

FACTORS INFLUENCING NEST MATERIAL SELECTION IN MARSH HARRIER (*CIRCUS AERUGINOSUS*)

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Abstract. Marsh Harrier used at least 30 plant species from natural and cultural landscapes and habitats for nest building on Lakes Meteliai, Obelija and Žaltytis (southern Lithuania). Helophytes dominated among plant species, particularly reeds, though the share of terrestrial plants (especially of robust agrolandscape plants) sometimes was very significant. The abundance and transportation distance of nest material most often determined the proportion of specific plant groups in a nest. The latter factor was modified by the peculiarities of nest material selection and handling, as well as by suitability of nest material to meet nest stability requirements. The peculiarities of nest material selection are interpreted as the endeavour to minimise energetic costs, at the same time ensuring the resistance of nest construction. Research results are presented as the description of a specific case of the species' breeding strategy.

Key words: Marsh Harrier, nest material selection, nest construction, energy costs

INTRODUCTION

Studies dedicated to Marsh Harrier (*Circus aeruginosus*) ecology only fragmentally have presented the data on nest composition of this species so far (Witkowski 1989; Pranaitis & Baublys 1991). The related information not only can not catch up with the data of such ecological-faunal summaries as, e.g., 'Birds of Europe, the Middle East and North Africa' (Cramp & Simmons 1997) or 'Fauna of Lithuania' (Logminas 1990), but sometimes appears to be even less valuable in comparison with the latter sources (Drobelis 2004). This serves as evidence that nests building questions still remain a side-issue in investigations concerned with Marsh Harrier biology and ecology.

However, nest building in birds frequently involves a lot of time and efforts. The costs of material transporting and handling suggest that nest building is energetically expensive activity (Putnam 1949). It has been confirmed (but little attention paid) that birds use methods reducing energetic costs necessary for nest building (Mountjoy & Robertson 1988; Nores & Nores 1994). This additionally implies that nest building behaviour and nest structure are constantly under some selective pressure. Consequently, studies on nest building behaviour can provide interesting clues to evolutionary history and ecology of the species (Collias 1986).

In the present paper we attempted to elucidate if nest material selection in Marsh Harrier can be mediated by a trade-off between ultimate requirements for nest con-

struction and availability, transportation distance, and handling properties of nest material. In relation to this we aimed to:

- 1) document the measurements of Marsh Harrier nests, nest material composition and its landscape-habitat origin;
- 2) test if the proportion of helophyte species in nest composition correlates with their share (i) at the nest-site and (ii) in the entire nest-patch;
- 3) determine if nest composition is associated with the type of the terrestrial landscape neighbouring the nest;
- 4) clarify the circumstances and reasons for substitution of one kind of nest material with some other kind.

MATERIAL AND METHODS

Study area

Research was conducted in 1983–1986 on Lakes Meteliai (54°18'N, 23°47'E), Obelija (54°18'N, 23°50'E) and Žaltytis (54°25'N, 23°24'E). Lakes Meteliai and Obelija are situated at a 1.1 km distance from each other, while Lake Žaltytis is located 20–23 km further. All the lakes are large water bodies in southern Lithuania, with the area and the coast line of 1,288 ha and 18.8 km, 575 ha and 11.1 km, 260 ha and 10 km; the length and the average width – 6.8 km and 1.9 km, 4.4 km and 1.2 km, and 4.2 km and 0.8 km; the average depth – 6.8 m and 4.4 m, 1.7 m, respectively. The description of study areas and the characteristics of the species' potential

breeding habitats have been presented in a number of earlier publications (Stanevičius 1992, 2002, 2004). In addition to direct assessment and measurements performed under field conditions, 1:5000-scale aerophotos of vegetation of Lakes Meteliai, Obelija and Žaltytis and the nearby territories made in April 1985 were used. Types of nest material were recorded and the percentage of each building material type (groups of landscape plants) was established for 36 nests located on Lakes Meteliai, Obelija and Žaltytis in 1983–1986. Three nests for unknown reasons substantially differed in their measurements from other nests. The eggs in such nests were laid on a thin vegetable layer (2–7 cm). Therefore, nests of this kind were not included into statistical averages of nest measurements as ‘extreme outliers’.

Nest material composition was determined by visually estimating the percentage of separate components in the total nest volume. This allowed a quantitative description of nest material composition without destroying the nest.

Potential resources of nest building material (plant species or their groups) in the environment were assessed according to two spatial levels: the potential breeding habitat (lake helophyte zone) and the neighbouring terrestrial landscape. Potential nest material in the breeding habitat was characterised quantitatively also on the basis of two spatial levels. At the nest-site level, percentage proportions of separate helophyte species were visually determined in the space within a 2.5 m-radius around the nest. At the nest-patch level, the percentage proportions of particular helophyte species were visually estimated under field conditions. A fragment of emergent vegetation, separated from other such fragments, was considered as a patch. The term ‘nest-patch’ means a patch holding a nest. The size of an average patch ranged between 0.90 ha on Lake Obelija to 3.83 ha on Lake Meteliai (Stanevičius 2004). Therefore, the proportion of plant species in the nest-patch is an approximate indicator in comparison with the corresponding proportion at the nest-site. Nevertheless we assume that the former indicator is relevant for characterising building material resources found in a larger space than those proximate to the nest-site.

Potential building material resources in terrestrial habitats were assessed indirectly, i.e., identifying the types of terrestrial areas neighbouring the nest-sites. The latest habitat classification of the publication ‘Interpretation Manual of European Union Habitats (Natura 2000)’ was not used as a reference. Diversity and peculiarity of the natural environment did not fit into the framework of the above classification, consequently following it would have prevented from obtaining necessary information that could help our research. Therefore, a more convenient, original and informative nest environ-

ment classification (in other words, the environment of nest material selection) into arbitrary categories – ‘territories’ – was used for the investigation.

The territories were distinguished according to their naturalness or the character of their land use, hydrological regime and dominating vegetation observed under field conditions. They varied according to basic landscape and habitat differences and were easily identified under field conditions. A particular territory was regarded as ‘neighbouring’ or ‘adjacent’ if it directly bordered the lakeside belt – fragment holding a nest. In all cases the neighbouring territory stretched along the lake shore at least 0.5 km on both sides of the nest. Further follow the descriptions of nest location in respect to such territories and their characteristics:

Forest territory. A large forest area separates the nest from other territories. By Lake Meteliai, it is a mixed forest (wet closer to the lake). Spruce predominates among conifers, birch and black alder – among deciduous trees. By Lake Žaltytis, it is a damp deciduous forest (birch, black alder) with an occasional admixture of pine.

Reed fen territory. The nest is built in the lake shore belt, close to a more or less flooded reed fen (in most places with sedges in the lower layer). The latter is also represented by sparse willow bushes, alder and birch, or their groups.

Sedge fen and meadow territory. The nest is built in the lake shore belt, where immediately behind a narrow belt of sparse alder, lies a large area of sedge fens and/or natural lake shore meadows. These two habitats often intermix. They are tide-inundated in wet springs. Isolated willow bushes occur in this territory. In many places cattle pasturing is common, but hay-making is rare.

Agrolandscape territory. The nest is located in the lake shore belt. The agricultural area stretches close to a narrow lakeside belt of sparse alder and birch. It is represented by the entire mosaic of farming lands (cultural meadows, winter crop areas, last year’s stubble, arable land).

It should be emphasised that nests were always built in the helophytic overgrowth of the lake, irrespective of the type of terrestrial territory neighbouring them. Thus, the ‘zone of lake helophytes’ was the only territory within lake boundaries and the nearest environment for each nest. It contained the nearest potential nest material resources. In terms of species composition, it was a homogeneous environment, because only narrow-leaved cattails (*Typha latifolia*) and reeds (*Phragmites australis*) represented emergent plants.

All plants found in nests were considered as potential nest materials present in the environment. Plants were roughly classified (Appendix 1) on the basis of general knowledge about species distribution in different land-

scapes and habitats. Information was collected while reconnoitering the study site. Also, Vilkonis (2001) was taken as a reference.

A simple linear least-square regression was used to explain the variation in the proportion of helophyte species in nest building material. The percentage proportion of helophyte species in nest material was always used as a dependent variable and the percentage proportion of helophyte species in nest-site and nest-patch emergent vegetation – as the independent one. Before the regression analysis, both dependent and independent variables were arcsine-transformed. The Kruskal-Wallis Anova and Median test was used to verify if the proportion of plant groups in nest material representing different territories was associated with the type of a neighbouring territory. The Spearman rank correlation test was employed for the analysis of proportional interdependence between different sorts of nesting material in the nest. The statistical analysis was performed using the software package Statistica (StatSoft, Inc. 1999).

RESULTS

Nest measurements and material

Marsh Harrier nests rose above water up to 68–93 cm (most often up to 35–40 cm). Sometimes, the span between the nest bottom and water reached 20 cm, i.e., the nest was suspended among plant stems (Table 1). In such cases, the actual nest height was smaller compared to the nest height above water. Very rarely nests with complete clutches were low – from 2 to 6 cm. The outer nest diameter was a more stable variable than height. It ranged from 40 to 75 cm, but usually from 45 to 55 cm. Marsh Harrier nests comprised 23 plant species or their groups (Appendix 1). As certain plants were identified only to the genus level (e.g., a few different sedge (*Carex* sp.) species were reduced to the same denomination), no fewer than 30 plant species were on the actual

list. Helophytes were mainly represented by three species: reed, cattail and bulrush (*Schoenoplectus lacustris*), but the latter was very rare. Sedge and less often loosestrife (*Lythrum salicaria*) were most common among marsh or wetland plants. Marsh parsley (*Peucedanum palustre*) and great hairy (*Epilobium hirsutum*) were less common, woody nightshade (*Solanum dulcamara*) and other plants occurred only randomly.

Centaury (*Centaurea* spp.), less often marsh thistle (*Cirsium palustre*), gramineous plants, common chickory (*Cichorium intybus*) represented meadow plants.

Plants of the agrolandscape or otherwise transformed natural territories were represented by thistle (*Carduus* sp.), burdock (*Arctium* sp.), creeping thistle (*Cirsium arvense*), common nettle (*Urtica dioica*), more seldomly sagebrush (*Artemisia vulgaris*) and rye (*Secale cereale*), stems of which were found in separate nests.

Wooded plants were represented by alder (*Alnus glutinosa*) and birch (*Betula* sp.), less often by willow (*Salix* sp.) twigs.

The assessment of nest material in terms of territorial

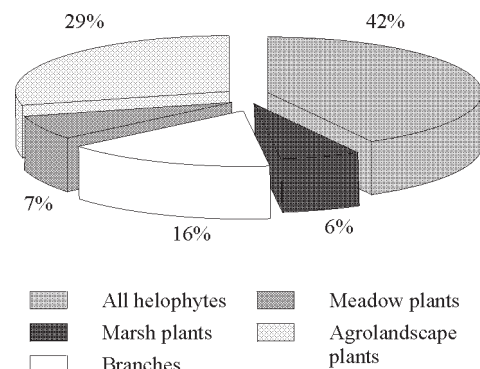


Figure 1. Share (in %) of plant species and their groups from different territories in 36 Marsh Harrier nests.

Table 1. Marsh Harrier nest measurements (in cm) on Lakes Meteliai, Obelija and Žaltytis.

| | Nest height above water | Actual nest height | Outer diameter of the nest |
|-------------------|-------------------------|--------------------|----------------------------|
| Meteliai (n = 12) | | | |
| Mean ± SD | 40 ± 16 | 35 ± 9 | 60 ± 6 |
| Range | 19–68 | 19–48 | 45–68 |
| Obelija (n = 14) | | | |
| Mean ± SD | 37 ± 25 | 33 ± 25 | 56 ± 10 |
| Range | 2–93 | 2–93 | 42–75 |
| Žaltytis (n = 7) | | | |
| Mean ± SD | 34 ± 18 | 31 ± 17 | 55 ± 10 |
| Range | 16–66 | 16–66 | 40–68 |

origin of plants suggested that helophytes accounted for the largest share (nearly one half) in the total volume of nest material on Lakes Meteliai, Žaltytis and Obelija. Plants of cultural landscapes were less often used as nest material. Wooded plants were in the third place, meadow and marsh plants made up the smallest share (Fig. 1).

Transportation distance and use of building material

The preference in birds between nest material available at a nest-site and that found in the entire nest-patch was tested. The linear least-square regression revealed a significantly positive relationship of the reed proportion found in nest material helophytes with that in nest-site vegetation and a significantly negative relationship with the cattail proportion in nest-site vegetation. No significant relationship was found between the reed proportion found in nest material helophytes and reed and cattail proportions in nest-patch vegetation. Both reed and cattail proportions at the nest-site explained nearly

one third of variance in the reed proportion found in nest material helophytes (Table 2a). No significant relationship was revealed between the reed proportion in all nest material and any of the four independent variables (Table 2b).

The proportion of cattail in nest material helophytes negatively correlated with the reed proportion and positively with cattail proportion in the nest-site plant community (Table 3a). Nevertheless, in both cases these independent variables explained only 15% of the variance in the dependent variable. The relationship between the proportion of cattail in nest material helophytes and other independent variables – reed and cattail proportions in the nest-patch – was statistically insignificant (Table 3a).

The proportion of cattail in total nest material had a statistically significant negative relationship with the reed proportion both in nest-site and nest-patch vegetation, and statistically significant positive relationship

Table 2. The relationship between proportion of reed in the nest and proportion of particular species of helophytes in nest surrounding vegetation: (a) proportion of reed in nest helophytes only; (b) proportion of reed in all nest material.

| (a) Independent variables | Slope | SE | Intercept | SE | r ² | F _{1,31} | p |
|--------------------------------------|--------|-------|-----------|--------|----------------|-------------------|---------|
| Reed proportion in the nest-patch | 0.350 | 0.191 | 52.175 | 12.497 | 0.311 | 3.340 | 0.077 |
| Reed proportion at the nest-site | 0.425 | 0.113 | 4.887 | 7.909 | 0.311 | 14.027 | 0.0007* |
| Cattail proportion in the nest-patch | -0.348 | 0.191 | 93.634 | 7.241 | 0.096 | 3.316 | 0.078 |
| Cattail proportion at the nest-site | -0.425 | 0.113 | 86.180 | 5.254 | 0.311 | 14.029 | 0.0007* |
| (b) Independent variables | Slope | SE | Intercept | SE | r ² | F _{1,31} | p |
| Reed proportion in the nest-patch | -0.010 | 0.148 | 33.546 | 9.718 | 0.0001 | 0.004 | 0.947 |
| Reed proportion at the nest-site | 0.084 | 0.100 | 27.84 | 6.963 | 0.022 | 0.720 | 0.402 |
| Cattail proportion in the nest-patch | 0.011 | 0.148 | 36.620 | 5.629 | 0.0001 | 0.005 | 0.941 |
| Cattail proportion at the nest-site | -0.085 | 0.099 | 35.497 | 4.625 | 0.022 | 0.727 | 0.400 |

* – significant relationship

Table 3. The relationship between proportion of cattail in the nest and proportion of particular species of helophytes in nest surrounding vegetation: (a) proportion of cattail in nest helophytes only; (b) proportion of cattail in all nest material.

| (a) Independent variable | Slope | SE | Intercept | SE | r ² | F _{1,31} | p |
|--------------------------------------|--------|-------|-----------|--------|----------------|-------------------|---------|
| Reed proportion in the nest-patch | -0.263 | 0.140 | 29.380 | 12.035 | 0.061 | 2.036 | 0.163 |
| Reed proportion at the nest-site | -0.280 | 0.119 | 30.223 | 8.294 | 0.151 | 5.529 | 0.025* |
| Cattail proportion in the nest-patch | 0.261 | 0.184 | 5.726 | 6.973 | 0.061 | 2.020 | 0.165 |
| Cattail proportion at the nest-site | 0.280 | 0.118 | 4.990 | 5.509 | 0.151 | 5.462 | 0.025* |
| (b) Independent variable | Slope | SE | Intercept | SE | r ² | F _{1,31} | p |
| Reed proportion in the nest-patch | -0.290 | 0.132 | 27.220 | 8.612 | 0.134 | 4.827 | 0.035* |
| Reed proportion at the nest-site | -0.334 | 0.075 | 29.702 | 5.247 | 0.388 | 19.696 | 0.0001* |
| Cattail proportion in the nest-patch | 0.291 | 0.131 | 1.087 | 4.985 | 0.130 | 4.880 | 0.034* |
| Cattail proportion at the nest-site | 0.334 | 0.075 | -0.408 | 3.486 | 0.388 | 19.669 | 0.0001* |

* – significant relationship

with the cattail proportion both in nest-site and nest-patch vegetation (Table 3b). Nevertheless, independent variables characterising a nest-site explained nearly 40% of variance in the dependent variable, whereas identifying a nest-patch – only 13% (Table 3b).

The preference in birds for plants from terrestrial territories (of landscapes, habitats) located closest to the nest-site was also verified. Usually the share of plants from exactly the nearest territory markedly increased: the proportion of helophytes increased mostly in the nests located in the territories rich in helophytes, proportion of marsh plants – in the nests built near large fens, whereas that of twigs – in the nests neighbouring forests (Table 4). The only exception was meadow plants which were more abundant in the nests built in the vicinity of the agrolandscape than in those close to meadows. The Kruskal-Wallis test confirmed that proportions of helophytes ($\chi^2 = 14.74$; $df = 3$; $p < 0.001$), marsh plants ($\chi^2 = 10.11$; $df = 3$; $p < 0.05$) and agrolandscape plants ($\chi^2 = 8.11$; $df = 3$; $p < 0.05$) found in the nests located in the neighbourhood of different territories were statistically significantly different. With regard to tree twigs, a statistically insignificant difference appeared most likely due to methodological difficulties in territory classification: trees and bushes represent not only forests, but also lakeside territories.

Helophytes most often dominated in nest material irrespective of what territory surrounded the nest. Their

domination was particularly marked in the nests located in nearly purely helophytic overgrowth (over 80% of total nest material) and in the ones built near forest landscapes (over 70% of total nest material; Table 4). The nests located in the neighbourhood of the agrolandscape made the only exception, where agrolandscape plants predominated over helophytes.

Preference and substitutions in nest material selection

The tendency of reed predomination over cattail prevailed regardless of the type of vegetation surrounding the nest: helophytes were largely represented ‘by reeds alone’ and never by ‘cattails alone’ in the nests found in pure reed stands, whereas in the nests located in pure cattail stands helophytes were represented not exclusively by cattail (as one might expect if birds selected ‘close at hand’ nest material), but entirely by reeds. Also, ‘only reeds’ and never ‘cattails alone’ represented helophytes in almost half of nests built in mixed reed-cattail beds (Table 5). It was tested if such ‘more preferable’ nest building material (reed) in principle can be replaced with some other – ‘less preferable’ material (cattail). If the answer is positive, the proportions of the above two plant species in nest material would be negatively related. The Spearman rank correlation revealed such negative relationship between percentage of reed and cattail in nest material (Table 6; $r = -0.45$, $p < 0.05$).

A strong negative correlation ($r = -0.72$, $p < 0.05$) was found between helophytes and agrolandscape plants

Table 4. Percentage (mean \pm SD) of plant groups in the building material of the nest located in the neighbourhood of different landscapes.

| Neighbouring territories (number of nests) | Plant groups in nest building material | | | | | Total |
|--|--|------------------|-------------------|------------------|----------------------|--------|
| | Helophytes | Marsh plants | Woody branches | Meadow plants | Agrolandscape plants | |
| Reed fen (5) | 80.60 \pm 20.29 | 0.00 \pm 0.00 | 13.00 \pm 14.71 | 1.00 \pm 1.41 | 5.20 \pm 8.44 | 100.00 |
| Sedge fen and lakeshore meadow (5) | 35.50 \pm 17.54 | 29.50 \pm 8.81 | 18.75 \pm 6.29 | 6.20 \pm 9.46 | 8.75 \pm 17.50 | 100.00 |
| Forest (5) | 73.33 \pm 15.27 | 0.00 \pm 0.00 | 23.33 \pm 11.54 | 3.33 \pm 5.77 | 0.00 \pm 0.00 | 100.00 |
| Agrolandscape (21) | 30.81 \pm 21.98 | 3.48 \pm 13.03 | 15.05 \pm 15.61 | 9.10 \pm 21.12 | 40.24 \pm 31.34 | 100.00 |

Table 5. Presence or absence of reed and cattail in nest material helophytes and in nest-site vegetation.

| Helophyte species in nest material | Helophyte species in nest-site vegetation | | |
|------------------------------------|---|--------------|-------|
| | Pure reed | Pure cattail | Mixed |
| Only reed | 15 | 2 | 4 |
| Only cattail | 0 | 1 | 0 |
| Mixed | 3 | 5 | 6 |
| Total nests: | 18 | 8 | 10 |

Table 6. Matrix showing the Spearman rank correlation between the proportion of different kinds of building material in 36 Marsh Harrier nests.

| | | | | | | | |
|-------------------------|--------|-------|--------|-------|--------|------|---|
| 1. Reed | - | | | | | | |
| 2. Cattail | -0.45* | - | | | | | |
| 3. All helophytes | 0.64* | 0.17 | - | | | | |
| 4. Marsh plants** | -0.16 | 0.00 | -0.18 | - | | | |
| 5. Twigs | 0.21 | -0.13 | 0.21 | -0.16 | - | | |
| 6. Meadow plants | -0.29 | -0.19 | -0.40* | -0.02 | -0.13 | - | |
| 7. Agrolandscape plants | -0.40* | -0.18 | -0.72* | 0.00 | -0.61* | 0.30 | - |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

* – r – values significant at $p < 0.05$ level; ** – other than helophytes

and twigs ($r = -0.61$, $p < 0.05$) in nest material, respectively. A statistically significant negative relationship was revealed between proportions of helophytes and meadow plants ($r = -0.40$, $p < 0.05$). Marsh plants revealed a significant correlation with none of plant groups.

DISCUSSION

Literature data suggest that the greatest majority of Marsh Harrier nests in the species' habitats are built on lakes or in marshes, among the stems of helophytes (Cramp & Simmons 1997; Hagemeyer & Blair 1997; Glutz *et al.* 1971). Nest building in other places than wetlands, though is well-known, is most often an exception to the general rule. The major nest building material of Marsh Harrier is helophytes, sedge, and twigs of trees and bushes. All this is in line with our research results. The reported nest measurements are also similar to those of our research. Hence, our sample cannot be assessed as one that represents nest building peculiarities typical of only one small local population. Data dealing with nest measurements and material composition were used while we attempted to find answers to the questions raised in this study. Therefore, we assume that our research results can be interpreted in the context of general ecological peculiarities of the species.

A nest can be defined as a structure that aids the development of eggs and survival of the young (Collias 1964). A Marsh Harrier nest is a big construction (Table 1). Nests of particularly large measurements are built in flooded places (Cramp & Simmons 1997, Pranaitis & Baublys 1991). All the nests studied were built in well-watered places (Stanevičius 2004). Nest construction should be strong enough to support the weight of big birds and their mobile nestlings, and to resist the activity of hydrodynamic processes. Therefore, construction

material should possess specific features that would ensure nest stability. The study area was distinguished by a great diversity of lake habitats (Stanevičius 1992, 2002, 2004) and neighbouring terrestrial landscapes (Vasiliauskienė *et al.* 1978), therefore birds were free to choose between different kinds of nest materials and transportation distances.

Marsh Harrier for the nest building on Lakes Meteliai, Obelija and Žaltytis used at least 30 plant species growing in natural and transformed landscapes. The comparison of our data on nest material composition with literature data (Ivanauskas 1959; Logminas 1990; Witkowski 1989; Cramp & Simmons 1997) is complicated by a superficial qualitative description in the latter. Data reported by Drobelis (2004) from different parts of Lithuania, though highly averaged, present the sequence of major nest material components according to their occurrence in the nest. Reed being at the top of that succession corresponds to our research results, whereas a low position of agrolandscape plants apparently contradicts our conclusions. Moreover, according to Drobelis, bulrush holds a comparatively high position in the sequence of nest material components, whereas sedge ranks higher in comparison with our results. Findings by A. Pranaitis and G. Baublys (pers. comm.) on Lake Žuvintas also add six new plant species to the nest composition list (Appendix 1). The six new species include: common Scottish pine (*Pinus silvestris*), European alder buckthorn (*Frangula alnus*), European water-hemlock (*Cicuta virosa*), marsh fern (*Thelypteris palustris*), meadow-sweet (*Filipendula ulmaria*), tussock cotton-grass (*Eriophorum vaginatum*). Besides, nests on Lake Žuvintas contain more willow twigs than those located on other lakes studied. Even these few comparisons suggest that the variety of nest material increases when explored in larger territories, because a larger space preconditions a higher environment heterogeneity on the whole (MacArthur & Wilson 1967; Lack 1976; Begon *et*

al. 1986). On the other hand, certain kinds of nest materials, helophytes in particular, are constantly found in great abundance in any wetland nests. Data on variations in nest material, if linked with related information about nest-site selection and nest measurements, can be valuable for the insight into the evolution of nest building behaviour. A greater dependency between the abundance of particular helophyte species in the nest and their occurrence at the nest-site in comparison with that in the nest-patch (Tables 2–3) can be explained by the fact that picking material at the nest-site reduces time and energy costs necessary for nest material procurement (Collias & Collias 1984; Nores & Nores 1994). The increase in proportions of helophytes in nest material most probably appears because birds break these plants during nest platform building (Schipper 1978). The relationship of nest material composition with the type of the neighbouring territory should also be interpreted in the context of shorter transportation distances. The significance of nest material transportation distances, in our opinion, is emphasised by the fact that under the lack of ‘more preferable material’ at the nest-site ‘less preferable material’, though abundant at the nest-site, can become a partial alternative (as in the case with reeds and cattails; Tables 5, 6). However, nest material substitution for some other is not only a mechanical reflection of variation in landscapes and habitats. It turned out that some kinds of nest materials are more likely to be substituted than others (Table 4). The ratio of helophytes and robust agrolandscape plants in nest material demonstrated the most common examples of substitution (Table 6). Though all the nests were surrounded by plentiful helophytes, the decrease in helophytes and increase in agrolandscape plants in nest composition were observed. This may be related to different energy costs required for handling the considered plants. A simple experiment proved that pulling and breaking reeds was a more difficult task than rooting out thistles or burdocks. The latter two were surprisingly weakly rooted in the soft spring soil. Besides, birds could handily pick up agrolandscape plants while sitting on the firm ground. Neither water, nor thickness of stems, the obstacles that birds could face, interfered with selection of helophytes. The fact that agrolandscape plants are located further from nests than helophytes is a drawback. Marsh Harrier (particularly males) usually hunts quite far beyond lake boundaries (Witkowski 1989; Buczek & Keller 1995; Jasionis 1994; our pers. observ.), especially in spring, before the young of water birds are hatched (Ivanaukas 1959). Yet we are not aware if birds can combine hunting with nest material selection, which could at

least partially compensate for energy costs of nest material transportation from more distant places. Still further research is needed to elucidate this possibility. In any case, upon the absence of near-at-hand agrolandscape plants, birds use larger quantities of helophytes and if agrolandscape plants are easily available, birds prefer the latter. The above-discussed dependency cannot be explained by the deficiency of helophytes, because it practically does not exist – nests are always built in the thick of helophytes. A strong negative relationship between robust agrolandscape plants and twigs in the nest can also be interpreted in light of handling properties and cost-benefits ratio. Marsh Harrier was often observed to pick up fallen twigs and branches cut down by man. Nest material selection of this kind requires less effort than plant breaking or uprooting. There is no reason for speculation that branches are less suitable as nest building material than robust agrolandscape plants. Consequently, we can make an assumption that because of less material handling costs birds benefit more from selecting branches in nearby territories, where the latter material can be plentifully found, than from selecting other alternative nest materials.

However, research showed that alteration of landscapes does not always mean that plants of the neighbouring landscape will dominate because of their abundancy and proximity, even if their handling properties are the advantage. For example, marsh plants (most often sedge and loosestrife) are never the basic alternative for any other plant group (Table 6), though they can be easily picked up and handled because of their slim and brittle stems. However, what is an advantage in respect to energetic costs of nest material selection can turn to be a disadvantage with regard to nest construction requirements. The inspection of nest cards demonstrates that meadow plants are mostly represented by short slim-stemmed brittle plants, such as centaury, common chickory, and gramineous plants. Such physical characteristics make these plants unsuitable for building a tall and strong nest platform especially in well-flooded places. The failure to meet the requirements of nest construction explains small proportions of meadow plants in the nests located in the neighbourhood of wetlands and meadows (Table 4) though short transportation distances and good handling properties might imply otherwise. Nevertheless, it seems that it is beneficial for Marsh Harrier to use meadow plants as a partial substitution for helophytes, at least to the extent which does not put at risk the firmness of nest construction. This conclusion is confirmed by a negative relationship between the proportions of these two plant groups in nest material (Table 6).

It takes Marsh Harrier 20 days to build the nest, counting from the mean dates of arrival at the nest-site and the first egg laying (Witkowski 1989). In Lithuania, Marsh Harrier makes its nest in April (Pranaitis & Baublys 1991; Drobelis 2004). April is also filled up with reproduction activities requiring additional energetic resources: nest-site establishment, courtship and mating. A female's energetic costs are further increased by consumption of body resources for egg production. The behaviour of individuals as a rule reflects their balanced efforts to distribute their energetic resources properly (Begon *et al.* 1986). We assume that the results of our research about what factors are important for birds in nest material selection should be assessed in the context of the above efforts. This would support that generally animal breeding behaviour can be understood as a system of trade-offs evolved to maximise the fitness of the organism (Begon *et al.* 1986; Krebs & Davies 1993; Hakkarainen & Korpimäki 1996). At the same time the results of our work can be treated as a special case of trade-off between various energy-consuming reproductive activities in the species breeding strategy.

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**FAKTORIAI ĮTAKOJANTYS NENDRINĖS LINGĖS
(*CIRCUS AERUGINOSUS*) MEDŽIAGOS LIZDUI
PASIRINKIMĄ**

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SANTRAUKA

Kraudamos lizdus Metelio, Obelijos ir Žaltyčio ežeruose (pietų Lietuva), nendrinės lingės naudojo ne mažiau kaip 30 augalų rūšių, augančių įvairiuose landšaftuose ir buveinėse. Pagal apimtį tarp jų dominavo helofitai, visų pirma nendrės, tačiau sausumos augalijos (ypač stambiasiebių agrolandšafto

augalų) dalis kartais būdavo labai ženkli. Statybinės medžiagos gausumas ir transportavimo atstumai dažniausiai apspėsdavo atskirų jos grupių proporciją lizduose. Šio faktoriaus poveikį koregavo skirtingų statybinių medžiagų paėmimo ir apdorojimo ypatybės bei tai, kaip tos medžiagos tenkina lizdo konstrukcijos tvirtumo reikalavimus. Statybinės medžiagos pasirinkimo ypatybės interpretuojamos kaip pastangos minimalizuoti darbo sąnaudas tuo pat metu garantuojant lizdo patvarumą. Tyrimų rezultatai įvardijami kaip rūšies veisimosi strategijos konkretaus atvejo aprašymas.

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Appendix 1. List and territorial origin of plants found in Marsh Harrier nests on Lakes Meteliai (12 nests), Obelija (12 nests) and Žaltytis (10 nests).

| | Meteliai | Obelija | Žaltytis |
|---|----------|---------|----------|
| Littoral helophyte zone | | | |
| Reed (<i>Phragmites australis</i>)* | + | + | + |
| Cattail (<i>Typha latifolia</i>)* | + | + | + |
| Bulrush (<i>Schoenoplectus lacustris</i>)* | + | + | - |
| Helophyte fen | | | |
| Cattail (<i>Typha latifolia</i>)* | + | + | + |
| Reed (<i>Phragmites australis</i>)* | + | + | + |
| Woody nightshade (<i>Solanum dulcamara</i>) | | | |
| Alder (<i>Alnus glutinosa</i>)* | + | + | + |
| Birch (<i>Betula</i> sp.)* | + | + | + |
| Willow (<i>Salix</i> sp.)* | + | | |
| Sedge fen | | | |
| Sedge (<i>Carex</i> spp.) | + | + | + |
| Loosestrife (<i>Lythrum salicaria</i>) | + | | + |
| Marsh parsley (<i>Peucedanum palustre</i>) | + | | + |
| Great hairy (<i>Epilobium hirsutum</i>) | + | | |
| Willow (<i>Salix</i> sp.)* | + | | |
| Lake-shore meadow | | | |
| Gramineous plants (other than sedge)* | + | + | + |
| Willow (<i>Salix</i> sp.)* | + | | |
| Marsh thistle (<i>Cirsium palustre</i>) | + | | + |
| Centaury (<i>Centaurea</i> spp.) | + | + | + |
| Deadnettle (<i>Lamium</i> sp.) | | | + |
| Common chickory (<i>Cichorium intybus</i>) | | | + |
| Dock (<i>Rumex</i> sp.) | + | + | + |
| Agrolandscape | | | |
| Rye (<i>Secale cereale</i>) | | + | + |
| Burdock (<i>Arctium</i> sp.) | + | + | + |
| Sagebrush (<i>Artemisia vulgaris</i>) | | + | + |
| Thistle (<i>Carduus</i> sp.) | + | + | + |
| Common nettle (<i>Urtica dioica</i>) | + | + | |
| Creeping thistle (<i>Cirsium arvense</i>) | + | + | + |
| Gramineous plants (other than sedge)* | + | + | + |
| Forest | | | |
| Alder (<i>Alnus glutinosa</i>)* | + | + | + |
| Birch (<i>Betula pubescens</i>)* | + | + | + |
| Other tree (not birch or alder) species | + | | + |

* – species encountered in more than one landscape were not used for landscape classification