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Habitat quality, breeding success and density in Tawny Owl *Strix aluco*

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Abstract

Habitat categories and songbird availability as a predictor of forest productivity were compared between Tawny Owl territories and areas not occupied by Tawny Owls near Gothenburg, south-western Sweden. There was no significant difference with regard to habitat categories. There was a significant positive correlation between density of territories and proportion of forest cover for each territory. With regard to songbird availability, there was a significant difference between occupied and not occupied sites. Tawny Owl population density and chick production was positively correlated with songbird availability. Prey remnants from nest boxes were investigated to find out the importance of birds in the diet.

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Introduction

The Tawny Owl *Strix aluco* is a residential diet generalist that depends on trees for nesting, roosting and hunting. As territory size and thus population density in Tawny Owls are believed to be regulated in accordance with the minimum food abundance in the worst thinkable year, the density and productivity of Tawny Owl pairs may serve as an indicator of an area's richness in terms of long term food supply. The density of Tawny Owls differs across habitats from 3–6 territories per km^2 in closed deciduous forest to 1–2 territories in coniferous forest (e.g. Mikkola 1983, Southern 1970, Redpath 1995). As a pause-travel predator, dependent on suitable perches for hunting, Tawny Owls are furthermore highly dependent on tree cover to be able to hunt successfully. Home range sizes and reproductive success has thus previously been found to correlate strongly with fragmentation of tree vegetation. For instance, home range size of Tawny Owls in England increased from 20–30 ha in continuous woods to more than 200 ha in open farmland (Redpath 1995).

Tawny Owls mainly feed on small rodents (e.g. Southern 1954). Redpath (1995) found a negative relationship between density of small rodents and forest size. In June, when ground cover makes it hard to catch small rodents, the proportion of birds as prey increases (Nilsson 1984).

In this study, I relate the distribution of Tawny Owl territories and their breeding success near Gothenburg, southwestern Sweden, to habitat features and songbird abundance. To investigate the importance of birds as part of diet in the studied area, prey remnants from nest boxes were analysed.

Field work and methods

Study area

The field work was carried out in Delsjöområdet close to Gothenburg in southwestern Sweden (5742N124E). Within 1900 ha, coniferous and deciduous forests are dominating around four lakes (Figure 1). Humans use parts of the area for recreation activities. Agriculture and forestry influence only a small part in the south. In the area for this study nest boxes were erected with a uniform distribution 300–1000 meters apart. Except from nest boxes, Tawny Owls accept a wide range of alternative nest sites (König et al. 1999). Therefore it can be assumed that availability of nest sites was the same for all Tawny Owls in the studied population.

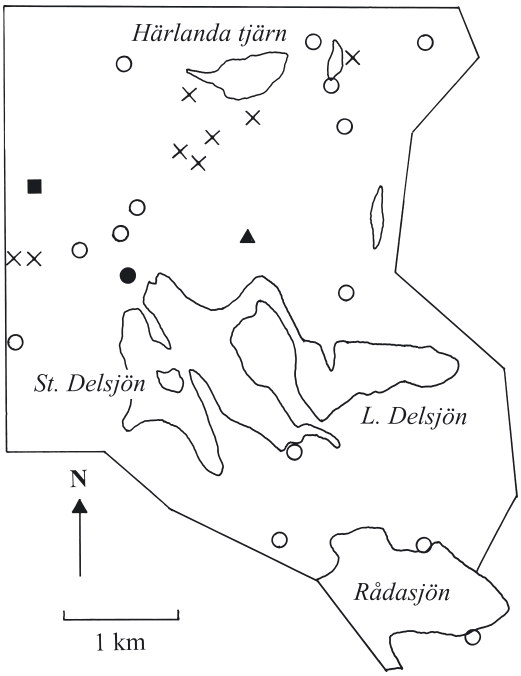

Figure 1. Map of the study area and the distribution of Tawny Owl territories in 1998–2003. Key to symbols: x = single hooting male or non-breeding pair, ❍ = breeding in one year, ● = breeding in two years, ▲ = breeding in three years, ■ = breeding in four years.
Karta over undersökningsområdet och utbredningen av kattugglereviren 1998–2003. Symbolnyckel: x = *ensam hoande hane eller icke häckande par,* ❍ =*häckning under ett år,* ● = *häckning under två år,* ▲ = *häckning under tre år,* ■ = *häckning under fyra år.*

Territory density

Occupied territories were counted using playback recordings (Redpath 1994). The area was covered with points 250–500 meters apart depending on assumptions for listening with regard to habitat and weather conditions. From each location, playback sessions of a strange male's hoot call lasted for 8 minutes. Censuses in this study were performed during clear, calm nights with optimal conditions for listening. This reduced the risk that present Tawny Owls were overlooked. The playback censuses were performed from February to March 2000 and 2001. In this study the earliest date for egg to be laid was mid February (personal observation in 2003). Thus a single hooting mail in February was taken as a minimum criterion for an established territory. All positions of hooting males, females and breeding pairs from 1998–2003 were located using a 1:10000 map. A density index for each Tawny Owl territory was calculated from the actual territory and its four closest neighbours. For measuring the area size, a polygon encircling the five territories was drawn. Number of territories divided by the polygon area gave an index for each territory (territories/km^2).

Habitat variables measured

The plant communities were investigated an area of 30 ha in each of 18 Tawny Owl territories, with the nest site in the centre, and in 10 areas of the same size where no breeding or territory-holding Tawny Owls were found. The areas not occupied were randomly selected from positions of nest boxes where no breeding was detected and no owls responded to the playback sessions. The plant community descriptions were obtained from *Park och naturförvaltningen Göteborgs kommun.* Plant communities were divided into habitat categories.

For the availability of songbirds, point counts were used (Svensson 1997). Within 18 occupied and 17 not occupied areas selected as mentioned above, all birds identified during five minutes were counted from one point in each area. The count was done twice between the end of April and mid May 2002 and once in mid April 2003. The counts began within the first hour of daylight, the time when the activity among songbirds is high, and lasted until 3 p.m. To reduce the effect of declining song activity during the day and to make the counts at different points more comparable, the counts in May were done in the opposite direction. In May the arrival of migratory birds also influenced the number. Since songbird populations does not vary much in numbers between years, the maximum number of birds counted at each site probably best shows the actual number of songbirds in the respective area. Therefore the maximum number was used as an index for the availability of birds.

Analyses of prey remnants

From 6 territories prey remnants from nest boxes were analysed. This study focuses on prey taken during the time when Tawny Owls feed chicks in the nest. In the study area, hatching varies from the second half of March (personal observation in 2003) until mid May (Persson 2000). The chicks stay in the nest for about 30 days (e.g. Southern 1970). Thus the

examined prey remnants belong to prey species taken by the owls from end of March until middle of June 1999–2003.

Prey species were identified from bones in the regurgitated pellets. For small mammals, skulls and mandibles were used, for birds bills, sternum and humerus, and for frogs the ilia. The maximum number was used as an estimate of the number of individuals eaten (e. g. Lundberg 1976).

Statistics

Tests for a difference between two groups, (i) areas occupied and (ii) areas not occupied by Tawny Owls, were made for (a) availability of songbirds and (b) proportion of landscape categories using the non-parametric Mann-Whitney *U*-test for two groups (U).

The following correlations were calculated using the non-parametric Spearman rank correlation coefficient (r_s): (a) Proportion of wooded area for each territory and Tawny Owl density, (b) Songbird availability and Tawny Owl density, and (c) Songbird availability and chick production in Tawny Owl territories.

All tests are two-tailed.

Table 1. Total production of eggs and young for each territory in the study 1998–2003.
Total produktion av ägg och ungar för varje revir i studien 1998–2003.

Territory *Revir*	Eggs *Ägg*	Young *Ungar*
1	?	6
2	1	0
3	?	1
5	8	4
6	3	0
8	4	0
10	13	7
11	4	2
13	2	2
20	3	0
21	4	4
24	3	0
27	?	3
29	?	3
32	3	0
34	2	0
38	4	4
39	5	3

Results

Owl density and breeding success

Twenty-six Tawny Owl territories were found during the years of study. In 18 of them breeding was carried out for at least one year. The definition of breeding in this study is that at least one egg had been laid. In eight of the territories, single hooting males or pairs were noticed without any breeding. For details about the distribution of territories see Figure 1. The density of Tawny Owl varied from 0.5 to 5 territories/km^2. Breeding data were collected from 18 territories in the study area. The production of eggs and young for each territory are given in Table 1.

Habitat and Tawny Owl density

From the analyses of plant communities in the study area, eight habitat categories were separated: *deciduous dominated forest, coniferous dominated forest, wooded swamp, open swamp, lake-shore, agricultural area, lawn* and *built-up area.* The distribution among them is shown in Table 2. A U-test between areas occupied and not occupied by Tawny Owls gave no significance for a difference with regard to proportion of habitat categories. There was a significant positive correlation between density of Tawny Owl territories and proportion of forest cover for each territory (Figure 2).

Songbird abundance, Tawny Owl density and breeding success

Areas occupied by Tawny Owls generally contained a higher number of songbirds than areas not occupied areas (Table 3). The abundance of songbirds in each territory was positively correlated with both the density of Tawny Owl territories (Figure 3) and the number of chicks produced during the study (Figure 4).

Analyses of prey remnants

The total material of identified prey is given in Table 4. From the years 1999 and 2000, the material originates from one nest box each year. From 2001 data were collected from four nest boxes, and in 2003 from two. With regard to biomass, Wood Mouse *Apodemus flavicollis* and *sylvaticus* dominated as a

Table 2. The proportion (%) of habitat categories for each territory and each investigated area not occupied by Tawny Owls.
Andel (%) av habitatkategorier för varje kattugglerevir och varje undersökt område utan kattugglerevir.

With territory *Med revir*	Deciduous dominated *Lövskogs-dominerat*	Coniferous dominated *Barrskogs-dominerat*	Wooded swamp *Skogbevuxen våtmark*	Open swamp *Öppen våtmark*	Agricultural meadow *Jordbruks-landskap*	Lawn *Gräsmatta*	Built-up area *Bostads område*	Lake *Sjö*
1	45	15	5			15	20	
2	45	30					25	
3	50	40	5			5		
5	60	25			10		5	
6b	40	20	2		3	35		
8	55	20			5		20	
10	10	75	15					
11a	50	20	5			5	20	
13	25	30	5		5	15	20	
20	40		25		35			
21	20	20	20		40			
24	15	15	35	20	25			
27		30	20	50				
29	50	20	10			5		15
32	10	60	30					
34	5	75	20					
38	50	40	10					
39	30	45	20					5
Without territory *Utan revir*								
4	25	25	3		2	15	30	
6a	25	20	15		5	30	5	
7a	40	40	10		5		5	
7b	50	20			10	5	5	10
9	20	50	5					25
11b	50	25	15			5	5	
12	55	5				15	25	
16	35	20	20				5	20
23	60	40						
35		55	15					30

Table 3. Difference in songbird availability (number per point) between Tawny Owl territories and investigated areas not occupied by owls.
Skillnad i förekomst av sångfåglar (antal per punkt) mellan kattugglerevir och områden som saknade kattugglor.

	With territories *Med revir*	Without territories *Utan revir*	Significance
Mean +s.e.	12.83 $\pm$0.71	10.3 $\pm$0.75	U=74.5
N	18	17	p=0.05

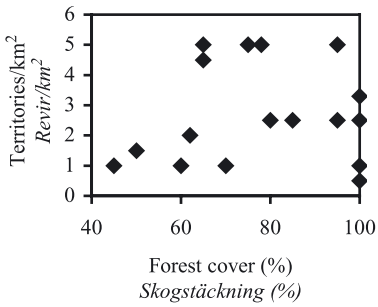

Figure 2. Correlation between Tawny Owl density and proportion of forest cover for each territory (n=17, r_s=0.45, p<0.05).
Förhållandet mellan kattuggletäthet och andel skog i varje revir.

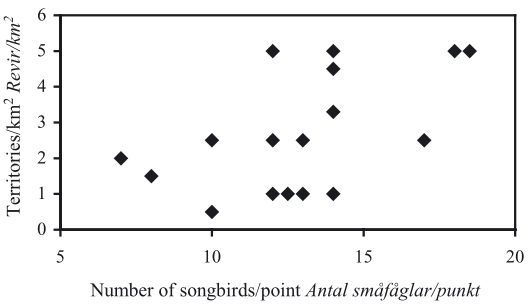

Figure 3. Correlation between Tawny Owl density and number of songbirds per point count for each territory (n=17, r_s=0.56, p<0.02).
Förhållandet mellan kattuggletäthet och antalet sångfåglar/punkt för varje revir (n=17, rs=0,56, p<0,02).

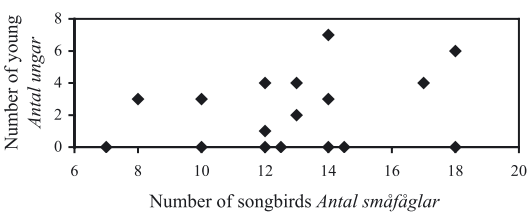

Figure 4. Total number of young produced in Tawny Owl territories during years of study correlated with number of songbirds per point count for each territory (n=17, r_s=0.51, p<0.05).
Totala antalet ungar producerade i kattugglerevir under åren för den här studien i förhållande till antalet sångfåglar per punkträkning i varje revir (n=17, rs=0,51, p<0,05).

prey species in the study area, but birds, Field Vole *Microtus agrestis* and Bank Vole *Chletrionomys glareolus* also made up a substantial part of the diet (Table 4).

Discussion

I found no significant difference between areas occupied and not occupied with regard to habitat categories defined as plant communities. Plant communities in itself may not influence breeding success or density of Tawny Owl. Tawny Owl depends on trees for roosting, nesting and hunting. All owls in this study bred in nest boxes. Availability of trees for roosting and hunting may not depend on forest type or plant species. Availability of prey, which has not been measured in this study, probably is the most important variable influencing breeding success and density in the Tawny Owl. Since the Tawny Owl is a generalist predator with a wide range of prey species (e.g. Southern 1954), most plant communities would contain food for Tawny Owls. Earlier studies have, like this study, shown a positive correlation between proportion of forest cover and Tawny Owl breeding density (e.g. Sanchez-Zapata & Calvo 1999, Repath 1995). Redpath´s (1995) negative correlation between forest size and number of small rodents indicates that availability of prey is not the explanation for the relation between owl density and proportion of forest cover. If the proportion of forest increases it can be assumed that the availability of trees for nesting, roosting and hunting also increases. This may be the most probable explanation for the correlation.

The positive correlation between both density and breeding success in Tawny Owl and number of songbirds and the significant difference between areas occupied and not occupied with respect to songbirds indicate that the abundance of passerine birds may be used as an indicator of suitability and productivity of Tawny Owl habitats. Birds form, after small rodents, the second most important prey for Tawny Owls during the breeding season in this study. Since birds as part of prey increase in June the number of songbirds in each territory probably positively influences the survival of fledged young. In a study of Tengmalm´s Owl *Aegolius funereus*, food conditions during the post-fledging and independence periods seemed to be crucial for the survival of the young (Korpimäki & Lagerström 1988).

Probably forest productivity not only influences songbird abundance but also the availability of small rodents which is the main food for Tawny Owls (e.g.

Table 4. Prey identified from Tawny Owl nests in Delsjöområdet, Gothenbourg, during 1999– 2003.
Identifierade byten från kattugglebon i Delsjöområdet, Göteborg, åren 1999–2003.

Species *Art*	Unit weight *Enhetsvikt*	Frequency *Frekvens*		Total biomass *Total biomassa*	
	g	No *Antal*	%	g	%
Bank Vole *Chletrionomys glareolus* *Skogssork*	25	56	14	1400	13
Water Vole *Arvicola terrestris* *Vattensork*	100	8	2	800	7
Field Vole *Microtus agrestis* *Åkersork*	30	58	15	1740	16
Wood Mouse *Apodemus sylvaticus/flavicollis* *Mindre/Större skogsmus*	20	151	38	3020	28
House Mouse *Mus musculus* *Husmus*	20	1	0.3	20	0.2
Brown Rat *Rattus norvegicus* *Brunråtta*	150	5	1	750	7
Common Shrew *Sorex araneus* *Vanlig näbbmus*	10	25	6	250	2
Pygmy Shrew *Sorex minutus* *Dvärgnäbbmus*	5	19	5	95	1
Water shrew *Neomys fodiens* *Vattennäbbmus*	15	1	0.3	15	0.1
Unidentified vole *Obestämd sork*	25	15	4	375	3
Amphibians *Groddjur*	20	32	8	640	6
Birds a* *Fåglar a**	15	7	2	105	1
Birds b* *Fåglar b**	75	18	5	1350	12
Birds c* *Fåglar c**	175	2	1	350	3
Total *Summa*		398	100	10910	100

* Birds a = size ca Redstart (15g); Birds b = size ca trush (75g); Birds c = size ca Wood Pigeon (175 g). *Fåglar a = storlek ca rödstjärt (15 g); Fåglar b = storlek ca trast (75 g); Fåglar c = storlek ca ringduva (175 g).*

Southern 1954). Finding a correlation between the availability of songbirds and rodents would be necessary before any conclusions could be drawn of songbirds as a predictor of Tawny Owl habitat quality.

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Sammanfattning

Habitatkvalitet, häckningsframgång och täthet hos kattuggla

Kattugglan *Strix aluco* är en resident bytesgeneralist, beroende av träd för boplats och jakt. Förekomsten av kattugglor varierar mellan olika habitatkategorier med högst täthet i sluten lövskog. I den här studien relateras kattugglans täthet och häckningsframgång till habitatval och förekomst av sångfåglar. På en yta av 1900 ha i närheten av Göteborg sattes kattuggleholkar ut på ett avstånd av 300–1000 meter från varandra.

Kattugglerevir inventerades genom uppspelning av en främmande hanes läte. Positioner för responderande ugglor samt konstaterade häckningar markerades på en karta (Figur 1). För bestämning av habitatkategorier användes en vegetationsbeskrivning över området framtagen av Park och naturförvaltningen, Göteborgs kommun.

Antalet ägg och ungar producerade i varje revir under åren för studien användes som ett mått på häckningsframgången (Tabell 1). Efter häckning analyserades bytesrester från boplatser i syfte att utröna vikten av fåglar i kattugglans diet.

Det var ingen signifikant skillnad mellan habitatkategorier i kattugglereviren jämfört med områden utan kattugglor. Mellan andelen skog i reviren och tätheten av kattugglor fanns en signifikant positiv korrelation (Figur 2).

Förekomsten av sångfåglar var signifikant högre i kattugglereviren jämfört med de områden där kattugglor saknades (Tabell 3). Kattugglans täthet och häckningsframgång korrelerade positivt med förekomsten av sångfåglar i reviren (Figur 3 och 4). Analysen av bytesmaterial visade att fåglar utgör knappt 20% av den totala bytesmängd under häckningssäsongen i studieområdet (Tabell 4).

Skillnaden mellan områden med respektive utan kattugglor avseende förekomst av sångfåglar och den positiva korrelationen mellan dem och kattugglans täthet och häckningsframgång ger en indikation om att tättingar kan fungera som en indikator för bra kattugglebiotoper.