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NESTING ECOLOGY OF BIRDS OF PREY AND OWLS NEAR SAUE DURING 1959–2006

Eet Tuule[1]*, Aarne Tuule[1] & Asko Lõhmus[2]

[1] Sütiste tee 3-61, 13419 Tallinn, [2] University of Tartu, Institute of Ecology and Geography, Vanemuise 46, 51014 Tartu
*E-mail: eet@tallinna-linnuklubi.ee

Abstract: The current paper summarizes the ecological data collected during surveys, which include 348 nests and 405 nesting cases of 17 species (breeding biotope, nesting tree and height, breeding success, clutch size, number of nestlings as well as fledglings and reproductive success) and was carried out in Harjumaa, near Saue, in an area of 60–90 km^2 during 1959–2006. Species nesting in stick nests preferred coniferous trees, while the opposite goes for three species using former crow nests. Pine was preferred to spruce probably because of the higher load-bearing capacity of branches even though spruce provided better shelter. Areas with the highest species diversity were mixed forests whereas highest contrast in the relative species diversity was detected between the species-rich stands comprising spruce and species-poor pure deciduous stands. Among medium-sized hawks biotope use contrasted most between the Honey Buzzard *Pernis apivorus* breeding in mixed or deciduous woodland and Goshawk *Accipiter gentilis* breeding in coniferous forests. Latter contrast may come from a later breeding season of the Honey Buzzard or because this species is trying to avoid the vicinity of the Goshawk. Long-term reproductive success of the 5 most common species out of 8 exceeded the average values for Estonia during the past years. However, this tendency is referring to a general long-term decrease in the reproductive success among raptors during the past 50 years on account of which the indicators for Saue could be high rather due to the past few decades and not the characteristics of the particular region.

Introduction

In Northern Estonia, in Saue, raptors have been observed for half a century. The number of local raptors has been studied in terms of stability in community numbers while at the same time a decline in species diversity has been observed since the 1960ies (Tuule *et al*. 2001). The current paper summarizes data of the nesting ecology of raptors, which has not been collected systematically, yet, is worthy of publishing for the two following reasons.

First, even though the number of breeding pairs is rather adequate for a raptor population, it fails to be a strong indicator since in case of suitable breeding sites are occupied the number of birds increasing or decreasing is the one of the non-breeding individuals and problematic to count. Therefore, a more precise overview would be given by changes in breeding success and mortality rate. In Estonia, studies on the mortality rate of raptors have recently been initiated (Lõhmus 2004a) while breeding success has already been monitored since the 1960ies among rare raptors (Randla 1976) and since the second half of the 1980ies among common raptors (*e.g.* Lõhmus *et al*. 1997, Lõhmus 2004b). Latter time series can also be extended twice by the data collected in Saue.

Second, the welfare of raptors depends on their ability to find new habitats, which has been demonstrated in northwestern Tartumaa (e.g. Lõhmus 2003, 2006) and Pärnumaa (Laur & Lelov 1990, Lelov & Laur 1990). At the same time, the geographical pattern of choosing new nesting sites may differ within species and nesting sites of the Lesser Spotted Eagle *Aquila pomarina* and the Black Stork *Ciconia nigra* populations in Estonia differ from the ones in Lithuania (Väli *et al.* 2004, Treinys *et al.* 2008). Therefore, in terms of species protection it is necessary to describe as well as study the local ecological specifics. Estonia has a variety of landscape types while also bird fauna differs strongly among regions. Thus, the current study is a supplement to the data gathered in earlier periods, especially in North Estonia. Besides the specifics, also ecological needs of raptors (*e.g*. preference in biotope or

nesting tree) remaining despite of the differences in landscape types attract major interest.

The current study is based on the main ecological indicators which have become evident during nest encounters – breeding biotope, nesting tree, nest height, breeding success, clutch size, number of nestlings as well as fledglings and reproductive success. Special attention is also paid to habitats of species breeding in former Hooded Crow nests and compared to crows. Additionally, species diversity of different biotopes is being compared. This study is also providing an overview of the slaughtering incidents of raptors (a total of 22) taking place during 1959-1984 that has not been described in the recent overview of Estonia (Lõhmus 2004a).

Material and methods

Observation plot

Saue observation plot is located in Harjumaa, between Keila-Laagri-Saku-Kiisa-Voore-Jõgisoo and lies mainly in the squares LF5575, LF6075, LF6575; LF5570; LF6070 and LF6570 (Fig. 1) according to the UTM grid network. The main area of the observation plot was covering 60 km^2 until it was extended up to 90 km^2 in the mid 1990ies. The terrain is rather plain with a relative height of 22 m.

The relative importance of cultivated landscape in an otherwise mosaic landscape type has reached half of the total size of the observation plot from an original of only one third (Table 1). However, the semi-natural grasslands have been modified to fields and mown bottomland meadows have overgrown with bushes. In a similar manner the area of wooded meadows has decreased to less than one tenth from an original of a quarter of the total area. About half of the observation plot has been covered by woodland while the rest has been occupied by settlements along with a few forest patches. Woodland is equally dividing into coniferous (36–38% of the total forested area; primely pine stands that have severely suffered from the ”storm of the century” on August the 6th in 1967), mixed (33–39%) and deciduous forest (25–29%)

with occasional patches of spruce and oak together with a few mansion parks diversifying the landscape. The most important water bodies in the region are Vääna and Keila rivers together with a couple of small lakes. Traffic near the observation plot is dense due to the vicinity of the capital city and is becoming even denser in time. At the same time woodland situation has greatly suffered from either establishment of new power lines or intensive logging. An even greater human impact lies on the observation plot due to urban sprawl.

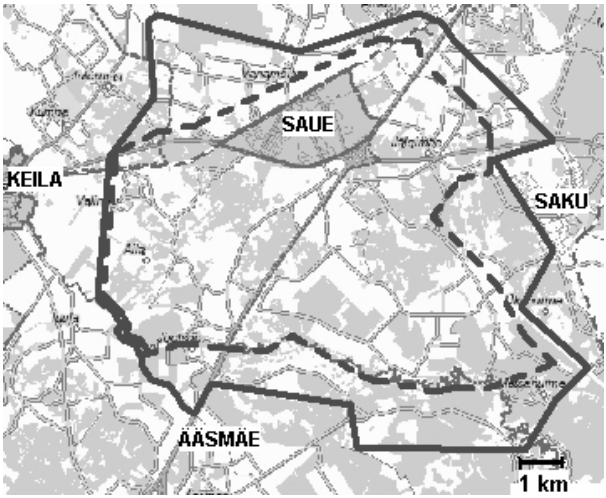

Figure 1. Map of the study area. Dashed line denotes the 60 km² area, solid line – the 90 km² area

Joonis 1. *Vaatlusala skeem. Punktiirjoonega 60 km², pidevjoonega 90 km² vaatlusala välispiir.*

Observations of the ecology of raptors

Observations were mainly carried out by Eet Tuule in the mid 1990ies and accompanied by Aarne Tuule. Mapping of breeding territories in Saue has been carried out systematically (however, with yearly fluctuations) and served to estimate the number of raptors (Tuule *et al.* 2001). However, data of breeding biology has been collected mainly during counts and are therefore unsystematic. Poorly described nest encounters have not been registered and, therefore, have not been included in the current paper. Moreover, two species out of 19 – Merlin *Falco columbarius* and Eagle Owl *Bubo bubo* – have been excluded from the study due to local extinction but have been described in earlier studies (Tuule *et al.* 2001). Despite everything, the data obtained is sufficient in order to briefly discuss all the main aspects of the nesting ecology of raptors.

Habitat descriptions rest on 348 different nests and describe the frequency of using different nesting sites and trees as well as nest height from the ground (visual estimation). Due to the longevity and stationary life of the raptors it is problematic to differentiate between various nests built by the same birds and therefore makes it difficult to describe the nesting sites. The problem lies in the matter of fact that in case the database includes a very different number of nests for different breeding pairs it may happen that information about the general nesting habits of the birds might be misleading because of only a few individuals. Also the current paper includes some of the so-called "replicate nests" whereas it is not possible to determine the number of birds reflecting these breeding habits due to the long-term nature of the study. Yet, all the nests are well representing the entire observation plot and were located in several different nesting territories of the common species: Honey Buzzard *Pernis apivorus* 11 (more or less frequently used 4–5), Goshawk *Accipiter gentilis* 9–10 (4–5), Sparrowhawk *A. nisus* 9–10 (4–6), Common Buzzard *Buteo buteo* 28 (22), Common Kestrel *Falco tinnunculus* 13, Hobby *F. subbuteo* 13, Tawny Owl *Strix aluco* 9 (7), Ural Owl *S. uralensis* 6 and Long-eared Owl *Asio otus* 19 territories.

Table 1. Landscape composition and the nesting habitats of common species.
Tabel 1. *Vaatlusala maastikujaotus ja tavaliste liikide pesitsusbiotoobid.*

Variable *Tunnus*	Biotope / *Biotoop*										
	pine forest / *männik*	spruce forest / *kuusik*	mixed conifer forest *sega-okasmets*	mixed forest /*segamets*	birch forest / *kaasik*	other deciduous forest *muu lehtmets*	wooded meadow *puisniit*	*Park* / park	village woodlot *külapuistu*	open cultural landscape *ava-kultuurmaastik*	Settlement / *Saue alev*
Studied landscape[a] (% of area) / ***Vaatlusala maastik***[a] *(% pindalast)*											
1959–1970	11	2	1	13	4	7	27	1	1	31	2
1971–1982	7	2	2	9	3	5	21	1	2	47	3
1983–1994	5	1	3	10	2	4	15	1	2	52	4
1995–2006	5	2	5	12	3	6	8	1	5	50	4
No. of species ***Liikide arv***	8	6	8	12	4	6	7	4	5	4	1
Species[b] (% of nests) / ***Liik***[b] *(% pesadest)*											
PERAPI [13]				77	15	8					
ACCGEN [20]	25	25	30	15					5		
ACCNIS [24]	25	8	4	38	8	4		13			
BUTBUT [114]	28	10	14	25	8	6	9				
FALTIN [40]	38	5		13	3	5	13		18	8	
FALSUB [25]	56		8	12			16	4	4		
STRALU [22]				27		5		36	18	9	5
STRURA [6]	33		33	33							
ASIOTU [69]	49	6	1	17		12	9		1	4	
CORNIX [548]	23	5	4	13	8	14	17	2	4	3	8

[a] 60 km² until 1994; 90 km² afterwards / *kuni aastani 1994 – 60 km², hiljem 90 km²*
[b] sample size in superspcript / *ülaindeksiga pesade arv*; abbreviations / *lühendid*: PERAPI – Honey Buzzard / *herilaseviu*; ACCGEN – Goshawk / *kanakull*; ACCNIS – Sparrowhawk / *raudkull*; BUTBUT – Common Buzzard / *hiireviu*; FALTIN – Common Kestrel / *tuuletallaja*; FALSUB – Hobby / *lõopistrik*; STRALU – Tawny Owl / *kodukakk*; STRURA – Ural Owl / *händkakk*; ASIOTU – Long-eared Owl / *kõrvukräts*; CORNIX – Hooded Crow / *hallvares*

Data of inhabited Hooded Crow nests have not been collected systematically, however, those 548 nests probably do not represent some kind of a tendency of the nesting habits of crows.

Breeding season has been monitored during four 12-year periods and breeding success (the relative importance of nests producing at least one fledgling; a total of 405 breeding attempts), clutch size (110 clutches), the mean number of nestlings in the age for ringing (135 nests) and the number of fledglings (289 nests) was evaluated. The main indicator for breeding success was reproductive success (number of fledglings per breeding attempt). Additionally, a few interesting observations have been included in the paper, for instance breeding in one and the same nest for several successive seasons.

Results

Data of the nesting biotope and nesting tree as well as nest height is presented in Tables 1–3 for the nine most common species and in Table 4 for eight other species. The relative importance of raptors inhabiting former Hooded Crow nests (mostly Common Kestrel, Hobby and Long-eared Owl) was high in pine stands on pine but also on spruce (however not in spruce stands but in mixed stands and woodlots inside the villages). Crow nests remained uninhabited inside the town of Saue. Species mentioned above together with several vulnerable species have been discussed in order of taxonomy.

Honey Buzzard was usually building the nest on conifers in a mixed forest whereas no nests were found in pure coniferous forest. The mean distance of seven registered nests was 86 m (40–180 m) from the border area of the forest. Honey Buzzard usually (69%) bred in the very same nest for several years (up to 4 years). Half of the nest were built by themselves otherwise old nests of crows were used and once a Common Buzzard nest was reconditioned. In 1979 one Honey Buzzard was found dead in Jõgisoo whereas the cause of the death remained unclear.

All three nests of the Hen Harrier *Circus cyaneus* were located within the border area of marshland, cultivated grassland and pasture: clutches with 5 eggs were found in 1964, nests with 4 nestlings in 1970

and 3 nestlings out of 5 fledged in 1993. Montagu's Harrier *Circus pygargus* appeared in the study area in 1992 and the only nest was registered in 1999, which was located within a marshland covered with Bush Cinquefoil *Potentilla fruticosa*. This nest produced 5 nestlings whereas only four fledged. There were no nests of the Marsh Harrier *Circus aeruginosus* found even though in 2006 one pair was observed to express territorial behaviour (and there were two recently fledged young Marsh Harriers sighted in late summer) within the border area of a bog, close to a small eutrophic lake (1.6 ha), called Kogre pond which is surrounded by several small ponds.

Most of the nests of the Goshawk was located in mature coniferous forest, somewhat less in mixed forest and always built on conifers. An old Common Buzzard nest was reconditioned twice and once an old Raven *Corvus corax* nest was used. In case of no major disturbance, nests were used for several successive seasons (61% of all nests) whereas three nests were inhabited for 6 years. One breeding Goshawk pair even inhabited a nest for at least 9 years; two nests produced fledglings in 8 years. The reason for deserting nests with such a long history, have always been anthropogenic. For example one nest destruction along with killing nestlings occurred in 1990 in a spruce patch of 12 ha. This nest had been inhabited by Goshawk for the past 7 years (mostly successfully) and located 300 m and 360-380 m off the nearest farms. In 1959 there was an incidence where one hunter shot an incubating female Goshawk that had built her nest 200 m off his house in Kanama (back then called Saue) village. Additionally, three slaughtering incidents of mature Goshawks during 1959-1984 are known (in August 1966, in June 1974 and in September 1976) and the remains of one young bird have been found in mid July in 1980.

Sparrowhawks have a hidden lifestyle and thus only a few nest registrations have been made whereas more than half of which derive from the last quarter of the representative period. Nests were mostly built on conifers and only for the current season. Three nests out of 22 (14%) were built by the raptors themselves while 8 (36%) times a former Hooded Crow nest was reconditioned, 4 times an old Woodpigeon

Columba palumbus, 3 times an old Jay *Garrulus glandarius* and once an Eurasian Red Squirrel *Sciurus vulgaris*, Magpie *Pica pica* and Fieldfare *Turdus pilaris* nest was used. Additionally, once a "witch's broom" was being used. In 1972 by the end of May a hunter shot an incubating female and in July 1962 one adult bird drowned in an asphalt basin belonging to the Road Office which had melt with heat and had a reflection similar to a water body.

The Common Buzzard was breeding in different forest types, however, mostly in coniferous stands whereby 72% of nests were built on conifers. On two occasions nestlings were raised on a steel pole of a high voltage power line, 14 m from the ground. About 12% of all the nests were built upon old Hooded Crow nests while at least 4 times a former Raven and once a Spotted Eagle *Aquila sp*. and Honey Buzzard nest was used. 27 (23%) nests were used at least twice whereas 14 (12%) of all the nests were inhabited during 3-5 successive years. In 1959 one nest with 5 eggs was found while nests with 4 eggs were registered three times. In 2006 all 4 nestlings hatched and fledged probably due to extraordinary high food availability. The reason lied in a numerous Water Vole *Arvicola terrestris* colony in a fallow in a riverfront next to the breeding site. Four slaughtering incidents of the Common Buzzard are known from 1959–1984: one adult bird was killed in 1963, another was found dead in July 1979 and a third was run over by car in 1980; one young individual was tangled in power lines in August 1971.

One of the territories of the Lesser Spotted Eagle *Aquila pomarina* was located in a border region of the observation plot but abandoned in the beginning of the 1970ies. Pair of eagles that was successfully breeding in some years inhabited another territory (whereby one bird was killed by humans in 1962; Tuule *et al.* 2001). In 2005 a third territory was established. The reproductive success for 4 breeding attempts is exactly 1 nestling per inhabited nest whereby twice only one and once two fledglings were produced. Both nests were located within damp spruce forests and built on spruce like all 3 nests of a mixed breeding pair of the Greater Spotted Eagle and Lesser Spotted Eagle who successfully bred 5 times during the past 7 years and produced one fledgling per season (productivity rate 0.71). Common

Buzzard inhabited one of their alternative nests in 2005 while another by a Pine Marten (*Martes martes)* in 2006.

Common Kestrel has not inhabited Saue in a consistent manner, being almost absent in 1985-1995 (Tuule *et al.* 2001). Preferred habitats for this species were forest patches within cultivated landscape whereas also spruce hedges near solitary farms within arable land were well accepted. All the nests, except two (former nests of Raven and Woodpigeon), that were built on trees (90% of all the nest locations; for nests built on artificial grounds see Tuule & Tuule 2002) were reconditioned Hooded Crow nests. Kestrels preferred nests on pines to those on spruces that, however, this was caused also due to the higher number of crow nests built on pines.

In case of suitable breeding conditions Kestrels tended to breed in the very same nest for several times – 15 nests were inhabited at least during two successive seasons (11 breeding territories, 38% of all the nests) while twice in 5 successive seasons. Furthermore, in a nest built in a stone wall of a windmill Kestrels had been breeding for at least 8 years (Tuule & Tuule 2002). Similar to the Sparrowhawk, there is known one slaughtering incident of an incubating female (in 1976) and one drowning incident of a young bird in an asphalt basin (in August 1962).

Hobby mainly preferred to breed in small pine stands or other forest patches with pine as a dominating tree and which had sufficient solar radiation. Nests located in highly favoured habitats (3 cases; that is 28%) were used during 2-3 successive years. Altogether 18 times out of 23 (78%) former Hooded Crow nests were used, twice (9%) Common Buzzard or Woodpigeon nests and once (4%) a Magpie nest. Hobbies preferred to use conifers as nesting trees whereas pine over spruce which is similar to Common Kestrel and Long-eared Owl. However, Hobbies tend to avoid the proximity of crows: in May 2002 a pair of Hobbies inhabited a former crow nest that was built on a spruce in a farm yard, however, after a fight with Hooded Crows breeding on the neighbouring tree that lasted for 2–3 days they were driven off the yard. Finally they inhabited a pine stand close to it but failed to breed due to nest predation (clutch size of 3). Their third breeding attempt took them

back to their first breeding site and remained unnoticed until the 31st of August (!). It was discovered due to a dead nestling lying below the nest. Two days later it appeared that crows killed another nestling. One adult bird was reported dead in July 1972 in Padula, however, had not suffered from any injuries.

Table 2. Nest location and nest height from ground in common hawk species in Saue, the Tawny Owl and Ural Owl.
Tabel 2. *Haukaliste ning händ- ja kodukaku pesakohad ja nende kõrgus maapinnast Sauel.*

Variable *Tunnus*	Species / *Liik* Honey Buzzard PERAPI	Goshawk ACCGEN	Sparrowhawk ACCNIS	Common Buzzard BUTBUT	Tawny Owl STRALU	Ural Owl STRURA
Nest location (% of nests) / ***Pesakoht*** *(% pesadest)*						
Spruce / *Kuusk*	38	67	29	33	4	33
Pine / *Mänd*	31	33	50	39		50
Birch / *Kask*	15		13	14		
Aspen / *Haab*	15		4	10	9	17
Poplar / *Pappel*					9	
Oak / *Tamm*				1	4	
Linden / *Pärn*					30	
Willow tree / *Remmelgas*			4	1	9	
Building / *Ehitis*					35	
Pylon / *Elektrimast*				2		
N	*13*	*18*	*24*	*115*	*23*	*6*
Nest height / *Pesa kõrgus*						
mean / *keskmine*	11.4	15.7	6.4	11.1	5.2	13.3
min-max	8-16	12-20	4.5-10	7.5-18	2.5-8	7.5-18
N	*13*	*18*	*24*	*114*	*18*	*6*
Height of nesting tree / *Pesapuu kõrgus*						
mean / *keskmine*	17.8	19.0	11.1	16.6		17.3
min-max	14-24	15-28	6.5-15	9-26		9-24

Pygmy Owl *Glaucidium passerinum* was registered breeding in 2005 when 4 recently fledged nestlings had been encountered in the border of a spruce forest and a wet peatland forest. Location of the nest remained unknown.

The main breeding habitat of the Tawny Owl is parks, mixed forests and forest patches within villages. This species tends to build the nest either in cavities of the linden or old buildings. The mean height of 13 nests located on trees was 5.3 m (between 3.5 – 8 m) and 4.8 m among 5 nests located on buildings (3–7m). Only three cases of nests inhabited during 2–3 successive years are known (13%, n=23) and two more cases where the same nest was inhabited more than once, however, not successively. The most intriguing nest encounters dates back to 1974 where 4 Tawny Owl nestlings fledged in a former crow nest located in a dense two-row spruce hedge. One adult bird was reported dead probably due to food shortage occurring in winter (January 1966) and one bird died of brain tumour (spring 1980; dissected by K. Nurk).

Apart from one young Ural Owl that was killed in 1959 (Tuule *et al.* 2001) there is very few data of this species breeding in Saue till 1974. Four out of six registered Ural Owls were open nesters whereas two of them inhabited former Common Buzzard nests and once an old squirrel or Raven nest was being used. Latter was being inhabited altogether 6 times during 8 successive years. The mean height of stick nests was 15 m. Twice this species was breeding 7.5 m high, on top of an old pine that got damaged in a storm whereas one side of the nest was leaning onto a higher part of the stem, which at the same time was protecting the nest. One owl nest was located in a knothole of an aspen that had become a rather large cavity. This species produced a mean of 2.25 fledglings per nest and the total reproductive success of the registered 11 Ural Owl nests was 1.64.

The landscape of Saue is covered by several forest patches and therefore serves as a highly suitable habitat for the Long-eared Owl. Several forest types were inhabited by this species whereas small pine stands located within open landscape were preferred over large spruce forests as well as hedges in open field. Long-eared Owls usually never

used the same nest more than once, therefore, tended to breed in former nests of other species. Out of the 69 registered nests were former nests of Hooded Crow – 56.5%, Magpie and Woodpigeon – 11.6%, squirrel – 5.8%, Common Buzzard and Jay – 2.9%, Raven – 1.5% while the origin of 7.3% of the nests remained unknown. Breeding success was significantly higher in years where mice were abundant. For example in 2002 and 2005 the mean number of fledglings per nest was 4.0 whereas in 1997-2001 only 2.4. Special attention needs to be paid to one particular late breeding attempt (see Randla 1976, Lelov 1997). On the 20th of June in 2002 one clutch of 4 eggs was encountered where hatching occurred on the 7th of July; on the 27th of July the female bird was registered inside the nest together with at least one of the nestlings and on August the 11th the weakest nestling was seen next to the nest while the other three had already moved somewhat further. This was probably a late replacement clutch where due to high food abundance even the weakest nestling was able to fledge. During 1959-1984 altogether 3 slaughtering incidents have been registered: one incubating adult was shot in 1964, due to rough weather conditions in early spring one adult male died of hunger in March 1967 and in 1970 one individual had tangled in the nets in a strawberry garden and died.

Short-eared Owl *Asio flammeus* usually inhabited water meadows near Keila river where also two nest encounters have been made: in 1972 a clutch of 5 was found where later all the nestlings fledged and in 1982 another clutch of 6 eggs was found. Also 4 nest encounters (3 territories) of the Boreal Owl *Aegolius funereus* have been made earlier (1959–1990). This species has been located within 10 different areas, which invariably have been spruce forests or mixed forests with spruce as the dominating tree. Three nests were located in cavities of the aspen whereas two of them were former Black Woodpecker *Dryocopus martius* nests. The fourth nest was found within a park in a shady area of spruces. It was located in a cavity of a linden and produced 4 fledglings by the end of the season. The other two successful breeding attempts of the Boreal Owl produced 4 and 5 fledglings, respectively.

Table 3. Nest location and nest height from ground in three species of raptor birds which preferred former Hooded Crow nests, and those of the crow in Saue.

Tabel 3. *Valdavalt vanades varesepesades pesitsevate röövlinnuliikide ja hallvarese pesakohad ja nende kõrgused maapinnast Sauel.*

Variable *Tunnus*	Species / *Liik* Common Kestrel FALTIN	Hobby FALSUB	Long-eared Owl ASIOTU	Hooded Crow CORNIX
Nest location (% of nests) / ***Pesakoht*** *(% pesadest)*				*
Spruce / *Kuusk*	38	32	25	28
Pine / *Mänd*	48	64	55	44
Birch / *Kask*	3		4	12
Aspen / *Haab*			3	7
Poplar / *Pappel*				1
Oak / *Tamm*			4	2
Linden / *Pärn*				<1
Willow tree / *Remmelgas*				1
Bird cherry / *Toomingas*	3		3	1
Rowan / *Pihlakas*		4		1
Hazel / *Sarapuu*			4	
Juniper / *Kadakas*			1	
Building / *Ehitis*	5			
Pylon / *Elektrimast*	5			
N	*40*	*25*	*69*	*548*
Nest height / *Pesa kõrgus*				
mean / keskmine	10.2	10.8	8.8	
min-max	3.5-20	6.5-20	3.5-22	
N	*39*	*25*	*69*	
Height of nesting tree / *Pesapuu kõrgus*				
Mean / keskmine	13.8	13.2	12.6	
min-max	8-24	7-23	6.5-25	
N	*35*	*25*	*69*	

* *additional 17 nests (3%) on other tree species* / lisaks 17 pesa (3%) teistel puuliikidel

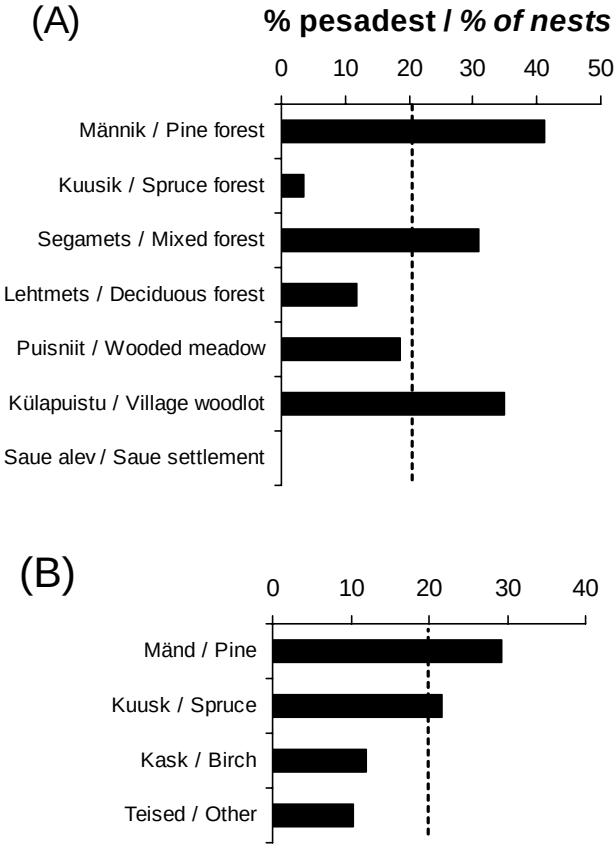

Figure 2. The relative number of Hooded Crow nests occupied by raptors (n = 113) as compared with the number of the nests occupied by crows in different biotopes (A) and trees (B; nests in settlement omitted) in Saue, 1959–2006. Only categories with >20 crow nests have been shown (cf. Table 1); dashed lines indicate the mean.

Joonis 2. *Röövlindude poolt asustatud varesepesade (n = 113) suhteline arv (% hallvarese asustatud pesade arvust; punktiirjoonega keskmine) eri biotoopides (A) ja puudel (B; alevi varesepesad arvestamata). Esitatud on kategooriad, kus oli teada >20 varesepesa (vrd. tabel 1).*

Species diversity is presented in Table 1 and in order to do so an additional number of vulnerable species has been included: Merlin in pine stands (2 nest encounters), Boreal Owl in spruce stands, Eagle Owl (1 nest encounter) and Boreal Owl in mixed coniferous forests, Lesser and Greater Spotted Eagle together with the Pygmy Owl in mixed stands, Hen Harrier and Montagu's Harrier together with Short-eared Owl in wooded meadows (including alvar and floodplain), Boreal Owl in parks and Hen Harrier in open cultivated landscape. In short, according to the distribution above, mixed forest was the biotope with the highest species diversity of raptors in Saue (Table 1). Whereby, in estimating the relative species diversity where area has been taken into consideration it appeared that forests comprising spruce were quite the opposite of the deciduous stands (Fig. 3). Among open landscape types wooded meadows had a significantly higher species diversity compared to modern cultivated landscape.

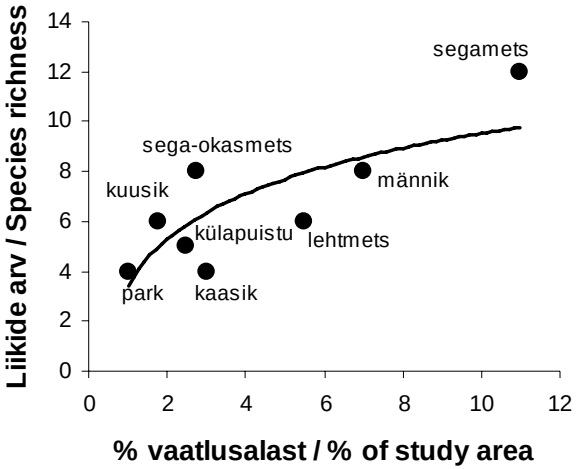

Figure 3. Relationship between the area and species diversity of the raptors for woodland types in Saue. For woodland type names see Table 1.

***Joonis 3**. Puistutüüpide pindala ja röövlinnu-liigirikkuse seos Sauel.*

Discussion

The current summary comprises data of almost half a century, however, remains rather insufficient for making conclusions of the breeding ecology of several raptor species. Therefore, only a few aspects have been discussed below.

Nesting trees and biotopes

Open nesters preferred to breed on conifers providing protection from unsuitable weather conditions as well as from predators, especially in the beginning of the breeding season (*e.g.* Solonen 1982, Tome 2003). Within the observation area pine was about four times more abundant than spruce when considering the total area of pure stands. Pine was also preferred over spruce (1.7 times among Sparrowhawks and 1.2 times among Common Buzzards) by raptors that build their nest themselves. However, Honey Buzzard and Goshawk preferred spruce to pine. The nests of the Lesser and Greater Spotted Eagles were without any exceptions located on spruce. Woodlands comprising spruce had also the highest species diversity. Spruce was the preferred nesting tree for raptors also in north-western Tartu since the shelter that this tree species provides compensates for the rather weak branches (Lõhmus 2006). However, latter is one reason why raptors breeding in former crow nests prefer nests on pines rather than spruces: strong branches support the old nests better to keep them from breaking apart very easily. Therefore, one probable reason for Kestrels and Long-eared Owls to breed in former crow nests might be the shade of spruce that provides protection from these able nest predators and might even be considered as a behavioural adaption of these raptors. For example, for Kestrels, the risk of nest predation rises with crows breeding in the neighbourhood (Kuznetsov 1998). Moreover, in Germany it has been shown that among all nest types, the reproductive success of Kestrels was lowest in open nests (Kostrzewa & Kostrzewa 1997). Therefore, it might be crucial for these birds to find a breeding habitat with stable basis for building a nest but important is also to remain at a safe distance from neighbouring crows.

Table 4. The reproductive parameters of common raptor species in Saue.

Tabel 4. *Tavaliste röövlinnuliikide sigivusnäitajad Sauel. LV pesakond – lennuvõimeline pesakond.*

Species and period *Liik ja period*	Mean (sample size) / *Keskmine (valimi suurus)*				
	breeding success, % *pesitsusedukus, %*	clutch size *täiskurn*	brood size *pesakond*	size of fledged brood *LV pesakond*	productivity *produktiivsus*
HoneyBuzzard, PERAPI	**88 (17)**	**1.9 (8)**	**1.6 (11)**	**1.2 (15)**	**1.06 (17)**
1959–1970	100 (4)	2.0 (2)	1.7 (3)	1.3 (4)	1.25 (4)
1971–1982	67 (6)	2.0 (3)	2.0 (1)	1.3 (4)	0.84 (6)
1983– 1994	100 (2)	1.0 (1)	1.0 (1)	1.0 (2)	1.00 (2)
1995–2006	100 (5)	2.0 (2)	1.5 (6)	1.2 (5)	1.20 (5)
Goshawk, ACCGEN	**72 (39)**	**3.5 (8)**	**3.1 (15)**	**3.1 (28)**	**2.20 (39)**
1959–1970	50 (4)	4.0 (1)	3.0 (4)	3.5 (2)	1.75 (4)
1971–1982	71 (14)	3.3 (4)	3.5 (6)	3.6 (10)	2.57 (14)
1983–1994	67 (9)	3.5 (2)	3.0 (3)	2.5 (6)	1.67 (9)
1995–2006	83 (12)	4.0 (1)	2.5 (2)	2.8 (10)	2.33 (12)
Sparrowhawk, ACCNIS	**73 (15)**	**4.0 (9)**	**3.3 (8)**	**2.9 (12)**	**2.14 (15)**
1959–1970	50 (2)	5.0 (1)	4.0 (1)	4.0 (1)	2.50 (2)
1971–1982			3.0 (1)		
1983–1994	67 (3)	4.7 (3)		4.0 (2)	2.67 (3)
1995–2006	89 (9)	3.4 (5)	3.2 (6)	2.6 (9)	2.28 (9)
Common Buzzard, BUTBUT	**61 (140)**	**2.6 (35)**	**2.1 (47)**	**1.9 (86)**	**1.14 (140)**
1959–1970	58 (19)	4.0 (3)	3.0 (4)	2.5 (11)	1.42 (19)
1971–1982	62 (26)	2.8 (9)	2.4 (8)	1.8 (16)	1.11 (26)

1983–1994	69 (29)	2.4 (5)	2.0 (5)	1.7 (20)	1.14 (29)
1995–2006	59 (66)	2.3 (18)	1.9 (30)	1.8 (39)	1.08 (66)
Common Kestrel, FALTIN	**83 (54)**	**4.6 (16)**	**3.9 (21)**	**3.2 (44)**	**2.69 (54)**
1959–1970	81 (16)	5.0 (5)	3.9 (10)	3.3 (12)	2.71 (16)
1971–1982	79 (14)	4.2 (5)	3.8 (6)	3.5 (11)	2.71 (14)
1983–1994	75 (4)	4.5 (2)	4.0 (1)	4.0 (3)	3.00 (4)
1995–2006	90 (20)	4.5 (4)	3.8 (4)	2.9 (18)	2.60 (20)
Hobby, FALSUB	**72 (25)**	**3.6 (8)**	**2.8 (5)**	**2.5 (18)**	**1.80 (25)**
1959–1970	75 (8)	4.0 (3)	3.0 (1)	2.5 (6)	1.88 (8)
1971–1982	75 (8)	3.0 (2)	4.0 (1)	2.7 (6)	2.00 (8)
1983–1994	67 (3)	4.0 (1)		2.0 (2)	1.33 (3)
1995–2006	67 (6)	3.5 (2)	2.3 (3)	2.5 (4)	1.67 (6)
Tawny Owl, STRALU	**67 (27)**	**4.0 (1)**	**3.0 (3)**	**2.8 (18)**	**1.85 (27)**
1959–1970					
1971–1982	63 (8)	4.0 (1)		3.0 (5)	1.88 (8)
1983–1994	88 (8)		3.0 (3)	3.1 (7)	2.75 (8)
1995–2006	60 (10)			2.2 (6)	1.30 (10)
Long-eared Owl, ASIOTU	**79 (56)**	**4.3 (17)**	**3.7 (14)**	**3.5 (44)**	**2.71 (56)**
1959–1970	80 (5)	4.5 (4)	3.0 (1)	3.8 (4)	3.00 (4)
1971–1982	83 (12)	4.5 (2)		3.7 (10)	3.08 (12)
1983–1994	79 (14)	5.0 (1)	4.0 (2)	3.6 (11)	2.86 (14)
1995–2006	76 (25)	4.0 (10)	3.7 (11)	3.2 (19)	2.40 (25)

The biggest difference in habitat preference among large raptors occurred between Honey Buzzard and Goshawk who clearly favoured mixed deciduous forest and coniferous forest, respectively. Evidential is the shelter that deciduous forest provides for the Honey Buzzard in late spring. Goshawk, therefore, does not have this advantage within the coniferous habitat in early spring. In Germany, another reason for the drastic differences in habitat preference between these two species has been suggested to be the threat that Goshawk opposes to Honey Buzzard (Kostrzewa 1991). Even though latter possibility does not find any support by the data collected in Estonia (Lõhmus 2004a) it still cannot be excluded. For example, in Saue, the habitat of the Common Buzzard was observed to be in-between these two biotopes; the same situation has been registered in Germany (Kostrzewa 1996) where the threat of the Goshawk to Common Buzzard has been successfully demonstrated (Krüger 2002). Goshawks killing Common Buzzards has found evidence also in Estonia (Lõhmus 2004a) and in case this species is trying to avoid the neighbourhood of the Goshawk (Kostrzewa 1991) it is possible that this might also be the case of the Honey Buzzard.

Breeding success

A comparison of several observation areas of raptors in Estonia has been carried out during 1994 – 2003. With reference to the main parameters for estimating reproductive success (Lõhmus 1999, 2004b), in Saue, significantly higher values have been demonstrated for 5 of the most common raptor species out of 8 (Table 4). Reproductive success of the other 3 species (Sparrowhawk, Common Buzzard, Tawny Owl) remains moderate. This comparison, however, is not quite correct since observations have been carried out during different periods of time and occasional observations may lead to methodical errors. Above all, occasional observations might overestimate the relative importance of successful breeding attempts. This may happen because nests that had been inhabited but failed early in the season remain unnoticed. In Saue, latter may be the case of the Honey Buzzard, despite the major contrast in breeding success (except the number of nestlings) between regions (Lõhmus *et al*. 1997). Moreover, in Saue the 90% breeding success is far

exceeding the maximums that have been shown for Estonia in the past (south-western Estonia 60–67%; Lõhmus *et al*. 1997, Väli & Laansalu 2002). Four species also exceeded the values for the mean number of fledglings (the only factor concerning falcons) of Estonia, which is suggesting an even smaller probability of methodical errors.

An even stronger effect on the results of the reproductive success may be opposed by changes that have occurred during several decades. Even though the data available does not enable more precise analyses it appears from Table 4 that an obvious decline has occurred in the breeding parameters (especially the number of fledglings per nest) of several species. For example, 5 out of 8 species (also rather low for Hobby) show the lowest reproductive success for the latest observation period. A similar tendency has been observed for the brood size of Tawny Owl and Long-eared Owl in the eastern and southeastern Estonia (Lõhmus *et al*. 1997). Considering the rather good status of the raptors of Estonia (*e.g*. Elts *et al*. 2003) a survey on the long-term decline in the reproductive success together with its possible causes would be an intriguing project for the future. Obviously, in order to make regional comparisons in the reproductive success of the raptors of Estonia it is essential to use the data of close periods of time.

In Estonia, there does not exist such systematic data as presented above. Nevertheless, the present data is supporting the idea that such high mean breeding parameters in Saue may above all be due to the period of time. The mean reproductive success of the Common Kestrel in eastern and southeastern Estonia (see Lõhmus *et al*. 1997) during 1959-1996 was 2.62 fledglings per breeding pair whereas during 1986-1996 it was similar to that of Saue or even somewhat higher in the case of Goshawk (2.36), Common Buzzard (1.13) and Hobby (1.98). Even though there is no pronounced tendency in the reproductive success of the Goshawk, in Saue, a significant decline in the numbers has been registered during the past few years (like in the rest of Estonia; Lõhmus 2004b). Therefore, the relative number of non-breeding territorial pairs and single individuals has been growing but has not been included for estimating the reproductive success. However, the number of Goshawks in the border area of Tallinn is rather high whereas even the

urban area has been successfully inhabited (according to E. and A. Tuule, written data of T. Drevsi).

Long-eared Owl is the only species in Saue that during the past 12 years has clearly exceeded (2.40) the values of the mean reproductive success of all the species in Estonia (less than 2.0; Lõhmus 1999, 2004b). Moreover, until 1970 the mean clutch size (4.5) and the mean number of fledglings (3.8) have exceeded the corresponding mean numbers for Estonia (4.2 and 3.2 respectively; Randla 1976). Therefore, the surroundings of Saue are a suitable habitat for this particular species.

The other numerous owl species in Saue is Tawny Owl. However, as human impact is becoming more and more intensive it is becoming a disturbing factor for the owls. The number of suitable nesting trees within parks and villages is declining and might become a limiting factor for this species (Lõhmus 2002).

Presumably the urban sprawl of Tallinn may seriously affect the future composition, numbers as well as breeding success of the raptors in the Saue observation plot. An unfortunate observation that became evident when studying the death causes of the birds is the fact that slaughtering of raptors in the beginning of the observation period (5 cases during 1959–1970, 4 cases during 1971–1982) which came to an end in the meantime (1983–1994) has been occurring once again (3 cases during 1995–2006).

Röövlindude pesitsusökoloogiast Saue ümbruses 1959.–2006. a.

Kokkuvõte. Artiklis käsitletakse 348 pesaleiu ja 405 asustuskorra põhjal 17 röövlinnuliigi pesitsusökoloogiat (pesitsusbiotoobi ja pesapuu valikut, pesa kõrgust, pesitsusedukust, täiskurna, rõngastusealise ja lennuvõimestunud pesakonna suurust ning produktiivsust) Harjumaal Saue ümbruses 60–90 km^2 suurusel alal 1959.–2006. a. Risupesades pesitsejad eelistasid okaspuid, kusjuures pesi enamasti ise ehitavad haukalised eelistasid kuuske männile, kolm valdavalt hallvarese vanades pesades pesitsevat liiki aga mändi kuusele. Tõenäoliselt on viimaste jaoks männi kindlamad tugioksad olulisemad kui parem

varjatus kuusel. Kõige rohkem liike leiti pesitsemas segametsades ning lehtmetsad olid suhteliselt liigivaesemad kui kuuse osalusega puistud. Suuremate kulliliste pesitsusbiotoopide seas vastandus herilaseviu sega- ja lehtmetsalembus kanakulli okasmetsa-eelistusele, mis võib tuleneda nii herilaseviu hilisest pesitsussesoonist kui ka kanakulli naabruse vältimisest. Kaheksast tavalisemast röövlinnuliigist viie pikaajaline sigivus oli suurem (ja ülejäänud kolmel samal tasemel) kui Eesti viimaste aastate keskmine. Avaldatud andmed viitavad siiski röövlindude sigivuse üldisele vähenemisele Eestis viimase poole sajandi jooksul, mistõttu Saue näitajad võivad olla kõrged varasemate aastakümnete hõlmamise, mitte niivõrd piirkondliku eripära tõttu.

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