Foraging substrate preferences of birds in a primeval mixed forest in the Western Carpathians: implications for management

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Theoretical background

**Optimal foraging theory:** birds are adapted by the processes of natural selection to optimize feeding strategies (energy intake) to maximize fitness.

**Foraging niche partitioning:** competition theory predicts that species should partition resources to coexist in environments with limited resources.

**Ecomorphological adaptations:** each species is morphologically adapted to utilize its foraging niche e.g. bill shape and size, limb morphology, body shape, etc.

**Search behaviour and attack strategies** are determined by ecomorphological adaptations so that each species can effectively utilize foraging substrates on which it is adapted.
Objectives & aims

1. What are resource partitioning patterns of birds in a primeval beech-fir forest?

2. What are the species specific foraging substrate preferences (e.g. plant species and tree morphological parts) of birds?

3. What are the interannual resource utilization patterns of birds in a guild of bark gleaners (Eurasian Nuthatch and Eurasian Treecreeper)?

4. How can resource partitioning and utilization patterns can be used for forestry management?
GEOGRAPHIC LOCATION OF THE STUDY SITE
GEOGRAPHIC LOCATION OF THE STUDY SITE

Malá Fatra National Park

1 : 150 000
Interior of Šrámková NNR: April and June aspect
Study site and vegetation sampling

1. Šrámková National Nature Reserve
   - the Malá Fatra Mts., north-western Slovakia, the Bystrička Valley
   - reserve established in 1967, area 243.65 ha,
   - primeval beech-fir Western Carpathian mountain forest
   - dominated by beech, fir, spruce and sycamore
   - 27.5 (500 × 550 m) plot with rectangular grid system, 850-1078 m a.s.l.

2. Vegetation survey
   - 11.3 radius circular plot method proposed for studies of bird-habitat relationship
   - 24 circular plot samples taken between August and mid-September in 1998-99
   - sampling protocol follows James and Shugart (1970) and Noon (1981)
   - circular plots were evenly spaced in a rectangular grid system 50 × 50 m
   - tree density and dominance, height, canopy cover, bush cover, bush height, vertical cover, herb layer cover and height, etc.
1. Sampling of bird foraging patterns
   - random (haphazard) point sampling of observed birds
   - classification of foraging behaviour according to scheme of Remsen & Robinson (1990), Studies in Avian Biology 13.
   - standardized field paper sheets: totally 39 estimated variables
   - type of variables: sex (1 variable), time (1), foraging height (3), direction of movement (2), foraging substrates (16), foraging strategies (4) in combination with morphological parts of plants (trunk, branch, twig, leaf)

2. Numerical analyses
   - 4214 foraging observations of 41 species
   - 30 observations as a minimum sample size requirement for further analyses
   - Guild structure: bootstrapped cluster analyses (UPGMA)
   - Foraging substrate preferences and patterns: Fisher’s exact test and Chi-square tests
Guild structure: a posteriori approach

Foraging substrates, heights and strategies

Foraging substrates and heights
Tree species preferences in foliage gleaning guild

1. Group of coniferous specialists
   - Goldcrest *Regulus regulus*: 66.7% fir, 29.0 spruce ($\chi^2 = 51.6$, d.f. = 1, $P < 0.001$)
   - Crested Tit *Lophophanes cristatus*: 70% spruce, 27% fir
   - Coal Tit *Pariparus ater*: 40.5% fir, 31% spruce and avoided beech ($\chi^2 = 30.8$, d.f. = 1, $P < 0.001$)

2. Group of broadleaved specialists
   - Wood Warbler *Phylloscopus sibilatrix*: 62.8% beech ($\chi^2 = 6.6$, d.f. = 1, $P < 0.01$, Yates correction)
   - Willow Warbler *Phylloscopus trochilus*: 40.0% sycamore ($\chi^2 = 278.6$, d.f. = 1, $P < 0.001$) and avoided beech and fir
Tree species preferences in foliage gleaning guild

3. Group of generalists (opportunistic foragers)
   - Chaffinch *Fringilla coelebs*
   - Marsh Tit *Poecile palustris*
   - Blackcap *Sylvia atricapilla*
   - Showed nonsignificant preference patterns to all species of dominant trees
Foraging substrate preferences in the flycatching guild

**Specialists**

**Generalists**

% utilization of airspace foraging substrate

- Delichon urbica
- Muscicapa striata
- Ficedula albicollis
- Ficedula parva
- Erithacus rubecula

Legend:
- FS
- AA
- PA
- AP
- Usp
- Ssp
- CA
- Ine
- SuchStrom
- PadStrom
- Hrab
- HolZem
- BylEtaz
- Skaly
- Vzduch
Table 1. Pairwise comparisons between proportional utilization of foraging on tree species and composition of tree layer. The results of Fisher’s exact test and Z-values of normal approximations are given. (* P < 0.05, ** P < 0.02, ***P < 0.01, NS – nonsignificant).
Fig. 3. Tree species preference index for Treecreeper *Certhia familiaris* (open bar) and Nuthatch *Sitta europaea* (hatched bars). The negative values indicate avoidance while positive values indicate preference for a given tree species.

Table 2. Use (%; pooled data) of tree species and substrates by Nuthatch and Treecreeper in an old-growth beech-fir forest in the Šrámková National Nature Reserve. Tree dominance represents study site tree species composition.
Inter-annual changes in resource use in bark gleaning guild

Fig. 4. Inter-annual changes in the use of coniferous (A) and deciduous trees and snags (B), as foraging substrates by Nuthatch and Treecreeper in the primaeval beech-fir forest in the Šrámková National Nature Reserve.

Legend:

Nuthatch *Sitta europaea* – ■ ● ▲
Treecreeper *Certhia familiaris* – □ ○ △
Summary and conclusions

- Species showed specific tree species and substrate preference patterns indicating complex interactions.
- Six foliage gleaning, flycatching and bark foraging species showed strong foraging preference for sycamore *Acer pseudoplatanus*.
- Bark gleaners were associated with feeding on snags.
- Sustainable mountain forest management for biodiversity aims especially in protected areas should lead to preservation of original species structures or at least require to grow trees attractive as foraging substrates for birds such as sycamore in reasonable dominance and leave higher number of snags.
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