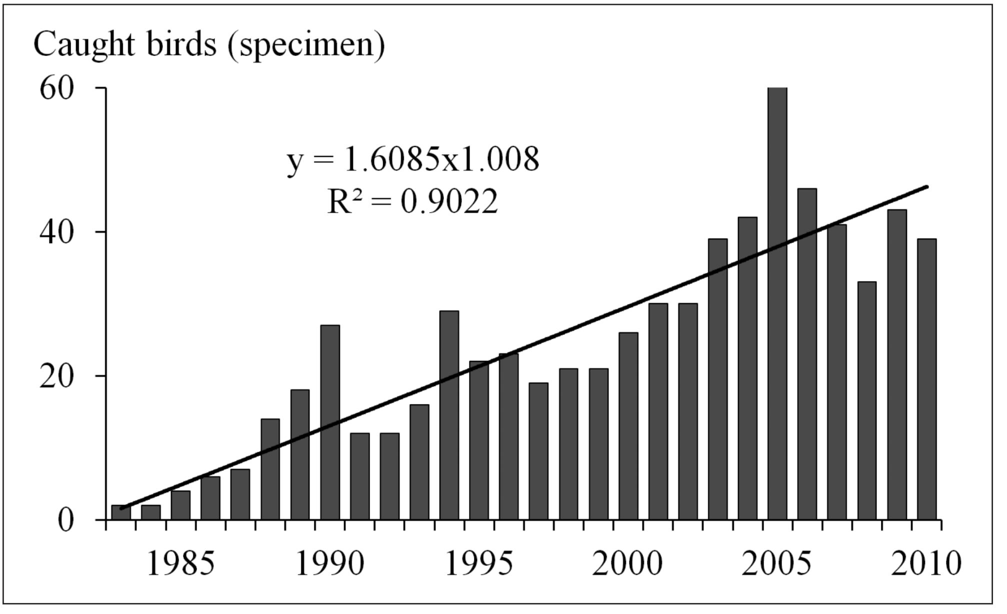

Figure 1. Yearly distribution of the number of caught Great-spotted Woodpeckers (fitted with the line of the best 'R2' value)

1. ábra A vizsgált faj egyedszámainak évenkénti eloszlása (a legjobb „R2" értékű illesztésekkel)

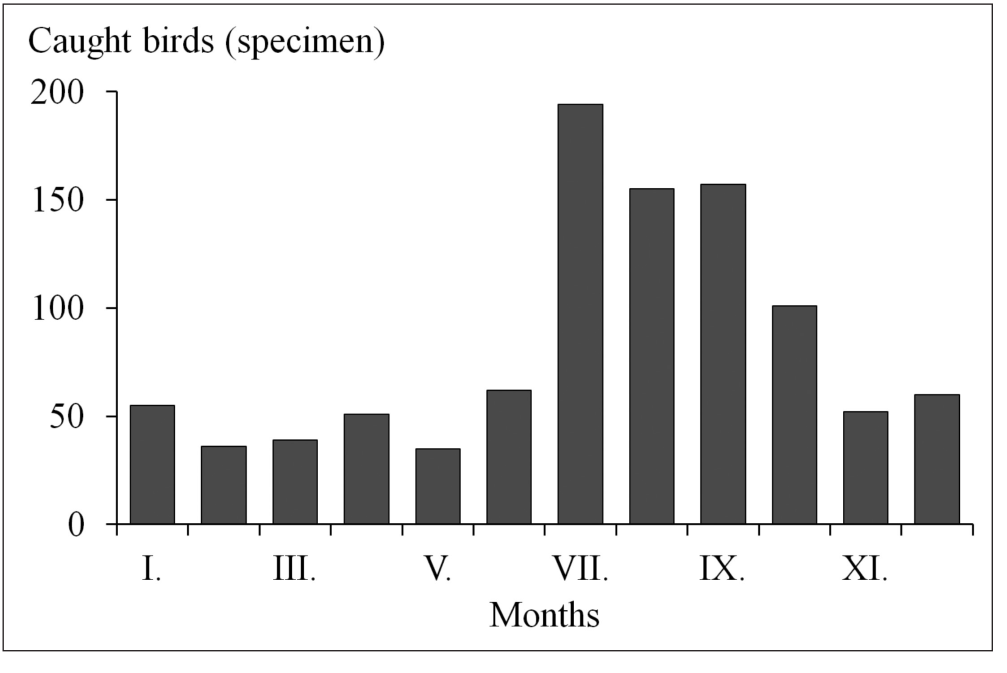

Figure 2. Monthly distribution of the number of captured woodpeckers

2. ábra A vizsgált faj egyedszámainak hónapok szerinti eloszlása at 5 and 10 m distance on both sides of the net. Measurements were made in three, 4 m long sections in each transect, resulting 12 records per net. The mean value of these 12 records gave the value of the vegetation profile. We made the measures with the Christen height meter. With this method, we measured the vegetation profile on the whole study area, because the nets were placed in the only small woodlots that are present in the study area. We determined six height categories (<5 m, 5-9.9 m, 10-14.9 m, 15-19.9 m, 20-24.9 m, >24.9 m) from the raw data in order to plot how frequent each height category was in the area.

We studied and plotted the relationship between vegetation profile and number of catches in the 5 net blocks. We fitted various lines with GraphPad InStat (www.graphpad.com) and MS Excel (www.microsoft.com).

Results

The study species increased in occurrence in the study period *(Figure 1)*. The majority of birds were captured from July to October, annually, with a peak in July. During the rest of the year, the number of birds caught was generally equal, with a moderate peak in March *(Figure 2)*.

Most of the birds caught had no or very few recoveries, although there were some birds which were caught more than 5 times or even more than 10 times *(Figure 3)*.

Tree coverage increased exponentially throughout the study period *(Figure 4)*. The abundance of the study species correlated positively with the increasing tree coverage *(Figure 5)*.

Almost half of the study area is covered by vegetation, shorter than 5 m, the higher vegetation categories are represented less and less *(Figure 6)*. Among all fitted lines, the logarithmic one appeared to be the best *(Figure 7)*.

Discussion

The studied area is fragmented, there are just small woodlots in this grove-like habitat, that makes a fragmented forest landscape. In the Ócsa Protected Landscape area these patches could be several hundred metres from each other. The study area is covers 30 ha of the total. So far, 8 woodpecker species of the 9 present in Hungary have already been recorded. The frequency of occurence of each species are different, because of their varied environmental needs. The study species increased in number in the time period. This species is a generalist which can attain high numbers even in fragmented landscapes (del Hoyo 2002, Török in Csörgő *et al*. 2009).

The majority of Great-spotted Woodpeckers were caught between July and October. This is the dispersal period of fully-fledged juveniles, when they look for foraging sites or try to occupy territories (Gorman 2004). The highest number of birds was caught in July. This activity decreases by October and so it is suspected that nearly all of these young birds abandon the area. The young birds fledge in June, in this month, their movements are mainly near the nesting cavity. Numbers of birds caught outside the dispersal period were generally even. It appears that this habitat can't support any more resident birds outside the breeding and dispersal periods, only the resident birds are present (del Hoyo 2002).

The strong relationship between the number of catches and the values of vegetation profile could be due to that there can be more prey in the taller, older and more

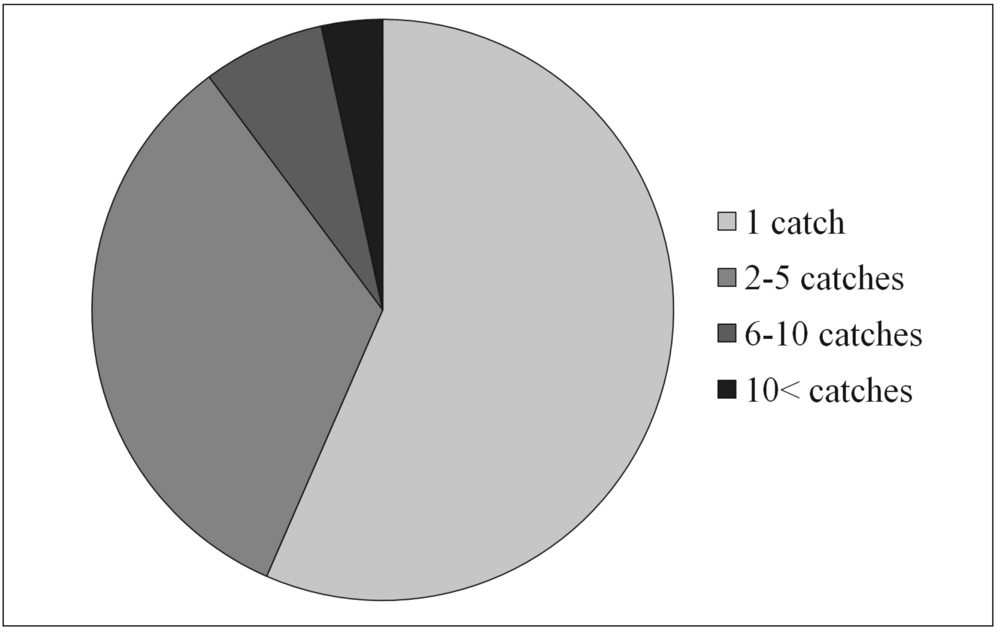

Figure 3. Distribution of the woodpeckers according to the number of catches
3. ábra A vizsgált faj egyedeinek fogásszám szerinti eloszlása

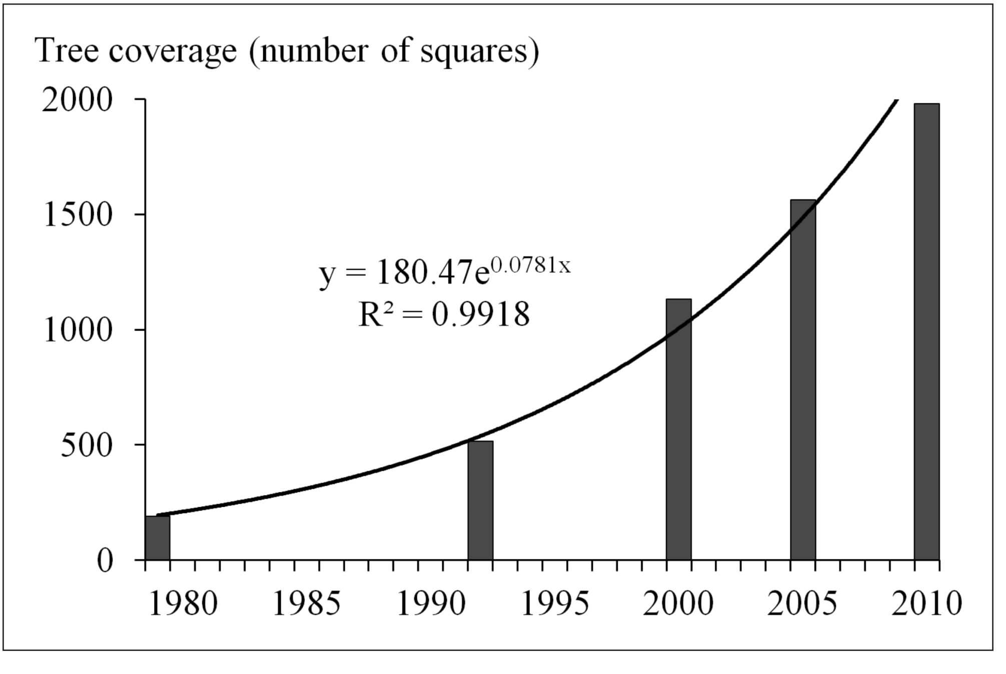

Figure 4. The tendency of tree coverage (fitted with the line of the best 'R2' value)
4. ábra A szukcesszió üteme a vizsgálati periódusban (a legjobb „R2" értékű illesztéssel)

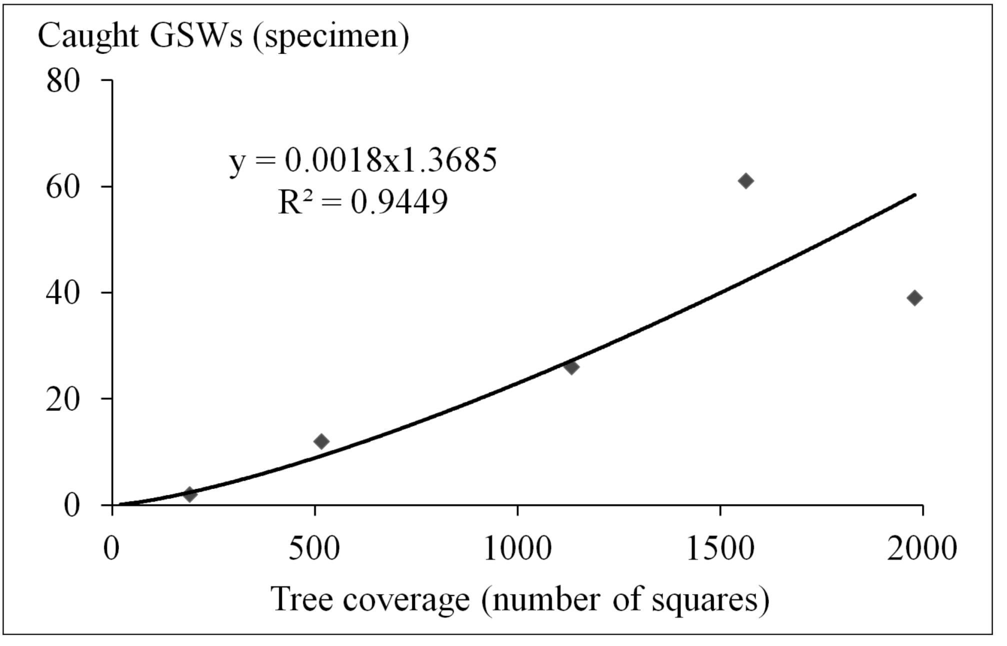

Figure 5. The relationship between tree coverage and numbers of the captured woodpeckers (fitted with the line of the best 'R2' value)

5. ábra A borítottság és az egyedszám összefüggései a vizsgált fajnál (a legjobb „R2" értékű illesztésekkel)

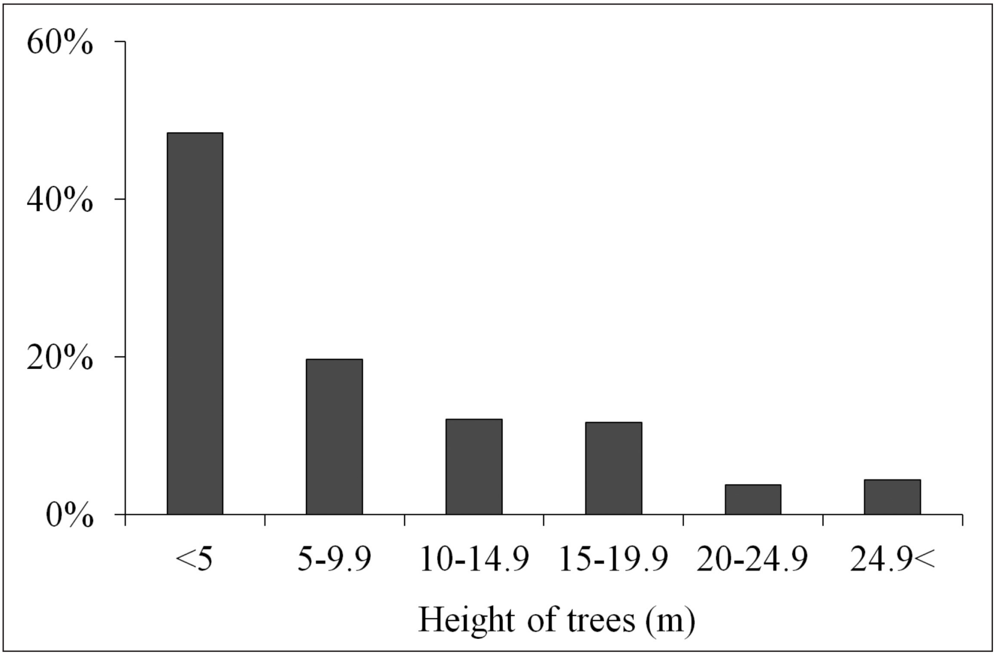

Figure 6. Percentage distribution of vegetation height according to the twelve sampling points per each net

6. ábra A vegetáció magasság szerinti eloszlása a vizsgált területen

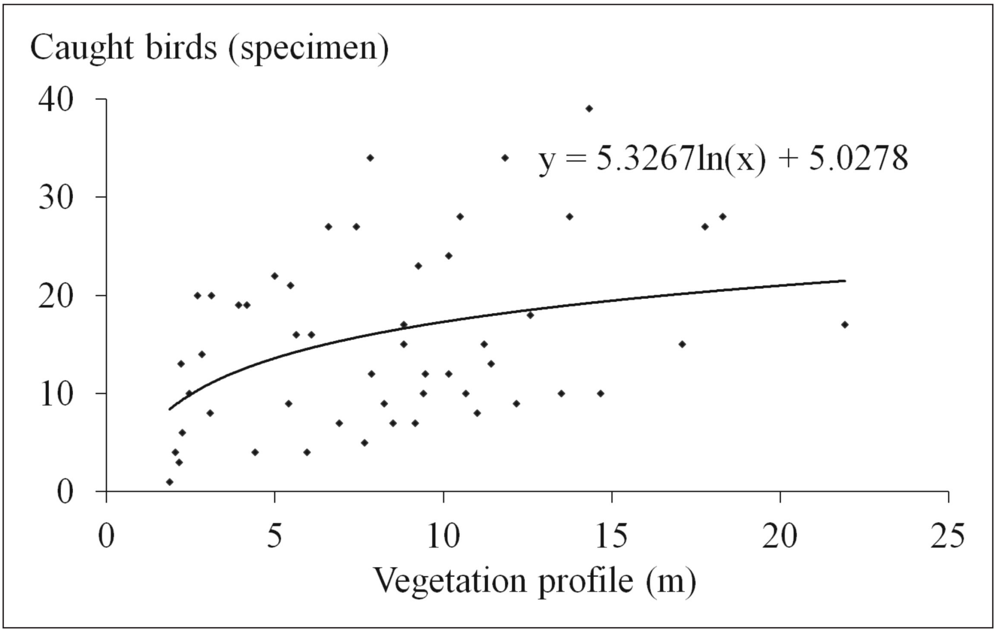

Figure 7. The relationship between vegetation profile and number of captured woodpeckers in each studied net block

7. ábra A vegetációs profil és a fogott példányszám korrelációja az összes hálóállás adataira

decayed trees (del Hoyo 2002, Gorman 2004). In the other hand woodpeckers prefer to move in the cover of trees to minimize the chance of encounter with predators such as Goshawk *(Accipiter gentilis)*, so the more dense the vegetation is, the safer it may be to forage there (Gorman 2004). According to our earlier studies, this is how the Great-spotted Woodpeckers mostly forage in this area. They look for their prey between branches, in the upper regions of trees (Ónodi & Csörgő 2012a, 2012c).

There were numerous cases when we've found extremely high capture rates in areas with low vegetation profile value. This may be due to the following characteristics of the habitat: there could be at least one specially preferred tree species, a decaying or dead tree with massive amount of prey, which could be a very important foraging site. There could be barkless, well-resonating branches too, on which the resident birds show their territorial drumming behaviour. There were nets, which showed extremely high capture rates despite the fact that the value of vegetation profile was low. This could be because the above-mentioned reasons. Above the net, in the woodlot, there live the highest trees in the study area (about 30 m high). Despite that, the vegetation profile value is low, because on the other side of the net there are just bushes, which decreased the value of the profile. There is a Walnut tree at a particular net, with low profile value. The study species prefers the nuts, so this could be the reason why we've found extremely high number of catches despite the very low vegetation (Cramp 1985, Székely 1987).

There were numerous nets without these mentioned preferable features, where we caught not surprisingly very few birds throughout the study period.

The prey species initially found their ecological needs in the quick-growing poplar and willow species, and so their populations have increased with the aging of the woodlots. Walnut trees occurred which are so preferred by the study species. Although the height of the vegetation has grown in the study period, the variation between the height of different vegetation types haven't changed so much. The present tallest trees were also the tallest ones at the start of the study. The shorter trees were in the shrub layer, so the nets under taller trees caught more birds than nets under shorter trees during the whole study period. The trees which are preferred nowadays, were preferred in the past too because there were more insects in the larger trees than in the younger, and, shorter ones. There could be some unpredictable circumstances, wood diseases, heart rot etc. which could make trees decay, to become important foraging or drumming objects. This could be some of the reasons for the pattern of catches changing throughout these years at nets under shorter trees (Gorman 2004, Ónodi & Csörgő 2012b).

As tree coverage increased over the years of the study, increasing numbers of woodpeckers came to the area during the dispersal period, from July to October. Most Great-spotted Woodpeckers left in autumn without being re-caught. Only a few birds spend the whole year as residents in the area. If the tendency of succession continues and edge effect decreases, no doubt more individuals will appear during dispersal periods, and more resident birds and even more nesting pairs of the sedentary species will probably occur (McWethy *et al*. 2009, Ónodi & Csörgő 2011, 2012b).

Numerous authors have studied the role of Picids in forest bird communities (Mannan *et al*. 1980, del Hoyo 2002, Gorman 2011), including how the changes in wooded habitats could affect the woodpeckers and their secondary cavity-nester species, or other bird species (Drapeau *et al*. 2000, Conner *et al*. 2002, Machmer 2002, Fink *et al*. 2006, Moore & Conroy 2006, Herrando *et al*. 2009, Franz *et al*. 2010, MacGregor-Fors *et al*. 2010). Conservation management of numerous forests influenced positively the density of secondary cavity-nesters (Zarnowitz & Manuwal 1985, Reed 1990, Wilson *et al*. 1995, Plentovich *et al*. 1998). For a couple of decades, numerous nest boxes were placed in the study area and the secondary cavity nesters mostly nest in them. These nest boxes were placed there to aid the settlement of these species. In some habitats the study species is a serious nest predator for hole-nester bird species, and some species avoid using the cavities of the Great-spotted Woodpecker (Wesolowski 2007). In spite of this, the arboreal vegetation of this area is still young, so this habitat hasn't got many tree hollows that usually occur in decaying trees. For this reason the cavities made by the study species could be the main choice for secondary cavity-nesters.

If the tendency of succession continues and edge effect decreases, no doubt more woodpeckers will excavate more cavities and more secondary cavity nester species will settle.

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