Past and present nest-site requirements of the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) and their possible conflicts with timber harvesting

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Abstract

Recently, the growing demand for raw timber has resulted in the intensification of forest use in the Baltic countries. The aim of this study was to examine whether the increased timber harvesting during the last decade has influenced the requirements of the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) for their nest-sites. In 2004, 7% of checked Lesser Spotted Eagle territories were disturbed by forestry operations. The general tendency was that the characteristics of stands used for nesting differed from the average forest stand characteristics in the landscape less than a decade ago. Eagles were found to nest in 19 different forest types, while previously just 13 of such forest types had been recorded. Less productive forests (2nd site class) and normally irrigated stands were not avoided nowadays. The average age of nest stands decreased by 16 years. Though oak remained one of the most preferred nest-trees (20% of all cases), spruce became the most common one (48%). This leads to the assumption, that the eagles are less selective nowadays than in the past. The increased timber harvesting during the last decade might explain why eagles switched to nest in stands, more similar to the surrounding forest landscape than in the past, and why some nest-site preferences remained and others disappeared. It is likely that during the next 30 years forest operations will be one of the most important factors, having an effect on the Lesser Spotted Eagle population in Lithuania.

Key words: Lesser Spotted Eagle, nest-site selection, timber harvesting, disturbance

Introduction

Recently, the growing demand for raw timber has resulted in the intensification of forest use in the Baltic countries. Timber harvesting in Lithuania has always been relatively uneven, especially during the war and occupation periods. State's policy between the World Wars I and II was to tolerate the expansion of the arable land to replace the forests. Significant increase in country's forest resources took place between the 1950s and 1990s, when harvest volumes were reduced and the required timber was taken from outside (Russia) resources (Kairiūkštis 2003). However, after the re-establishment of the independence, followed by the process of restitution of private forests ownership, forest felling started to grow up (*Lietuvos miškų ūkio statistika* 2003).

Unbalanced forestry usually reduces the availability of some structural elements in forests, thus many species, which require such elements as habitats, have suffered declines, become threatened or extinct (Lõhmus 2003a). It is well known that harvesting of mature forest stands is one of the main factors influencing the abundance and regional distribution of forest birds (Virkkala 1987, Avery and Leslie 1991, Haila *et al.* 1994, Edenius and Elmberg 1996, Jansson 1999). There exists a general consensus that many boreal and temperate forest raptors have specific requirements for their nest-sites, which may be in conflict with the intensive forestry (Lõhmus 2003a). It is unlikely that the timber harvesting increase during the last 12 years has not had any impact on forest raptors.

Raptor species differ in their tolerance to anthropogenic activity (Krüger 2002), including timber harvesting (Lõhmus 2003a). Raptors are influenced by the increased disturbance levels, the alteration of foraging areas and nest-sites (Lõhmus 2003a). For this investigation we have selected the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) - a sensitive forest raptor species which clearly prefers to nest in mature forests and large trees (Lõhmus 2003a). Apart from this reason for possible conflict between the Lesser Spotted Eagle (LSE) nest-sites requirements and timber harvesting, this species is sensitive for other reasons

as well: low reproductive rate (Cramp and Simmons 1980, Bergmanis *et al*. 2001, Vali 2003), high first-year mortality - approx. 60% and heavy persecution in migration places (Meyburg *et al*. 2004). LSE has unfavourable conservation status in Europe (Tucker and Heath 1994) and it is included into the EU Birds directive list Annex I (EEC/79/409). Nowadays, forest felling operations are assumed as the main threats for this eagle species (Meyburg *et al*. 2001). Considering the small distribution range, which is concentrated to Eastern Europe (Bergmanis 1999), it is highly probable that the growing forest harvesting in this region might have critical adverse impact on LSE world population.

The aim of this paper is to examine whether the increased timber harvesting during the last decade has influenced the requirements of Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) for their nest-sites.

Material and methods

The nests of the Lesser Spotted Eagle were searched for in 18 administrative districts of Lithuania during 2001-2004, though the main material was collected in the central, northern and eastern parts of the country (Fig.1). Two search methods were applied: i) nests, found in winter, were checked during the breeding season and ii) watching of the eagle's behaviour from the elevated points, tree tops, forest edges. The use of two complementary methods was expected to eliminate the sampling bias, nests were found independently of terrain properties, distance from forest edges, breeding success, forest type, *etc.*

Altogether, data on 80 nests (for nest tree – 108) was used in this study. The principle "one territory – one nest" was followed. Only the most recently used nest was accounted if one pair had several nests. Forest stand with a nest tree was considered a nest – site to enable comparison of our data with the historical data (see below). Six parameters were used to describe the nest site: i) forest type, ii) site humidity index, iii) site index (defined according to the stand height at a certain age), iv) stocking level, v) stand age and vi) nest-tree species. State forest cadastre databases served as the data source to provide the forest stand characteristics.

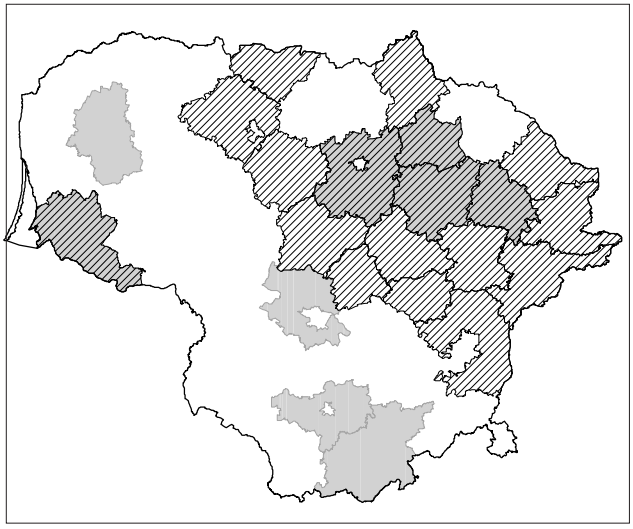


Figure 1. Administrative districts under investigation: grey color - past LSE nest sites (Drobelis 1994), streaked shade – present nest sites

Data published by E. Drobelis (1994) was used as the source of information on the past nest - site characteristics of the Lesser Spotted Eagle. This material had been collected from 127 nests during 1978-93 mainly in 9 administrative districts of Lithuania (Fig. 1). Ten percent difference in the nest - site variables was used as the indicator of possible change in the nest–site use.

To ascertain preliminary change in nest-site selection we also assessed foregone and present preferences of eagles.

The disturbance on the Lesser Spotted Eagle was estimated in 2004 by field checking of 91 nesting areas. The extent of disturbance was expressed as the proportion of areas, negatively affected by timber harvesting. We considered i) any clear cut within 100 m from the eagle nest and ii) any other cutting in the same zone in April - August as a negative effect. This consideration with the official protection rules for eagle nests (*Pagrindinių miško kirtimų taisyklės* 2004).

Results

Seven percent of checked Lesser Spotted Eagle territories were disturbed by forestry operations in 2004. Once, the nest was destroyed only, twice both the nest trees and surrounding stands were felled down. The edge of the clear felling area was 20 m from the nest tree in three cases. The clutches were destroyed in 2 of them, when cuttings were done during the breeding season.

Before 1994, nests of Lesser Spotted Eagle were found in 13 forest types, however 77% of all nests were found in six forest types. Between 2001 and 2004, eagles were nesting in nineteen forest types, but 78% of nests were again found in 6 forest types. However, of the six most frequently used forest types for the two periods only two forest types - *Aegopodiosa* and *Hepatico-oxalidosa* – were the same. Notably, the *Oxalido-nemorosa* forest type was among the most used ones before 1994, whereas since 2001 its importance has decreased. It is obvious, that since 2001

eagles used forest types more similar to what was available in the landscape, than they formerly did (Fig. 2).

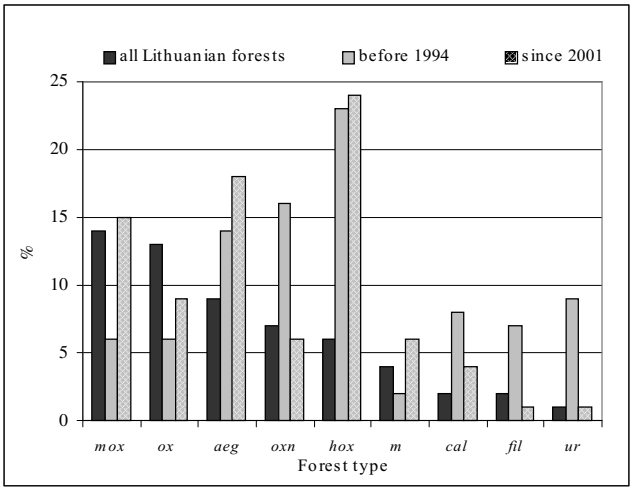
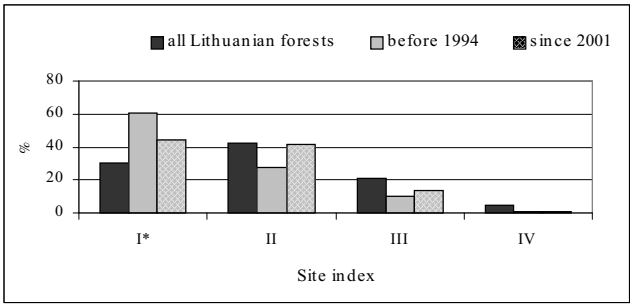


Figure 2. Forest type of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

The average site class of the stands with a nest was 1.51 and 1.73 respectively before 1994 and since 2001. A relatively larger number of nests (by 18%) were found in the 1st site class stands and less (by 15%) in the 2nd class stands before 1994. Average site class in Lithuanian forests is 1.9 (*Lietuvos miškų statistika* 1998) and during the last decades has increased by just one decimal (Kairiūkštis 2003). The preference of an eagle to the productive stands remains at the same level, but the 2nd site class stands are not avoided any more – they seem to be used equally to their share in landscape since 2001 (Fig. 3). The obtained data also reveal a marked (by 18%) decrease in nest sites found on wet soils. Since 2001, eagles have also less avoided normally irrigated stands and slightly more preferred temporally wet stands (Fig. 4).



* I^a and I site indexes together

Figure 3. Site index of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

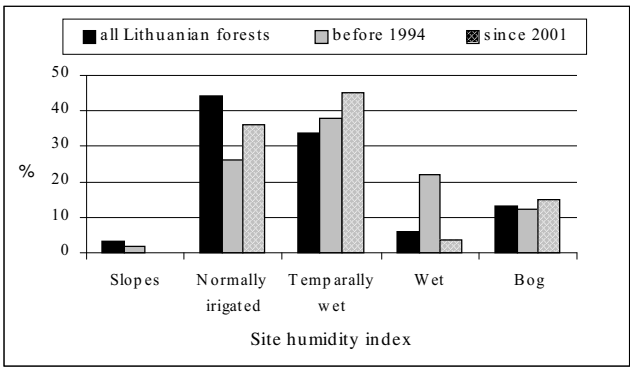


Figure 4. Site humidity index of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

Very diverse stands with respect to stocking level (0.1-0.9) were used before 1994, when the average stocking level was 0.64±0.13. Since 2001, nests have been found in more uniform stands in terms of stocking level (ranging 0.5-0.1), when the average stocking level was 0.69±0.098. The difference between stocking levels is statistically significant ($t=3.14$). The share of stands with stocking level 0.5, 0.7 and 0.8 used by LSE is close to the one available in the landscape since 2001. Moreover, the stands with stocking level 0.6 seemed to be preferred as well as the stands with stocking levels 0.9 and stands with value 1.0 - avoided (Fig. 5). Unfortunately, there were no data on the eagle's nests distribution with respect to the stocking level before 1994. However, considering the average stocking level in Lithuanian forests (0.71 during 1978-87 and 0.7 in 2001: *Lietuvos miškų ūkio statistika* 2001, Kairiūkštis 2003), we can assume, that the stands used for nests during the last decades were more similar (in terms of stocking level) to the ones available in landscape since 2001 than before 1994.

The age of stands used for nesting ranged between 40-180 years in the first, and 30-170 years in the second period. The mean stand age differs by 16 years: 94±29 and 78±29, respectively; this difference is statistically significant ($t=3.87$). In contrast to this decrease, the average age of Lithuanian forests increased from 48 to 53 years. Although the largest number of nests was found in stands of VIII age class before 1994 (26%), the VII age class has been the most common since 2001 (27%) (Fig. 6). Relatively young stands (<70 years) are more often used nowadays than earlier (29% and 14% respectively).

The largest part of the nests was found in oak trees before 1994, whereas the share of this tree species was by 20% less later, when spruce trees were used for nesting much more often (by 23%) (Fig. 7).

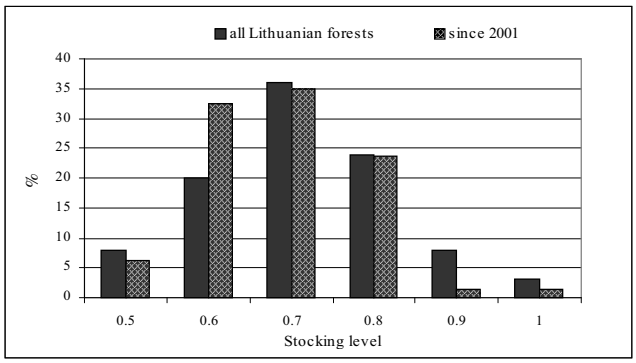


Figure 5. Stocking level of stands with present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

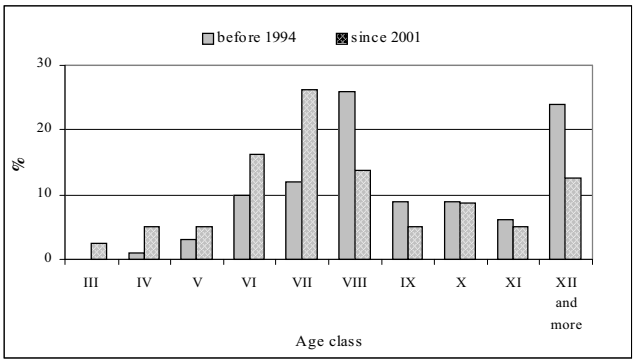


Figure 6. Distribution of stands with past and present LSE nest sites by stand age classes

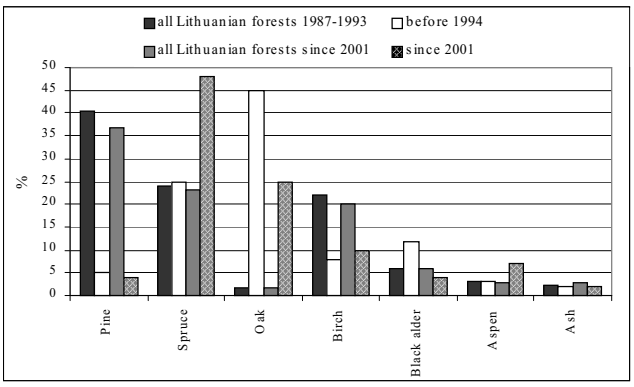


Figure 7. Species of past and present nest tree as well as the prevailing tree species in all Lithuanian forest (after Kairiūkštis 2003; Lietuvos miškų ūkio statistika 2001)

Though spruce became the most common nest tree, oak remains one of the most preferred nest-trees, because its share in the landscape is relatively small (1.8%). Black alder trees seem to be more seldom used as the nest trees since 2001, whereas the aspen trees, on the contrary, more often.

Discussion and conclusions

Considering that i) the information on the majority of checked nests was provided to stakeholders and ii) stakeholders should protect LSE according to the national laws, we suppose, that the 7% disturbance probability is likely to underestimate the real disturbance extent of forestry operations on the Lesser Spotted Eagle in Lithuania. All the recorded disturbance cases were in "well known" nest-sites (stakeholders were informed about the nests of rare species). Two disturbance cases were recorded in special protected areas, designated for Lesser Spotted Eagle protection. Thus, given that even existing protection rules could not protect LSE effectively, and most of the nest sites are not protected even formally (e.g. due to the lack of information on nest sites), we assume that the real pressure of timber harvesting is more heavy than stated in this study, particularly in private forests. We believe that timber harvesting disturbance on LSE in state forests can be minimised implementing better control during FSC certification audits. In private forests, however, we are inclined to rely on compensation for protection of nest-sites.

The most obvious differences in the past and present nest-site preferences are with respect to forest type, stand age and nest tree. The obtained data indicated, that the eagle's preference to build a nest in spruce trees nowadays is similar to the one reported in other countries: 47% in Belorus (Ivanovsky and Tishechkin 1993), 46% in Latvia (Bergmanis 1999), 71% in Estonia (Vali 2003). The use of wet stands for nesting remained practically the same, what is common in other places of distribution range (Ivanovsky 1996, Langgemach *et al*. 2001). More productive forest stands continue to be preferred, what is most likely related to the faster development of the suitable for breeding conditions (Bergmanis 1999). Though more forest types have been used for nesting now, the preference for two forest types remained. Finally, it is noteworthy that the younger stands seem to be used more frequently for nesting nowadays than a decade ago.

The general tendency observed was that the characteristics of stands used for nesting differed from the overall characteristics of stands in the landscape less now than in the past. This leads to the assumption, that eagles are less selective nowadays than in the past. Possible reasons for the decrease in eagles' selectivity could be:

1. Differences in the sample. Data on the nests before 1994 was collected mostly in 9, whereas since 2001 in 18 administrative districts. Thus, the larger study area and greater diversity in environmental con-

ditions could have had some influence. For instance, nest – sites are very different in Vitebsk and the Pripyat basin regions in Belorus (Ivanovsky and Tishechkin 1993). The methods, used to search for nests before 1994, are not documented well enough. Using only one method (*e.g.*, searching raptors nests in winter and checking in summer) could introduce some bias in the sample. However, considering the large sample sizes and largely overlapping study areas, we accept that this single reason cannot explain the differences in the past and present nest – site requirements.

2. Selectivity decrease due to the population density. The relationship between raptors' population density and selectivity is well documented: when the population increases, selectivity decreases and *vice versa* (Lõhmus 2001). Unfortunately, there is no monitoring of Lesser Spotted Eagles at the national level carried-out in Lithuania. However, fewer LSE pairs or even none were detected to breed in Eastern Lithuanian forests during 2001-2004 (auth. observ.) in comparison with the research carried out in 1990-ies by Mažiulis (1985) and Drobelis (1990). These results are in full agreement with the documented sharp world population's decline in the second half of the eighties (Meyburg *et al*. 2001). Therefore, it is very unlikely that the population of eagles increased during the last decade and the density–selectivity relationship cannot explain the decreased selectivity.

3. Selectivity decrease is related to the intensified timber harvesting. The data by E. Drobelis were collected in the period of the most environment-friendly forestry, when the extent of final felling was low and the share of mature stands was increasing (Kairiūkštis 2003). Only 37% of the volume increment was utilized during this period. In 1978-92, the total cutting amount was small - about 3 mil. m^3 per year. This could explain, why the eagles used for breeding relatively older stands, less affected by forestry operations (Drobelis 1994). Since 1993, timber harvesting increased up to 4.5-6 mil. m^3 per year (*Lietuvos miškų ūkio statistika* 2002), which makes up to 70-80% of annual increment. The invasion of *Ips typographus* a decade ago influenced over-cuts, especially in spruce forests. Despite the increased timber harvesting, the percentage of mature forest is larger nowadays than in the past, *e.g.*, in 1978-87 – 20.9% and 2000- 32.5% (Kairiūkštis 2003). The increased statistical age of Lithuanian forests does not necessarily mean that eagles have better opportunity to select mature or overmature stands due to ecological requirements and a variety of interactions, if these stands are disturbed by nearby cuttings or are far from foraging areas or too near to conspecifics.

Though a species which can flexibly respond to the growing timber harvesting pressure and disturbance level by reducing its requirements for nests sites can be considered as not conflicting with timber harvesting, the characteristics of nest - sites might have long-term influence on bird's reproduction (Rauter *et al.* 2002). Recently, oak has been the most used nest tree, with large and strong branches, capable of maintaining large nests (Drobelis 1994), where eagles can breed for 10 years (Vali 2003). Nowadays, spruce became the most used nest tree. It has suitable crown structure for nest building in young age. However, the nest of an eagle, when used for many years, becomes large and heavy. Such a nest may fall down from young trees, the branches of which are not strong enough to maintain it. This opinion is supported with field observations - we found six fallen down nests from such spruce trees in 2001-2004. Thus, the reduction of large-branched trees in economic forest use (Brazaitis and Kurlavičius 2003) and other habitat properties may push eagles to select younger, less suitable stands and nest trees.

We suppose that the seven year period is rather short to analyse the changes in eagle's nest - site selection due to delayed response to quickly changing forest environment. Undisturbed eagles can use the same nest for 10 (Väli 2003) or even 20 years (Šablevičius pers. comm.). So, our sample could possibly include such nests-sites, which were selected before the intensification of timber harvesting and nest-sites, which are located in the protected areas. In spite of this, we are convinced that the differences in past and present nest – site characteristics are associated with the increased timber harvesting. Taking into account the future harvesting perspectives (2001-2010- 6.5, 2011-2020-7.5 and 2021-2030- 8.3 mil. m^3 per year: Rutkauskas 2003) we can forecast that during the next 30 years forest operations will become one of the most important factors affecting the Lesser Spotted Eagle population in Lithuania.

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ТРЕБОВАНИЯ МАЛОГО ПОДОРЛИКА (*AQUILA POMARINA* C.L.BREHM) К ГНЕЗДОВЫМ МЕСТАМ В НЫНЕШНЕЕ ВРЕМЯ И В ПРОШЛОМ: ВОЗМОЖНЫЙ КОНФЛИКТ С РУБКАМИ ЛЕСА

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Резюме

Возрастающий спрос на сырьевую древесину в последнее время приводит к увеличению лесопользования в странах Балтии. Цель настоящего исследования заключается в проверке имел ли влияние возросший за последнее десятилетие объем сплошных рубок на требования малого подорлика к выбору гнездовых мест. В 2004 году, 7% из проверенных территорий малого подорлика были затронуты лесохозяйственными мероприятиями. Некоторые показатели гнездовых мест потерпели лишь незначительные изменения. Общая обнаруженная тенденция заключалась в том, что характеристики лесных насаждений, используемых для гнезд, менее отличаются от средних характеристик леса в ландшафте в данное время, чем в прошлое десятилетие. Гнездовые деревья найдены на 19 разных типах леса, так как ранше – только на 13. Менее продуктивные леса (2 класс бонитета) и насаждения на сухих почвах в нынешнее время менее избегаются. Средний возраст насаждений с гнездовыми деревъями уменшился на 16 лет. Хотя дуб остается одной из самых привлекательных пород для гнезд (20% всех случаев), наиболее частой породой (48%) становится ель. Это приводит к идее, что малый подорлик менее селективен сейчас чем в прошлом. Мы полагаем, что возросший объем лесных рубок за последнее десятилетие объясняет почему малый подорлик стал гнездить в насаждениях, более похожих на окружающие лесные ландшафты, чем в прошлом, и почему некоторые предпочтения сохранились, тогда как другие исчезли. Существует большая вероятность того, что в течении последующих 30 лет лесохозяйственные мероприятия будут оставаться одним из наиболее важных факторов, оказывающих существенное влияние на популяцию малого подорлика в Литве.

Ключевые слова: малый подорлик, выбор гнездовых мест, лесные рубки, помеха