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Wood quality and the Tawny Owl *Strix aluco* in different forest types of central Italy

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Abstract

We correlated breeding density and proportion of wooded area *per territory* of Tawny Owl *Strix aluco* measured in four deciduous forest types with forest elevation and songbird abundance, both regarded as estimators of forest productivity. The proportion of wooded area was positively correlated to forest elevation, being low in coastal thermophilous oak woods and increasing in hilly mesophilous oak woods and in mountain beech woods. Songbird abundance showed a reverse pattern as the proportion of wooded area per owl territory was negatively correlated to songbird abundance. No correlation was observed between these variables and the breeding density of owls. The low proportion of wooded area *per territory* in coastal thermophilous oak forests likely depends on that this wood type provides old trees with suitable cavities for nesting and large prey availability, thus representing the optimal habitat for the Tawny Owl in central Italy. We suggest that wooded area *per owl territory* may be used to predict the quality of different forest types.

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Introduction

Populations of woodland birds are influenced by forest characteristics (e.g. Newton et al. 1977, Petty & Avery 1990, Fuller 1995, Penteriani & Faivre 1997), wood proportion being a key factor explaining breeding density and regularity in nest spacing (Newton et al. 1977, Hirons 1985, Petty 1989, Redpath 1995). Populations of the Tawny Owl *Strix aluco*, a territorial raptor that regularly breeds in farmlands (Hirons 1985, Redpath 1995), rocky and mountain areas (Sánchez-Zapata & Calvo 1999), as well as in cities (e.g. Ranazzi et al. 2000), reach their highest densities in deciduous forests (Southern 1970). The distribution of territories remains almost constant for many years, and the period during which any particular wood maintains suitable conditions for nesting depends on factors like tree species and management, especially on the timing and extent of thinning (Newton et al. 1977, Petty 1989).

Despite considerable interest in Tawny Owl ecology, more information is needed about the influence of landscape variables such as amount of habitat, habitat patch size, amount of edge, and fragmentation of habitat patches on territory occupation and nest site selection. The occurrence of differences in population density at the habitat level would mean that the Tawny Owl could be used as an indicator to assess differences in forest quality. In this study we correlate the amount of wooded areas *per owl territory* with forest elevation and songbird abundance, both regarded as predictors of forest productivity.

Methods

Study area.

From 1995 to 2000 we monitored Tawny Owls in 44 census plots with a wide range of forest proportion, ranging from 6% to 99%. Census plots are located in urban Rome (41°53 N, 12°28 E) (see Ranazzi et al. 2000), as well as in rural areas of Latium and Abruzzo. The coastal sub-region bordering the

Tyrrhenian Sea shows a typical Mediterranean climate with three months of summer drought and mean annual rainfall less than 700 mm. The hilly sub-region shows a more temperate climate, with one to two months of summer drought and a mean annual rainfall between 800 mm and 1100 mm. The mountain Apennine region shows a typical temperate climate, with mean annual rainfall generally higher than 1100 mm (Penteriani & Faivre 1997, Blasi et al. 1999).

The size of most forest patches ranged from 100 to 500 ha, with only a few larger than 2000 ha. All forests have been previously cut within the last 200 years. However, forest patches older than 50 years are common.

Census methodology

Occupied territories were censused by nocturnal playbacks and passive listening for adults and young. The area covered by wood in each plot was covered by transect routes that varied in length depending on forest size. In forests larger than 500 ha only a part of the wooded area was censused, according to route facilities. Playback stations were located at approximately 250 m intervals along the transect routes. Playback sessions of a stranger male 'hoot' calls lasted approximately five minutes and were performed during the winter and the breeding season from early January to the end of August, generally between 9 p.m. to 2 a.m. During each session at least two of us were present, using a SANYO portable stereo with 2 3 6 W loudspeakers.

Playback sessions were not performed in autumn since fledglings may still be present in the parents' territory and thus cause an overestimation of the number of owls and occupied territories. Also during the breeding period we investigated territory range and nesting area by listening for fledglings (Ranazzi et al. 2000). To reduce disturbance by the acoustic stimulation we did not visit the same area more than three times during one breeding season. Males respond rapidly to playbacks, which reduces the risk that we missed any territorial owls (Redpath 1995). Furthermore, censusing Tawny Owls for many consecutive years from the same playback positions reduces the risk of overestimating the number of territories, which could be a risk especially in high-density populations.

During playback sessions, responding individuals were located using 1:10,000 maps. We tried to stimulate all the neighbouring territorial pairs or single males each time an unknown Tawny Owl territory was located. Male contacts and disputes along boundaries, as well as female 'kewick' calls were also noted. We considered the centre of each territory to be located at the nesting area for breeding birds. For single birds or for pairs that failed to breed we considered it to be at the diurnal resting site, which we located by searching for individuals resting on trees, feathers, drops, and other traces, and by collecting pellets and prey remains (Petty 1989).

Breeding density and habitat proportion

We used the nearest neighbour distance (n.n.d.) method (e.g. Newton et al. 1977, Penteriani & Faivre 1997, Ranazzi et al. 2000) to estimate breeding density. Spacing was calculated using the centre of occupied territories (see below). In our calculations we used the maximum number of independent territories observed during the study period, irrespective of if pairs or single birds occupied them. We chose this method to achieve comparable estimates of density and habitat proportion in all census plots, as woods suitable for nesting are sometimes separated by unsuitable habitats (Ranazzi et al. 2000).

Our study plots were divided into four classes according to the dominant vegetation type (e.g. Blasi et al. 1999): (i) urban mixed woods, with fragmented patches of mature vegetation including *Platanus* sp., *Quercus ilex*, *Pinus pinea*, *Cedrus* sp., and *Cupressus sempervirens*; (ii) beech woods, represented by mature stands of *Fagus sylvatica* distributed in mountain areas up to 1000 m above sea level; (iii) mesophilous oak woods, with mature stands of mixed oaks (*Q. cerris*, *Q. frainetto*, and *Q. robur*) and beeches distributed between 200 m and 1000 m above sea level; and (iv) thermophilous oak woods, represented by mature stands of *Q. ilex* and *Q. suber* distributed along coastal dry zones.

The proportion of wooded area was measured across the whole 'n.n.d.-area' using aerial photographs, 1:10,000 technical maps and the VIDEOPLAN KONTRON PC package. Wooded area was used as descriptor of the amount of nesting habitat suitable for Tawny Owls. We calculated an average for the territories in each "n.n.d.-area" by dividing the total surface of woods by the number of territories occupied across the whole area. To verify that this estimate corresponds to the average proportion of suitable habitat in individual territories we measured the total surface of wooded area in ten 300 m-radius occupied plots. The size of circular plots (= 28.8 ha) was comparable to the mean size of

Tawny Owl territories in the same area (= 29.8±10.8 ha, n = 20, Ranazzi et al. 2000), which means that the amount of wooded area *per territory* resembles the average value of total surface of wooded areas in occupied territories.

Songbird abundance

The relative abundance of songbirds was obtained both from the literature (Sarrocco & Sorace 1997) and by own estimates with the line transect method. We obtained data from six urban mixed woods, five thermophilous oak woods, eight mesophilous oak woods, and five beech woods. Transect length ranged between 1.0 km and 7.5 km. The abundance of songbirds was expressed as individuals km^{-1}. We used songbird abundance recorded in six forest fragments where Tawny Owl density was assessed to explore the relationships between the amount of wooded areas per owl territory and song bird abundance, and between breeding density and song bird abundance. The abundance of songbirds provides an indirect estimation of forest productivity in different wood types (Petty & Avery 1990, Fuller 1995, Penteriani & Faivre 1997).

Statistics

The effect of altitude and songbird abundance on breeding density and the proportion wooded area *per territory* was analysed by means of linear regression models. All tests were two tailed. Curve fits and statistics were obtained using the statistical software PRISM 2.0 (GraphPad Software, 1995).

Results and discussion

A total of 586 owl territories were located in 44 census plots. Wooded area *per territory* varied among forest types ($F_{3,40} = 57.5$, $P < 0.001$) being lowest in thermophilous oak woods (mean ± SD = 7.1±0.4 ha), higher in mixed urban woods (= 10.8±2.4 ha) and mesophilous oak woods (= 13.3±2.6 ha) and highest in mountain beech woods (= 22.5±3.4 ha) (see Figure 1). The abundance of songbirds showed an opposite pattern, decreasing along the elevation gradient (Figure 2). Wooded area *per territory* was positively correlated to forest elevation (Figure 3), and negatively correlated to songbird abundance (Figure 4). Owl breeding density was not correlated either to elevation (Figure 5) or to songbird abundance (Figure 6).

Mature oak woods that provides old trees with cavities suitable for nesting in combination with high prey availability may support dense populations of Tawny Owls even if they have a low proportion of wooded area *per territory* (Southern 1970, Hirons 1985). Beech woods have few available natural cavities for nesting in combination with low prey abundance (Penteriani & Faivre 1997); they have more wooded area *per territory*. Wooded area *per territory* was correlated to forest elevation and songbird abundance. Otherwise, the breeding density of Tawny Owls was unaffected by elevation and bird abundance, suggesting that their habitat requirements do not depend on forest characteristics. Variables measuring ecological traits at the population level (e.g. breeding density) or at the individual level (e.g. territory size) may reflect differences in habitat composition between the studied areas (Van Horne 1983).

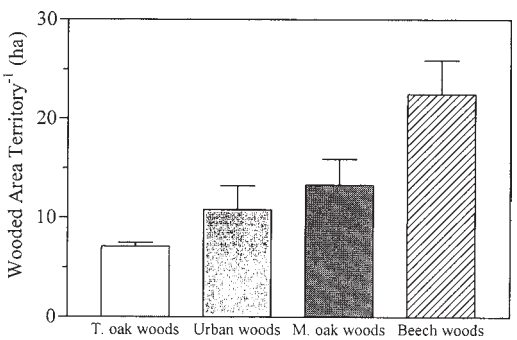

Figure 1. Average values of wooded area *per owl territory* in four different forest types in central Italy.
Genomsnittlig skogstäckt areal per ugglerevir i fyra olika skogstyper i centrala Italien.

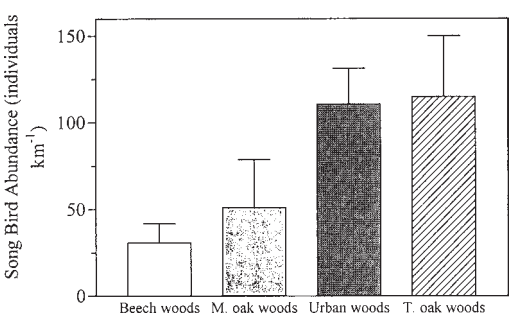

Figure 2. Average values of songbird abundance in four different forest types in central Italy.
Genomsnittlig täthet av småfåglar i fyra olika skogstyper i centrala Italien.

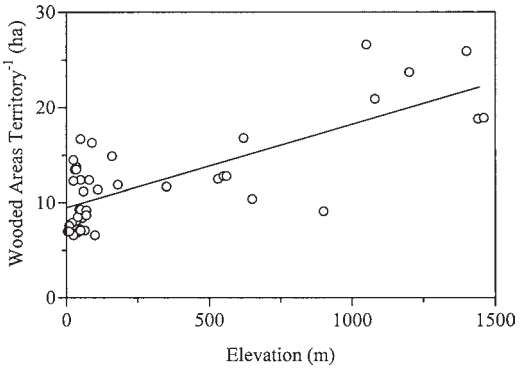

Figure 3. Relationship between forest elevation and wooded area *per owl territory* (Y = 0.01x + 9.48, $r^2 = 0.56$, $p < 0.001$, d.f. = 42).
Förhållandet mellan skogens höjdläge och skogstäckt areal per ugglerevir.

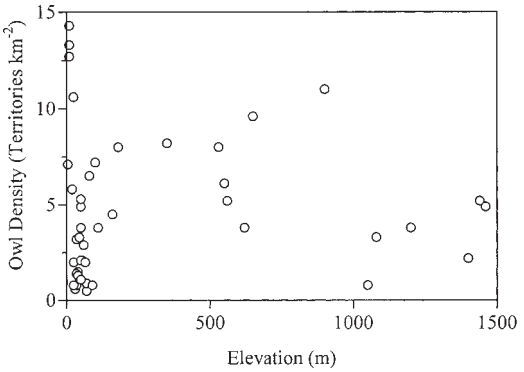

Figure 4. Relationship between forest elevation and owl breeding density (Y = 0.0x + 4.65, $r^2 = 0.0$, $p = 0.87$, d.f. = 42).
Förhållandet mellan skogens höjdläge och tätheten av häckande ugglor.

The most promising species serving as indicators of environmental conditions are those that are easily recognised and monitored and whose functional relationships to habitat changes are clearly understood (e.g. Hanley 1996). Some species are good indicators of forest quality because they are habitat specialists and especially sensitive to habitat change. Monitoring their population response to management will make it possible to use them as indicators. Other species, however, may be good indicators because they require a wide range of habitat characteristics that broadly encompass the habitat needs of many other animals and plants as well. Their value is especially great for planning and broad scale analysis rather than monitoring *per se*. As reported by Southern (1970), Petty (1989), Redpath (1995), and the present work, requirements for forest cover and structure that necessitate a diversity of vegetation types, as well as the generalist feeding style that allows to successfully colonise poor-quality habitats (e.g. Ranazzi et al. 2000), suggest that Tawny Owl may fall into that category.

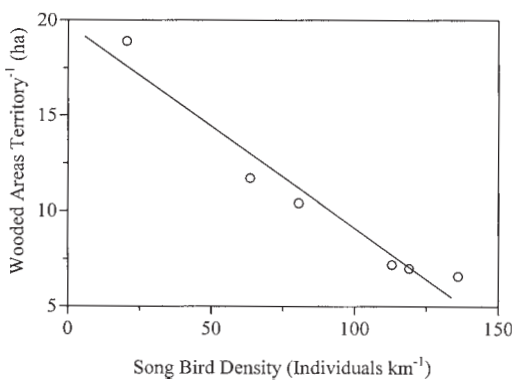

Figure 5. Relationship between song bird abundance and wooded area *per owl territory* (Y = -9.16x + 181.1, $r^2 = 0.95$, $p < 0.001$, d.f. = 4).
Förhållandet mellan småfåglarnas täthet och arealen skog per ugglerevir.

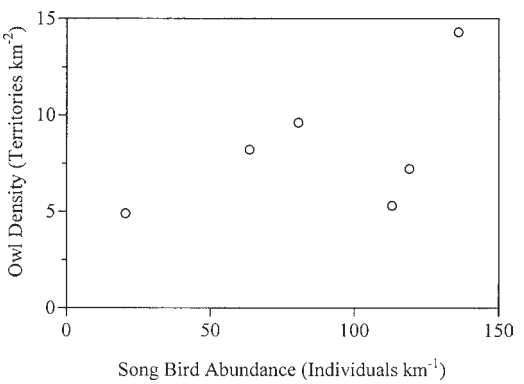

Figure 6. Relationship between songbird abundance and owl breeding density (Y = 6.14x + 4.63, $r^2 = 0.31$, $p = 0.25$, d.f. = 4).
Förhållandet mellan småfåglarnas täthet och tätheten av häckande ugglor.

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Sammanfattning

Skogskvalitet och kattugla i olika skogstyper i centrala Italien

Typen av skog och dess kvalitet är av avgörande betydelse för tätheten av häckande fågel. Åtminstone i södra och mellersta Europa häckar kattugglan *Strix aluco* tätast i lövskog, men den häckar även i jordbruksmark, bergstrakter och i stadsmiljöer. Lite är känt om kattugglans preferens för olika habitattyper.

Med olika inventeringsmetoder har vi undersökt kattugglans förekomst i 44 olika bevakningsområden i närheten av Rom, mellan åren 1995 och 2000. Områdenas storlek varierade mellan 100 till 500 ha, med några till och med större än 2000 ha. Vi inventerade både med hjälp av playback och genom passiv lyssning längs vägar som användes som transekter genom skogsområdena. Inventeringspunkterna förlades med ungefärliga 250 m intervaller längs dessa vägar och de besöktes nattetid, mellan kl. 21.00 till 02.00, från början av januari till slutet av augusti varje år. För att undvika att kvarstannande ungfåglar noterades som revirhållande gjorde vi inga besök under hösten, och för att minimera risken för tillvänjning och störningar använde vi playback högst tre gånger per år och revir.

Vi delade in studieområdena i fyra olika habitatklasser: i) urban blandskog ii) bokskog i bergsområden upp till 1000 m.öh., iii) mesofil ekskog mellan 200 till 1000 m.ö.h., och iv) termofil, torr ekskog på havsnivå.

Vi lokaliserade 586 ugglerevir i våra 44 bevakningsområden. Proportionen skogsklädd yta per revir var lägst i den kustnära, termofila ekskogen (7.1 ± 0.4 ha) och ökade sedan gradvis i den urbana blandskogen (10.8 ± 2.4 ha) och den mesofila ekskogen (13.3 ± 2.6 ha) och var högst i bergsbokskogen (22.5 ± 3.4 ha) (Figur 1). Detta ger en ökning av proportionen skog med höjden över havet (Figur 3). Tätheten av småfågel visade ett nästan omvänt mönster och minskade med höjden över havet (Figur 2) vilket gav en negativ korrelation mellan höjd och småfågelförekomst (Figur 4). Tätheten av häckande kattugglor, slutligen, korrelerade varken med höjd över havet eller småfågelförekomst.

Att uggleförekomsten inte var högst i den mest skogsklädda biotopen, bokskogen, tror vi beror på att den innehåller relativt få lämpliga boträd. Det glesare kustnära, termofila habitatet med ekskog däremot innehåller gamla ekar med många lämpliga håligheter för häckning. Även om vi inte fann en korrelation mellan skogstyp och tätheten av kattugla tror vi att denna art kan användas som indikatorart, bl.a. på grund av att den är lättinventerad.