Study of birdlife and bats in areas potentially suitable for wind farms in Valga's special plan areas

Pursuant to § 53(1) of the Nature Conservation Act, disclosure of the exact location of the habitat of species in protection categories I and II in the mass media is prohibited

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The research report was completed in September 2024 and supplemented in January 2025 in accordance with the comments submitted by the Environmental Board in its letter No. 6-5/24/7768-5 dated 17 December 2024.

Table of contents

Introduction

The aim of this study is to assess the impact of the construction and operation of wind turbines on birds and bats in four study areas within the Valga municipality wind energy special planning area that are potentially suitable for the establishment of a wind farm. To this end, existing data from the EELIS (Estonian Nature Information System), the Environmental Agency (hereinafter *EELIS)* and PlutoF databases was compiled. In addition, field studies were conducted in 2023 to determine the use of the study areas by birds and bats.

As part of this work, a study of birds and bats was carried out in four study areas located in the Valga municipality within the special planning area for wind energy (Figure 1). The location of the study areas, together with a 500 m buffer zone, was specified in the initial terms of reference for the study. The study areas are of interest to parties interested in special planning for the construction of wind farms, i.e. they are potentially suitable areas for the construction of wind farms. The aim of the study was to determine the suitability of the areas under investigation for the construction of wind farms, including restrictions related to birdlife and bats and the necessary mitigation measures.

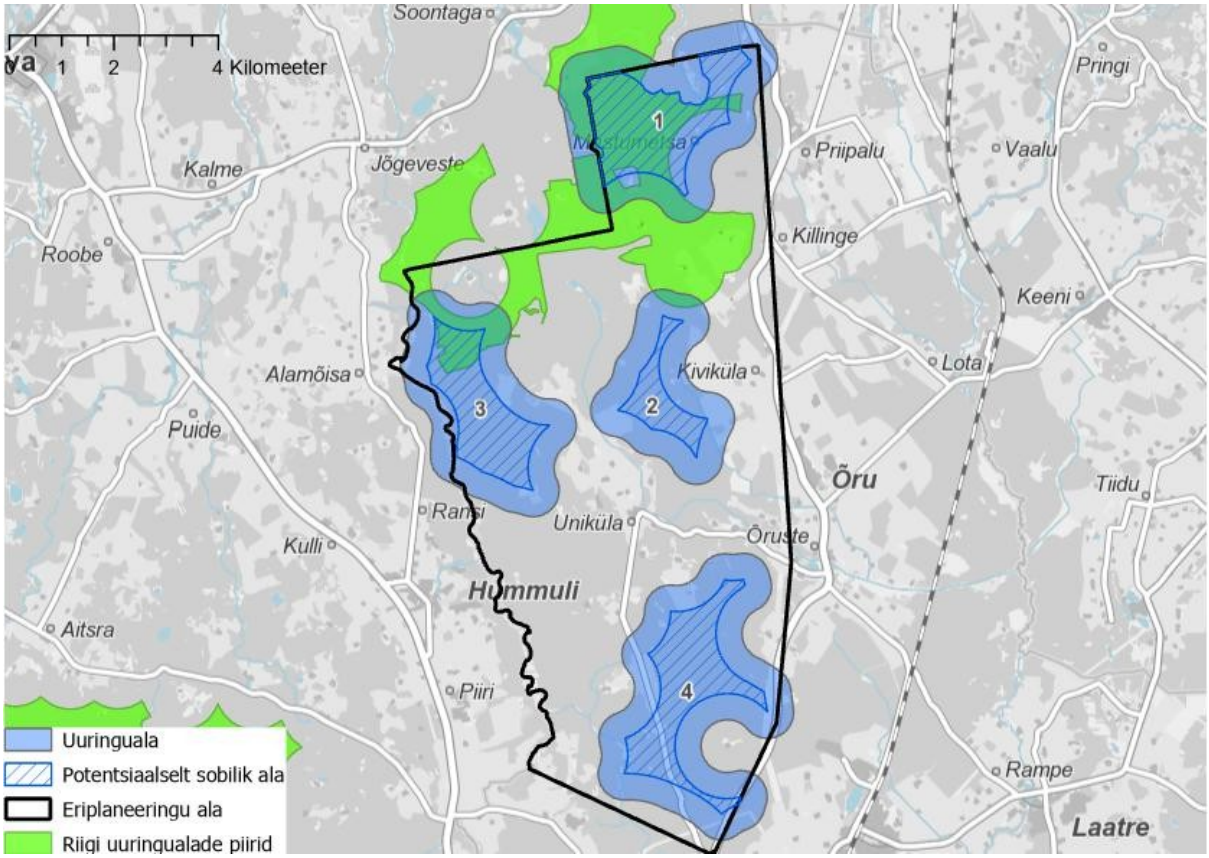

Figure 1. Location of the study areas.

Table 1. Data on potentially suitable areas and the areas of the study areas.

Designation	Potentially suitable area, ha	Area of study area, ha
1	431	1090
2	131	594
3	331	891
4	391	123

Areas 1 and 3 covered by this study overlap with the Valga-Tõrva potential priority development area being studied by the state, for which nature studies are being conducted by the Environmental Agency. At the time of compiling this

study report, the second interim report of the bird survey[1] had been completed, and its data was taken into account in the preparation of the study report.

[1] Loodustaju OÜ. 2023. Interim report II of the public procurement "Bird survey to identify priority development areas for wind energy for the Environmental Agency". Public procurement reference number 260767. Part 13 Valga-Tõrva.

1 Bird survey

1.1 Material and methodology

The following work was carried out during the bird survey:

1. Existing bird data was compiled from the following sources:
    - EELIS;
    - PlutoF;
    - Estonian Ornithological Society, Eagle Club. 2022. Analysis of terrestrial bird populations across Estonia. Public procurement no. 239156. Map layers from the Environmental Agency's spatial data service.
2. Point observations of bird populations were carried out.

    Focus species: all species were recorded, but priority was given to protected and conservation-important species, especially hawks, falcons, black storks, cranes, geese, etc. Observation points were selected in the study area so as to cover at least half of the study area, preferably at least 75–80%. The initial selection of observation points was made using orthophotos, and the number and location of observation points was later specified during preparatory fieldwork. The location of the observation points is shown on separate drawings for each study area.

    In spring (March to May), summer (June to August) and autumn (September to November), counts were carried out from predetermined counting points. The minimum number of census hours was 36 hours in one area in autumn (September-November), 36 hours in spring (March-May) and 18 hours in summer (June-August). The length of one observation cycle (one census from one observation point) was 2-3 hours. Observations could be made from different observation points on the same day. The counting times were preferably distributed evenly throughout the daylight hours. Depending on the bird group and phenomenon, it was necessary to pay more attention to certain parts of the day. For example, in the case of migration, most species are more active during the four hours after sunrise, while birds of prey are more active around midday, when rising air currents have formed.

    The following were recorded bird species, number (in the case of flocks), flight altitude (using laser binoculars or estimating flight altitude using objects of known height), the time spent by the bird in the study area (seconds) and, preferably, the flight trajectory sketched on a field card or smart device. A quantitative estimate of the frequency of bird use of the airspace in the area was obtained, as well as input for species-based collision frequency prediction models, if these are decided to be used.

3. An inventory of breeding birds was carried out. For this purpose, the nesting territories of protected bird species were mapped using the point count method[2] and a decoy count was carried out for woodpeckers, hazel grouse and capercaillie[3] . In addition, an inventory of forest birds (primarily capercaillies) was carried out in study areas 1 and 4 (described in more detail in the relevant areas). Large nesting sites were searched for separately in study areas 3 and 4 (in addition, nests were searched for during the decoying of woodpeckers, hazel grouse and black grouse), and in study areas 1 and 2, nests were searched for in parallel with decoy counts, and the occupancy of known black grouse nests was also checked.
4. An assessment of the suitability of the black stork's feeding area and the sustainability of its habitat was compiled.

[2] https://www.eoy.ee/ET/13/14/punktloendus/

[3] https://www.keskkonnaagentuur.ee/seireankeedid (Woodpeckers)

1.2 General description of the impacts on birdlife

Wind farms affect birds in three main ways[4]:

1) Birds may be killed by collision with wind turbine blades or masts.
2) Their existing habitats change or are damaged and are no longer suitable for birds.
3) Disturbance forces birds to change their habitat.

The impact of wind turbines on birds is most evident in collision mortality – flying birds may collide with wind turbines (primarily with the blades, but there are also examples of birds flying into the mast) and associated infrastructure, resulting in death or injury. Bird collisions with wind turbines are not particularly frequent, but birds, including protected species, are killed in wind farms. The risk depends primarily on the location of the wind farm, the terrain and the behavioural characteristics of the bird species. Gliders, including storks and cranes, and especially birds of prey, which often do not avoid wind farms collide with wind turbines relatively frequently([5]).

The risk of collision is also linked to the barrier effect – in order to avoid the wind farm, birds must fly past or above the wind farm, which reduces the usability of certain habitats or increases the birds' energy expenditure[6] . The barrier effect has a more significant impact on larger (i.e. covering a large area) wind farms or in cases where a wind farm is built on a regular bird migration route (e.g. a migration route or daily flight path between nesting and feeding areas). Considering the size and location of the Valga study areas inland, away from the main migration corridors, no significant barrier effect on bird populations is expected in the case of this specific plan.

The construction of wind farms may also be accompanied by a direct loss of bird habitat and a decline in habitat quality due to disturbance[7]. The direct loss of habitat resulting from the construction of wind turbines is usually relatively minor, but the construction of access roads and electrical connections must also be taken into account at the construction sites of wind turbines. Disturbances affecting habitat quality caused by wind farms occur during the construction phase, during the operation of the wind turbines and during the dismantling phase. The source of disturbance may be the wind turbines themselves (including noise generated by the wind turbines[8] , flickering light and shadows) and/or other related infrastructure, or increased human activity associated with the wind farm e[9] (both wind farm maintenance and other traffic using the access roads).

The extent and significance of the disturbance varies depending on the species and species group and possible habituation to wind turbines[9] . Bird groups that are considered to be more sensitive to disturbances associated with wind farms (and therefore more likely to avoid wind farms) include swans, geese, cranes, waders and some species of passerines. More recent studies have confirmed that forest birds (e.g. capercaillies)[9,10] avoid wind farm areas.

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[4] Mägi, M. 2022. Analysis of terrestrial birdlife across Estonia. Public procurement no. 239156. Report. Appendix 3. Wind turbines and birds – review of scientific literature. Available at: https://kliimaministeerium.ee/elurikkus-keskkonnakaitse/looduskaitse/uuringud-projektid-ja-analuusid#analuus-ja-lisad

[5] De Lucas, M and Perrow, M.P, 2017. Birds: displacement. In: Martin R. Perrow (ed): Wildlife and Wind Farms, Conflicts and Solutions. Volume 1 Onshore: Potential Effects. Chapter 8

[6] Hötker, H., 2017. Birds: displacement. In: Martin R. Perrow (ed): Wildlife and Wind Farms, Conflicts and Solutions. Volume 1 Onshore: Potential Effects.

[7] Nazir MS, Bilal M, Sohail HM, et al. 2020. Impacts of renewable energy atlas: Reaping the benefits of renewables and biodiversity threats. International Journal of Hydrogen Energy 45: 22113–22124, https://doi.org/10.1016/j.ijhydene.2020.05.195

[8] López-Peinado A, Lis Á, Perona AM, López-López P . 2020. Habitat Preferences of the Tawny Owl (Strix aluco) in a Special Conservancy Area of Eastern Spain. Journal of Raptor Research 54: 402–413, https://doi.org/10.3356/0892-1016-54.4.402

[9] Coppes, J., Braunisch, V., Bollmann, K., Storch, I., Mollet, P., Grünschachner-Berger, V., Taubmann, J., Suchant, R., Nopp-Mayr, U., 2020. The impact of wind energy facilities on grouse: a systematic review. Journal of Ornithology (2020) 161:1–15.

[10] Taubmann, J., Kämmerle, J-L., Andrén, H., Braunisch, V., Storch, I,, Fiedler, W., Suchant, R. and Coppes, J., 2021. Wind energy facilities affect resource selection of capercaillie Tetrao urogallus. Wildlife Biology 2021 (1),. https://doi.org/10.2981/wlb.00737.

As a result of disturbances, birds may no longer use habitats in or near wind farms, or may use them less frequently[11].

The primary task in reducing the impact on birdlife is therefore to carefully select the location of the wind farm [12]. The primary task in selecting a location is to avoid planning wind turbines in areas that are most sensitive from the point of view of birdlife and near the habitats of species that are sensitive to disturbance or prone to collision.

1.3 Study area 1

1.3.1 Overview of registered habitats of protected species

The EELIS database was analysed for species in protection category I within a 5 km radius of the study areas, for species in protection category II within a 2 km radius, and for species in protection category III in areas overlapping with the study areas. The data used is as of 01.04.2024.

The black stork (*Ciconia nigra*) habitat KLO9128283 is located 2.6 km from the study area. According to the Estonian Red List of Threatened Species (2019 assessment), the black stork is classified as 'critically endangered'. The nest (id -1036847573) is located 3 km from the study area (Figure 2). The habitat was last monitored on 31 May 2023 as part of national monitoring, when it was not inhabited by the target species. According to the monitoring, the nest was last occupied in 1999, when there were three chicks in the nest**. Thus, based on the monitoring, the habitat has not been occupied for the last 24 years.**

Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, no large-scale logging has taken place in the habitat forest. Therefore, the forest area suitable for the habitat has been preserved. EELIS has no information that the nest has collapsed, nor is there any information on the condition of the nest tree.

Based on an analysis of the feeding areas of black storks equipped with GPS transmitters (hereinafter GPS analysis)[13], there is one known feeding water body for black storks in the study area (Soontaga stream, VEE1012700). The feeding areas for black storks were determined on the basis of data from all years monitored with suitable transmitters (2007-2022). Based on the analysis of GPS data, this is not a priority feeding water body. The feeding water body is located outside the potentially suitable wind farm area.

The registered habitat **of the osprey (*Pandion haliaetus*)** KLO9129625 is located 2.6 km from the study area. According to the Estonian Red List of Threatened Species (2019 assessment), the osprey belongs to the category "vulnerable". The nest (id -1178468493) is located 3.1 km from the study area (Figure 2). As part of national monitoring, the habitat was last checked on 17 July 2022, when it was not inhabited by the target species. According to monitoring data, the nest was last occupied in 2018, when one dead chick was found in the nest. Therefore, based on monitoring, the habitat has not been occupied in the last five years. According to EELIS data, the nest was occupied in all monitoring records in the period 2000–2018. The 2020 monitoring data indicate that it is an artificial nest.

Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, no large-scale logging has taken place in the forest habitat. Thus, the forest area suitable for the habitat has been preserved.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129608 is located 2.9 km from the study area. The nest (id -1772107859) is located 3 km from the study area (Figure 2). According to the Estonian Red List of Threatened Species (2019 assessment), the lesser spotted eagle belongs to the 'near threatened' category. As part of national monitoring, the habitat was last checked on 1 August 2023, when it was not inhabited by the target species. Based on monitoring, the nest was last occupied by a lesser spotted eagle in 2011, when the nest was established and one chick was raised there. From the Environmental Agency's spatial data service

[11] Mägi M, Saag P. 2024. The impact of wind turbines on fauna: mitigation and compensation measures. Environmental Board
[12] Mägi M, Saag P. 2024. The impact of wind turbines on wildlife: mitigation and compensation measures. Environmental Board
[13] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

Based on the available map layer of terrestrial bird species, a reduced 1 km zone 1 area is recommended for this habitat.

Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, no large-scale logging has been carried out in the forest habitat. However, regeneration felling has been carried out in forest areas adjacent to the habitat.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129305 is located 3.3 km from the study area. The nest (id 212990292) is located 3.6 km from the study area (Figure 2). As part of national monitoring, the habitat was last checked on 1 August 2023, when it was uninhabited by the target species and the nest had collapsed. According to the monitoring, the nest was last established in 2019, when the nest was established but breeding failed. According to the EELIS database, the nest was also inhabited in 2018, when it was first registered. According to the Land Board's forest change map data (for the period 2012–2021), no large-scale logging has taken place in the forest habitat since the nest was first registered.

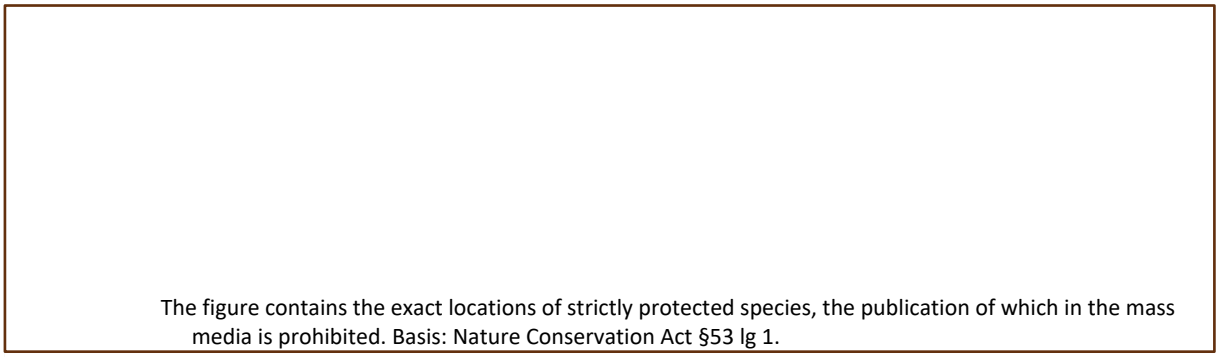

Figure 2. Registered habitats of Category I protected bird species within a five-kilometre radius of Study Area 1 and feeding waters determined on the basis of GPS analysis[14]of black storks.

According to the Estonian Red List of Threatened Species (2019 assessment), the northern goshawk belongs to the 'vulnerable' category. Study area 1 overlaps with the habitat of **the northern goshawk (*Accipiter gentilis*)** KLO9133077 (Figure 3). This habitat also overlaps with a potentially suitable wind farm area. The habitat was registered on 31 July 2023. It is in satisfactory condition. The nesting tree is a spruce and one young bird was observed in some places. The habitat was registered after the analysis of the terrestrial bird fauna was completed.

Study area 1 overlaps with the habitat of **the northern goshawk (*Accipiter gentilis*)** KLO9120519 (Figure 3). The last habitat observation according to the EELIS database was on 24 April 2023, when the nest had fallen down. The habitat was registered

[14] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

EELIS in 2015 and has been established with varying success between 2015 and 2020. Successful nesting was last recorded in 2020.

The figure contains the exact locations of strictly protected species, the publication of which in the mass media is prohibited. Basis: Nature Conservation Act §53 lg 1.

Figure 3. Registered habitats of the capercaillie and zones analysed for terrestrial bird species within a two-kilometre radius of study area 1. ***Habitat KLO9133077 was not registered at the time of the terrestrial bird species analysis.***

According to the Estonian Red List of Threatened Species (2019 assessment), the capercaillie belongs to the 'vulnerable' category. The study area overlaps with the **capercaillie (*Tetrao urogallus*)** habitat KLO9131764 (Koopesoo, Figure 4). The last observation in the EELIS database is from 16 April 2021, when three capercaillie cocks were counted and it was noted that the lek was populated. This is a habitat registered on the basis of habitat modelling. According to map data, no significant logging has taken place in the habitat in recent years.

The capercaillie (*Tetrao urogallus*) habitat KLO9101751 (Virna, Figure 4) is located 670 m from the study area. The last observation in the EELIS database is from 22 April 2018, when three capercaillie cocks were counted. No significant logging has been carried out in the habitat in recent years, based on map data.

Based on the analysis of terrestrial bird species, almost the entire study area overlaps with capercaillie zones 1 and 2, which means that, according to habitat modelling, it is a suitable habitat for capercaillie and its buffer zone. In addition, the area borders on the capercaillie habitat Koopesoo (KLO9131764), which was entered into EELIS on 9 July 2024.

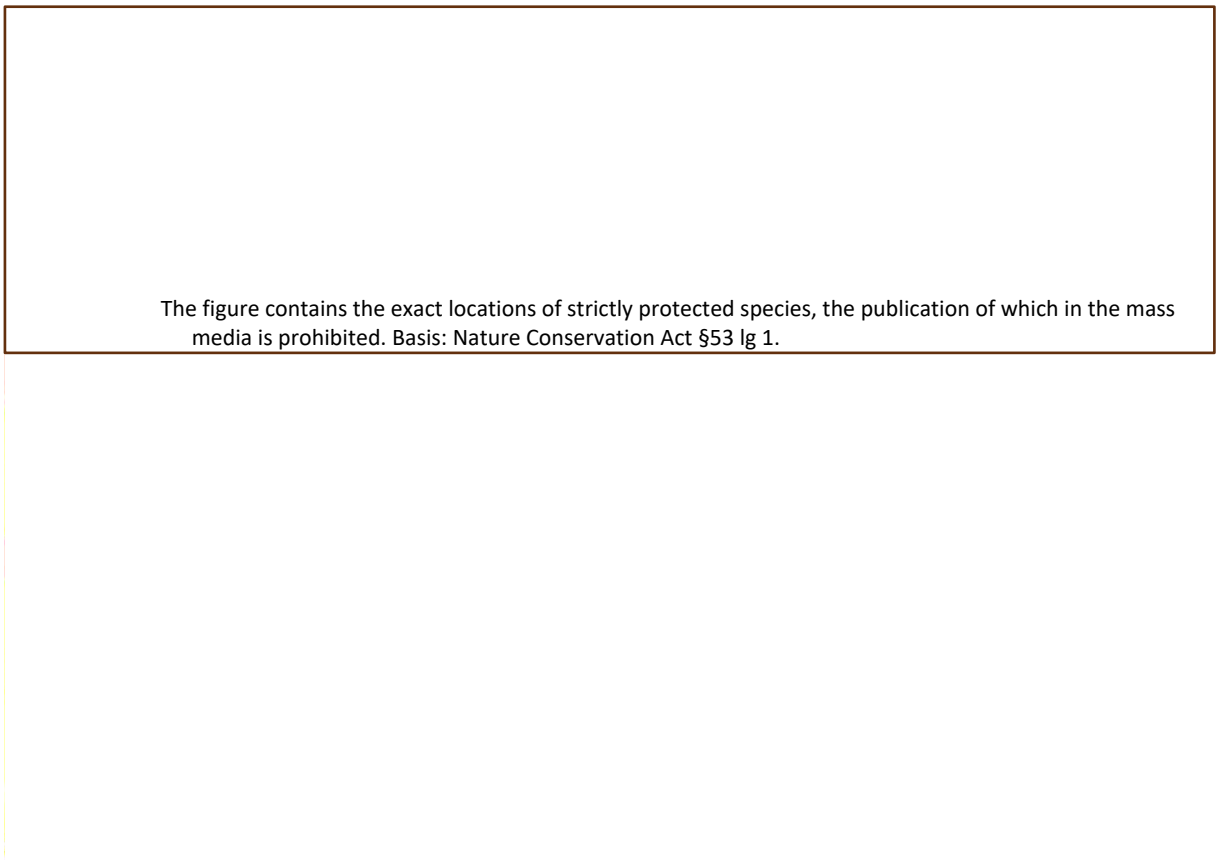

Figure 4. Registered habitats of the capercaillie and zones of analysis for terrestrial birds within a two-kilometre radius of study area 1. In addition, area 1 is adjacent to the Koopesoo (KLO9131764) habitat of the capercaillie, which was entered into EELIS on 9 July 2024.

Based on the EELIS database, the locations of bird species in protection category III are shown in Figure 5 B. The habitats of species in protection category III in this area have been entered into EELIS mainly on the basis of the Repower project study[15]commissioned by the Environment Agency in 2024.

According to the analysis of terrestrial bird species, there is an overlap between study area 1 and zone 3 areas, i.e. the modelled habitats of the hazel grouse (*Tetrastes bonasia*) (Figure 5).

[15]https://keskkonnaportaal.ee/sites/default/files/2024-10/REPowerEU_KAURi_survey areas_final report_20241009_public.pdf

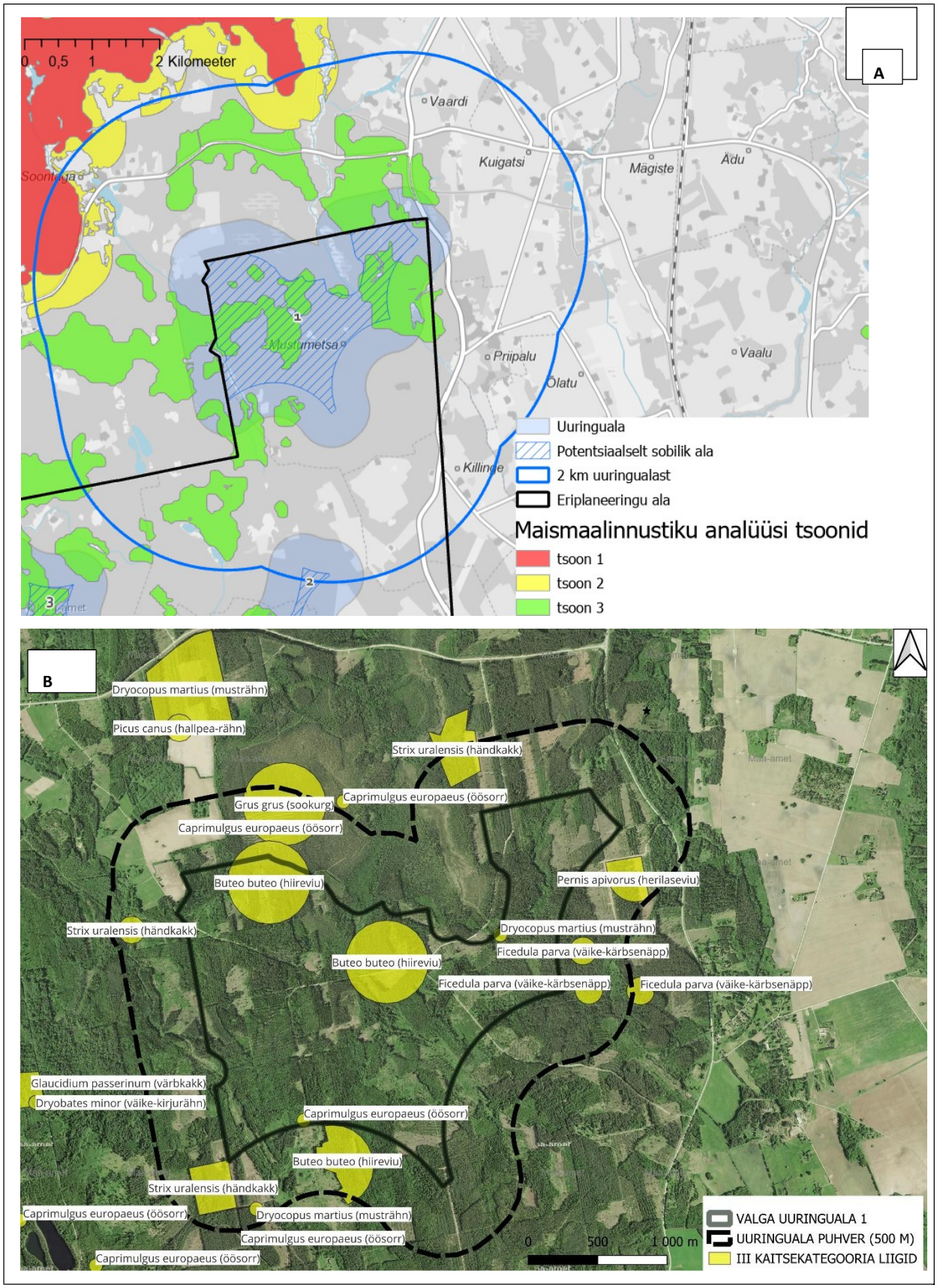

Figure 5. Analysis zones for terrestrial bird species within a two-kilometre radius of study area 1 and species in protection category III found in the study area and its 500-metre buffer zone.

According to the terrestrial bird analysis, there is little overlap between study area 1 and zone 3 of the greater white-fronted goose (*Anser albifrons*) in the northern part.

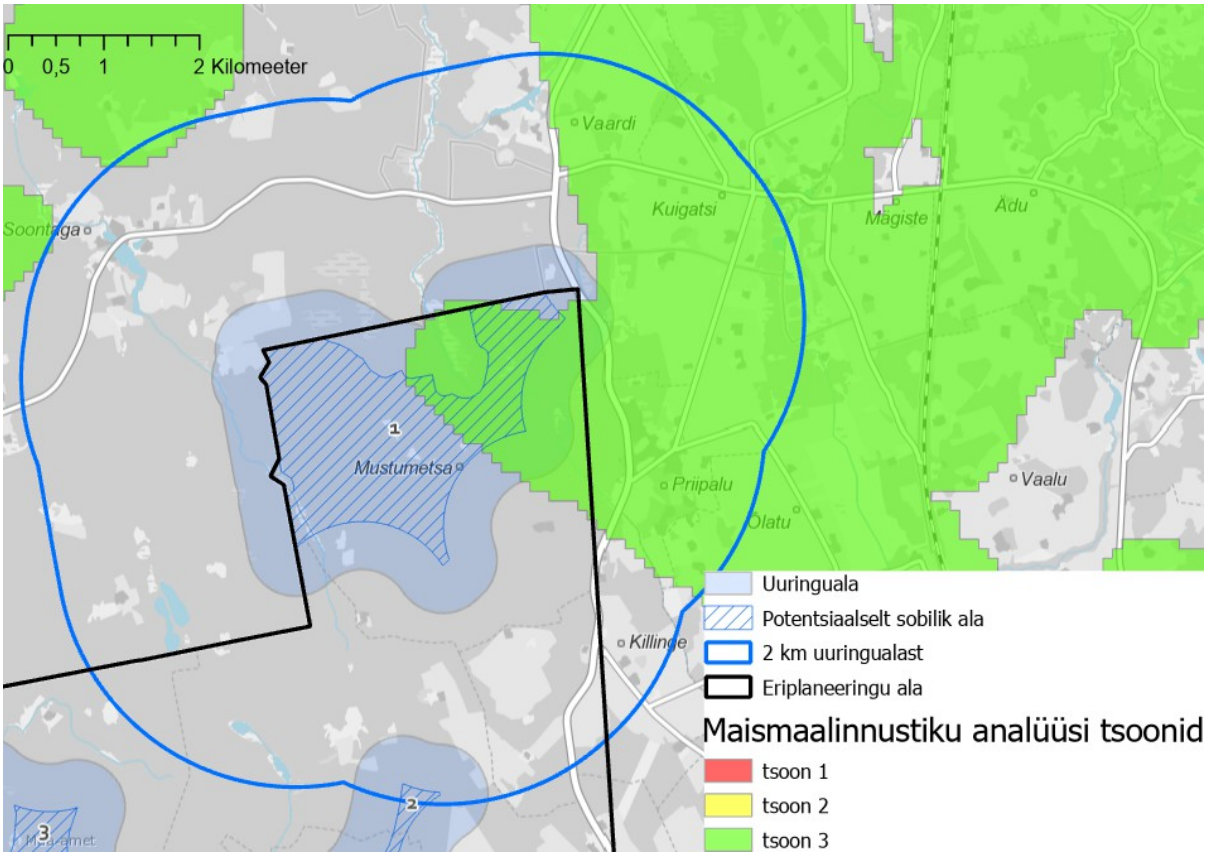

Figure 6. Greater white-fronted goose terrestrial bird analysis zones within a 2 km radius of study area 1.

1.3.2 Observations of capercaillie and other waterfowl

As the capercaillie is predominantly a sedentary bird, its habitat requirements must be taken into account in various dimensions based on its ecology (Capercaillie KTK, 2015):

- a very limited area, i.e. the immediate mating area (approx. 50 ha);
- up to 3 km^2 in relation to the landscape i.e. within a 1 km radius of the lekking area;
- at the regional level (up to 20-30 km^2 or an area within a 3 km radius around the lekking area, connecting several lekking areas (cit in Metsise KTK, 2015: Sjöberg, 1996; Linden et al., 2000; Sirkiä et al., 2011).

The habitat requirements of the capercaillie also depend on gender and the seasonality of life cycles:

- mating season (male birds);
- breeding season (female birds);
- habitat requirements outside the breeding season (males and females in summer, autumn and winter).

In study area 1 in Valga, fieldwork on capercaillies and other grouse species was carried out between April and May (03.04.2023, 07.04.2023, 16.04.2023, 22.04.2023, 10.05.2023; Figure 7). For capercaillies, the model of capercaillie leks compiled by M. Leivits (2021) was used as a basis, and potential leks were selected, where characteristic short droppings were sought under and around lekking trees. Longer droppings were identified as feeding trees, which are important feeding areas for capercaillies. Koopesoosse (also known as

as Priipalu bog, which was restored by RMK[16] 2021–2022) in April to obtain additional information about the cocks visiting the mating grounds in addition to the morning capercaillie count (Figure 7). The trail cameras were placed near potential mating trees, which were identified based on the presence of short droppings. The trail cameras were removed in the first half of October.

[16] https://media.rmk.ee/files/Priipalu_projekt.pdf

The figure contains the exact locations of strictly protected species, the publication of which in the mass media is prohibited.
Basis: Nature Conservation Act §53 lg 1.

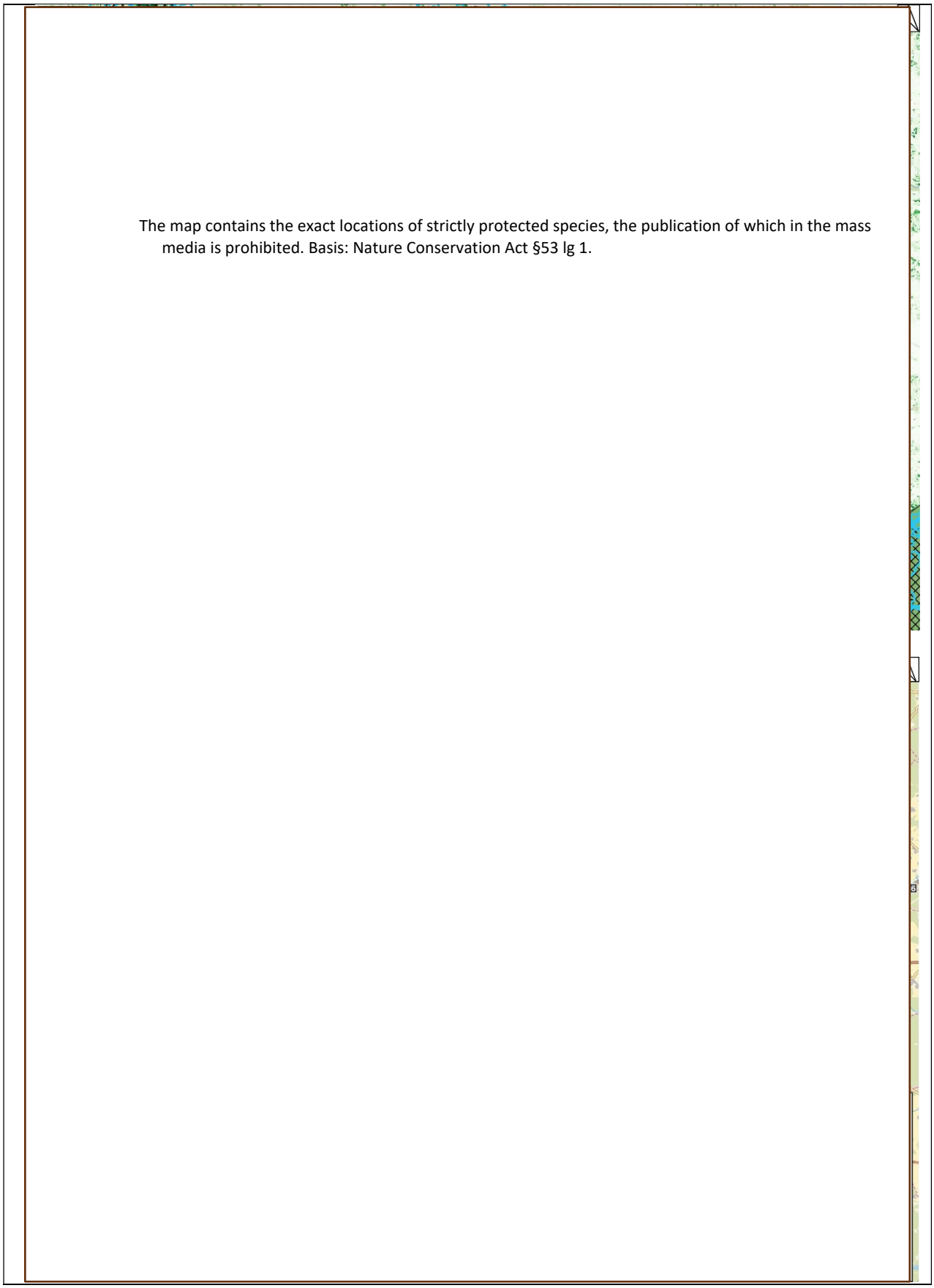

Figure 7. Based on the capercaillie mating model, capercaillie search areas were created where capercaillie mating is most likely to occur. The printed letter indicates the name of the area and the number indicates the area in hectares. The capercaillie

mating area is located in areas E and D, while areas A, B, C, F and G are capercaillie feeding areas based on fieldwork. Figure (7 B) shows the important core areas for capercaillies, step boards, the prediction model for lekking areas and the MLA (2022) connection corridors between sub-regions in relation to possible development areas; Figure 7 C shows a diagram of capercaillie nesting sites instead of lekking sites and the capercaillie perches D created on the basis of these.

Based on the EOÜ MLA (2022), the study areas overlap with capercaillie zone 2, which consists of connection corridors between sub-regions (see **Figure 7B** and **Figure 7C**). The infrastructure to be built may hinder capercaillie movements, as quarries, wind turbines, power lines and roads may be obstacles to capercaillie movements between habitats. **This may lead to fragmentation of the capercaillie metapopulation, a decrease in the genetic diversity of subpopulations and an increased risk of their extinction (draft capercaillie conservation plan). According to the draft, the Koopesoo site (KLO9131764) is a capercaillie stepping stone, but the Virna site, which is also a capercaillie lekking site, is not included. Based on the capercaillie lekking site model, connectivity between the northern Koopesoo lekking site and the southern Virna lekking site is ensured, with a 1 km buffer zone taken into account for both lekking sites, and no wind turbines recommended for the study area. Significant traces of capercaillie activity (primarily feeding areas) were also observed in the pine forests of study area 4. However, according to both the capercaillie nesting model and the lekking model, there are no significant lekking or breeding forests in study areas 2 and 3.**

Based on the analysis of terrestrial bird communities, almost the entire study area 2 overlaps with capercaillie zones 1 and 2, i.e. according to the habitat modelling, it is a suitable habitat for capercaillie and its buffer zone. However, the capercaillie lekking site and breeding site model does not show any significant lekking sites or breeding biotopes for capercaillie in study area 2 (there are practically no pixels with a strength of >70%). The forests in study area 2 have been managed very intensively over the last 10–11 years (based on data from the Forest Register for 2012–2022). Based on fieldwork in study area 2 and its 500 m buffer zone, no observations or traces of capercaillie were found based on decoy counts, point counts of breeding birds and point observations. Therefore, based solely on modelling data, this study area cannot be considered a favourable habitat for capercaillies, but one important connection corridor (including a feeding area) for capercaillies remains north of the Virna lek area towards the Nauska lakes and Soontaga stream.

Capercaillie search areas were not mapped in study area 3, as there are practically no potential lekking areas based on the lekking model. Based on the orthophoto, these are actively managed stands, where, in principle, based on the model, lekking could only occur in isolated northern forest patches, but these have been intensively managed in recent years and do not offer much hope for stable capercaillie lekking. During fieldwork, a single capercaillie feather was found in the centre of the study area, but no other signs of capercaillie activity were observed in study area 3.

Consequently, survey areas 2 and 3 have unfavourable habitats, including clear-cut and drained forests, where capercaillies do not prefer to operate, but rather avoid such so-called degraded habitats, as evidenced by the unsuitable lekking and nesting model maps. A suitable movement corridor, which also contains suitable forests for nesting, may also run along the Väike-Emajõgi River in a south-westerly direction, where corridors of at least 800 m (400 m on both banks) have been taken into account, where no wind turbines will be erected. Several suitable nesting forests are located 3 km south of the hunting grounds, in the forests between study areas 2-3 and 4, which are outside the development areas. In addition, no wind turbines will be built in the feeding forests found in study area 4.

As the capercaillie is a grouse that is closely connected to the ground in its lifestyle and, as is characteristic of grouse, flies low at a height of 20-30 m near the treetops, along logging roads or prefer to fly along forest edges or move along the ground, especially with their young during the period when the chicks are not yet able to fly, it can be assumed that the species is adaptable to moving between wind turbines located 500-600 m apart. At the same time, possible stepping stones (mainly suitable breeding forests) are provided for capercaillies to move to the south-western core areas (Figure 7 D).

Morning monitoring of capercaillie mating in Koopesoo was carried out on 06.05.2023, but no capercaillie cocks were seen during the morning observation. Trail cameras managed to capture 1–3 capercaillie cocks during the mating season (one mating capercaillie cock on 28 April 2023, afternoon observations of cocks on 5 May 2023, one individual displaying at 1 p.m. on 18 May 2023, and one capercaillie cock on 27 September 2023). During monitoring in the morning (6 May 2023), 5–6 displaying capercaillies (LK III cat) were recorded.

Photo 1. Capercaillie cock displaying in Koopesoo bog on 28.04.23 at 5:14.

Photo 2. Capercaillie cock in Koopesoo bog on 4 May 2023 at 4:09 p.m.

Photo 3. Capercaillie in Koopesoo bog on 27.09.23 at 7:41.

One pair of cranes (LK III cat) raised their young in Koopesoo bog, and hare (LK III cat) were actively feeding in the bog. In addition, one feeding black grouse (LK III cat) was recorded.

Based on observations from trail cameras, it was confirmed that roe deer fed in the bog on a daily basis. Elk were observed less frequently, but one female elk raised two calves in the bog. Small predators observed in the bog included raccoon dogs and pine martens (these were mostly individual sightings). Among large predators, trail cameras recorded the movements of a younger brown bear.

The results of the fieldwork showed that the main capercaillie mating area is concentrated in the Koopesoo bog (areas E and D), where 1–3 capercaillie cocks were observed by trail cameras. During the fieldwork, a maximum of two capercaillie cocks were seen at a time taking flight from pine trees near the Koopesoo bog. To the west of Koopesoo bog are feeding forests suitable for capercaillies, which were identified on the basis of long feeding droppings. In area C, the tail feathers of a capercaillie cock killed by a predator were found. In the southern areas (F and G), traces of capercaillie feeding were observed. The south-eastern feeding area (F) has been severely affected by drainage due to recently constructed drainage ditches and is not suitable as a breeding ground. The capercaillie sightings in the south-eastern area G are also related to the capercaillie feeding area (Figure 8).

As the Koopesoo bog was restored only a few years ago, the importance of this area as a mating area for capercaillies may increase in the future. It is important to ensure an undisturbed movement corridor between the Virna capercaillie mating area and the Koopesoo capercaillie mating areas so that individuals can move between these mating areas without disturbance. According to the analysis of the Estonian land bird population si([17]), a buffer zone with a radius of 1 km around the repopulated mating area (zone 2) and connecting corridors between sub-areas are envisaged, covering

[17] Estonian Ornithological Society, Eagle Club. 2022. Analysis of terrestrial bird populations across Estonia. Public procurement no. 239156.
Map layers from the Environmental Agency's spatial data service

as much suitable habitat as possible. **From the capercaillie's point of view (taking into account its breeding and habitat areas and the associated buffer zone), it is very difficult to erect wind turbines in the Valga study area 1, as the majority of the potential development area is located within a one-kilometre buffer zone of the capercaillie's breeding area.** The southern capercaillie search areas are suitable as feeding areas, as is the south-western search area. The south-eastern capercaillie observations are also related to the capercaillie feeding area. **It is also important to ensure an undisturbed connection corridor from the southern Virna mating area to the Koopesoo mating area.**

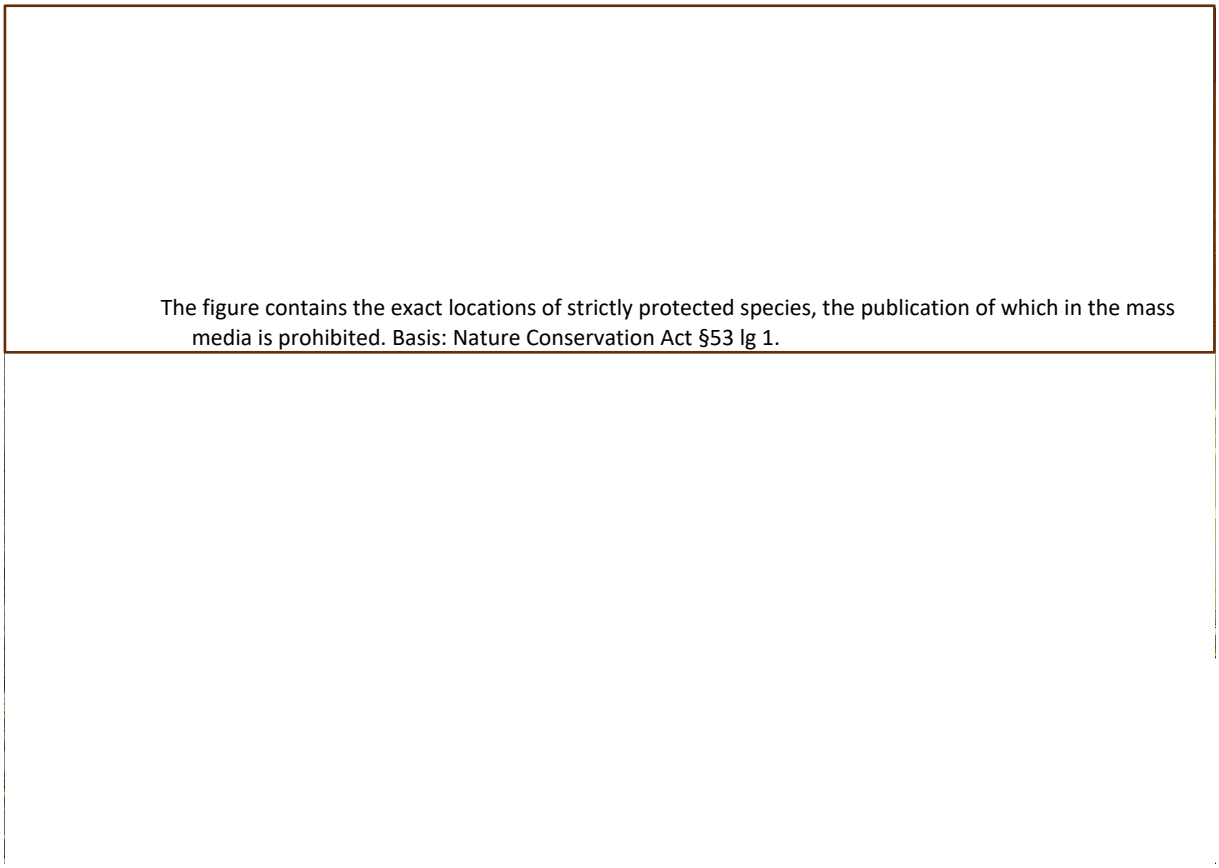

Figure 8. Observations of capercaillies in study area 1.

Fieldwork on capercaillies was carried out in the spring, based on a model of capercaillie leks. The Koopesoo bog is a suitable lek area for capercaillies, where 1-3 cocks were recorded during the capercaillie lek period with the help of trail cameras. The importance of Koopesoo bog as a capercaillie lekking site is likely to increase in the future due to the restoration work carried out there, which will have a positive effect on capercaillie lekking through the restoration of the water regime. Outside Koopesoo bog, capercaillies were mainly observed in feeding areas (Figure 8).

1.3.3 Lure findings of woodpeckers, cuckoos, hazel grouse and black grouse; protected and important breeding birds and their habitats

Six woodpecker decoy sites and 20 sites where woodpeckers, hazel grouse and black grouse were decoyed on 3 May 2023 and capercaillies on 8 May 2023 were placed in study area 1 in Valga. A point count of breeding birds was also carried out at these 20 points on 1 June 2023 (lists of birds by area are attached as an appendix) and protected and important bird species (KO) were recorded in accordance with Appendix 7 of the EOÜ bird survey. The coordinates of the point counts by area are given in Tables 15-20 of the supplementary material.

Spring, autumn and summer airspace observations were carried out at four points (Figure 9) and the locations and times of bird airspace use observations, together with weather conditions in the study area, are presented in Table 11 in the appendix.

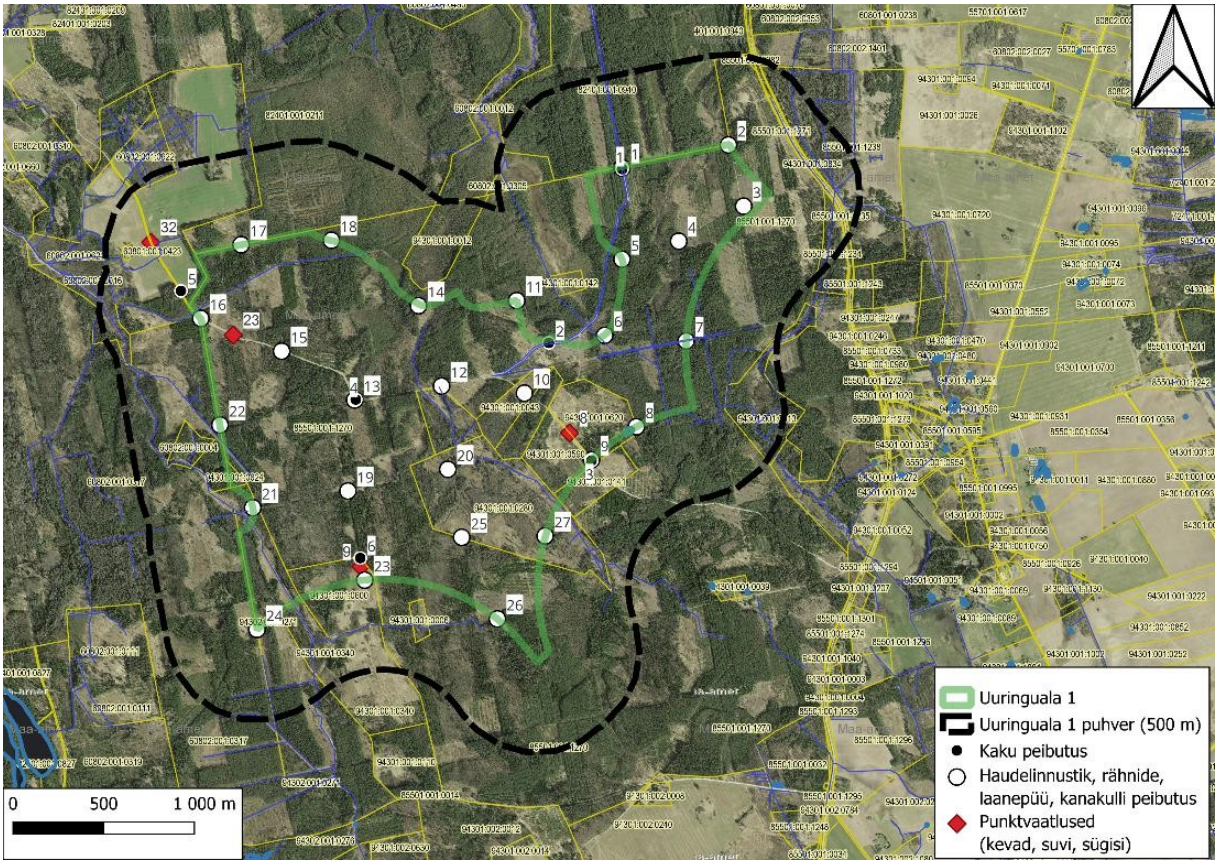

Figure 9. Luring points for woodpeckers, cuckoos, hazel grouse and capercaillie; counting points for protected and important breeding birds and migration observation points.

Table 2. Protected and important bird species mapped during decoy and point counts and their mapped habitats using forest register data in the study area 1. Mapped protected species and their habitats are shown in Figure 10.

ID	HABITAT BASED ON FOREST REGISTER	SPECIES MAPPED DURING FIELD WORK
1	MO birch forest, JP pine forest, SS pine forests	Händkaku nesting territory
2	SS pine forests	roo-loorkulli pot nesting area, laanepüü, raudkulli jaguar, crane
3	Old JP pine forests and birch forests	woodcock, wood sandpiper and black grouse
4	Older JP and PH pine forests	black grouse, woodcock
5	Old JP pine forest	black woodpecker, wood pigeon, woodcock
6	Old JP pine forests	wood pigeon, black woodpecker, hazel grouse
7	Older and old JP and PH pine forests	woodcock, black grouse, wood pigeon, raven pot breeding territory
8	JP pine forests	Lesser spotted woodpecker, Eurasian treecreeper
9	Old and older PH, JP, JK pine forests	capercaillie, black woodpecker, horse-tailed woodpecker, nesting site of the hazel grouse
10	Old JK-JP and PH pine forests	nesting site of the honey buzzard
11	JK-JO pine forests	Horse chestnut, hollow tree
12	Old JM pine forest	capercaillie, hazel grouse, buzzard nesting site
13	Old MS aspen forest	Lesser spotted woodpecker
14	Old JM-MS pine forests	oak woodpecker
15	Old JM birch forest	Raudkulli pot nesting territory
16	Old birch groves	Crane, wood sandpiper, lesser spotted woodpecker

17	Diverse commercial forests	hawks (lesser spotted eagle, goshawk) flight area and hunting grounds, woodcock, wood sandpiper and crane
18	Young JK spruce forest	roe deer
19	Predominantly middle-aged JK spruce forests and birch forests	Hunting grounds of buzzards and ravens
20	Older JK birch forests	Buzzard nesting territory
21	Older JK spruce and pine forest	Lesser spotted woodpecker, grey-headed woodpecker, migration of birds of prey (sparrowhawk, eagle owl, raven), buzzard nesting forest
22	cleared and felled JM pine forests, spruce forests and birch forests	hunting and migration area of birds of prey (buzzard, golden eagle), hobby, corncrake, crane, woodcock, red-backed shrike, corn crake, meadow pipit, woodcock, barn swallow, grey shrike
23	Older JM spruce forests	woodcock, grey-headed woodpecker
24	Middle-aged JO Kaasik and Old JO black grouse	woodcock, grey-headed woodpecker and black grouse hunting
25	Older JP pine forest	Hoburästas
26	Mainly older and old JO, JK, PH, MO, MS, KR, RB pine forests, SS spruce forests	capercaillie feeding area, rails pot nesting territory
27	Middle-aged AN grouse	forest tinder
28	Old JO spruce and pine forest	small flycatcher
29	Middle-aged ND spruce forest	black woodpecker, lesser spotted eagle in flight
30	Middle-aged JK, AN copses, clearings, older JM pine forest	Hawk hunting, woodcock, wood pigeon, woodcock, black woodpecker
31	Middle-aged JK spruce forests and birch forests	small flycatcher
32	Older JO, KR pine forests, JK spruce forests, aspen forests, middle-aged AV spruce forests, to a lesser extent smaller clearings	black woodpecker, lesser spotted woodpecker, grey-headed woodpecker, marsh harrier hunting, buzzard hunting
33	Older JO, JK, JP, KM pine forests	buzzard nesting site
34	Middle-aged and older RB pine forests, SS pine forests and coppices	capercaillie and black grouse mating grounds, capercaillie feeding grounds, hazel grouse, black grouse hunting grounds, woodcock, crane, wood sandpiper and woodcock
35	Older PH, SN, SS pine forests	capercaillie feeding area, hazel grouse

Abbreviations for habitat types: MO – blueberry bog; JP – hare's-tail cottongrass-cowberry; SS – transition bog; PH – cowberry; JK – hare's-tail cottongrass; MS – blueberry; JM – hare's-tail cottongrass-blueberry; JO – hare's-tail cottongrass-bog, MS – fen; KR – haircap moss; RB – bog, AN – sedge, ND – reed; KM – haircap moss-blueberry, SN – blueberry.

A new corncrake nest was identified in Valga study area 1 (located in zone 1 buffer zone based on the EOÜ study, for which a distance of 1000 m is recommended), where the species was discovered during fieldwork in the spring of 2023 and was also present on 25 February 2024 (Figure 10). This is likely to be a bird from the south, as the nearest southern location, 1.4 km away (KLO9120519, Mustumetsa), both nests (-854891712 and 1020767630) have collapsed, which is confirmed by the 2023 monitoring data in the EELIS database, and during fieldwork, no nests could be found in the trees there.

One permanent monitoring point (No. 8) was located 900 m from the nesting site, and a corncrake was spotted in flight on 3 May 2023 from the point southeast of the site, and another observation was made during migration on 17 October 2023. The cormorant's hunting strategy involves rapid dives towards the ground to catch its prey (primarily grey wagtails, wagtails, wagtails and

magpies, house sparrows, collared doves, wood pigeons and finches; among mammals, its prey has mainly consisted of squirrels and hares[18]), the risk of collision with tall wind turbines (>200 m) is very low. There are only a few known cases of crow deaths due to wind turbines ([19] ,which may be related to the species' feeding strategy – the vast majority of the species' food sources can be found on the ground (e.g. red squirrels, hares) or at lower flight altitudes (<100 m; pigeons, ducks, crows).

The EOÜ analysis of terrestrial birds (2022)[17] indicates that wind turbines are generally not planned for Zone 1. However, there are exceptions:

a) nesting sites that are unlikely to be inhabited;
b) if, for example, data on the habitat use of birds equipped with transmitters confirm that the area is not used to an extent that would necessitate restrictions;
c) the implementation of highly effective mitigation measures (stopping wind turbines during critical periods).

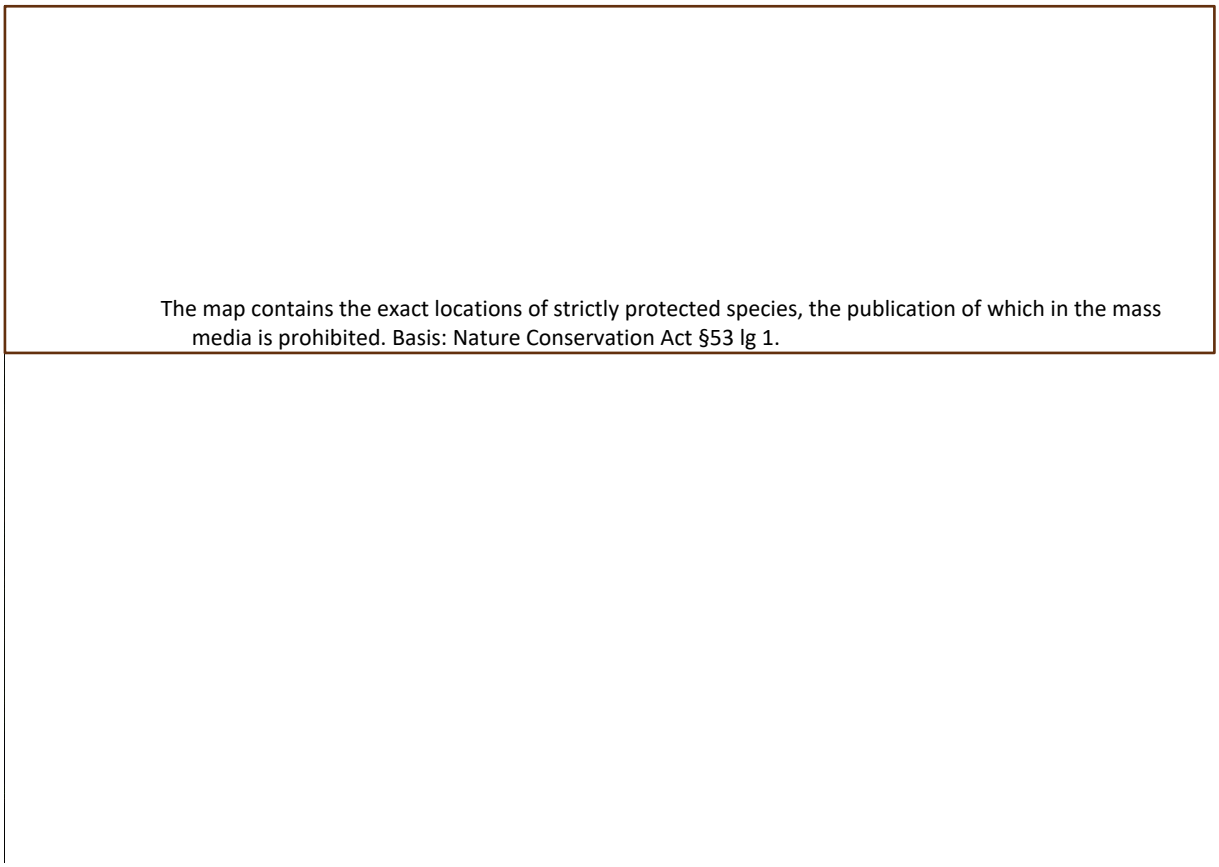

Figure 10. Habitats of protected and important species mapped as a result of fieldwork in the Valga study area 1. Protected and important species and their habitats are listed in Table 2.

A total of four nests inhabited in 2023 (including national monitoring data) were found in study area 1 and its 500 m buffer zone (both hornets and wasps belong to LK III), three of which belonged to wasps (KLO9133702, KLO9133704, KLO9133703) and one eastern nest of a honey buzzard (KLO9133755). The possible feeding areas of buzzards and honey buzzards were analysed below. As the buzzard hunts its prey in open terrain, the location of open terrain near the nesting area is important, as it can be used to assess possible

[18] Action plan for the protection of the corncrake, Environmental Board, 2022.
[19] Rydell, J.; Ottvall, R.; Pettersson, S.; Green, M. The Effects of Wind Power on Birds and Bats - an Updated Synthesis Report 2017; Swedish Environmental Protection Agency (Naturvårdsverket): Stockholm, 2017; p 132.

likely feeding areas. The honey buzzard's main hunting ground is forest land, where it searches for prey at the edges of forests, in forest clearings, on felled areas and in clearings, and sometimes in meadows. The honey buzzard often stops near ditches and other small bodies of water.

According to Estonian researchers, the home ranges of buzzards determined using GPS transmitters in Estonia ranged from 3.2 $km^2$to 4.7 km^2[20].During the summer period in July, the range was 1.7–2.8 km^2. This means that the main range of activity from the nest can extend to 0.74–1.2 km. Forests can be an important hunting ground for buzzards. In forests, they lie in wait near hedges, ditches and ditches, and in commercial forests also on clear-cut areas. However, open habitats usually play the main role as hunting grounds for buzzards. They are certainly not used completely at random, but areas closer to the forest edge are preferred. Birds equipped with GPS transmitters have shown that the flexible buzzard uses most of the biotopes found in the vicinity for hunting, but certain types of land are still preferred. For example, our buzzards appreciate the abundance of grasslands([21]) .

Figure 12 shows the open landscapes located in the vicinity of the buzzard's nesting areas (landscapes covered with woody vegetation are depicted as forest compartments, cultivated land and open areas, and watercourses, Figure 11). Open landscapes include arable land and open areas. Based on Figure 12, there are only a few open areas within the wind energy development area. The north-western nesting site is located closest to arable land. The south-western nesting site, located in the centre of the area, is located in a forest landscape. It can be concluded that the north-western buzzard visits farmland more often, while the others use the forest clearings as hunting grounds. The honey buzzard nesting site is located in the buffer zone of the development area, and the Lota stream, which the bird can use as a hunting ground, is located nearby.

The construction of the wind farm poses a collision risk to the buzzard. Of all birds of prey, buzzards suffer the highest mortality rate in wind farms, followed by kestrels, red kites and white-tailed eagles[22]. In Northern Europe, the highest mortality rate among birds of prey due to wind turbines has been found among buzzards, which avoid wind turbines to a very small or moderate extent (250–500 m distance)([23]) **Due to the high abundance of buzzards, it is not advisable to establish wind turbines in study area 1.**

[20] Väli, Ü., Sein, G., Laansalu, A., Sellis, U. What habitats do our buzzards prefer? Eesti Loodus, November 2015.

[21] Väli, Ü., Sein, G., Laansalu, A., Sellis, U. What habitats do our birds prefer? Eesti Loodus, November 2015.

[22] Rydell, J.; Ottvall, R.; Pettersson, S.; Green, M. The Effects of Wind Power on Birds and Bats - an Updated Synthesis Report 2017; Swedish Environmental Protection Agency (Naturvårdsverket): Stockholm, 2017; p 132.

[23] Rydell, J.; Ottvall, R.; Pettersson, S.; Green, M. The Effects of Wind Power on Birds and Bats - an Updated Synthesis Report 2017; Swedish Environmental Protection Agency (Naturvårdsverket): Stockholm, 2017; p 132

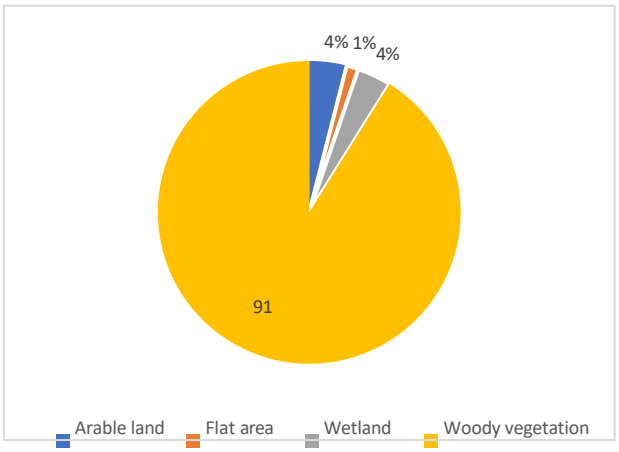

Figure 11. Based on the distribution of land use, the feeding areas of the 1 viude in the study area are likely to be located on forest land on slopes and along ditches.

1.3.4 Nests

Nests were not searched for separately, but were observed in study area 1 during the luring of woodpeckers, hazel grouse and capercaillie, when older forests were actively searched for nests in tree crowns. During the point count and aerial observations (36+18+36) of breeding birds, attention was also paid to hawks, including various territorial and chick calls in the area, and possible nesting trees were searched for when these were heard. Potential nesting territories of birds of prey were also mapped (see Table 2 and Figure 12).

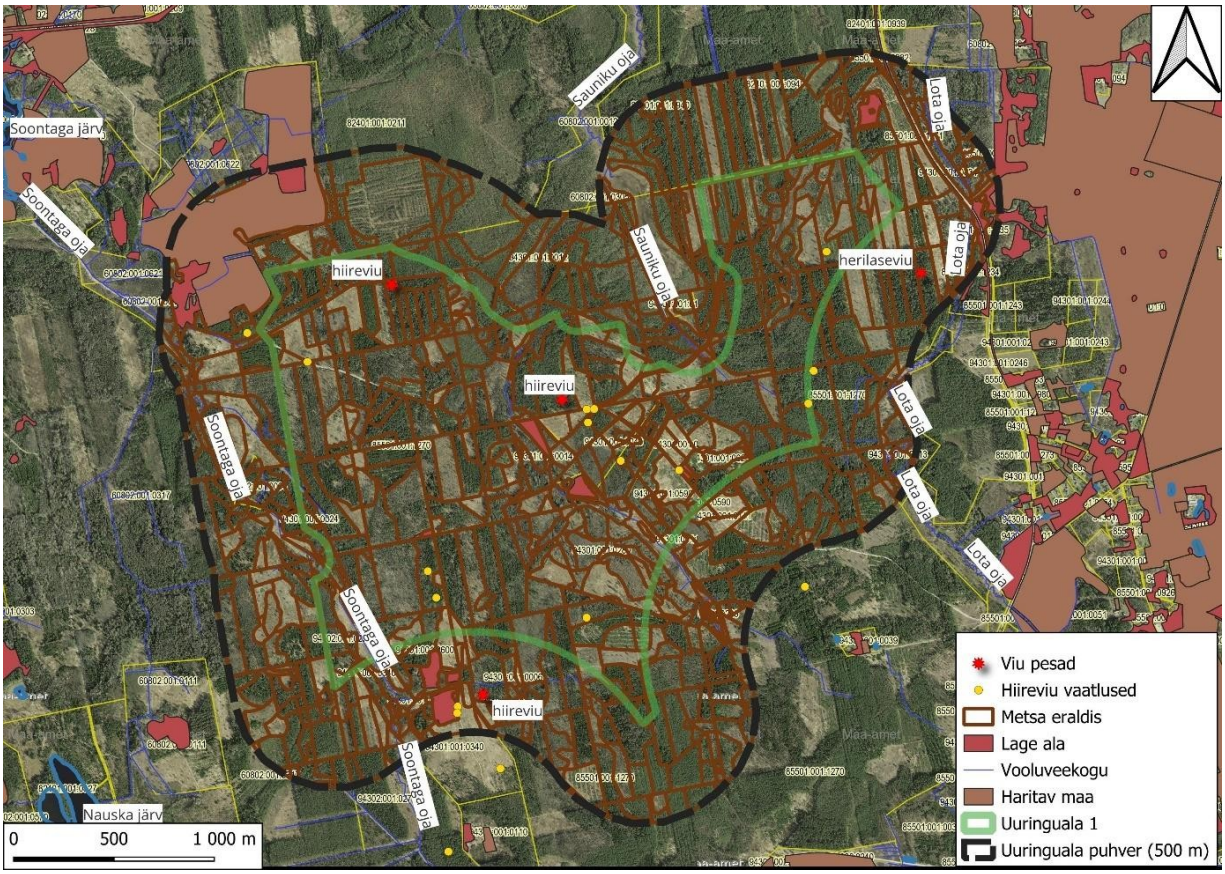

Figure 12. Location of buzzard and honey buzzard nests in study area 1, with possible feeding areas and observations made during fieldwork.

1.3.5 Spot observations

Spring observations in the rotor safety zone

In study area 1 in Valga, the spring migration of geese was rather modest, with a total of 580 individuals counted (Table 3). Over 80% of the geese (475 individuals) flying north were located in the rotor safety zone (range 90-180 m).

During the spring migration, 16 whooper swans (LK II category) were observed flying at an altitude of 30–50 m. There were 38 migration observations of the common crane (LK III category), with the largest number of birds seen being 23 individuals flying northwest at an altitude of 300 m (Table 3).

One of the most exciting migration finds were a few common goldeneyes (LK II category), which were heading north, probably towards Lake Võrtsjärv (Table 3). All individuals flew within the rotor safety zone. The EOÜ terrestrial bird survey (2022) indicates that there is no need to consider the common goldeneye in inland Estonia, as they rarely stop at inland waters during migration and not at all in winter. Migration over land takes place above the wind turbines.

During the spring migration period, mouse owls (LK III cat, 9 observations) were observed in the safety zone of wind turbines, six of which were located in the safety zone of the turbine rotor (Table 3).

Among the rarer birds of prey, a lesser spotted eagle was observed during the spring period (LK I cat; three spring observations, where in one case the bird was flying at an altitude of approx. 70 m, in another case the eagle rose higher in the air column, and in the third case the species was flying in the north-western part of the area, see Table 3 ID17 and ID29 and Figure 13) and the Eurasian hobby (LK III cat; casual observation, bird flying overhead).

Summer observations

During the summer census period, the most common bird of prey observed was the common buzzard (five observations at an altitude of 150 m). Individual observations were made of the following localised birds of prey: common buzzard (LK III cat), common buzzard (at an altitude of 150 m). Of the falcons, a merlin was observed in the rotor safety zone (100 m).

Of the protected species, barn swallows (LK III cat; 8 individuals) were observed in the rotor safety zone, seven of which were flying at an altitude of 130–150 m (Table 3). A flock of great spotted woodpeckers (four individuals) was also observed flying southeast at an altitude of 120 m. A wood pigeon was observed three times at an altitude of 116 m flying northwest. Two individuals of the corncrake (LK III cat) were observed flying at an altitude of 150 m (Table 3).

During the summer point count, 11 grey herons were observed in the rotor safety zone (160 m) among the important bird species.

Autumn migration observations

During the autumn census period, a total of 725 geese/geese were counted, 76% of which flew within the rotor safety zone (548/725).

Although 66 songbirds were observed during migration, none of them flew within the rotor safety zone (the flight range was between 30 m and 78 m on average). One small bird flew within the rotor safety zone at a height of 100 m during migration.

Of the birds of prey, the most frequently observed was the buzzard, which was observed in the rotor safety zone twice at a height of 125 m. Kestrels were observed four times, with the birds staying at an average height of 90 m (two observations) and 150 m (two observations). A buzzard was observed once in the rotor safety zone at a height of 90 m. A lesser spotted eagle was observed twice, once in the buffer zone of the study area in the south at a height of 250 m and once at the southern end of the study area

at the southern end of the study area at a height of 100 m, heading southwest (Figure 13). A merlin was observed once at a height of 23 m, heading west (Figure 13).

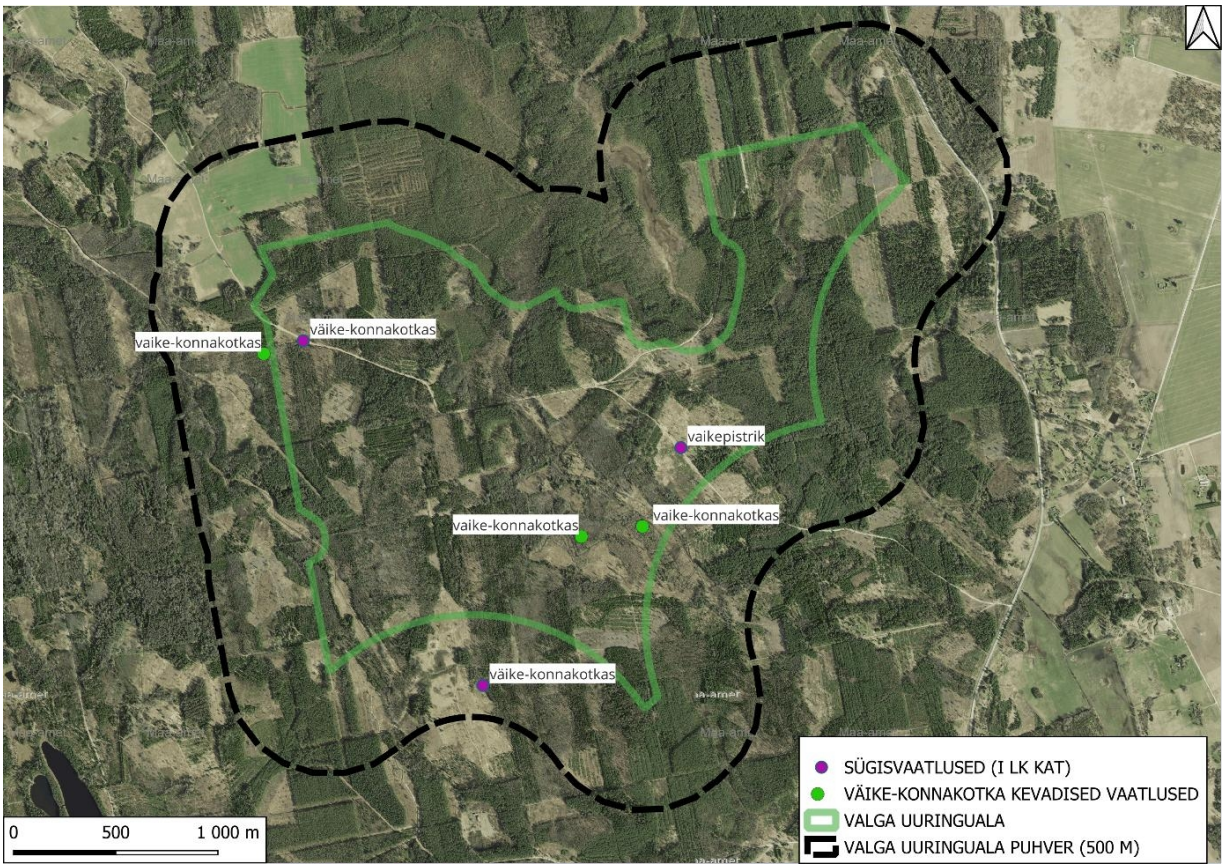

Figure 13. Category I protected species mapped based on point observations in the Valga study area 1.

Table 3. Results of spring/summer/autumn point observations (min 36 h, 18 h and 36 h) carried out in the Valga study area 1, by bird species. The direction of bird migration, their abundance (no.) and altitude are shown. Birds flying in the rotor safety zone are marked in red.

Birds	Direction	Height (m)	NR	Total
SPRING				
grey heron	NW	80	1	1
geese	N	129	475	580
	NE	40	5	
	NW	50	44	
large-leaved hani	N	100	41	
	SE	80	8	
tundra-rabahani	N	50	7	
sookurg	N	80	3	38
	p	40	2	
	NW	300	23	
	S	30	3	
	SW	50	1	
	W	20	3	
	Y	53	3	
songbird	N	30	2	16
	NE	50	10	

	W	50	2	
	Y	50	2	
	p	80	2	
	NW	100	4	
	S	100	1	9
	SE	200	1	
mouse	NA	100	1	
	p	30	1	
	NE	60	1	
iron ore	S	10	1	3
roo-loorkull	Y	250	1	1
konnakotkas	Y	70	1	1
greater spotted eagle	N	95	5	5
	N	35	5	
horse chestnut	Y	30	1	6
	N	30	1	
smoke stack	p	30	2	3
	p	40	3	
tikutaja	NE	30	1	4
woodcock	p	20	3	3
	N	80	1	
wood sandpiper	NA	30	2	3
SUMMER				
grey heron	N	160	11	11
	E	200	7	
silver haigur	SE	200	7	14
mouse	p	150	5	5
lõopistrik	p	100	1	1
iron	p	50	1	1
roo-loorkull	p	150	1	1
crane	Y	150	2	2
	p	40	1	
	E	80	1	
õõnetuvi	NW	116	3	5
large coot	SE	120	4	4
white stork	p	200	1	1
	p	150	6	
	p	50	1	
smoke swallow	Y	130	1	8
	p	60	2	
	S	5	1	
horse chestnut	Y	60	1	4
AUTUMN				
	S	197	177	
goose	SW	154	192	
greater white-fronted goose	N	100	2	725

	S	166	258	
	SW	135	27	
tundra-rabahani	SW	175	66	
white-cheeked goose	S	180	3	
	N	30	2	
	S	78	52	
song thrush	SW	47.5	12	66
Humpback swan	NW	30	2	2
little swan	S	100	1	1
crane	SE	80	35	35
	p	200	1	
	S	66.5	12	
	SE	80	1	
	SW	125	2	
	W	60	1	
iron crow	SW	42	3	20
chicken coop	Y	90	1	1
	p	150	2	
mouse eagle	S	90	2	4
	S	250	1	
lesser spotted eagle	SW	100	1	2
silent	W	23	1	1
raptor	NA	20	1	1
lõopistrik	W	80	1	1
õõnetuvi	S	28	1	1
kiivitaja	NW	80	61	61
grey-headed woodpecker	p	30	1	1
	E	30	1	
	NE	20	1	
horsefly	S	36	26	28
	S	75	2	
smoke stack	SW	40	3	5

Y-overflight, p-stationary, N-flight north, NE-flight northeast, E-flight east, SE-flight southeast, S-flight south, SW-flight southwest, W-flight west, NW-flight northwest.

1.4 Study area 2

1.4.1 Overview of registered habitats of protected species

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129608 (Figure 14) is located 3.5 km from study area 2. The habitat description is provided in section 1.3. Based on the map layer of terrestrial bird species available in the EELIS database, a reduced 1 km zone 1 area is recommended for this habitat.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129606 (Figure 14) is located 2.38 km from the study area. The habitat was last checked on 5 July 2021 as part of national monitoring, when it had fallen down. According to the monitoring, the habitat was last established by the lesser spotted eagle in 2008. According to the EELIS database, the nest had already fallen into disrepair during the 2015 monitoring. Based on the map layer of terrestrial bird species diversity, a reduced 1 km zone 1 area treatment is recommended for this habitat.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129605 is located 2.39 km from the study area. The nest (id -1999279627) is located 4.1 km from the study area (Figure 14). The habitat was last checked on 18 July 2020 as part of national monitoring, when it was not established. Based on monitoring, the habitat

was last established by a golden eagle in 2015. Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, extensive regeneration felling has been carried out in the area adjacent to the habitat.

Based on an analysis of the feeding areas **of black storks** equipped with GPS transmitters [24],there is one known feeding water body for black storks in the study area (Raamsoo stream, VEE1011800). Based on the analysis of GPS data, this is not a priority feeding water body in the study area. The section used as a feeding water body is outside the potentially suitable wind farm area.

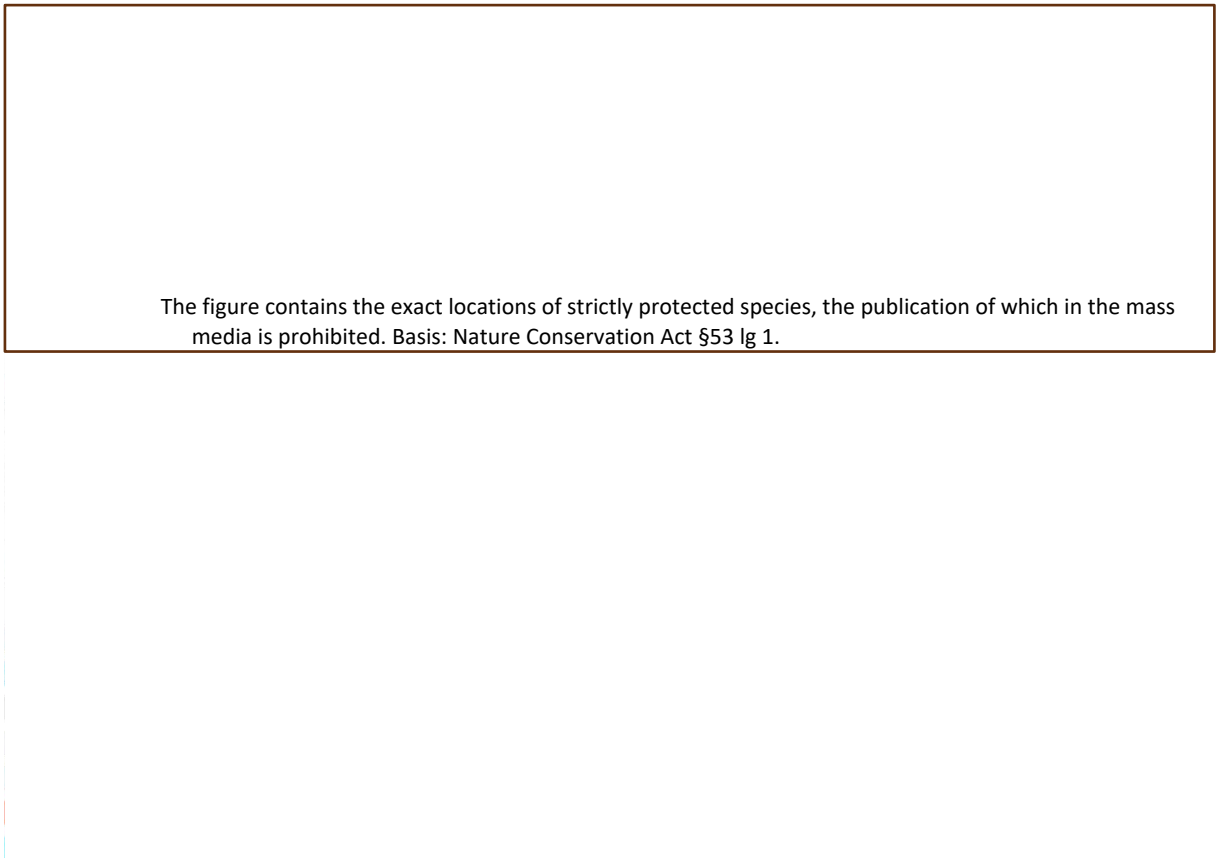

Figure 14. Registered habitats of Category I protected bird species and known feeding waters of black storks within a five-kilometre radius of study areas 2 and 3.

The habitat of **the capercaillie (*Tetrao urogallus*)** KLO9101751 is located 1000 m (500 m from the buffer zone) from the development area. The last observation in the EELIS database is from 22 April 2018, when three capercaillie cocks were counted. According to map data, no significant logging has taken place in the habitat area in recent years.

Based on the analysis of terrestrial bird species, almost the entire study area overlaps with capercaillie zones 1 and 2, which means that, according to the habitat modelling, it is a suitable habitat for capercaillie and its buffer zone. However, the capercaillie lekking site and brood biotope model does not show any significant lekking sites or brood biotopes for capercaillie in study area 2 (there are practically no pixels with a strength of >70%). The forests in study area 2 have been managed very intensively over the last 10–11 years (based on data from the Forest Register for 2012–2022). Based on fieldwork in study area 2 and its 500 m buffer zone, no observations or traces of capercaillie were found based on decoy counts, point counts of breeding birds and point observations. Therefore, based solely on modelling data, the study area cannot be considered a favourable habitat for capercaillies, but an important connection corridor (including feeding area) for capercaillies remains north of the Virna hunting area towards the Nauska lakes and Soontaga stream.

[24] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

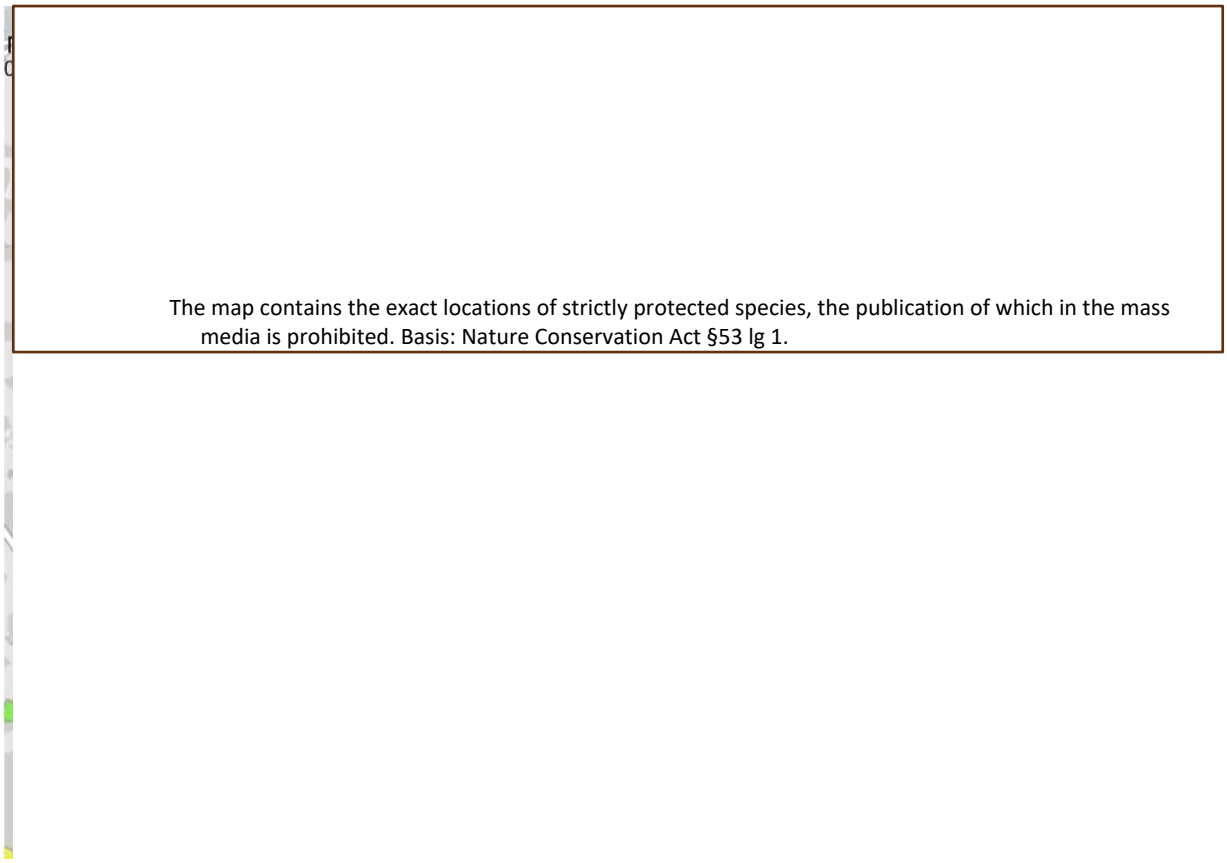

Figure 15. The registered habitats of the capercaillie and the zones analysed for terrestrial birds in study areas 2 and 3.

No locations of bird species in protection category III according to EELIS have been registered in study area 2.

According to the terrestrial bird analysis, study area 2 overlaps with the hazel grouse (*Tetrastes bonasia*) zone 3 areas, i.e. the modelled habitats of the species (Figure 16).

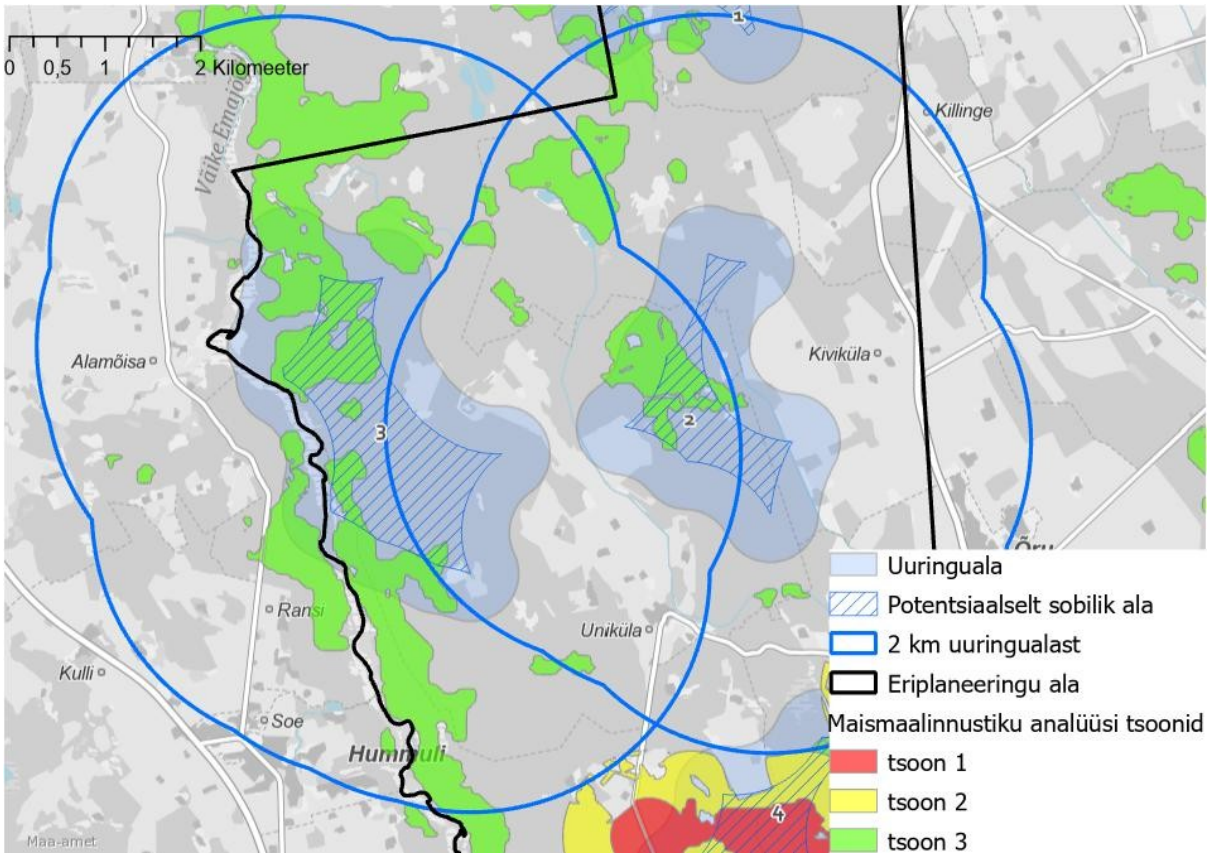

Figure 16. Hazel grouse terrestrial bird analysis zones within a two-kilometre radius of study areas 2 and 3.

1.4.2 Observations of capercaillie and other grouse

A total of 14 observations of grouse were made during fieldwork, of which six were hazel grouse and eight were black grouse (Figure 17). No traces of capercaillie activity or individuals were observed in area 2. Grouse were observed during the mating season on 6 May 2023, when a maximum of three cocks were observed mating in the eastern fields, and on 19 May 2023, when a maximum of two cocks were observed mating in the eastern fields. On 26 May 2023, one black grouse was observed displaying on the western farmland. Black grouse displays took place either within the 500 m buffer zone on farmland or outside the buffer zone. In autumn, a single cock was seen on 30 September 2023 in the eastern part of the area, and a single black grouse was observed on 10 October 2023 in the western part of the area. On 3 November 2023, a grouse was seen flying north in the western part of the field (flight altitude 20 m), and on 17 November 2023, nine cocks were seen flying in a north-westerly direction in the eastern part of the field.

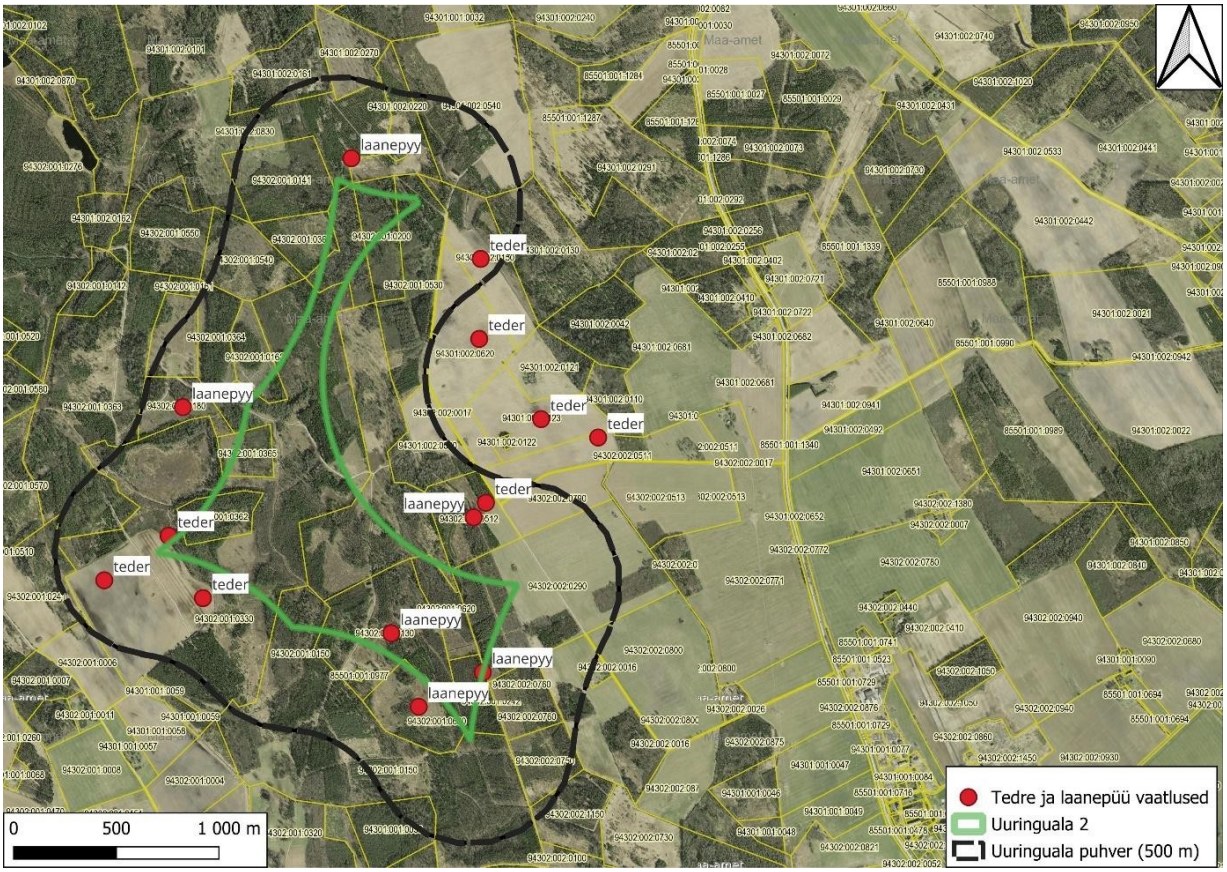

Figure 17. Two grouse and hazel grouse were observed in the Valga study area.

1.4.3 Lure findings of woodpeckers, cuckoos, woodcocks and corncrakes; protected and important breeding birds and their habitats

Six woodpecker decoy points were placed in the Valga study area 2, which were decoyed on 8 May 2023, and 22 points where woodpeckers, hazel grouse and black grouse were decoyed on 6 May 2023 (Figure 18). A point count of breeding birds was also carried out at these 22 points on 18 June 2023 (lists of birds by area are attached as an appendix) and protected and important bird species (KO) were recorded in accordance with Appendix 7 of the EOÜ bird survey.

Airspace point counts were mainly carried out at three points, with one northern point (No. 197) and point 14 serving as additional observation points. The locations (Figure 18) and times of airspace use observations, together with weather conditions in the study area, are presented in Table 12 in the supplementary material.

Woodcock observations were made on 6 May 2023, when a male bird was heard calling in the eastern area between the buffer zone and the study area boundary, and one calling individual was recorded on 6 May 2023 in the south-eastern corner (Figure 17). Two woodcock observations were made in the south-eastern area on 10 May 2023 (one at the boundary of the study area and the other in the buffer zone). In autumn, two vocalising woodcocks were recorded, one singing in the northern part of the study area and the other in the eastern part of the buffer zone.

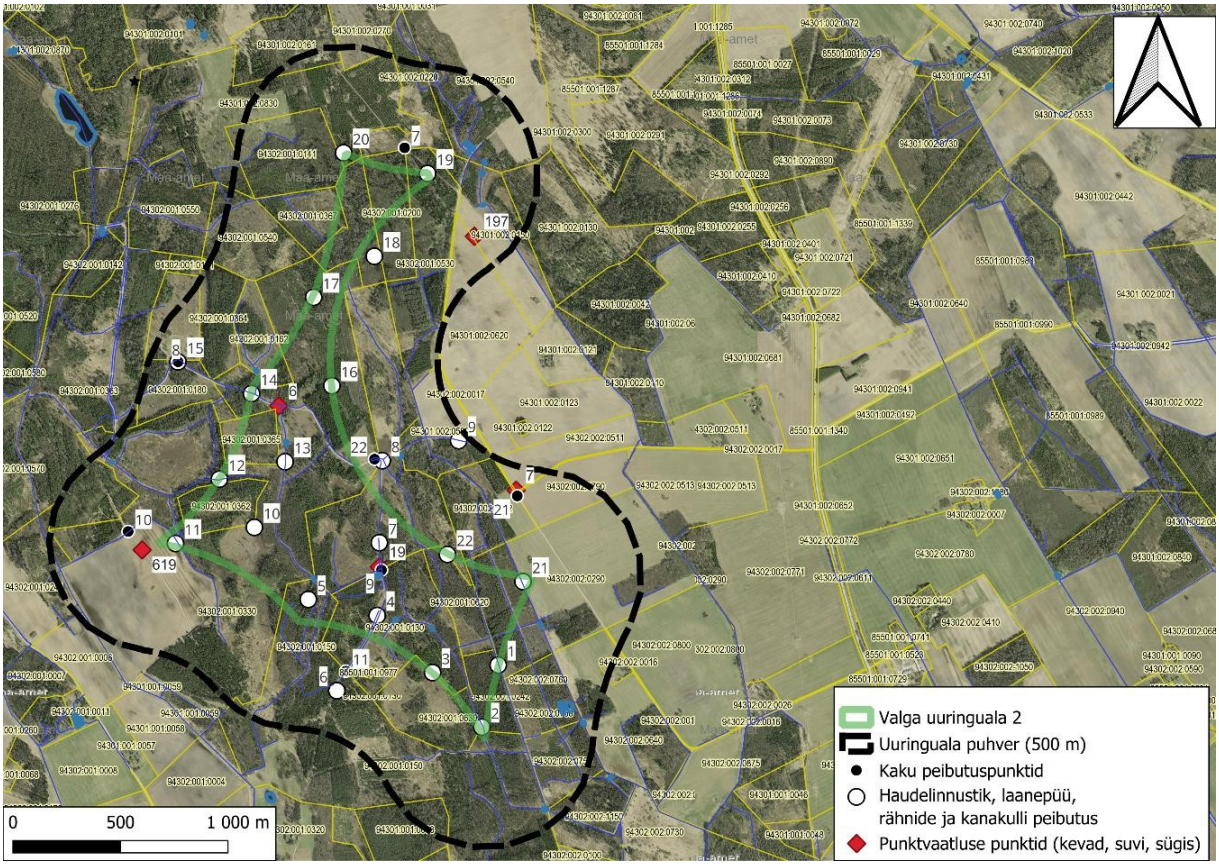

Figure 18. Luring observations of woodpeckers, cuckoos, woodcocks and corncrakes carried out in study area 2 in Valga, and points of point observations carried out.

Table 4. Protected and important bird species and their habitats in study area 2, mapped during decoy and point counts. The corresponding protected bird species and their habitats are shown in Figure 19.

ID	FOREST REGISTER HABITAT	SPECIES MAPPED DURING FIELD WORK
1	old aspen forest	white-backed woodpecker
2	young and middle-aged JM, JK spruce-birch forests	small flycatcher
3	JK spruce forest	Lesser spotted woodpecker, habitat of the black woodpecker and the great spotted woodpecker, black grouse, hazel grouse
4	old JK, JM, ND copses	wood pigeon, black woodpecker, small flycatcher, white-backed woodpecker, home and hand-carved territory
5	Old JK spruce forest	wood pigeon
6	Older ND, JK spruce forest	grouse, black grouse
7	Older AN spruce forest and JK pine forest, old JM spruce forest	wood pigeon, grey-headed woodpecker, black woodpecker
8	logging site	nesting territory of the Eurasian hobby, common crane, black woodpecker
9	JK pine forest,	woodcock, corncrake territory, black grouse
10	Old MS, JM pine forests, older AN birch forest	woodcock, corncrake, woodcock
11	Older MS pine forest, younger JM birch	wood sandpiper
12	Arable land	corn crake, corncrake

13	Older JP spruce forest, spruce regeneration	turtle dove
14	Younger JK spruce forests	Raven nesting territory
15	Older AN grouse	Horsefly
16	Old JM grove	laanepüü
17	Older AN grove	õõnetuvi
18	Older MO, JO pine forest, old JO coppice	small flycatcher x3, woodpecker, forest tit, nuthatch, willow warbler (nesting unsuccessful)
19	Older MO pine forest, older JO coppice	wood pigeon, buzzard nesting territory
20	Old and older JO copses	Lesser spotted woodpecker
21	Older JO grove, younger ND spruce forest ND aspen forest	woodcock, woodpecker
22	Older JO ( ) Younger JO ( ) Younger JM ( ) aspen	white-backed woodpecker
23	Old MO pine forest	grey-headed woodpecker, black woodpecker
24	Older JO forest, old ND forest	Lesser spotted woodpecker, Eurasian treecreeper, black woodpecker, Eurasian nuthatch, Eurasian jay Possible nesting territory
25	Younger JK spruce forest	Raven nesting area, teder
26	Farmland	Horse-tailed grasshopper, corn bunting, grey plover, grey wagtail, corncrake, field lark, mouse-eared grasshopper, corn bunting
27	Farmland	corn bunting
28	Old JK birch forest, older MS pine forest	wasp nest forest
29	Old JM pine forest, logging site	woodcock, wood sandpiper, woodcock

Abbreviations for habitat types: MO – blueberry bog; JP – hare's-tail cottongrass; SS – transition bog; PH – cottongrass; JK – hare's-tail cottongrass; MS – blueberry; JM – hare's-tail cottongrass-blueberry; JO – hare's-tail cottongrass-bog, MS – fen; KR – haircap moss; RB – bog, AN – sedge, ND – reed; KM – haircap moss-blueberry, SN – blueberry.

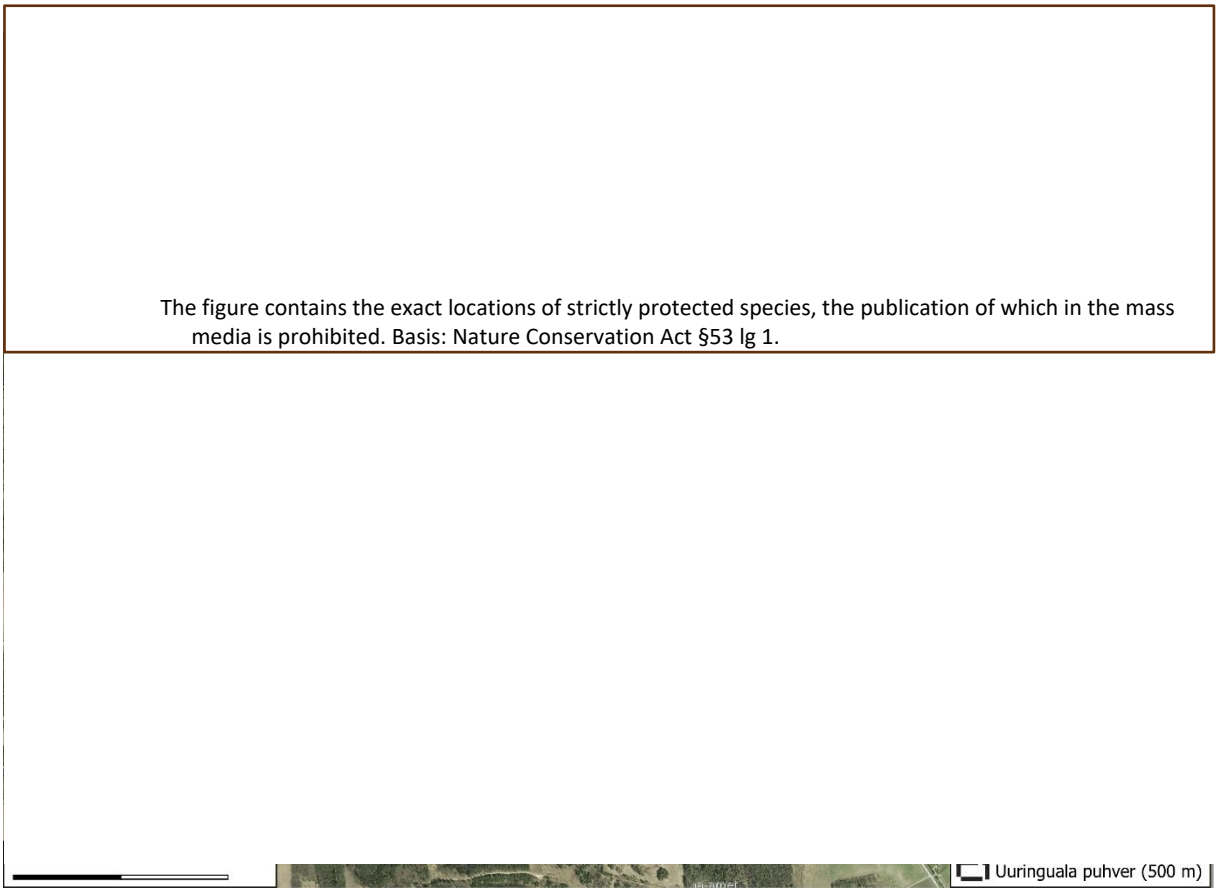

Figure 19. Protected and important bird species mapped in the Valga study area 2. The description of habitats is based on data from the Forest Register, and the bird species mapped during fieldwork are listed in Table 4.

1.4.4 Nest boxes

Rustic nests were not specifically sought in study area 2, but were observed in study area 1 during the luring of woodpeckers, hazel grouse and capercaillie, when rustic nests were sought in tree crowns while passing through older forests. During the point count of breeding birds and regular point observations, attention was also paid to birds of prey, including various territorial and chick calls in the area, and when these were heard, possible nesting trees were searched for and potential habitats were mapped based on territorial observations. One probable buzzard nest was found in the study area (Table 4 ID 18, Figure 19). In addition, several potential nesting sites were mapped, partly in the study area and partly in the buffer zone, for the Eurasian eagle-owl (see Table 4: ID 3, Figure 19) and the Eurasian buzzard (Table 4: ID 19, Figure 19). a mouse hawk nesting site in the study area (Table 4: ID 24, Figure 19), a potential black kite nesting site in the buffer zone (Table 4: ID 25, Figure 19), a honey buzzard nesting site (Table 4: ID 28, Figure 19), and the nesting territories of the Eurasian hobby were mapped in the buffer zone (Table 4: ID 8 and 29, Figure 19).

1.4.5 Spot observations

Spring observations in the rotor safety zone

In study area 2 in Valga, spring migration of geese was greater than in study area 1. A total of 2,031 geese were counted (Table 5), of which 936 were greylag geese and 103 were tundra swans. The goose family remained at 992 geese. The minimum flight altitude was 50 m and the maximum 300
m. *Approximately* 60% of the geese (1,208 individuals) flying during migration were located in the rotor safety zone (Table 5).

During spring migration, 65 whooper swans (LK II cat) were observed flying at an altitude of 30–40 m. Of the whooper swans, 55 individuals headed north (Table 5). Four individuals of the mute swan (important species) were observed, and three individuals remained at the family level.

A total of 28 whooper swans (LK III category) were observed during migration, five of which flew within the rotor safety zone (Table 5). A total of 14 (mouse) buzzards were observed during spring migration, 10 of which flew within the rotor safety zone.

A little bittern was observed once (6.05.23, Figure 20) in the rotor safety zone (150 m) and a corncrake was observed once in flight (150 m). A kestrel was observed once at a height of 90 m. The following protected species of birds of prey were also observed, but not in the rotor safety zone: a buzzard (one observation) and a red kite (four observations) (Table 5).

Of the important species, one kestrel (90 m) and two silver gulls (100 m) were observed in the rotor safety zone. Summer observations in the rotor safety zone

During the summer period, a total of eight buzzards were observed flying at an average altitude of 157 m (range 150–200 m). A total of six honey buzzards were observed at an altitude of 150 m. A total of two red kites (LK III cat) were observed at an altitude of 14 m. One buzzard was recorded flying at an altitude of 150 m, and one observation was made of a kestrel perched at an altitude of 150 m (Table 5).

On four occasions, white-tailed eagles (LK III category) were observed at a height of 150 m. A flock of 11 grey herons was observed at a height of 150 m, heading north.

Four observations of common gulls were made at an altitude of 120–150 m. Four observations of barnacle geese were made in the safety zone at an altitude of 90–150 m.

Autumn observations in the rotor safety zone

The autumn migration of geese (greylag goose, bean goose, tundra bean goose, white-fronted goose) was more modest compared to the spring migration, when a total of 359 geese were counted. The migration took place at altitudes between 80 m and 300 m. The predominant migration altitude was 240 m and higher (98% of geese), and two tundra swans were observed in the rotor safety zone at an altitude of 170 m (Table 5).

The 107 songbirds observed in the rotor safety zone were seen at an average altitude of 106 m. The small birds (14 individuals flying southwest) were observed in the collision safety zone at an altitude of 103 m. Observations of swans of an undetermined family were made for 99 individuals flying at an altitude of 108 m. All swans in the rotor safety zone (220 individuals) were migrating in a south-westerly (SW) direction.

Both spring and autumn migration observations of swans were made predominantly in the eastern buffer zone (18 observations) or outside it (8 observations) than in the western buffer zone (2 observations) or outside it (1 observation). As the main flight direction was southwest, this flight trajectory covered the forests in the study area.

Of the birds of prey, the most frequently observed during the autumn migration period in the rotor safety zone were buzzards (eight observations) at an altitude of 160 m and one rough-legged buzzard (LK III cat) at an altitude of 180 m.

Three observations were made of white-tailed eagles, with the birds flying at an altitude of 145 m on two occasions and 180 m on one occasion (Figure 20). White-tailed eagles were observed in the eastern buffer zone of the study area on 17 October 2023 and 17 November 2023.

One observation of a red kite was made at an altitude of 110 m. A merlin was observed flying at an altitude of 100 m at the border of the study area buffer zone (Figure 20).

Three common buzzards were also observed at a height of 90 m and 270 red-backed shrikes at a height of 100 m.

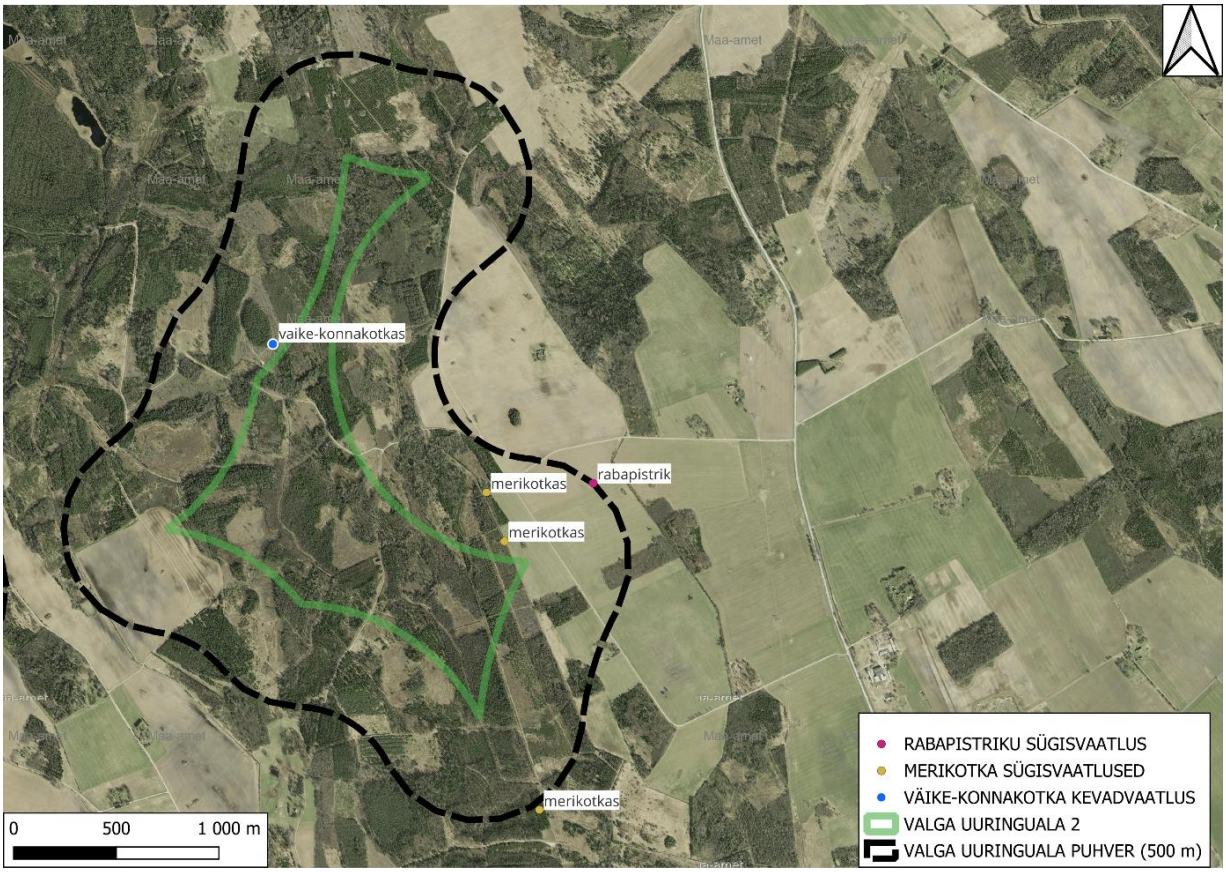

Figure 20. Observations of Category I protected bird species mapped during point observations (36+18+36) in the spring and autumn periods in the Valga study area 2.

Table 5. Results of spring/summer/autumn point observations (min 36 h, 18 h and 36 h) carried out in the Valga study area 2 by species, family or order. The direction of bird migration, their abundance (no.) and altitude are shown. Birds flying in the rotor safety zone (90-180 m) are marked in red.

Birds	Direction	Altitude (m)	NR	Total
SPRING				
haneline	E	108	213	2031
	N	125	519	
	NE	200	49	
	NW	143	211	
greater white-fronted goose	E	97	101	
	N	118	388	
	NE	200	116	
	NW	200	83	
	SE	120	163	
	SW	150	29	
	W	300	56	
tundra-rabahani	N	95	103	
blue-throated duck	Y	40	3	3
Humpback swan	NE	15	2	4
	W	30	2	
songbird	N	40	55	65

	SE	40	9	
	W	30	1	
swan	SW	50	3	3
	N	147	5	
	NE	47	5	
	S	200	12	
	Y	80	3	
crane	NA	300	3	28
	E	5	1	
	N	100	1	
	p	150	4	
	NE	100	1	
	SW	200	2	
	W	125	3	
mouse	Y	150	1	13
viu	p	150	1	1
roo-loorkull	Y	150	1	1
chickadee	Y	20	1	1
	SW	40	2	
iron crow	Y	60	1	3
lesser spotted eagle	p	150	1	1
goshawk	p	90	1	1
	S	60	1	
cheerleader	Y	90	1	2
metstilder	S	70	1	1
tikutaja	SW	40	2	2
silver gull	r	100	2	2
gull	Y	50	1	1
	E	40	3	
õõnetuvi	S	60	1	4
	p	20	1	
smoke stack	S	30	1	2
	N	60	1	
horse chestnut	p	30	1	2
white stork	Y	215	2	2

SUMMER

mouse	p	157	8	8
wasp	p	150	6	6
osprey	NW	30	2	2
rails	p	145	2	2
roo-loorkull	Y	150	1	1
lõopistrik	p	150	1	1
white stork	p	150	4	4
crane	p	70	2	2

grey heron	N	150	11	11
kiivitaja	Y	70	13	13
	S	150	2	4
laughing gull	SW	120	2	
	N	90	2	
	S	150	2	5
õõnetuvi	Y	40	1	

AUTUMN

	SW	300	30	
goose	W	240	244	
	E	80	3	
	SW	280	13	359
large-leaved hani	W	200	65	
tundra-rabahani	SW	170	2	
white-cheeked duck	W	200	2	
curlew	SW	50	3	3
	NW	45	40	
	S	200	3	
	SW	106	107	
song swan	W	210	16	169
	SW	108	99	
swan	Y	80	1	100
small duck	SW	103	14	14
crane	SE	75	35	35
	p	160	8	
	S	200	1	
marsh harrier	SW	198	8	17
hairy-footed viper	SW	180	1	1
	SW	180	1	
sea eagle	W	145	2	3
	p	200	3	
	S	80	1	
iron	Y	110	1	5
rape seed	Y	100	1	1
	E	80	1	
õõnetuvi	SW	90	3	4
grey-headed woodpecker	Y	60	1	1
white-backed woodpecker	p	30	1	1

	p	100	270	
knight	W	70	1	271
fish eagle	W	80	2	2
cormorant	W	200	17	17
horsefly	N	70	1	1

Y-overflight, p-stationary, r-migratory, N-flight north, NE-flight northeast, E-flight east, SE-flight southeast, S-flight south, SW- flying southwest, W- flying west, NW- flying northwest.

1.5 Study area 3

1.5.1 Overview of registered habitats of protected species

There are no registered habitats of Category I protected bird species within a 5 km radius of Study Area 3. Based on data from GPS-equipped black storks, there are also no feeding waters for black storks within the study area.

The habitat **of the capercaillie (*Tetrao urogallus*)** KLO9101751 is located 500 m from the study area (Figure 15). The last observation in the EELIS database is from 22 April 2018, when three capercaillie cocks were counted. Based on the analysis of terrestrial bird species, almost the entire study area overlaps with capercaillie zones 1 and 2, which means that, according to habitat modelling, it is a suitable habitat for capercaillie and its buffer zone.

The study area overlaps (potentially suitable wind area adjacent) with the habitat **of the northern goshawk (*Accipiter gentilis*)** KLO9119206 (Figure 21). The last EELIS-compliant habitat observation was on 12 May 2023, when nests -1807914332; 890787226 and KLO9113035 were unoccupied. An archiving proposal has been made for nest 890787226, as the nest has been destroyed due to clear-cutting in the vicinity of the nest. Previously (2018–2020), nest 890787226 was successfully inhabited. There is an extensive area of clear-cut forest between the location of the possible wind turbines and the nest of the corncrake.

Based on the above, it can be assumed that the condition of the habitat has deteriorated due to logging. The construction of one wind turbine within the 1 km buffer zone recommended in the analysis of the mainland bird population will not have any additional significant adverse impact on the habitat. Construction work must be carried out within the 1 km buffer zone outside the nesting period from 31 July to 1 March.

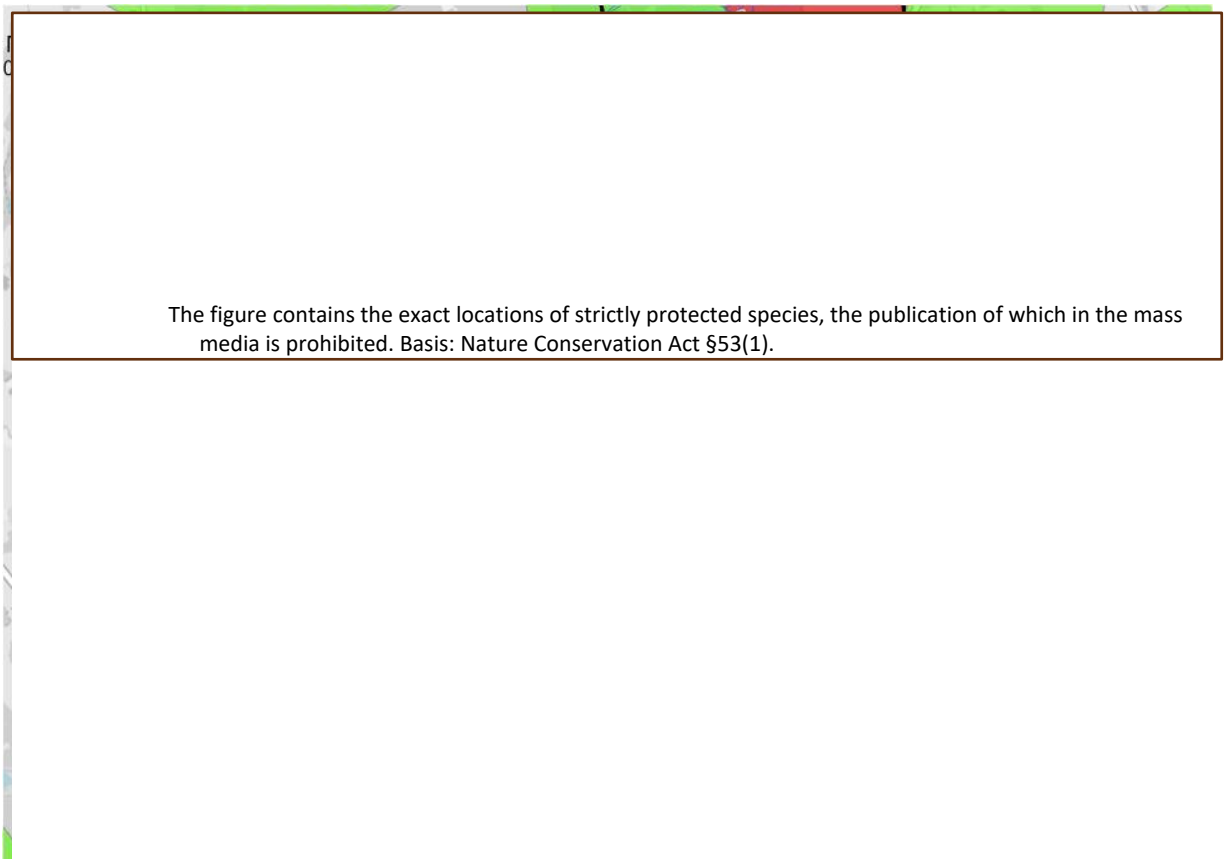

Figure 21. Registered habitats of the corncrake and analysis zones for terrestrial birds within a two-kilometre radius of study area 3.

No locations of bird species in protection category III according to EELIS have been registered in study area 3.

According to the terrestrial bird analysis, there is an overlap between *study* area 3 and the areas of zone 3, i.e. the modelled habitats of the hazel grouse *(Tetrastes bonasia*) (Figure 16).

2.3.1. Observations of capercaillie and other grouse

Capercaillie search areas were not mapped in study area 3, as there are practically no potential mating areas based on the mating model. Based on the orthophoto, these are actively managed stands, where, in principle, based on the model, lekking could only occur in isolated northern forest patches, but these have been intensively managed in recent years and do not offer much hope for stable capercaillie lekking. During fieldwork, a single capercaillie feather was found in the centre of the study area, but no other signs of capercaillie activity were observed in study area 3.

Grouse were mainly found in the central part of the study area and in the southern areas, both within and outside the buffer zone. Grouse locations are shown in Figure 22 and mapped habitats in Table 6. No grouse individuals or signs of activity were observed in the study area.

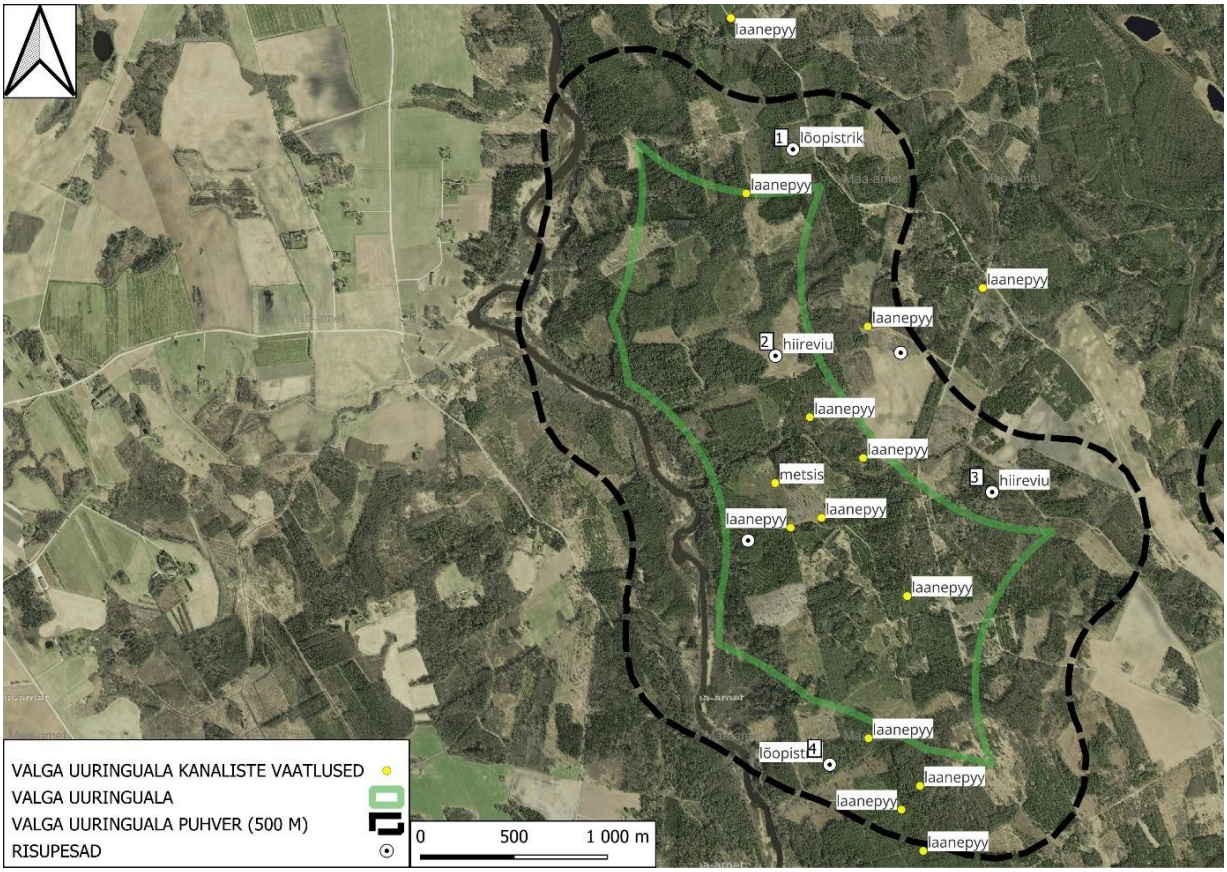

Figure 22. Observation of grouse and nests found in study area 3 in Valga.

1.5.2 Lure findings of woodpeckers, cuckoos, hazel grouse and black grouse; protected and important breeding birds and their habitats

Four woodpecker decoy points were placed in the Valga study area 3, which were decoyed on 8 May 2023, and 18 points where woodpeckers, hazel grouse and black grouse were decoyed on 27 May 2023 (Figure 23). A point count of breeding birds was also carried out at these 18 points on 27 May 2023 (lists of birds by area are attached as an appendix) and protected and important bird species (KO) were recorded in accordance with Appendix 7 of the EOÜ bird survey.

In the southern part of the area, the corncrake was still being lured on 15.03 and 20.03.24 near its habitat (KLO9119206) and in older pine-dominated natural forests, but the species could not be heard.

Aerial observations were mainly carried out at three points (4, 22 and 5) and at two additional observation points 224 and 225 (Figure 23). The times of the spring, autumn and summer aerial observations, together with the weather conditions in the study area, are presented in Table 13 in the supplementary material to the study.

Nests were mapped in the study area during the luring of woodpeckers, hazel grouse and capercaillie, when older forests were searched for nests in tree crowns. During the point count of breeding birds and regular point observations, attention was also paid to hawks, including various territorial and chick calls in the area, and when these were heard, possible nesting trees were searched for and potential habitats were mapped based on territorial observations, which are presented in Table 6.

1.5.3 Rustic nests

Separate searches for brushwood nests were conducted in older (60+) forests in the central and southern parts of the study area on 15.03.24 and 20.03.24, where a possible kestrel nest was found at point 4 (Figure 22) and one buzzard's nest (point 3, Figure 22). One buzzard's nest was found in a clear-cut area at point 2 (Figure 22). One kestrel's nest was found during the national survey at point 1 (Figure 22).

Photo 4. A buzzard's nest found in the eastern buffer zone at point 3 (see Figure 22) between the branches of a birch tree, decorated with fresh spruce branches and with adult birds staying near the nest.

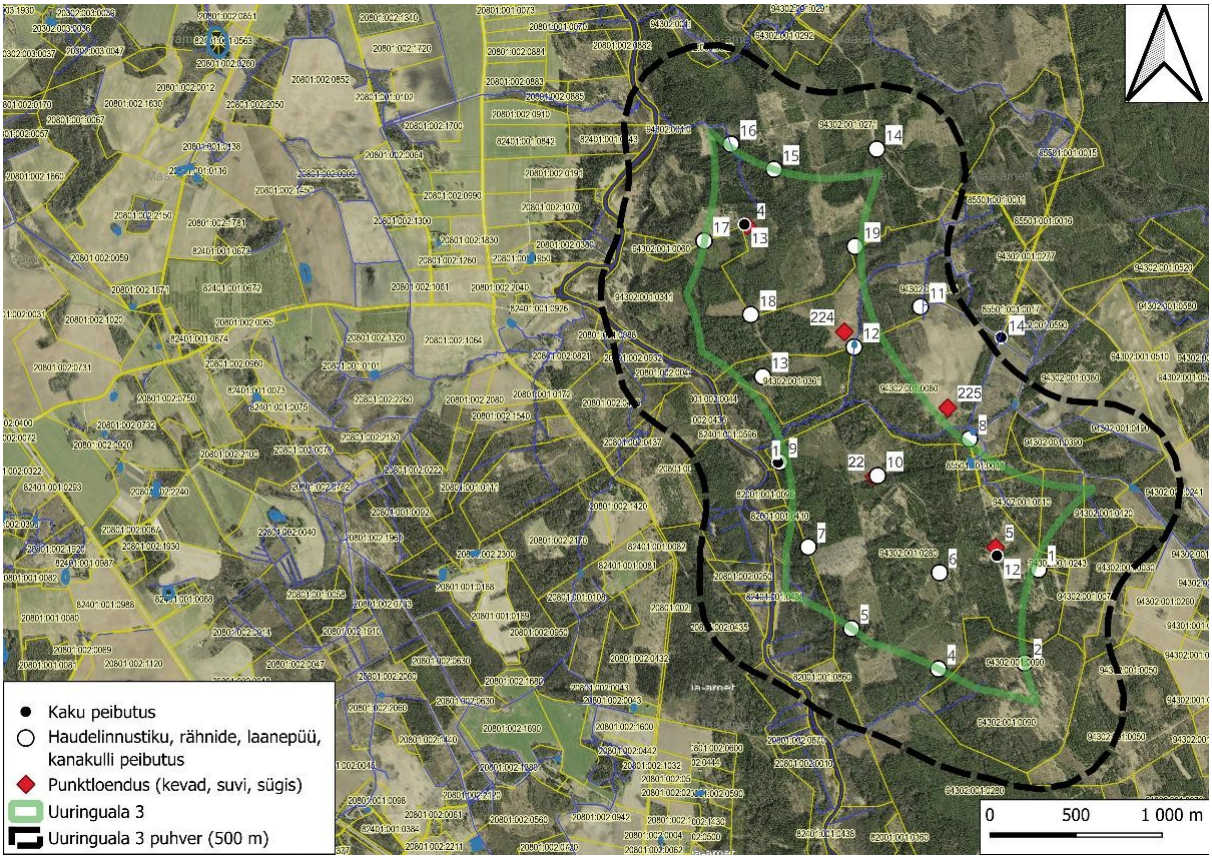

Figure 23. Observation points for corncrakes, breeding birds, woodpeckers, hazel grouse, black grouse and spot observations (36+18+36) in survey area 3 in Valga.

Table 6. Protected and important bird species and their habitats mapped in the Valga study area 3, as shown in Figure 23.

ID	FOREST REGISTER HABITAT	SPECIES MAPPED DURING FIELD WORK
1	Old and middle-aged PH pine forests, clearings with retention trees	black woodpecker
2	Old PH-MS-JM pine forests, clearings	marsh harrier possible breeding territory, woodcock x2
3	Old JK pine forest	wasp breeding territory, marsh harrier migration corridor, possible kestrel nest
4	Old JK coppice and JK pine forest, middle-aged JK spruce forest, young JK pine forest	bee-eater nesting territory, woodcock
5	Old JK pine forest, JK birch forest, older ND birch forest and middle-aged JK birch forest	marsh harrier nesting territory
6	logging site	buzzard hunting grounds
7	Old and younger PH pine forests, logging site	herilasviu and raudkulli nesting territory
8	Old PH pine forest, logging area	black woodpecker (LK II cat), nesting territory of honey buzzard and black woodpecker, hoopoe, black woodpecker, lesser spotted woodpecker
9	Younger MS coppice	marsh harrier nesting territory
10	Older JP groves, young JP spruce forests	Hoburästas, small-billed woodpecker, black woodpecker
11	Younger JM birch forest	Mouse hawk hunting

12	Older JM grouse	Black grouse nesting territory
13	Young JM pine forest and PH spruce forest	black grouse nesting territory, song thrush, corncrake and buzzard migration corridor, corncrake hunting ground
14	Young PH pine forest	fieldfare
15	Older MD birch forest and MO pine forest, clearings	Mouse eagle nesting territory
16	Old JP-PH pine forests, younger JK pine forests	Honey buzzard nesting territory
17	Mainly clearings, old JK aspen forest and birch forest	black woodpecker nesting territory, lesser spotted woodpecker, lesser grey-headed woodpecker, black woodpecker, meadow pipit, hobby, wood sandpiper, woodcock, buzzard and black woodpecker migration corridor, goose migration corridor
18	Old JK coppice	wood sandpiper
19	Old JP pine forest	Hoburästas, raudkulli migration corridor
20	Old JK aspen forest and PH pine forest, younger JK spruce forest, older TR birch forest	breeding territory of the hazel grouse
21	Old MS pine forest	Lesser spotted woodpecker, Eurasian treecreeper, Eurasian nuthatch
22	Older SS pine forest	black woodpecker, horse-tailed flycatcher, barn swallow
23	Old JP spruce forest	marsh harrier
24	Older JK pine forest	grey-headed woodpecker
25	riverbank area	Mouse hawk hunting ground
26	Väike-Emajõgi,	Osprey hunting grounds
27	Young PH pine forest, logging site	nesting site of the Eurasian hobby, nightjar
28	Old SS pine forest, logging site	marsh harrier and honey buzzard hunting grounds
29	Old JM-JK pine forests	black woodpecker
30	Older JK-JP pine forests	Hoburästas, white-backed woodpecker (LK II)
31	logging site	buzzard nesting site
32	logging site	barn owl, meadow pipit, buzzard hunting ground
33		field lark heading west from the forest
34	Younger JK spruce forest	black grouse
35	Middle-aged JK birch forest and spruce forest	Haukaliste (bee-eater, mouse-eater, crow, kestrel) hunting, woodcock and black woodpecker
36	Middle-aged JK aspen forest	Probable nesting site of the hobby
37	Older JM spruce forest	Honey buzzard hunting ground, woodcock
38	Middle-aged JK birch forest	Kanakulli hunting
39	Older JM grouse	Kanakulli hunting ground
40	Farmland	Red-backed shrikes
41	Older JP pine forest	Kanakulli hunting ground
42	Middle-aged JK and ND spruce forest	Raudkulli hunting ground, mouse eagle nesting site
43	Younger PH pine forest	White-backed woodpecker
44	Younger JK pine forest	Osprey gliding
45	Middle-aged JK capercaillie	Buzzard hunting, woodcock
46	Old pine forests, JK aspen forests	wood pigeon
47	Old and older PH pine forests, younger PH spruce forests	grouse

48	Old JK birch forest	white-backed woodpecker, lesser spotted woodpecker, woodcock, buzzard
49	Old JP pine forest	white-backed woodpecker, lesser spotted woodpecker, buzzard
50	Older JP pine forest	white-backed woodpecker, lesser spotted woodpecker, buzzard

Abbreviations for habitat types: MO – blueberry bog; JP – hare's-tail cottongrass; SS – transition mire; PH – cottongrass; JK – hare's-tail cottongrass; MS – blueberry; JM – hare's-tail cottongrass-blueberry; JO – hare's-tail cottongrass-bog, MS – fen; KR – haircap moss; RB – bog, AN – sedge, ND – reed; KM – haircap moss-blueberry, SN – blueberry.

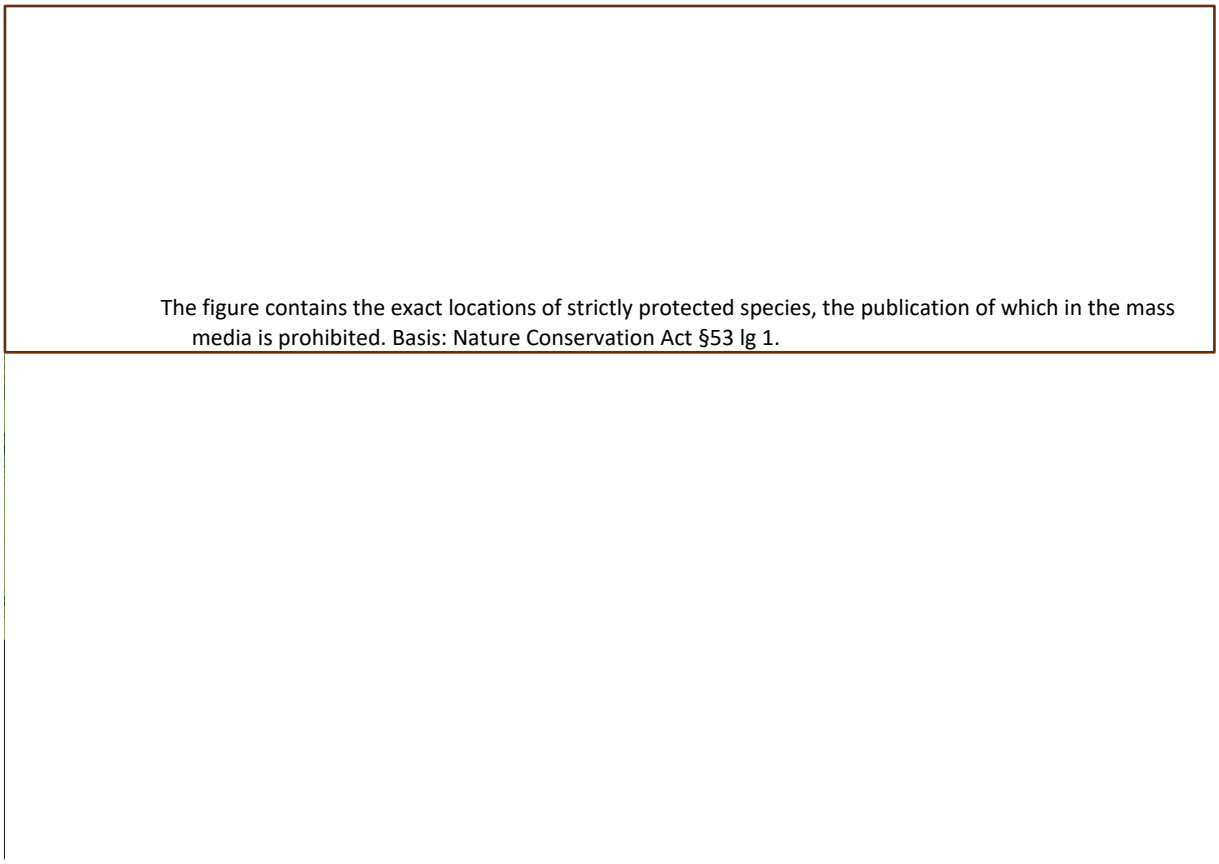

Figure 24. Protected and important species mapped in the Valga study area 3 and their habitats, the descriptions of which are provided in Table 6.

1.5.4 Point observations

Spring migration observations

During the spring migration period, a total of 998 geese/ducks were observed, 96% (957/998) of which flew in the rotor safety zone at an average altitude of 160 m. The most common species during migration were the greater white-fronted goose (437), the tundra swan (207) and unidentified geese (333, Table 7).

Approximately 16% (6/38) of the observed cranes were flying in the rotor safety zone.

Of the hawks, the most common were buzzards, 54.5% of which flew within the rotor safety zone (6/11, at an average altitude of 100 m and 150 m, Table 7). The predominant direction of migration was south and southwest. All birds (5/5) observed in the rooster's flight path were located in the rotor's safety zone at an altitude of 150 m. The rooster observations were made on the north-west to south-east line, mainly in the central and south-eastern parts of the study area. This is the hunting territory of the common buzzard. All three observations of the black kite were also made in the rotor safety zone at an altitude of 140 m. The common buzzard was observed twice, once flying in the rotor safety zone at an altitude of 150 m.

Of the bird species in protection category I, the osprey was observed twice: once in the western part of the study area in the buffer zone at a height of 150 m near the Väike-Emajõgi River, and once

at the southern border of the study area at an altitude of approximately 200 m, moving southwards (Figure 25). The lesser spotted eagle was observed in the south-western part of the study area at the borders of the buffer zone (Figure 25).

Of the important species, the Eurasian hobby was observed four times, and all observations were made in the rotor safety zone at an average height of 90-130 m.

Observations of summer resident bird species

Of the hawks, the most frequently observed species was the honey buzzard, with 67% (8/12) of observations located in the rotor safety zone at a height of 150 m. All six observations of buzzards were located in the rotor safety zone at an average height of between 150 and 167 m.

During the summer period, a osprey was observed once in the north-western buffer zone of the study area, where it circled at an altitude of 200 m and then swooped down, probably to the Väike-Emajõgi River to catch prey (Figure 25). A white-tailed eagle was spotted once at an altitude of 200 m flying over the north-western part of the study area buffer zone (Figure 25).

The osprey was observed three times, and 67% (2/3) of the observations were in the rotor safety zone at an average height of 90 m.

Of the important species, cormorants were also observed in the rotor safety zone, with all 40 observations taking place in the rotor safety zone at an average height of 130 m and 150 m. A common tern was observed in the rotor safety zone at a height of 120 m on one occasion. One barn swallow was also observed in the rotor safety zone at a height of 150 m on one occasion.

Observations of autumn migration species

During autumn migration, only a few geese (three observations) and one greater white-fronted goose were

observed in the area. Thirty-eight cranes were observed flying at a height of 120 m in the rotor safety zone.

Of the hawks, buzzards were observed, with approximately 88% (7/8) of observations located in the rotor safety zone at an average height of 94 m. Of the sparrowhawk observations, all three observations were located in the rotor safety zone at a height of 90 m. Two observations of kestrels were made in the rotor safety zone at a height of 100 m. One observation of a white-tailed eagle was made in the centre of the study area, where the eagle was heading south at a height of 100 m (Figure 25 and Table 7).

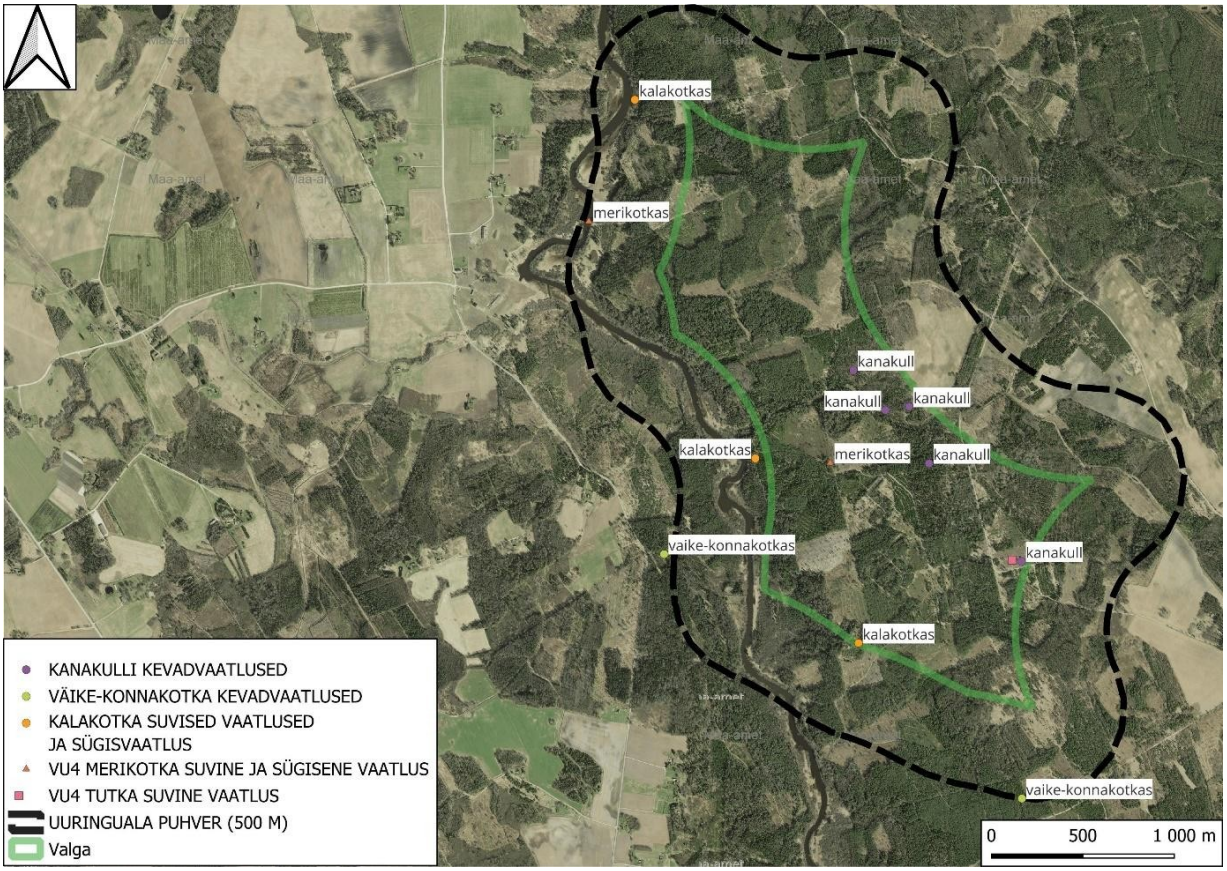

Figure 25. Species in protection categories I-II mapped based on 3 point observations in the Valga study area.

Table 7. Results of spring/summer/autumn point observations (min. 36 h, 18 h and 36 h) conducted in study area 3 in Valga, by bird species and family. The direction of bird migration, their abundance (no.) and altitude are shown. Birds flying in the rotor safety zone are marked in red.

Birds	Direction	Average altitude (m)	NR	Total
SPRING				
hani	N	160	313	998
	NE	700	30	
large-leaved hani	N	157	437	
tundra-rabahani	N	158	207	
white-cheeked	N	190	11	
white stork	p	200	1	3
	W	800	1	
	Y	300	1	
crane	E	220	4	38
	N	225	4	
	p	400	3	
	NW	150	1	
	S	150	5	
	W	300	5	
	Y	250	16	
mouse	p	200	1	11
	S	150	3	
	SW	100	3	
	W	200	1	
	Y	200	3	
herilaseviu	Y	300	1	1
kanakull	p	150	5	5
iron crow	p	140	3	3
roo-loorkull	N	200	1	2
	p	150	1	
Osprey	p	150	1	2
	S	200	1	
lesser spotted eagle	p	200	1	2
	Y	200	1	
songbird	E	60	3	7
	S	50	4	
blue-throated duck	E	80	3	3

common tern	S	70	1	1
	E	115	2	
	N	130	1	
kiivitaja	S	90	1	4
tikutaja	S	70	1	1
õõnetuvi	N	30	1	1
	S	80	2	
smoke swallow	W	60	2	4
	p	30	1	
pine cone bird		**30**	**1**	2
SUMMER				
	r	150	1	
grey heron	W	130	1	2
white stork	Y	225	2	2
	p	150	8	
wasp	S	200	4	12
	p	167	4	
mouse	S	150	2	6
Osprey	p	200	1	1
sea eagle	Y	200	1	1
	p	90	2	
end cap	Y	200	1	3
crane	p	200	1	1
cormorant	NW	150	19	40
	SW	130	21	
fish eagle	S	120	1	1
kiivitaja	p	85	2	2
radar	SE	200	2	2
õõetuvi	Y	60	2	2
horse chestnut	S	80	2	2
smoke fly	Y	150	1	1
AUTUMN				
goose	SW	200	3	3
large-leaved hani	S	190	1	1
blue-throated duck	N	130	2	2
sõtkas	S	180	9	9
crane	SW	120	38	76
silver gull	NE	300	1	1
	E	80	1	
mouse hawk	S	225	2	3
	S	94	7	
iron crow	SW	50	1	8
lõopistrik	S	90	3	3
windmill	S	100	2	2
sea eagle	S	100	1	1
smoke stack	NW	35	4	4

Y-overflight, p-stationary, r-migratory, N-flying north, NE-flying northeast, E-flying east, SE-flying southeast, S-flying south, SW- flying southwest, W- flying west, NW- flying northwest.

1.6 Study area 4

1.6.1 Overview of registered habitats of protected species

The habitat **of the black stork (*Ciconia nigra*)** KLO9128282 is located 2.5 km from study area 4 (Figure 26). The nest (id - 626942051) is located 3 km from the study area (Figure 2620). The habitat was last checked on 2 June 2023 as part of national monitoring, when it was not inhabited by the target species. Monitoring data has been available in the EELIS database since 2011, and the habitat has not been occupied during that time. The 2017 monitoring report notes that the nest has been destroyed.

Based on an analysis of the feeding areas of black storks equipped with GPS transmitters [25], there is one known feeding water body for black storks in the study area (Naadimõtsa ditch, VEE1011902). Based on the analysis of GPS data, this is a partially priority feeding water body. The feeding water body overlaps with a potentially suitable wind farm area.

Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, no large-scale logging has been carried out in the habitat forest.

In addition, the black stork habitat KLO9133649, located 4.3 km from the study area, is entered in the 2024 register. This is a re-entry in the register based on previously archived entries KLO9101991

[25] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

(last nesting in 1989, collapsed in 2009) and KLO9108861 (nesting failed in 2009, nest collapsed in 2012). According to EELIS data, the habitat is sustainable and can be repopulated. The habitat is delimited according to the boundaries of existing permanent habitats and corrected on the basis of cadastral boundaries. Known nests in the habitat, KLO9101991 and KLO9108861, have collapsed.

The registered habitat KLO9129606 **of the lesser spotted eagle (*Clanga pomarina*)** is located 4.3 km from the study area (Figure 26). The habitat was last checked on 5 July 2021 as part of national monitoring, when it had collapsed. According to monitoring, the habitat was last established by a lesser spotted eagle in 2008. According to EELIS, the nest had already collapsed during monitoring in 2015.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129605 is located 4.2 km from the study area. The nest (id -1999279627) is located 3 km from the study area (Figure 26). The habitat was last checked on 18 July 2020 as part of national monitoring, when it was found to be unoccupied. Based on monitoring, the habitat was last occupied by a lesser spotted eagle in 2015.

Based on the Land Board's forest change map data (for the period 2012–2021) and orthophotos, relatively extensive logging has taken place in the forest habitat.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129604 is located 4.39 km from the study area (Figure 26). The habitat was last checked as part of national monitoring on 2 August 2022, when it was uninhabited. According to the monitoring, the habitat was last inhabited by the lesser spotted eagle in 2015. Based on the orthophoto, large-scale logging has been carried out in the habitat forest.

The registered habitat **of the lesser spotted eagle (*Clanga pomarina*)** KLO9129601 (Figure 26) is located 4.2 km from the study area. As part of national monitoring, the habitat was last checked on 21 July 2023, when it was inhabited and one chick was growing in the nest. Based on monitoring, the habitat has been inhabited throughout the period 2016–2022. Logging has been carried out near the habitat, but the forest habitat has largely been preserved.

The registered habitat KLO9129600 **of the lesser spotted eagle (*Clanga pomarina*)** is located 4.5 km from the study area (Figure 26). As part of national monitoring, the habitat was last checked on 15 July 2023, when it was inhabited and the nest had fallen down. Based on monitoring, the habitat has been inhabited throughout the period 2003–2022. The area surrounding the habitat forest has recently undergone regeneration felling, but the core of the habitat forest has been preserved.

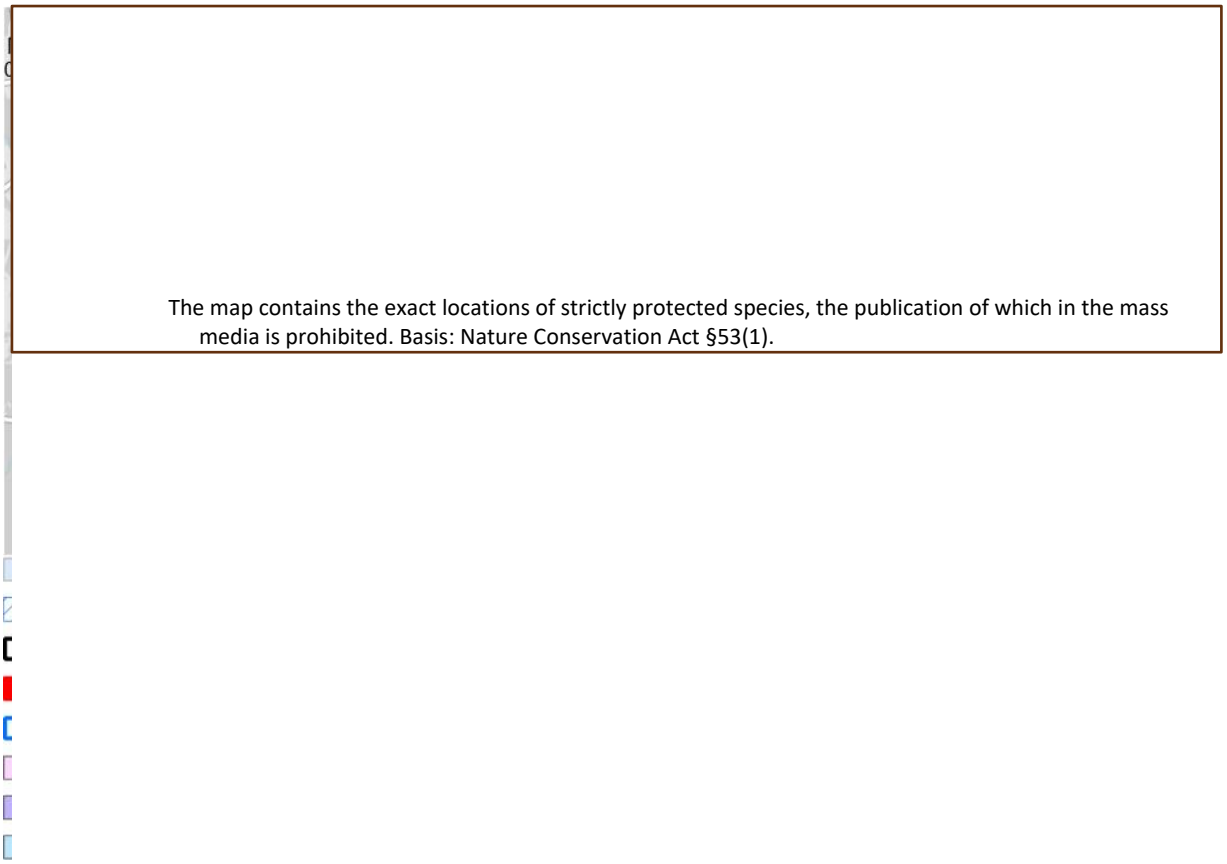

Figure 26. Registered habitats of Category I protected bird species and known feeding waters of black storks within a five-kilometre radius of the study area.

The habitat **of the northern goshawk (*Accipiter gentilis*)** KLO9130897 is located 130 m from the study area (Figure 27). The nest was registered in 2022. According to EELIS, nesting was successful in both 2022 and 2023. The habitat was also inhabited on 03.06.24, when there were two chicks in the nest (id -78008892).

There are several clear-cut areas between the location of the possible wind turbines and the capercaillie nest. The Environmental Board has additionally confirmed the habitat (KLO9130897) on 31.01.2024 with clear-cut forest notification no. 50000685407. The clear-cutting has probably been carried out by now, as the notification is valid for one year. The forest notification contains the following conditions:

"The Environmental Board grants consent for logging on the following condition: 1. Logging (including timber transport) in the capercaillie habitat may not be carried out during the capercaillie nesting period from 1 March to 31 July. The Environmental Board recommends: 1. When carrying out clear-cutting, preserve at least 15% of the pre-felling tree stock as groups of dominant individual trees with large crowns. 2. Leave dead trees in place. 3. Do not fell or selectively fell trees within 100 m of the nesting tree (the black grouse nesting tree is located in compartment 5 of VL545, approximately 26 m northwest of the southern tip of compartment 6). The black woodpecker is most sensitive to disturbance during the nesting period, when it is preparing to nest, laying eggs, incubating and raising its young, as disturbance can easily cause the nesting to fail. Although any human presence near the nest during the sensitive period may disturb the black-throated diver, the main disturbance factor is logging during the breeding season. The black-throated diver's breeding season begins in March and lasts until the end of July.

Based on the above, it can be assumed that the condition of the habitat has deteriorated due to logging. The construction of one wind turbine within the 1 km buffer zone recommended in the analysis of the mainland bird population will not have any additional significant adverse impact on the habitat. Construction work must be carried out within the 1 km buffer zone outside the nesting period from 31 July to 1 March.

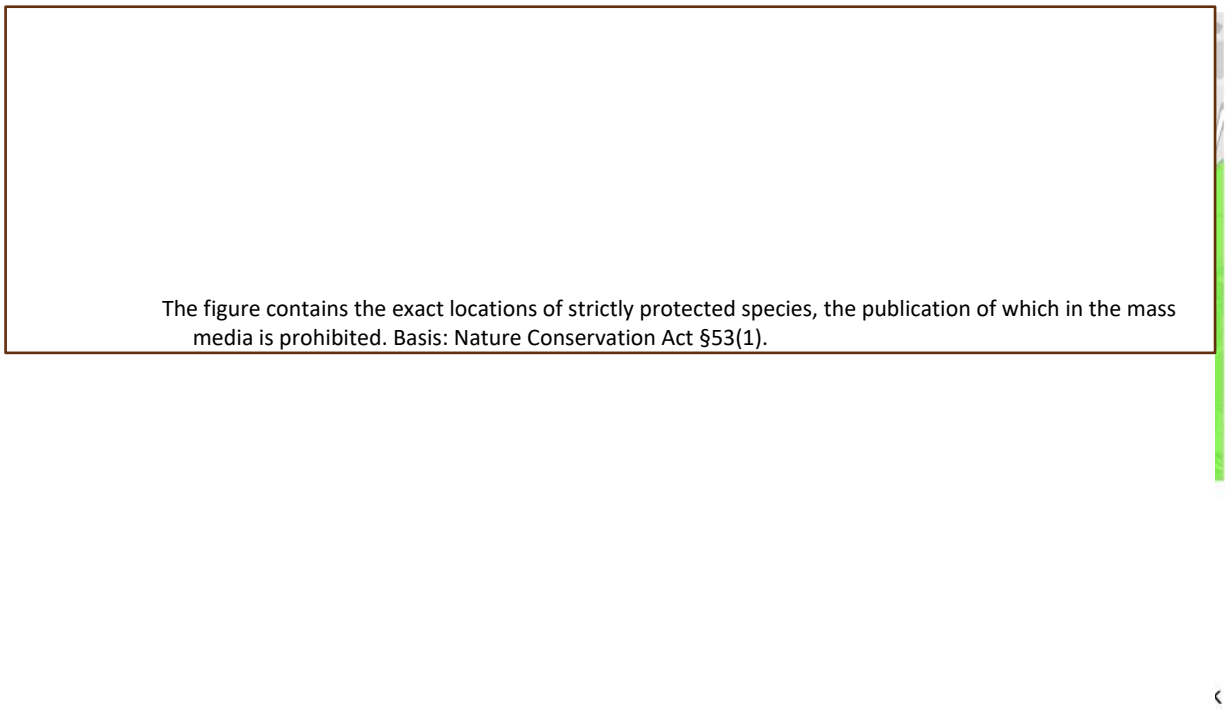

Figure 27. Registered habitats of the corncrake and corresponding zones in the analysis of terrestrial bird fauna within a two-kilometre radius of study area 4.

Based on the analysis of terrestrial bird populations, almost the entire study area 4 overlaps with capercaillie zone 2. This is a presumed migration corridor between habitats (Figure 28), but a more detailed analysis of capercaillie habitats is provided in section 1.3.2. However, according to the draft of the new capercaillie action plan, the area was not designated as a core area or stepping stone. Possible capercaillie stepping stones based on the nest model are presented in section 1.3.2.

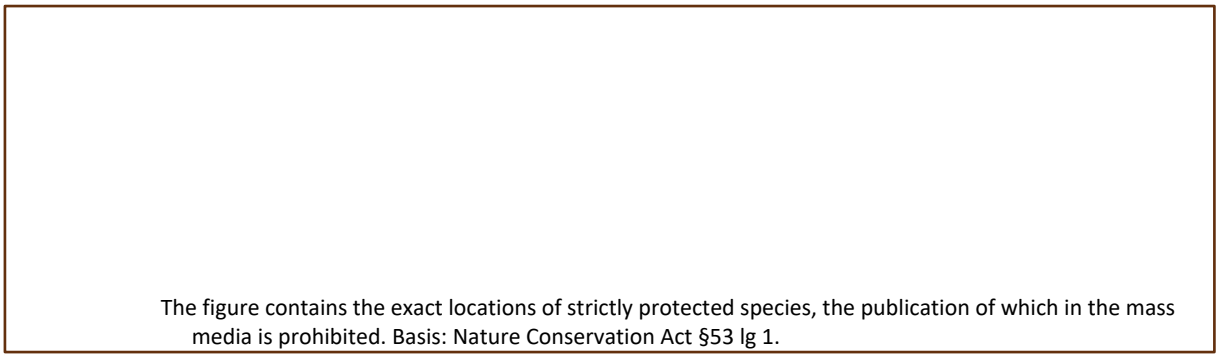

Figure 28. Analysis zones for the capercaillie's terrestrial habitat within a two-kilometre radius of study area 4.

Based on EELIS, the study area has four habitats of the common buzzard (*Buteo buteo*) registered in a 500 m buffer zone, KLO9126365. The nest was registered on 20 March 2020 (Figure 29).

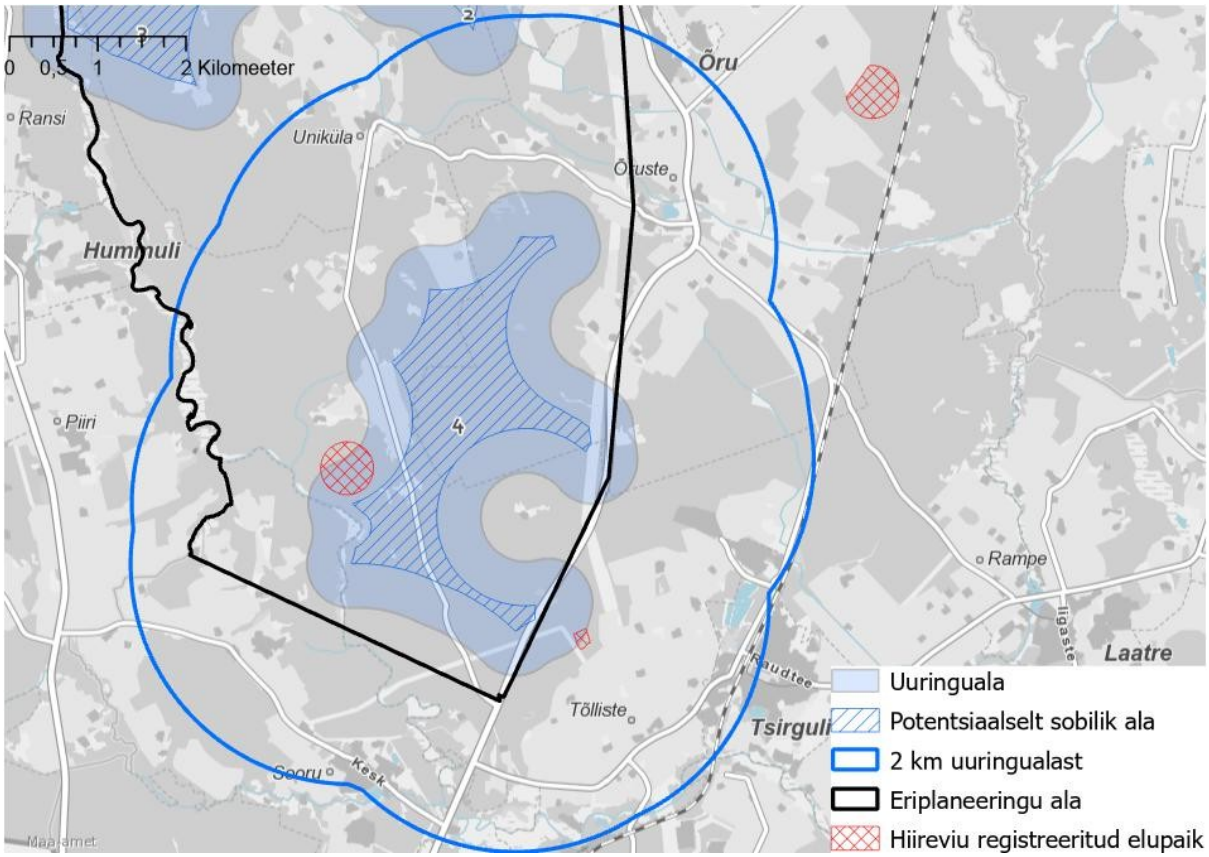

Figure 29. Registered habitats of buzzards within a two-kilometre radius of study area 4.

According to the terrestrial bird analysis, study area 4 overlaps with hazel grouse (*Tetrastes bonasia*) zones 1, 2 and 3, i.e. the modelled habitats of the species and the habitats mapped on the basis of random observations and their buffers (Figure 30).

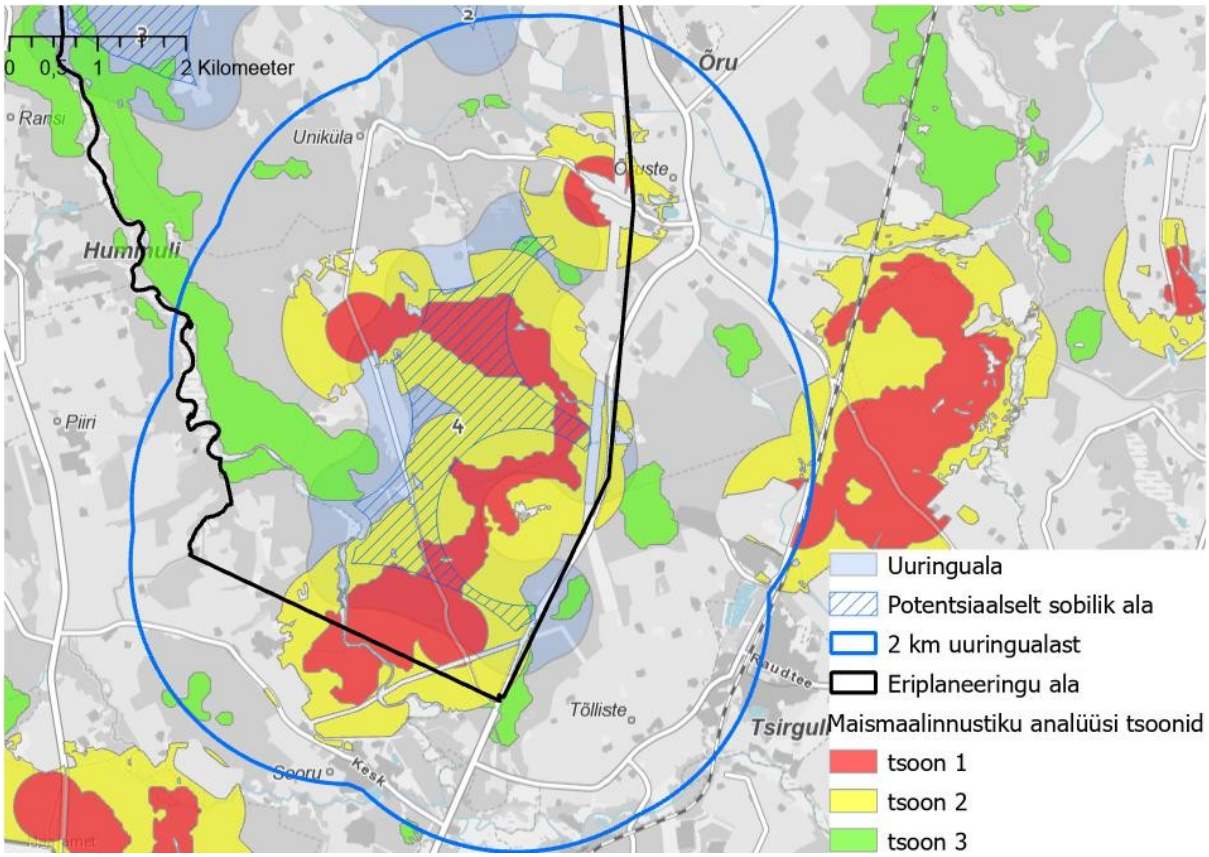

Figure 30. Hazel grouse terrestrial bird analysis zones within a two-kilometre radius of study area 4.

According to the terrestrial bird analysis, there is little overlap in study area 1 with zone 3 of the greater white-fronted goose (*Anser albifrons*) in the northern part (Figure 31).

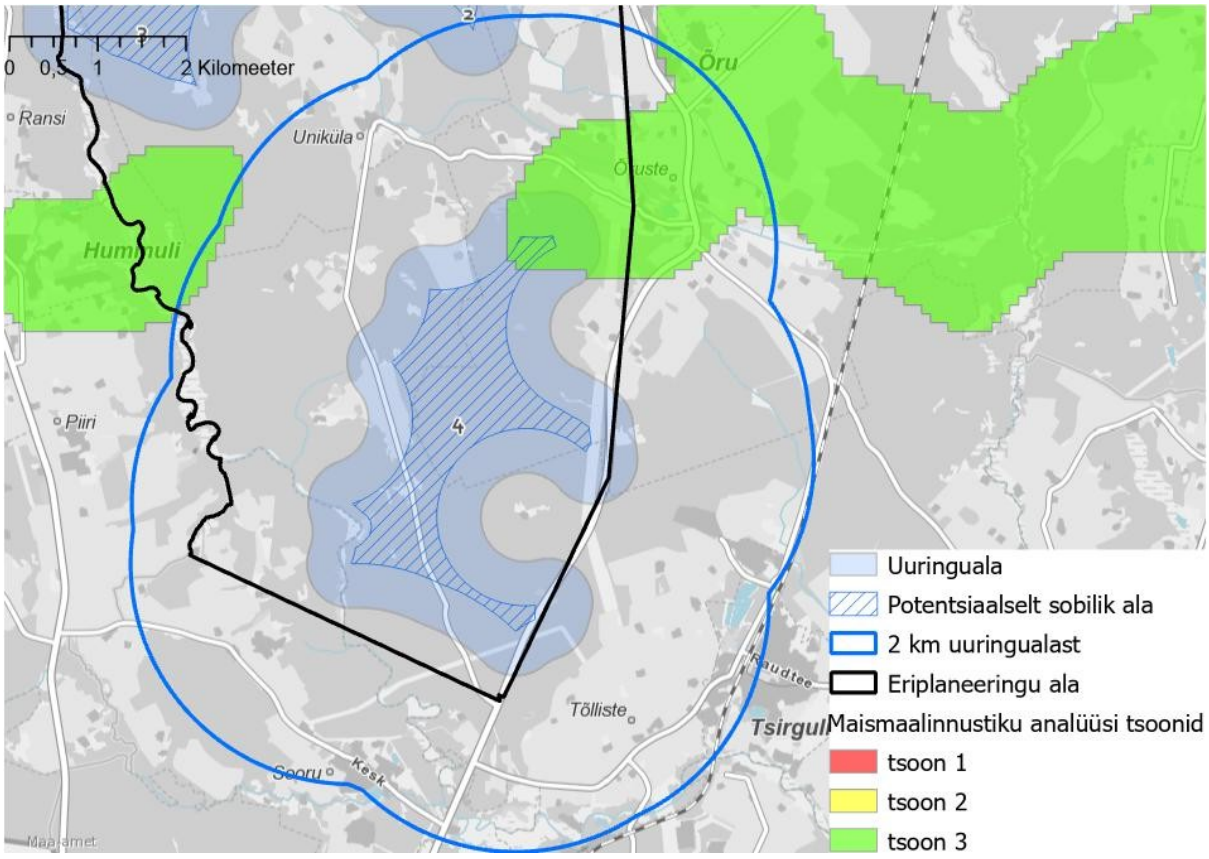

Figure 31. Zones of the greater white-fronted goose terrestrial bird analysis within a two-kilometre radius of study area 4.

1.6.2 Observations of capercaillie and other waterfowl

The capercaillie search areas were selected according to the model of breeding grounds (area I with an area of 5 ha; area K S=12 ha, area J S=9 ha, area H S=57 ha and area L S=8 ha, Figure 32). Traces of capercaillie activity were only found in area H and in the forest to the south of it, which was outside the search area. These were feeding traces, and the area is particularly important for capercaillie in terms of feeding.

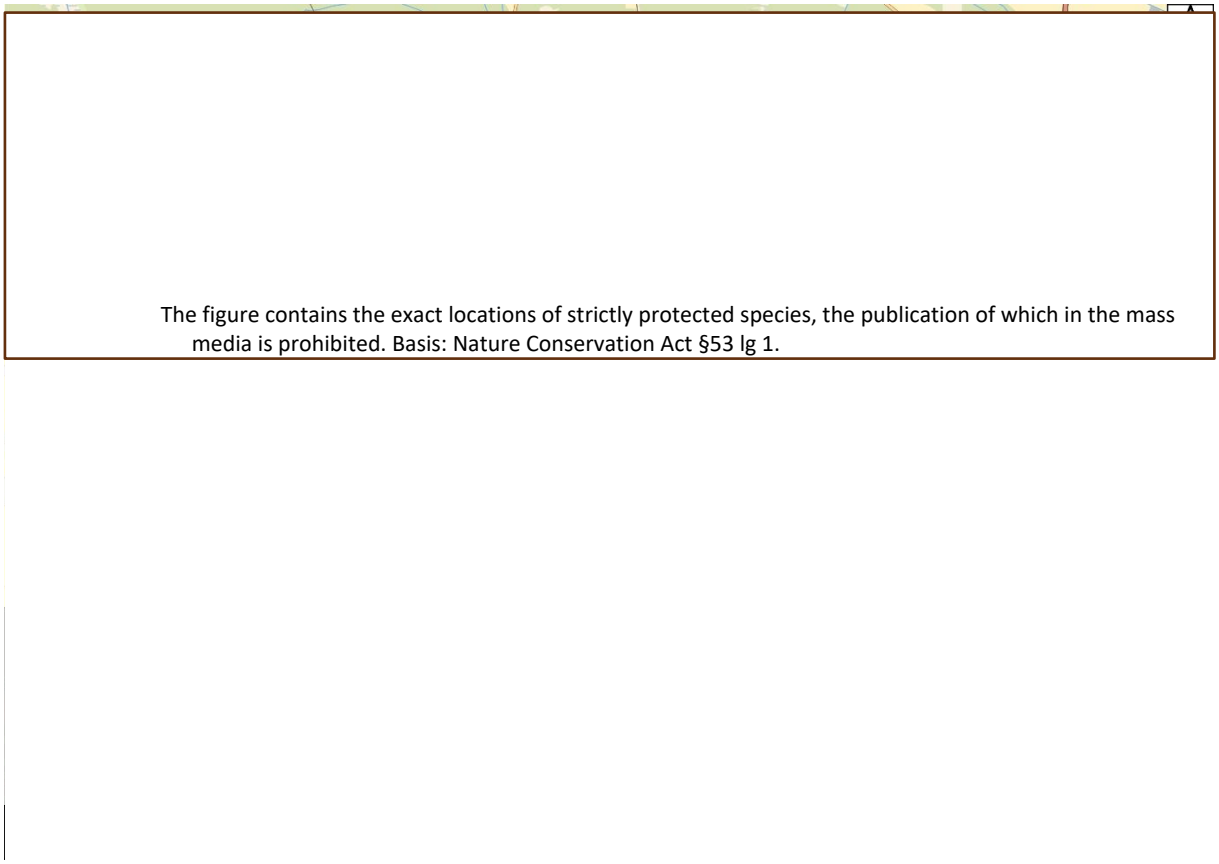

Figure 32. Capercaillie search areas selected according to the capercaillie habitat search model, with channel observations and nest finds.

The figure contains the exact locations of strictly protected species, the publication of which in the mass media is prohibited. Basis: Nature Conservation Act §53 lg 1.

Figure 33. Capercaillie search area in study area 4.

Photo 5. Potentially suitable lekking area according to the lekking area model, which turned out to be an intensively drained pine forest.

According to the lekking site model, the potentially suitable lekking area turned out to be intensively drained pine forests in search area H (57 ha) (Photo 5). The search area was crossed by both transverse and longitudinal ditches, and due to the impact of drainage, birch growth had intensified in the pine forest, and suitable play areas were unlikely to be found in such a dense forest. The only traces of capercaillie activity were found on wide drainage ditches under pine trees – two of them were single dried winter droppings and two were capercaillie feeding trees. In one case, there were both short and long droppings under a pine tree, which indicated

a possible single cock playing, where a trail camera was installed on 9 April 2023. However, during subsequent observations, the capercaillie was no longer seen near the drainage ditch.

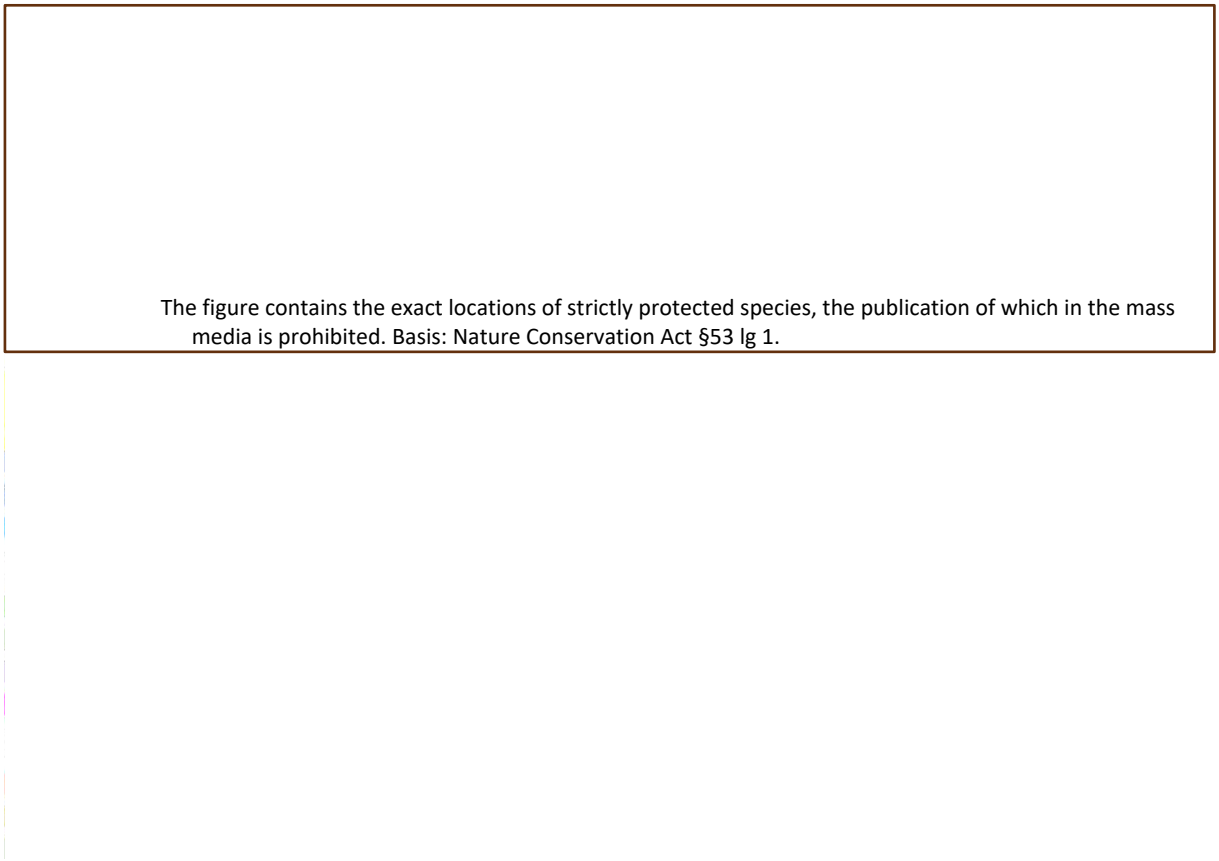

Figure 34. Registered habitats of bird species in protection category II within a two-kilometre radius of the study area.

1.6.3 Luring sites for woodpeckers, cuckoos, hazel grouse and capercaillies; protected and important breeding birds and their habitats, searches for nest boxes

Five cuckoo decoy points were placed in study area 4 in Valga, which were decoyed on 8 May 2023, and 25 points where woodpeckers, hazel grouse and black grouse were decoyed on 10 May 2023 (Figure 35). A point count of breeding birds was also carried out at these 25 points on 18 June 2023 (lists of birds by area are attached as an appendix) and protected and important bird species (KO) were recorded in accordance with Appendix 7 of the EOÜ bird survey.

Airspace point counts were mainly carried out at three points (1, 3 and 2021) and at two additional observation points (320 and 21). Spring, autumn and summer aerial observations were carried out at four points (Figure 9) and the locations of bird aerial observations, together with observation times and weather conditions in the study area, are presented in Table 14 in the supplementary material.

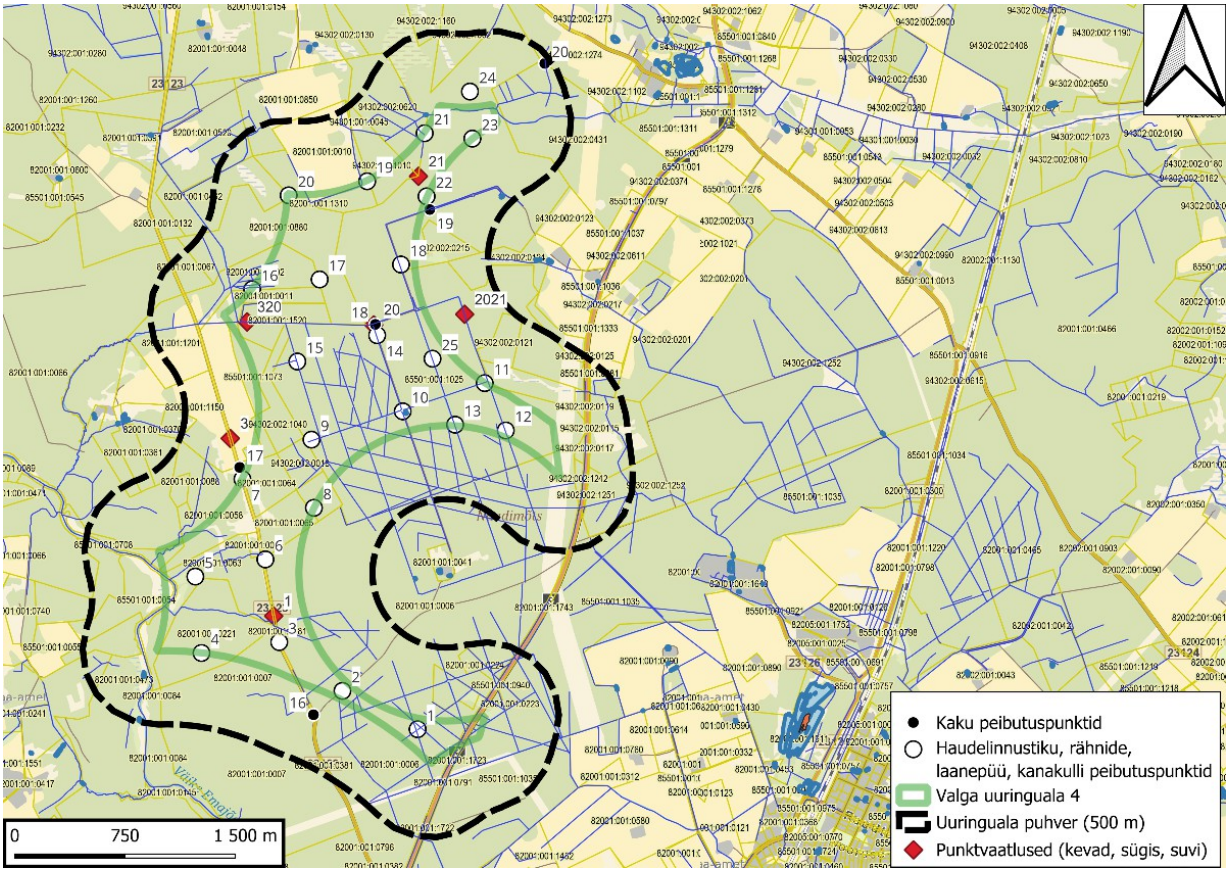

Figure 35. Counts of corvids, breeding birds, woodpeckers, hazel grouse and capercaillie, and spring, summer and autumn point observations carried out in study area 4 in Valga.

Table 8. Protected and important bird species and their habitats mapped in the Valga study area 4, which are also mapped in Figure 36.

ID	FOREST REGISTER HABITAT	FIELD WORK SPECIES
1	Mainly middle-aged JM, SS, KR, MS, RB, SN pine forests, old JM, MO pine forests, young KR, KM, SS pine forests, birch forests	capercaillie feeding area, grey-headed woodpecker, hazel grouse, black grouse, buzzard
2	middle-aged KM pine forest	Horsefly
3	Older KM pine forest	horse chestnut
4	Old JM pine forest	small flycatcher
5	Younger KR pine forest, older JM pine forest and birch forest	colourful crow
6	Older MS pine forests and middle-aged KR spruce forests	õõnetuvi
7	Old JM pine forest, riverbank swamps	Lesser spotted woodpecker, hazel grouse (LK II cat), wood warbler, woodpecker, wood warbler, black woodpecker, long-tailed tit
8	Old and older JO coppices, old JM spruce forest	grey-headed woodpecker, black woodpecker, white-backed woodpecker black woodpecker
9	Arable land	kiivitaja, horsefly, irrelevant migration corridor geese and hawks
10	logging site	corn crake, red-backed shrike
11	Middle-aged JK spruce forest	õõnetuvi, herilaseviu pot nesting territory

ID	FOREST REGISTER HABITAT	TYPES OF FIELD WORK
12	JK aspen forest	õõnetuvi
13	middle-aged KM pine forests	horse chestnut
14	Old MS, JM pine forests, old KR birch forest, middle-aged KM pine forest, younger ND birch forest	woodcock, white-backed woodpecker (LK II cat)
15	Old JK spruce forest and JK birch forest	small flycatcher
16	Middle-aged KR pine forests and KS birch forests	Honey buzzard and marsh harrier pot nesting territory
17	JM, birch forest and aspen forest, AN grey alder forest	nest spruce, black grouse nesting territory
18	Old JM grove	Lesser spotted woodpecker x2, Lesser spotted woodpecker
19	Old MS copse, middle-aged JM-JK spruce forests, copse	grey-headed woodpecker, turtle dove, black woodpecker pot nesting territory
20	Old ND coppice	small flycatcher
21	Old AN thicket	Lesser flycatcher x2
22	Old KM spruce forest	tree pipit
23	Older JK spruce forest, younger JM spruce forest	Horse chestnut
24	Old MS aspen forest	black grouse
25	Old JK forest	crane
26	Older JK spruce forest	marsh harrier nesting territory
27	old JM aspen forest	white-backed woodpecker
28	Middle-aged AN grey alder	black woodpecker
29	Old JM aspen forest, older JO birch forest	Mouse eagle nesting territory
30	Older JM pine forest	Hoburästas x2, black woodpecker
31	logging site	Eurasian wryneck x8
32	Old AN cap	bog-hen flight
33	Old JM aspen forest	horse chestnut
34	logging sites	crane
35	Older JO pine forest	black woodpecker
36	Younger JK aspen forest	wood pigeon, horse-tailed thrush
37	unregistered forest land	rails nesting territory
38	logging sites	horse chestnut, wood sandpiper, geese flight corridor and migration area for birds of prey
39	logging sites	woodpecker, hoopoe, barn swallow
40	Older KM pine forest	meadow pipit

Abbreviations for habitat types: MO – blueberry bog; JP – hare's-tail cottongrass; SS – transition bog; PH – cottongrass; JK – hare's-tail cottongrass; MS – blueberry; JM – hare's-tail cottongrass-blueberry; JO – hare's-tail cottongrass-bog, MS – fen; KR – haircap moss; RB – bog, AN – sedge, ND – reed; KM – haircap moss-blueberry, SN – blueberry.

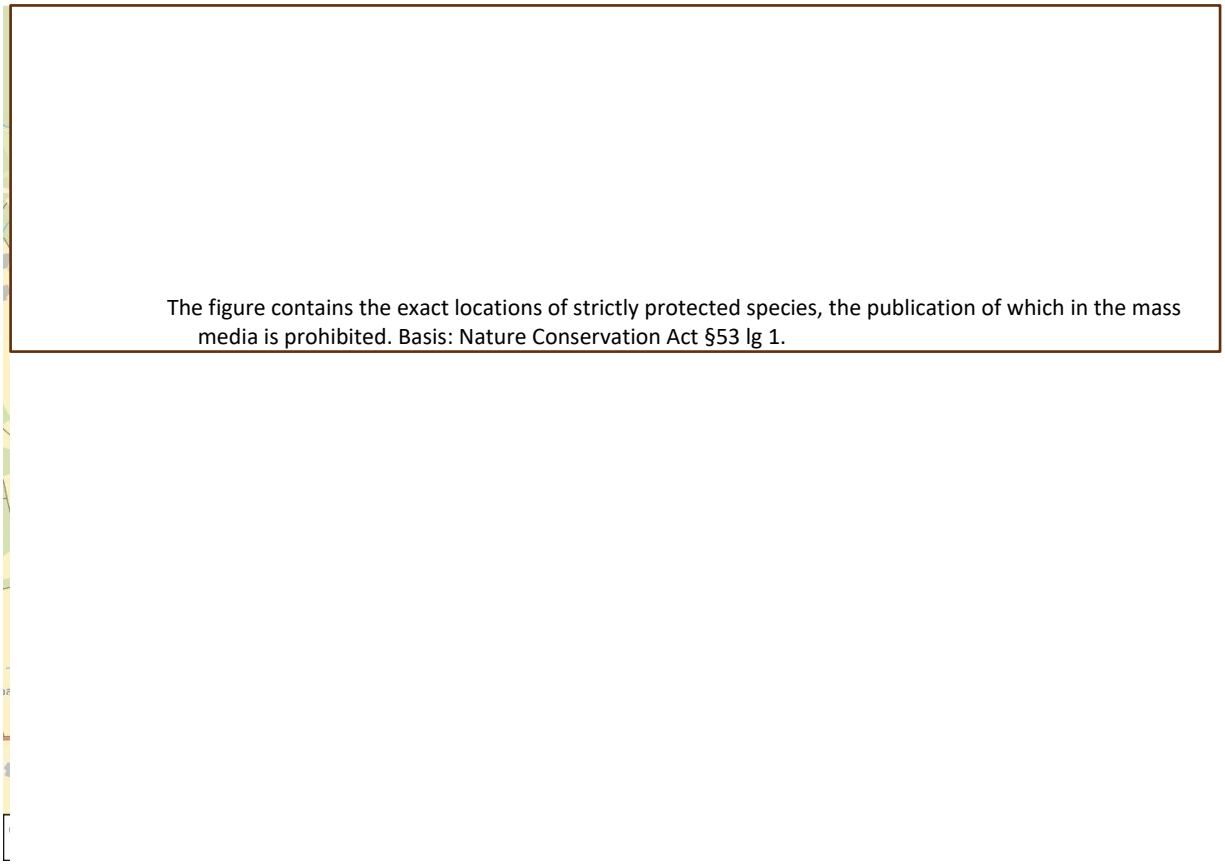

Figure 36. Protected and important species mapped in the Valga study area 4, together with their habitats. Habitats and KO species are listed in more detail in Table 8.

1.6.4 Nest sites

Nests were mapped in study area 4 during the luring of woodpeckers, hazel grouse and capercaillie, when older forests were searched for nests in tree crowns. During the point count of breeding birds and regular point observations, attention was also paid to hawks, including various territorial and chick calls in the area, and when these were heard, possible nesting trees were searched for and mapped. Possible habitats were mapped based on territorial observations, which are listed in Table 9. One small unoccupied nest was discovered in a spruce tree in the northern part of the area. The nest was unoccupied and may have belonged to a buzzard (Figure 32).

Separate searches for nests were conducted on one day in older (60+) forests in the eastern and south-eastern parts of the study area 1.04.24, but no nests were found.

1.6.5 Spot observations

Spring migration observations

During the spring migration period, a total of 779 geese were observed, of which the most common species was the greater white-fronted goose (94 individuals). Greylag geese accounted for 12% (94/779) of the geese, flying at an average altitude of 150 m in the rotor safety zone (Table 9).

A total of 17 geese were observed, of which approximately 59% (10/17) flew in the rotor safety zone at an average altitude of 175 m.

Of the hawks, the most frequently observed during the migration period were buzzards, all seven of which were observed in the rotor safety zone at an altitude of 180 m. Three observations were made of honey buzzards, and on two occasions the bird was observed

at an average height of 115 m in the rotor safety zone. Both the Eurasian hobby and the common buzzard were observed once at a height of 150 m in the rotor safety zone.

Of the birds of prey in protection categories I-II, a lesser spotted eagle was observed in the western part of the area near farmland outside the buffer zone at a height of 200 m during the spring period (**Figure 37**). One observation of a hen harrier was made in the same area at a height of 200 m (**Figure 37**).

Summer observations

In summer, the most frequently observed birds of prey were honey buzzards (3 observations) and buzzards (2 observations), all of which were located in the rotor safety zone at a height of 150 m. A red kite was observed once in the rotor safety zone at a height of 150 m (Table 9). One lesser spotted eagle was observed in the northern part of the study area at a height of 150 m (**Figure 37)**.

Barn swallows were observed on three occasions, one of which flew within the rotor safety zone at a height of 100 m.

Other significant species observed included kestrels, approximately 31% (4/13) of which flew within the rotor safety zone at a height of 130 m.

Autumn migration observations

Autumn goose migration remained low in the study area (77 observations in total). A total of 96 songbirds were observed, 42% (40/96) of which flew in the rotor safety zone at an average height of 110 m and 150 m (Table 9). Lesser white-fronted geese were observed on two occasions.

Ducks were observed on 131 occasions, with birds flying in the rotor safety zone at an average altitude of 130 m and 150 m.

Of the birds of prey, buzzards were observed most frequently during migration (5 observations in total), with birds observed in the rotor safety zone at an altitude of 150 m on two occasions. A kestrel was observed once in the rotor safety zone at an altitude of 90 m on the eastern side of the study area (Figure 27). A white-tailed eagle was observed twice – in one case, the species was flying overhead (direction unknown) at a height of 100 m in the eastern buffer zone, and in the other case, the eagle was seen in the western buffer zone at a height of 80 m, heading west. A black kite was observed on three occasions, flying in the rotor safety zone at an average height of 105 and 180 m.

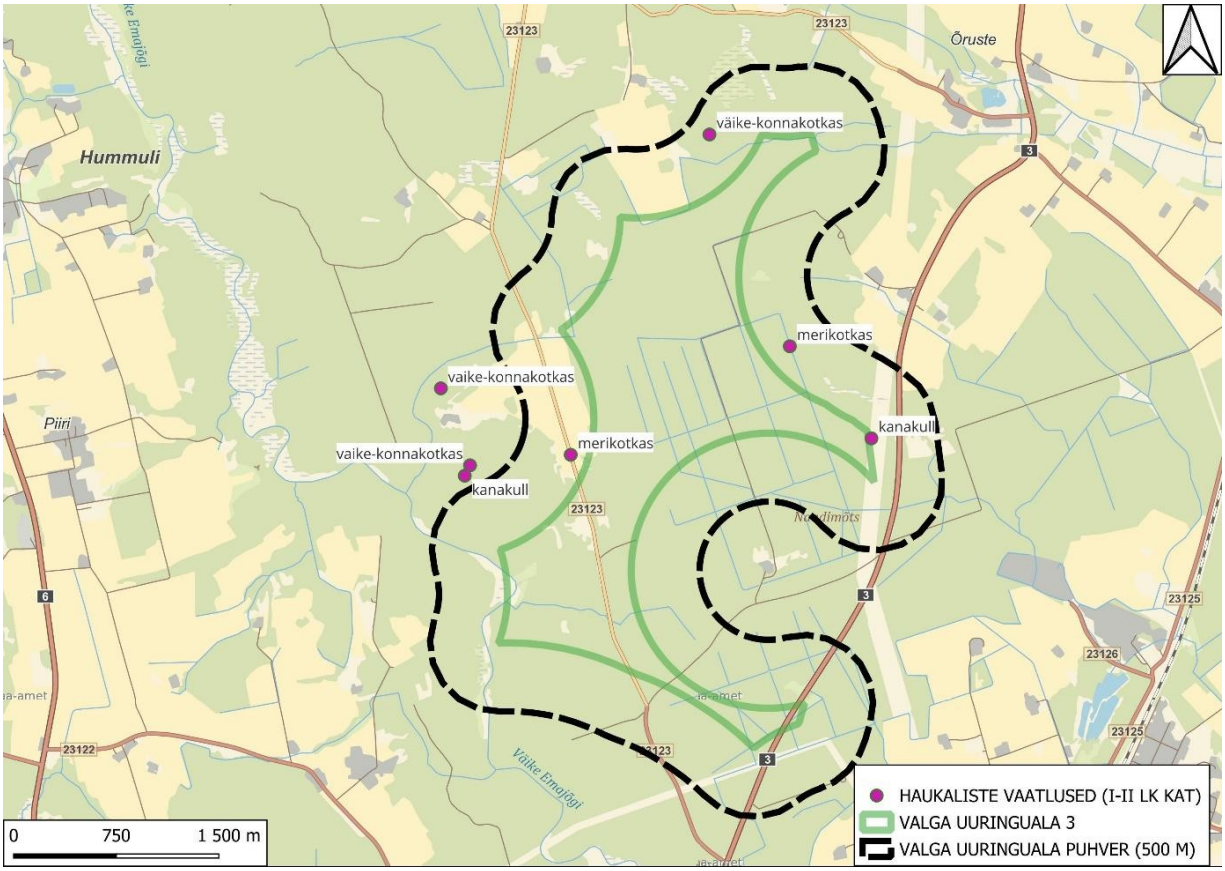

Figure 37. Birds of prey in protection categories I-II mapped during point observations in the Valga study area 4.

Table 9. Results of spring/summer/autumn point observations (min. 36 h, 18 h and 36 h) carried out in the Valga study area 4, by bird species. The direction of bird migration, their abundance (no.) and altitude are shown. Birds flying in the rotor safety zone (90-180 m) are marked in red.

Birds	Direction	Altitude (m)	NR	Total
SPRING				
	N	195	439	
	NE	317	177	
Geese	NW	350	67	779
grey goose	S	30	2	
greater white-fronted goose	N	150	94	
pike	p	200	2	2
chicken	p	200	1	1
mouse hawk	p	180	7	7
	p	115	2	3
wasp	Y	200	1	
iron	p	150	1	1
roo-loorkull	p	150	1	1
lesser spotted eagle	p	200	2	2
white stork	p	200	2	2
	N	200	7	17
crane	Y	175	10	
õõnetuvi	N	30	2	2
black-headed gull	N	70	1	1
silver gull	r	100	1	1
kiivitaja	E	50	1	1
metstilder	S	40	1	1
meadow pipit	S	80	1	1
smoke swallow	N	47	5	5

SUMMER				
grey heron	W	200	1	1
blue-throated duck	N	50	2	2
pike (ironhead)	Y	150	1	1
Hornet	p	150	3	3
mouse hawk	p	150	2	2
lesser spotted eagle	p	150	1	1
	E	54	1	
	S	85	8	
kiivitaja	W	130	4	13
metstilder	S	85	1	1
	NW	60	2	
smoke swallow	Y	100	1	3
horse chestnut	SW	30	1	1
AUTUMN				
geese	SW	250	32	
greater white-fronted goose	SW	80	45	77
song thrush	NE	110	2	
	S	150	38	
	SW	250	46	
	W	88	10	96
small boat	SW	250	2	2
	N	130	11	
partlane	W	150	120	131
	E	38	2	
	SW	150	2	
mouse	Y	300	1	5
hairy-footed viper	W	60	1	1
chicken	S	90	1	1
	W	80	1	
sea eagle	Y	100	1	2
	N	180	1	
iron	SW	105	2	3
wind catcher	W	60	1	1

Y-overflight, p-stationary, r-migratory, N-flight north, NE-flight northeast, E-flight east, SE-flight southeast, S-flight south, SW- flying southwest, W- flying west, NW- flying northwest.

1.7 Sustainability of black stork habitats

The black stork (I cat) prefers old fertile mixed forests, paludified forests and wooded meadows as its habitat, and to a lesser extent also swamp forests, building its nest in the middle of a forest massif[26]. For example, it is known that the average forest cover within a 3 km radius of the nest is 74 ±16%([23]). This is a human-shy species that avoids human activity in the landscape (clear-cutting, recreational areas). The main threats are intensive forest drainage, which causes the loss of feeding grounds. Increased disturbance during the nesting season is also a significant threat. According to the *IUCN* Red List, the black stork is in a favourable status (last assessed in 2016), with a population of between 24,000 and 44,000 individuals([27]).

The conservation objectives for 2018 are as follows, in accordance with the species conservation action plan:

[26] Black Stork (*Ciconia nigra*) Conservation Action Plan, 2018.
[27] https://www.iucnredlist.org/species/22697669/111747857#population

Short-term (5 years) conservation objectives:

- Ensure the survival of the species in Estonia at its current population level (60–90 pairs).
- identify the key factors causing low population productivity.

Long-term (15 years) conservation objectives:

- ensure nesting and feeding opportunities for the current black stork population, enabling an increase in numbers;
- apply all knowledge about the species that is expected to improve the status of the black stork population in Eastern Europe. The indicators are an increase in the number of breeding pairs in Estonia, an increase in the area of black stork habitats under strict protection, and an increase in the number of individuals at migration counting points (Georgia, Bosporus, Israel) and wintering areas.

The objective of the environmental strategy for the protection of biodiversity is to ensure the existence of habitats and communities necessary for the survival of viable populations of species, one measure of which is the number of black stork pairs in Estonia. The longer-term goal is to increase (restore) the species' population in Estonia to at least 200 pairs. This cannot be achieved in 15 years, but we must move steadily towards this goal by preserving potential sustainable black stork habitats that are currently uninhabited for at least 200 pairs to nest. It is also not possible to achieve an increase in the species' population by acting only within Estonia.

To protect black stork habitats, permanent reserves that follow natural boundaries will be established in sustainable nesting sites that have been populated over the last 10 years[23]. The special protection zone (SPZ) covers black stork nesting sites and the surrounding habitat suitable for nesting within a radius of at least 250 metres, preferably up to 500 metres, mainly comprising stands of trees that are more than 70 years old([23]) .The restricted zone (RZ) comprises the area outside the special protection zone, but in natural habitats, wooded meadows and pastures within a radius of at least 500 metres from black stork nests. Permanent forestry is permitted in the RZ, and logging is permitted from 1 October to 14 March. People are permitted to stay in the SCZ, pick berries and mushrooms, and hunt from 1 September to 14 March([28]) .

In the study area 1, located 2.6 km from the **black stork (*Ciconia nigra*)** habitat, the last nest was established in 1999 (KLO9128283, with three chicks in the nest). **Thus, based on monitoring, no nest has been established in the habitat in the last 24 years.** This black stork habitat overlaps completely with the Soontaga LKA (KLO1000264), whose conservation objective is to protect various, including priority, forest and grassland communities (6450 fen meadows, 9010* old natural forests, 9050 spruce forests rich in herbs, 9080* swamp and bog forests, 91D0* transition mire and bog forests). The nearest observation points, which are outside the buffer zone of study area 1, are located in the south-western part and the observations date from August 2011 (16–17 August 2011).

Based on the Land Board's forest change map data (for the period 2012–2022) and orthophotos, no large-scale logging has been carried out in the habitat forest. Thus, the forest area suitable for the habitat has been preserved. The EELIS database does not contain any information that the nest on the spruce tree has fallen down. As the proportion of old-growth forest has been preserved in this location and there are no signs of disturbance (e.g. clear-cutting, nest tree breakage) in the black stork's habitat, this is likely to be a sustainable habitat.

Based on an analysis of the feeding areas of black storks equipped with GPS transmitters[29],there is one known feeding water body for black storks in the study area (Soontaga stream, VEE1012700, Figure 2 and Figure 10). Based on the analysis of GPS data, this is not a priority feeding water body. The feeding area (*approx. 1*.1 km long) is located outside the potentially suitable wind farm area, and the plan does not provide for the installation of wind turbines in this feeding area, i.e. the connection between the nesting site and the feeding area is guaranteed.

[28] https://www.riigiteataja.ee/akt/101062021007?leiaKehtiv

[29] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

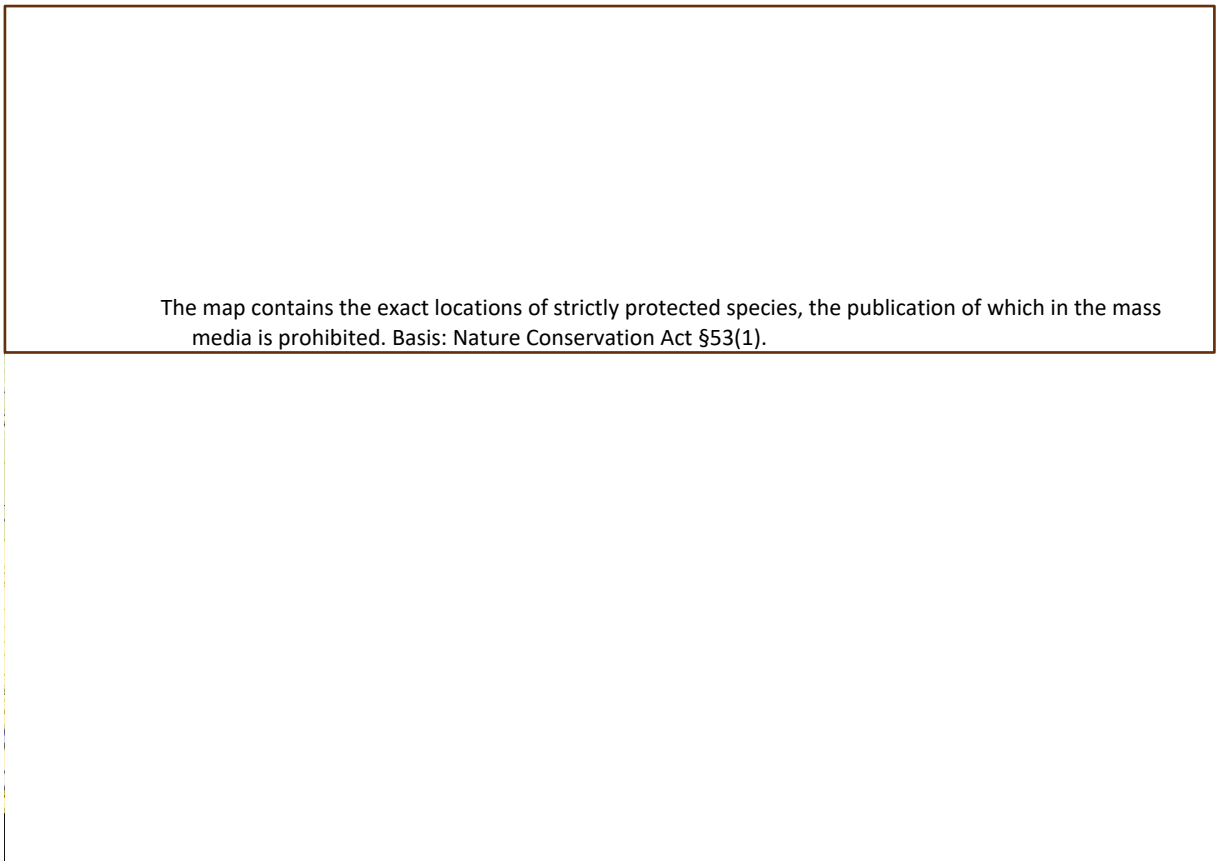

Figure 38. Location of black stork feeding waters and observation data in the study area.

The black stork (*Ciconia nigra*) habitat KLO9128282 is located 2.5 km from study area 4. The nest (id -626942051) is located 3 km from the study area (Figure 26). The habitat was last checked on 2 June 2023 as part of national monitoring, when it was not inhabited by the target species. Monitoring data has been available in the EELIS database since 2011, and the habitat has not been occupied during that time. The 2017 monitoring report notes that the nest has been destroyed. Therefore, the nesting site has not been used by black storks for
for more than 10 years.

During the fieldwork carried out in the course of this study, the nest site was found on a pine tree, but it has largely collapsed (Photo 5). However, based on data from the Forest Register (2012–2022), orthophotos and field observations, the habitat has remained intact.

Photo 5. Based on fieldwork, the black stork's nest in Mõneku has collapsed and has been uninhabited for over ten years. One side branch had broken off higher up in the pine tree and fallen onto the main branch supporting the nest.

Based on an analysis of the feeding areas of black storks equipped with GPS transmitters[30], there is one known feeding water body for black storks in the study area (Naadimõtsa ditch, VEE1011902). Based on the analysis of GPS data, this is a partially priority feeding water body. The feeding water body overlaps with a potentially suitable wind farm area. This feeding water body is part of a maintained land improvement system headwater area of up to 10 km², which is a headwater protection zone (NAADI-1 (TTP 484). As this is an actively drained area, it can be assumed that, due to the impact of drainage, the water body is particularly important in the spring, when amphibians, which are an important food source for black storks during this period, may be found there. The closest black stork sightings date back to 2017: one sighting was 2.7 km east of the development area, one was >4 km south, and one was >4 km west. These are isolated sightings. No black storks were seen in the development areas during fieldwork in 2023. As part of the KAUR RePower study, a black stork was seen once (observation by Annali Alberts on 05.07.2023) in the Lota stream area (in the eastern part of study area 1 in this report).

In Estonia, a study of feeding areas was conducted in 2007–2010 based on the feeding sites of ten GPS-tagged black storks. The most common feeding sites for storks were ditches and small excavated streams, which differed in use from natural streams and large excavated streams. However, when taking into account the total length of watercourses around the nest, the black storks' preference for watercourse types was quite different. Ditches were avoided, but there was no difference between large and small natural and deepened streams. Consequently, the most frequent feeding sites were

[30] Eagle Club. 2022. Acquisition of information on eagles and black storks equipped with satellite and GSM transmitters and analysis of nesting season data and supplementary feeding of black storks.

ditches, which resulted from their large number in the surrounding landscape, but are not the best quality feeding sites. Considering the choice of feeding water bodies in the landscape surrounding the nest, black storks clearly preferred natural and deepened streams, which were also revisited most often ([31]).

Based on fieldwork and literature, the Väike-Emajõgi River bordering study areas 3 and 4 is not a suitable feeding water body for black storks in these sections, as its depth is 2-3 m in the Jõgeveste section, for example (**photo 9**). After Hummuli, the river valley widens, the floodplain becomes marshy and the river bends become wider. Downstream from Jõgeveste, the marshy floodplain is up to 2 km wide in places. After Soontaga village, the riverbed becomes winding again and forms old river channels ([32]). Therefore, there are no water bodies suitable for feeding black-headed gulls in sections 3 and 4 of the study area bordering the Väike-Emajõgi River. In area 4, the Kalda ditch flows into the Väike-Emajõgi River, which is deep and steep about 500 m before it flows into the river, preventing fish from swimming upstream. After 500 m, the ditch flows along flatter ground, with one branch heading north and the other east. Several water intake ponds have been built on the Kalda ditch, providing a temporary food source (amphibians) in the spring. In study area 4, drainage ditches that have recently been straightened also flow into the Väike-Emajõgi River (**photos 6-8)**. These ditches are also located on a steep slope where the water flow is very fast, and deep sediment basins (**photo 8)** have been built on the ditches before they flow into the river, which are not suitable for feeding black-headed gulls. As the water flow in the ditches on the slope is very fast and sediment-rich during the high water period and the water level is very low during the low water period, such ditches unfortunately do not support fish stocks, but rather act as ecological traps.

A suitable water body for feeding could be the Õru stream (VEE1011700), which is approximately 2.5 m wide and mostly 0.2-0.3 m deep (up to 0.6 m deep in some places)[33]. Õru stream borders research area 2 to the east, where aerial observations failed to detect any black storks. Previous important feeding sites (Raamsoo Stream, Soontaga Stream, Naadimõtsa Ditch), based on GPS surveys, have been described above, and these streams are likely to be a certain indicator of which feeding waters in this area are suitable for black storks. In areas 1-4 of the study area, there may no longer be sufficient food sources (especially fish) and suitable sustainable feeding waters for black storks. The watercourses in study area 1, where black storks were observed once during the Repower study, can be considered to have higher potential.

In general, it can be said that development areas 2–4 lack suitable feeding waters for black storks, as evidenced by PlutoF observations and spot observations made during this study. Based on GPS surveys, no suitable feeding waters have been identified in development areas 2–4, but suitable feeding waters are located to the east of the development areas, where GPS data points are also more dense.

[31] Black Stork (*Ciconia nigra*) Conservation Action Plan, 2018.
[32] Estonian rivers. Järvekülg, A. Tartu, 2001.
[33] Estonian rivers. Järvekülg, A. Tartu, 2001.

Photo 6. A drainage ditch that does not support a suitable feeding ground for black storks.


Photos 7 and 8. Constructed drainage ditches that are not suitable for feeding black storks.

Photo 9. View of the Väike-Emajõgi River in the western part of study area 4, which is not a suitable water body for black-headed gulls to feed on.

It is important to preserve the priority feeding area in study area 4 based on GPS data and not to plan wind turbines closer than 500 m to priority feeding areas. It is also necessary to ensure the connectivity of the feeding area and the eastern habitat (KLO9128282) in study area 4, which means that wind turbines must not be built in the area between the priority feeding area and the habitat.

According to the EOÜ MLA (2022 a), a 4800 m buffer zone (zone 1 buffer) is provided for the black stork habitats KLO9128283 and KLO9133649. However, as there are no feeding waters suitable for black storks in development areas 1–3, as shown by PlutoF data and spot observations carried out in the field as well as map analysis, and since no suitable feeding waters have been identified in development areas 1–3 based on GPS surveys, but suitable feeding waters are located east of the development areas, the buffer zone in the listed locations should be reduced to 3000 m, as recommended in the document "The impact of onshore wind farms on biota and the recommendations of the Environmental Board for their planning in local government comprehensive plans (as of 10 November 2021)". Also, reduce the buffer zone to 3800 m from the location in study area 4, provided that a minimum buffer zone of 500 m is applied to the priority feeding water body.

In connection with the permanent habitat of the black stork in Mõneku (KLO3000519), correspondence took place between Lemma OÜ (12 February 2024) and the Environmental Board (21 March 2023, No. 7-9/24/2688-3), in which the following was pointed out: *The permanent habitat of the black stork in Mõneku has three black stork nests entered in the EELIS database, which have now been archived, and the black stork habitat in this permanent habitat is not entered in the EELIS database, and extended the deadline for the current procedure until 12 April 2024 in order to consult with the NGO Kotkaklubi on issues related to the sustainability and protection needs of this permanent habitat.*

As a result of the consultation, it was found that, *in the opinion of the species expert, the protection and preservation of the permanent habitat of the black stork in Mõneku is still necessary, because the habitat located on state land, where mainly 120-130-year-old forests grow, is very representative and, although the target species last nested there in 2009, it is likely that the habitat will be repopulated by the target species. As this is a representative habitat that continues to require protection, the Environmental Board will enter the black stork habitat into the EELIS database, where the habitat will be delimited, on the recommendation of a species expert, within the same boundaries as the existing permanent habitat of the black stork in Mõneku,* which is located approximately 3,800 m from the Valga study area (Figure 39).

Fieldwork also confirmed that the permanent habitat (KLO3000519) remains suitable and representative for the possible reintroduction of black storks.

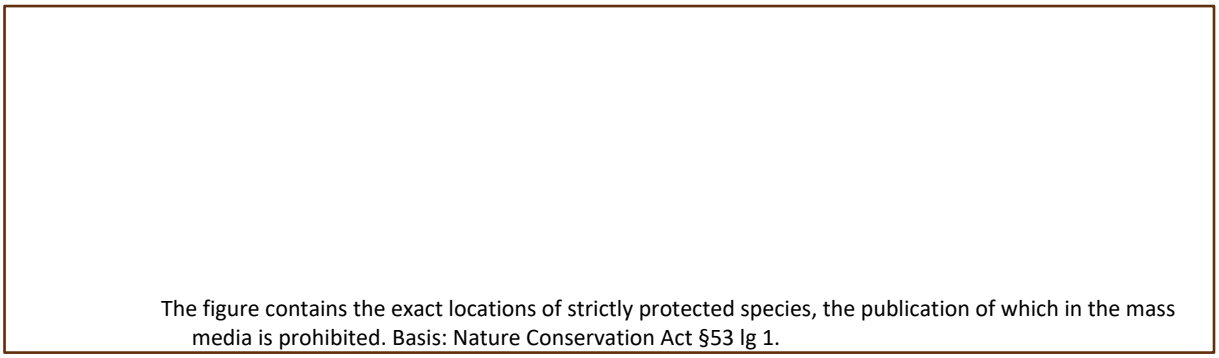

Figure 39. Location of the black stork and nearby observations of black storks, together with feeding waters.

1.8 Conclusions regarding study areas 1-4

1.8.1 Study area 1

From the perspective of the capercaillie (taking into account its mating and nesting grounds and the associated buffer zone), it is very difficult to erect wind turbines in study area 1 in Valga, as the majority of the potential development area is located within a one-kilometre buffer zone of the capercaillie's mating grounds. The southern capercaillie search areas are suitable as feeding areas, as is the south-western search area. The south-eastern capercaillie observations are also related to the capercaillie feeding area. It is also important to ensure an undisturbed connection corridor from the southern Virna breeding area to the Koopesoo breeding area in order to ensure connectivity between populations.

The bird fauna of study area 1 is species-rich due to the mosaic landscape, where wetlands alternate with higher pine and mixed forests, allowing several species to nest in different habitats.

A new nesting forest for the corncrake was found in the study area, which is subject to a 1000 m buffer zone.

A total of four nests were found in the area, three of which belonged to the Eurasian tree sparrow and one to the Eurasian bee-eater. Due to the presence of the Eurasian woodcock, capercaillie and other protected species, it is not recommended to build wind turbines in the study area.

1.8.2 Study area 2

According to the survey, this is not a habitat for highly important protected species (category I), but it is a migration and transit corridor mainly for geese and swans (spring and autumn migration) and songbirds (especially in autumn), and to a lesser extent for hawks.

It is important to implement mitigation measures during the bird migration period, e.g. switching off wind turbines during the peak migration period, which may vary depending on the species (geese and swans in September-October, songbirds in November). The exact measures should be developed in parallel with migration observations during wind turbine operation. During the breeding season, it is also important to

to switch off wind turbines to prevent the death of birds of prey, using camera-based shutdown systems when birds of prey fly near the rotor blades, especially from 12 noon onwards, when rising air currents carry them to higher air layers.

1.8.3 Study area 3

Based on the study, there are no habitats of Category I protected bird species in the study area. Restrictions must be imposed during the bird migration period, taking into account geese, cranes and birds of prey. It is also important to switch off the turbines during the breeding season if birds of prey enter the rotor danger zone.

The construction of wind turbines should be avoided in the Väike-Emajõe primeval valley, as it contains older forests that are better habitats for birds and the river is used by ospreys for feeding. Construction work must be carried out outside the nesting period of the corncrake (KLO9119206) between 31 July and 1 March in the part of the nesting tree buffer zone.

1.8.4 Study area 4

Do not install wind turbines in the feeding areas of capercaillies. Based on the survey, there are no habitats of Category I protected bird species in the survey area. Restrictions must be imposed during the bird migration period, taking into account geese, cranes, songbirds and hawks. It is also important to switch off the turbines during the breeding season if birds of prey enter the rotor danger zone. Construction work must be carried out outside the nesting period 31 July-1 March in the part of the nesting tree buffer zone where the capercaillie (KLO9130897) is found.

1.9 Recommendations for mitigation measures

General measures for wind farm planning:

- Construction work in the nesting buffers of the capercaillie habitats (KLO9119206 and KLO9130897) must be carried out outside the nesting period, i.e. 31 July to 1 March.
- Preserve as much as possible the mapped habitats of protected and conservation-important species, at least 50% of the mapped habitats for category III protected species and at least 90% of the habitats for category II protected species. Where species of protection categories II and III co-occur, take into account the conservation requirement (90%) for habitats of species of higher protection category (II).
- Preference should be given to areas with a lower representation of protected species (e.g. clearings, young forests) where there are no protected species in natural forests nearby.
- Do not construct overhead lines in forest landscapes; give preference to underground cabling.
- Make maximum use of existing roads and, when constructing new roads, take into account the location of protected species
  to reduce the fragmentation of the habitats of protected species.
- When constructing wind turbines, it is recommended to increase their visibility to birds (use colour combinations that reduce the risk of collision or other technologies that improve the visibility of wind turbines to birds).

General measures during the operating period:

- During the migration period, wind turbines should be shut down during periods of high bird activity or using an appropriate control system in all study areas[34].
- Shut down wind turbines near Category I and II birds of prey (nesting sites) using machine learning programmes such as http://nvisionist.com/nvbird-wtg/ or similar programmes. The measure is

[34] IFC (International Finance Corporation), EBRD (European Bank for Reconstruction and Development, KfW Group 2023. Post-Construction Bird and Bat Fatality Monitoring for Onshore Wind Energy Facilities in Emerging Market Countries. Good Practice Handbook and Decision Support Tool. https://www.ifc.org/en/insights-reports/2023/bird-bat-fatality-monitoring-onshore-wind-energy-facilities

Particularly important in study area 1 due to the nesting territory of the corncrake and in study area 3 due to the hunting territory of the corncrake. The implementation of the measure can be recommended in all study areas, as birds of prey in protection categories I and II (lesser spotted eagle, white-tailed eagle, osprey, etc.) use the airspace in all study areas to reach their feeding grounds, e.g. farmland, Väike-Emajõgi River.

- If possible, equip birds of prey nesting in the vicinity with GPS devices to assess their risk of death and/or flight trajectory due to the wind turbines.

Follow-up proposal:

- Conduct a bird inventory using a counting method comparable to the methodology used in this study (conduct a point count of birds, woodpeckers, hazel grouse and capercaillie luring) at least twice in the five years following the final or substantial completion and commissioning of the wind turbines in the relevant development area (the first time after the wind turbines are commissioned and the second time five years after the first inventory).
- Search for dead birds, including tests of searcher performance and predation load, two years after the final or substantial completion and commissioning of the wind turbines, in accordance with the methodology. The methodology is described in section 5.3 of the analysis of land birds. Searches for dead birds are carried out twice a month during snow-free periods. Monitoring is carried out under all wind turbines in the wind farm within a radius at least equal to the length of the wind turbine blade, measured from the wind turbine tower (depending on the search conditions, the search area may be reduced). The monitoring scheme may be refined based on the analysis of the monitoring results.

2 Bat survey

2.1 Materials and methodology

The following work was carried out during the bat survey:

1. Existing bat data was compiled from the following sources:
    - EELIS;
2. A bat survey was conducted:
    - The aim of the bat survey was to determine whether there were any important roosting sites, feeding sites, summer colonies and shelters for bats in the area. The activity of bats in spring, summer and autumn also had to be determined.
    - Bats were recorded from sunset to sunrise, and observations were carried out on nights with favourable weather conditions for bats – air temperature >10˚C, calm and no precipitation. The selected bat survey methodology and the counting points selected in the wind farm area made it possible to assess the species composition and abundance of bats in the study area. Attention was paid to the fact that the blades of the wind turbines are higher than the treetops, which was taken into account when selecting the survey methodology.

The *Eurobats* guide[33]was used as a reference for bat monitoring, on the basis of which the following was clarified:

1) the species composition of bats in the area
2) the spatial use of bats depending on the season, in order to clarify spring and autumn migration routes and feeding areas, including above tree crowns
3) possible mitigation measures and follow-up monitoring options.

The Wildlife Acoustics Song Meter Mini Bat automatic detector was used in the bat survey areas. The data was processed using *Wildlife Acoustics Kaleidoscope Pro 5 Analysis Software.* In spring and early summer, the detectors were installed at a height of 1.8–2.0 m on tree trunks. In August, the detectors were installed at a height of 10–20 m in the tree canopy to monitor migration above the canopy (Photo 6). The usual home range size of bats was estimated to be 5000 m (Appendix 1, draft 8.02.23), which was also taken into account when placing the detectors in the landscape. However, a buffer zone of only 5000 m does not guarantee the representation of different habitats and the location of colonies during the breeding season. Therefore, 2–3 detectors were installed in the study areas and moved from time to time.

The bat data obtained in this study reflect their relative abundance in the study area, as it is not possible to distinguish individuals flying continuously at the same point, e.g. from a roosting colony. Based on the data, it is possible to identify spring and autumn migration routes and, to some extent, summer feeding areas.

In this study, bats are treated as a family, as processing the data separately is time-consuming and it is often impossible to distinguish between pond bats and water bats based on spectrogram data. Representatives of the *Pipistrellus* family are also treated together.

Based on camera analysis, breeding forests important for bats were selected, including those listed in Annex 1[(35) of]the Bat Conservation Action Plan. Therefore, forests that are at least 100 years old and provide bats with habitats in tree hollows or bark crevices are considered important breeding and feeding forests. It can be assumed that 100-year-old forests also produce more insect mass (moths, diptera, etc.) suitable for feeding bats due to their many microhabitats. In addition, forests with at least 55-year-old aspen trees covering at least 10% of the area of the compartment are considered suitable for feeding and breeding. A 200 m buffer zone (100 m on both sides of the river, i.e. 200 m in total) has been taken into account for water bodies (Väike-Emajõgi), where wind turbines will not be built, as the riparian communities and water bodies provide the necessary

[35] Appendix 1. GUIDELINES FOR ASSESSING THE IMPACT OF WIND FARMS ON BATS IN ESTONIA. Draft (08.02.2023).

feeding opportunities for bats (e.g. flying squirrels). The edge effect was taken into account when converting forest land to agricultural land, where a buffer zone of at least 200 m must be left for bats to feed at the edge of the forest (*Pipistrellus*) or in open landscapes with feeders such as the great spotted woodpecker.

A minimum buffer zone of 500 m has been implemented around bat breeding colonies and roosting sites, based on the latest scientific findings (see section 3.1.).

Photo 6. In August, detectors were installed at tree canopy height to better monitor migration.

Based on the results of fieldwork, areas in the wind farm area were mapped where there are good habitats and feeding grounds for bats, where bat populations are high and where the construction of wind turbines should be avoided or mitigation measures should be used.

2.2 The impact of wind turbines on bats

The impact of wind farms on bats can be divided into two categories based on the mechanism of impact: habitat loss and alteration, and bat mortality. The occurrence and extent of both impacts depend on the location of the wind turbines in the landscape, which is why it is important to assess the suitability of the development area as a bat habitat prior to the construction of wind turbines. In addition to the location of the wind turbines, the extent of the impact may also vary depending on the season. In terms of impact, two periods are mainly distinguished: the migration period and the summer period, with the risk of mortality being higher during the autumn migration. In general, the potential impacts of habitat change are considered to be minor (often small), and the impacts of mortality, depending on the location, are considered to be

large to very large[36]. However, recent studies have shown that in the case of modern wind turbines built in forest landscapes, bat species avoid the vicinity of wind turbines (the impact extends to several hundred metres), which is presumably due to the decline in habitat quality associated with the construction of wind turbines. The way to mitigate both the risk of bat mortality and habitat loss is the same – when planning wind farms, good bat habitats should be avoided([37]).

The main cause of bat mortality is direct contact with moving wind turbine blades, but under specific conditions, mortality due to barotrauma is also possible [38,39]. Bat fatalities have been recorded mainly in onshore wind farms in Europe and North America, but some data are also available from other regions[40,41,42] . The available data on fatalities is largely related to whether and how bat fatalities have been monitored.

The problem of bat mortality is widespread and, in some cases, significant, but the extent of the impact varies greatly from place to place. According to a summary published in 2016, the number of bats killed in wind farms varies greatly across European onshore wind farms, ranging from 0 to 11 bats per MW([43]). However, a 2010 study([44]) puts the range at 0 to 23 bats killed per MW. The risk of death is generally higher in locations where wind turbines are located in or near habitats suitable for bats, such as forests and water bodies, the home range of some bat colonies, or in areas where bats congregate during migration[45] Thus, both resident populations are affected.

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[36] Rodrigues, Luisa, Lothar Bach, M.-J Dubourg-Savage, B Karapandža, D Kovač, T Kervyn, Jasja Dekker, et al., eds. 2014. Guidelines for Consideration of Bats in Wind Farm Projects. EUROBATS Publication Series 6. Bonn: UNEP/EUROBATS.

[37] Ellerbrok, J.S., Delius, A., Peter, F., Farwig, N. and Voigt, C.C., 2022. Activity of forest specialist bats decreases towards wind turbines at forest sites. Journal of Applied Ecology 59(2); Gaultier, S.P., Lilley, T.M., Vesterinen, E.J. and Brommer, J. E., 2023. The presence of wind turbines repels bats in boreal forests. Landscape and Urban Planning 231 (2023) 104636).

[38] Baerwald, Erin F., Genevieve H. D'Amours, Brandon J. Klug, and Robert M. R. Barclay. 2008. 'Barotrauma Is a Significant Cause of Bat Fatalities at Wind Turbines'. Current Biology 18 (16): R695–96. https://doi.org/10.1016/j.cub.2008.06.029.

[39] Lawson, Michael, Dale Jenne, Robert Thresher, Daniel Houck, Jeffrey Wimsatt, and Bethany Straw. 2020. "An Investigation into the Potential for Wind Turbines to Cause Barotrauma in Bats." PLOS ONE 15 (12): e0242485. https://doi.org/10.1371/journal.pone.0242485.

[40] Rydell, Jens, Lothar Bach, Marie-Jo Dubourg-Savage, Martin Green, Luisa Rodrigues, and Anders Hedenström. 2010. "Bat Mortality at Wind Turbines in Northwestern Europe." Acta Chiropterologica 12 (2): 261–74. https://doi.org/10.3161/150811010X537846.

[41] Voigt, C.C., A.G. Popa-Lisseanu, I. Niermann, and S. Kramer-Schadt. 2012a. 'The Catchment Area of Wind Farms for European Bats: A Plea for International Regulations'. Biological Conservation 153: 80–86. https://doi.org/10.1016/j.biocon.2012.04.027.

[42] Gaultier, Simon P., Anna S. Blomberg, Asko Ijäs, Ville Vasko, Eero J. Vesterinen, Jon E. Brommer, and Thomas M. Lilley. 2020. 'Bats and Wind Farms: The Role and Importance of the Baltic Sea Countries in the European Context of Power Transition and Biodiversity Conservation'. Environmental Science & Technology 54 (17): 10385–98. https://doi.org/10.1021/acs.est.0c00070.

[43] Arnett, Edward B., Erin F. Baerwald, Fiona Mathews, Luisa Rodrigues, Armando Rodríguez-Durán, Jens Rydell, Rafael Villegas-Patraca, and Christian C. Voigt. 2016. "Impacts of Wind Energy Development on Bats: A Global Perspective." Bats in the Anthropocene: Conservation of Bats in a Changing World, edited by Christian C. Voigt and Tigga Kingston, 295–323. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-25220-9_11.

[44] Rydell, Jens, Lothar Bach, Marie-Jo Dubourg-Savage, Martin Green, Luisa Rodrigues, and Anders Hedenström. 2010. 'Bat Mortality at Wind Turbines in Northwestern Europe'. Acta Chiropterologica 12 (2): 261–74. https://doi.org/10.3161/150811010X537846.

[45] Arnett, Edward B., Erin F. Baerwald, Fiona Mathews, Luisa Rodrigues, Armando Rodríguez-Durán, Jens Rydell, Rafael Villegas-Patraca, and Christian C. Voigt. 2016. 'Impacts of Wind Energy Development on Bats: A Global Perspective'. Bats in the Anthropocene: Conservation of Bats in a Changing World, edited by Christian C.

where the impact may be greater on females and young animals[46] as well as migratory populations[47] . In addition, it should be noted that many bat species are habitat-specific, and a wind farm located in the home range of a breeding colony is likely to affect the population over a long period of time.

The risk of coming into contact with wind turbine blades and thus being killed also varies between species. Wind turbines mainly threaten species that fly high and use open habitats, while species that fly low and close to trees are rarely killed by wind turbines. In north-western Europe, where the bat fauna is largely similar to that of our region, the vast majority (98%) of bats killed in wind farms belong to the families *Nyctalus, Pipistrellus, Vespertilio* and *Eptesicus*([48]) ·All of these families are also represented in the bat fauna of Estonia. According to the same source, species belonging to *the Myotis* and *Plecotus* families have a low risk of death, as they usually hunt closer to the ground and tend to avoid open landscapes. The distribution of bat species found in Estonia into species with high and low collision risk is presented in Table 10. At the same time, the parameters of wind turbines and their possible impact must also be taken into account in the near future. The studies on which Table 10 is based were conducted mainly in the vicinity of wind turbines with a mast height of approximately 90–100 m, located in open areas or on the edges of forests and on the coast. However, as wind turbines become taller, it is likely that they will also be located above forests, where much less is known about bat habitat use.

Bat mortality in wind farms may be a seasonal phenomenon, and the number of animals killed is often higher during the autumn migration period, which is why wind turbines located on migration routes increase the risk of bat mortality. Therefore, bat mortality in wind farms is a problem with cross-border implications. For example, some of the bats killed in wind farms in Germany are very likely to originate from the Baltic States([49]) ·

The European bat conservation agreement EUROBATS has compiled guidelines for taking bats into account in wind energy planning. The guidelines state that turbines should not be installed in forests or less than 200 metres from their edges, as this increases the risk of bat mortality. However, a recent study on large bats showed that a 500-metre buffer zone should be implemented around breeding colonies, as wind turbines installed less than 500 metres away must be shut down depending on bat activity([50]) · More recent studies have shown that wind turbines have a repellent effect on large bats (60

Voigt and Tigga Kingston, 295–323. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-25220-9_11.

[46] Kruszynski, Cecilia, Liam D. Bailey, Lothar Bach, Petra Bach, Marcus Fritze, Oliver Lindecke, Tobias Teige, and Christian C. Voigt. 2021. "High Vulnerability of Juvenile Nathusius' Pipistrelle Bats (Pipistrellus Nathusii) at Wind Turbines". Ecological Applications n/a (n/a). https://doi.org/10.1002/eap.2513.

[47] Lawson, Michael, Dale Jenne, Robert Thresher, Daniel Houck, Jeffrey Wimsatt, and Bethany Straw. 2020. “An Investigation into the Potential for Wind Turbines to Cause Barotrauma in Bats.” PLOS ONE 15 (12): e0242485. https://doi.org/10.1371/journal.pone.0242485.

[48] Rodrigues, Luisa, Lothar Bach, M.-J. Dubourg-Savage, B. Karapandža, D. Kovać, T. Kervyn, Jasja Dekker, et al., eds. 2014. Guidelines for Consideration of Bats in Wind Farm Projects. EUROBATS Publication Series 6. Bonn: UNEP/EUROBATS.

[49] Gaultier, Simon P., Anna S. Blomberg, Asko Ijäs, Ville Vasko, Eero J. Vesterinen, Jon E. Brommer, and Thomas M. Lilley. 2020. ‘Bats and Wind Farms: The Role and Importance of the Baltic Sea Countries in the European Context of Power Transition and Biodiversity Conservation’. Environmental Science & Technology 54 (17): 10385–98. https://doi.org/10.1021/acs.est.0c00070.

[50] UNEP/EUROBATS IWG on wind turbines and bat populations. Report of the IWG to the 27th Meeting of the Advisory Committee Sarajevo, Bosnia and Herzegovina, 27-29 March; EUROBATS: Sarajevo, 2023; p. 54.

individuals were equipped with GPS transmitters) from a distance of 500 m[51] and for northern bats, a repellent effect has been demonstrated from a distance of 600 m and for flying bats from 800 m from the nearest wind turbine[52]

Particular attention should be paid to broadleaf forests. In the Estonian context, it is also appropriate to consider mixed forests as an important forest type, as they are known to be important habitats for bats. When planning wind farms, the immediate vicinity of colonies and important bat habitats/feeding areas should also be avoided. At the same time, EUROBATS points out that in the densely forested Nordic countries, it may be unavoidable to build wind turbines in forest areas. In such cases, specialists should be involved in site selection and, based on the best available knowledge and, if necessary, data collected during fieldwork, areas should be selected where there are likely to be few bats and the risk of mortality is as low as possible([19]).

Table 10. Distribution of bat species found in Estonia in onshore wind farms based on the risk of mortality.

Species name	Species name in Latin	Risk class (Rydell 2010)	Risk class (Rodrigues 2014)
pond bat	*Myotis dasycneme*	low risk	medium risk
pond bat	*Myotis daubentonii*	low risk	low risk
Daubenton's bat	*Myotis brandtii*	low risk	low risk
long-eared bat	*Myotis mystacinus*	low risk	low risk
Natterer's bat	*Myotis nattereri*	low risk	low risk
brown long-eared bat	*Plecotus auritus*	low risk	low risk
park bat	*Pipistrellus nathusii*	**high risk**	**high risk**
pipistrelle	*Pipistrellus pipistrellus*	**high risk**	**high risk**
pygmy bat	*Pipistrellus pygmaeus*	**high risk**	**high risk**
northern bat	*Eptesicus nilssonii*	**high risk**	medium risk
silver bat	*Vespertilio murinus*	**high risk**	**high risk**
great spotted bat	*Nyctalus noctula*	**high risk**	**high risk**
small noctule	*Nyctalus leisleri*	**high risk**	**high risk**
European long-eared bat	*Barbastella barbastellus*	low risk	medium risk

2.3 Database data consolidation

The EELIS database was analysed for bat sightings within a 2 km radius of the study areas. EELIS data was used as of 12 February 2024.

The EELIS data revealed that there is one known important bat habitat within a 2 km radius of study areas 2, 3 and 4 (Figure 40). This is Hummuli Manor Park (KLO1200584), which is a summer roost for bats. According to EELIS, this is a very important habitat. The park area borders the Väike Emajõgi River, which is a feeding area for bats. The following species have been recorded in the manor park: brown long-eared bat (*Plecotus auritus,* (KLO9108818), Daubenton's bat (*Myotis daubentonii)* (KLO9108820), northern bat (*Eptesicus nilssonii)* (KLO9108815), and Natterer's bat (*Myotis nattereri)* (KLO9108767). According to the national red list, the brown long-eared bat, Daubenton's bat, and northern bat are in a favourable condition, but Natterer's bat is in the near threatened category.

[51] Reusch, C., Paul, A. A., Fritze, M., Kramer-Schadt, S., & Voigt, C. C. 2023. Wind energy production in forests conflicts with tree-roosting bats. Current Biology. 33(4): 737-743.e3

[52] GAULTIER, S. P., LILLEY, T. M., VESTERINEN, E. J., & BROMMER, J. E. (2023). The presence of wind turbines repels bats in boreal forests. Landscape and Urban Planning, 231, 104636.

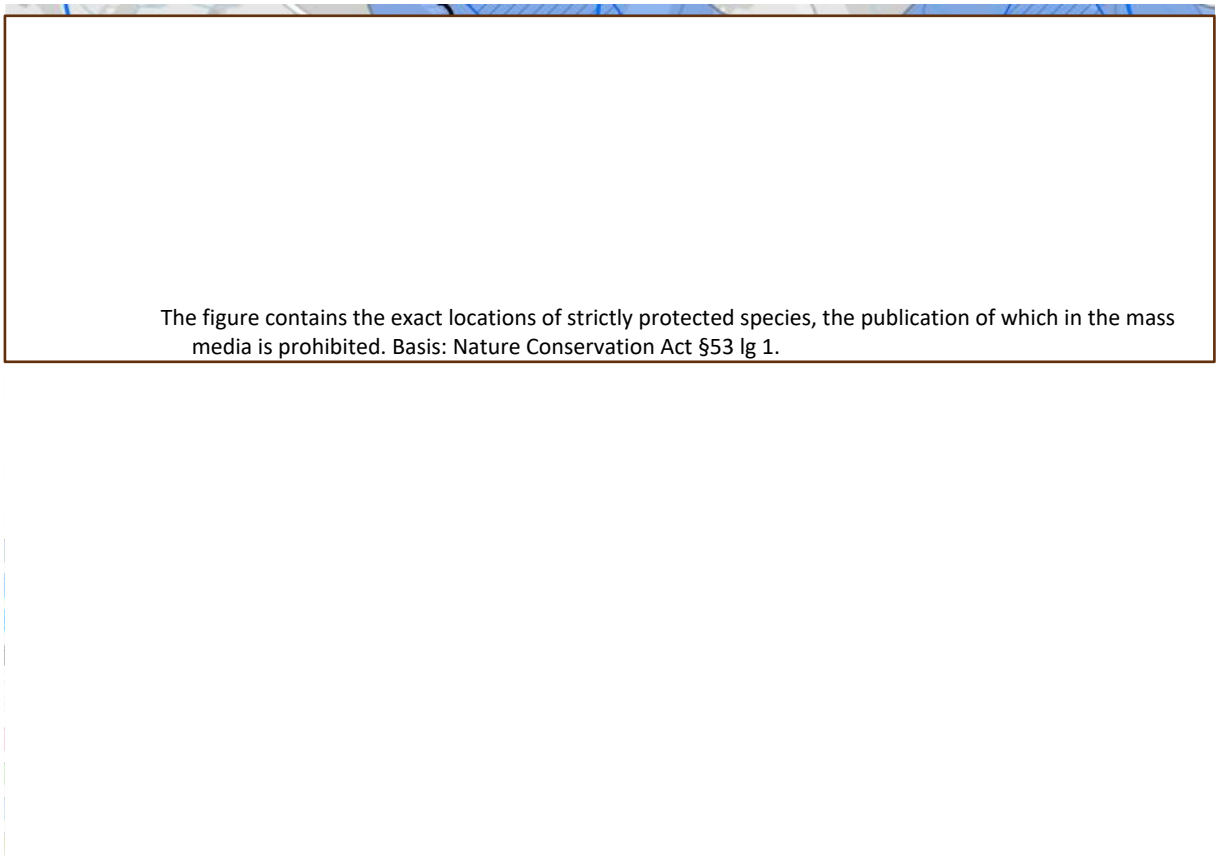

Figure 40. Occurrence of bat habitats in the study areas.

3.2. Fieldwork results

2.3.1 Study area 1

Of the land types in study area 1, woody vegetation (91%) dominated, with arable land and wetlands each accounting for 4% and open areas for 1% (Figure 41).

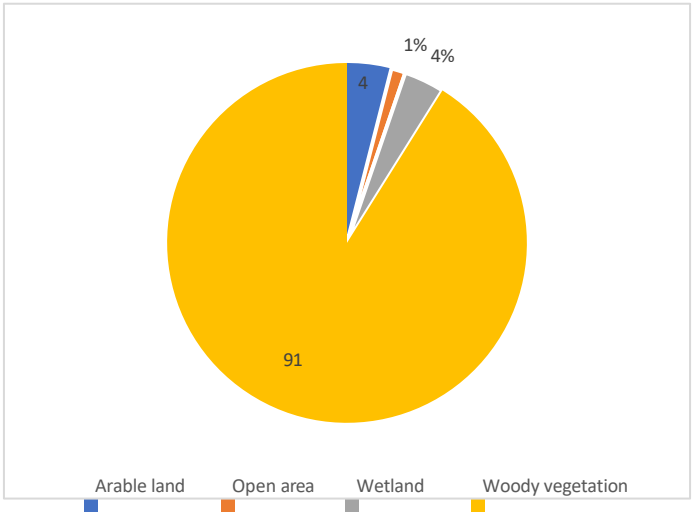

Figure 41. Proportional distribution of land types in study area 1.

The vast majority of stands are old pine forests (51%) with an average age of 84 and an area of 577 ha, followed by middle-aged (55 years) spruce forests (22%). Coniferous forests account for over 70% of the area

of the stand. Middle-aged deciduous forests (55 years) account for 23% of the area. The most suitable forests for bats, where the age of aspen trees is at least 55 years and their proportion is at least 10%, cover a total of 26 ha (Figure 42).

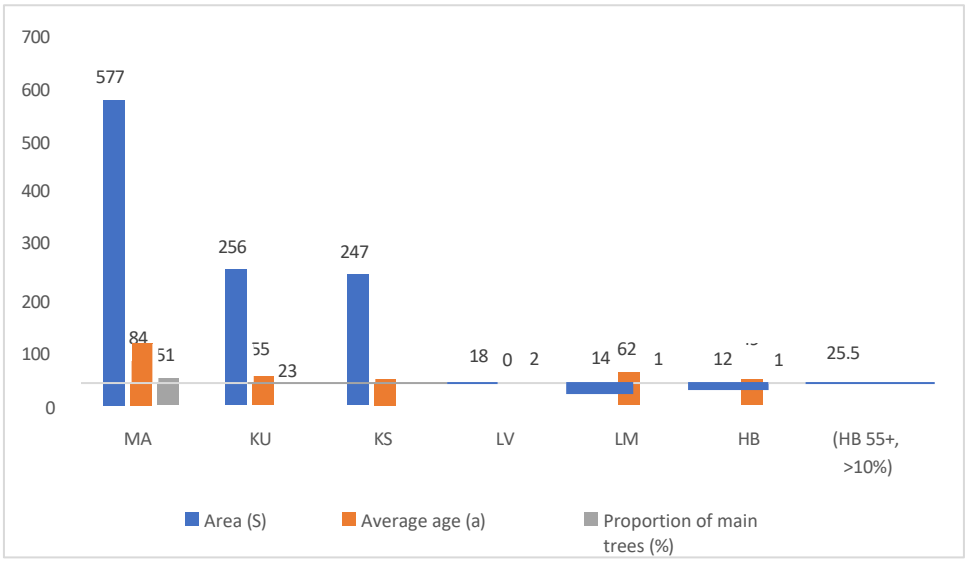

Figure 42. Forest stands in study area 1 based on their area and average age and the proportion of tree species. The figure shows forest stands aged 55 years or older in the development area where the proportion of aspen is at least 10% and which may be important habitats for bats. (MA – pine, KU – spruce, KS – birch, LV – grey alder, LM – black alder, HB – aspen).

In study area 1, two bat detectors were used in parallel at a total of three points (Figure 43). A total of 482 bat vocalisations were recorded in the study area. At point 2, bats were recorded for one night during their spring migration (10-11 May), but a feeding ground for wild animals was discovered nearby and it was decided to move the detector to point 3 (Figure 43) for safety reasons, where it recorded from 21 May to 7 July 2023, i.e. during the spring migration period and the summer breeding season. Point 1 recorded bats during the autumn migration period (4 August–28 September 2023; Figure 43).

Figure 43. Locations of bat detectors used in study area 1 in Valga.

During spring migration (10.05-31.05), a total of 93 bat calls were recorded at detectors 2 and 3, most of which were from the common pipistrelle (49) and the northern bat (30, Figure 44).

During the summer breeding season (1 June–8 July), a total of 196 bat calls were recorded near detector 2, most of which were northern bats (144) and greater mouse-eared bats (33, Figure 44).

During autumn migration (4 August–28 September), a total of 193 bat calls were recorded at tree canopy height near detector 1. The northern bat was recorded most frequently (119), followed by the pipistrelle (*Pipistrellus,* 53), with less than ten vocalisations of other species (Figure 44).

The relative abundance of bats in study area 1 remained rather modest. No mass spring migration was observed in study area 1, but the greater mouse-eared bat was the most common species during the migration period. According to the national red list, the common pipistrelle belongs to the near threatened category [(explanation: locally distributed and moderately abundant species. The long-term population trend is stable, but the short-term trend has turned negative. As this is a long-lived species, a further decline in the population can be expected (many barn owls are killed in European wind farms([53])].

The results also show that the detectors were not located near breeding colonies, although during the breeding season, increased activity of northern bats was observed near detector No. 3, as well as a slight increase in the relative abundance of greater mouse-eared bats, which probably indicates the presence of more individuals in the area during the breeding season. Autumn migration activity was approximately twice as high as spring migration activity in the area. While the main species during spring migration was the greater mouse-eared bat, the main species during autumn migration was the northern bat.

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[53] UNEP/EUROBATS IWG on wind turbines and bat populations. *Report of the IWG to the 27th Meeting of the Advisory Committee Sarajevo, Bosnia and Herzegovina, 27-29 March*; EUROBATS: Sarajevo, **2023**; p 54.

One reason for the low abundance of bats in the study area may be the scarcity of old aspen stands. For example, old aspen stands account for less than 1% of the total forest area (Figure 42), with coniferous forests making up the vast majority, approximately 74% (Figure 44).

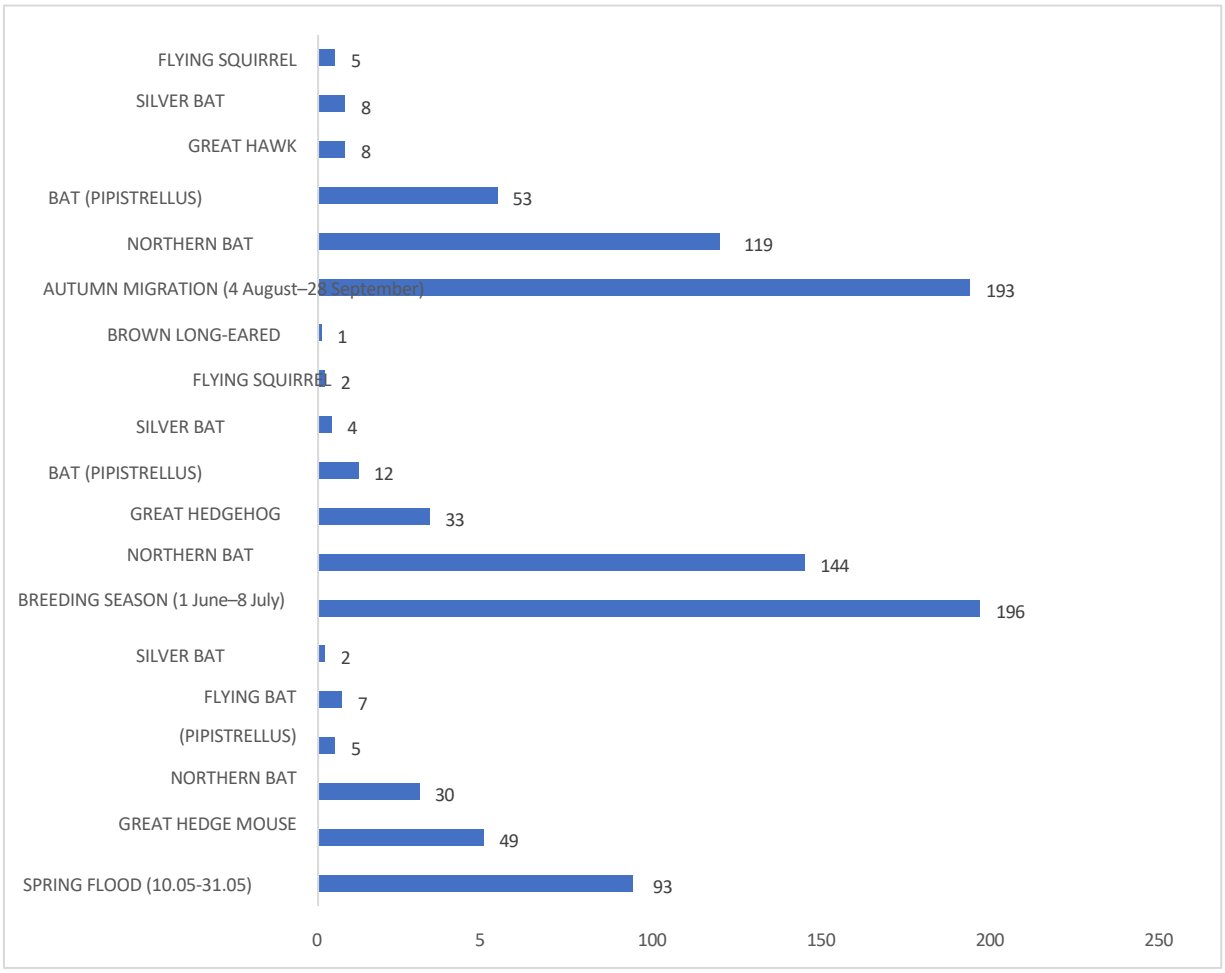


Figure 44. Results of fieldwork on bats in study area 1 during spring migration, breeding season and autumn migration.

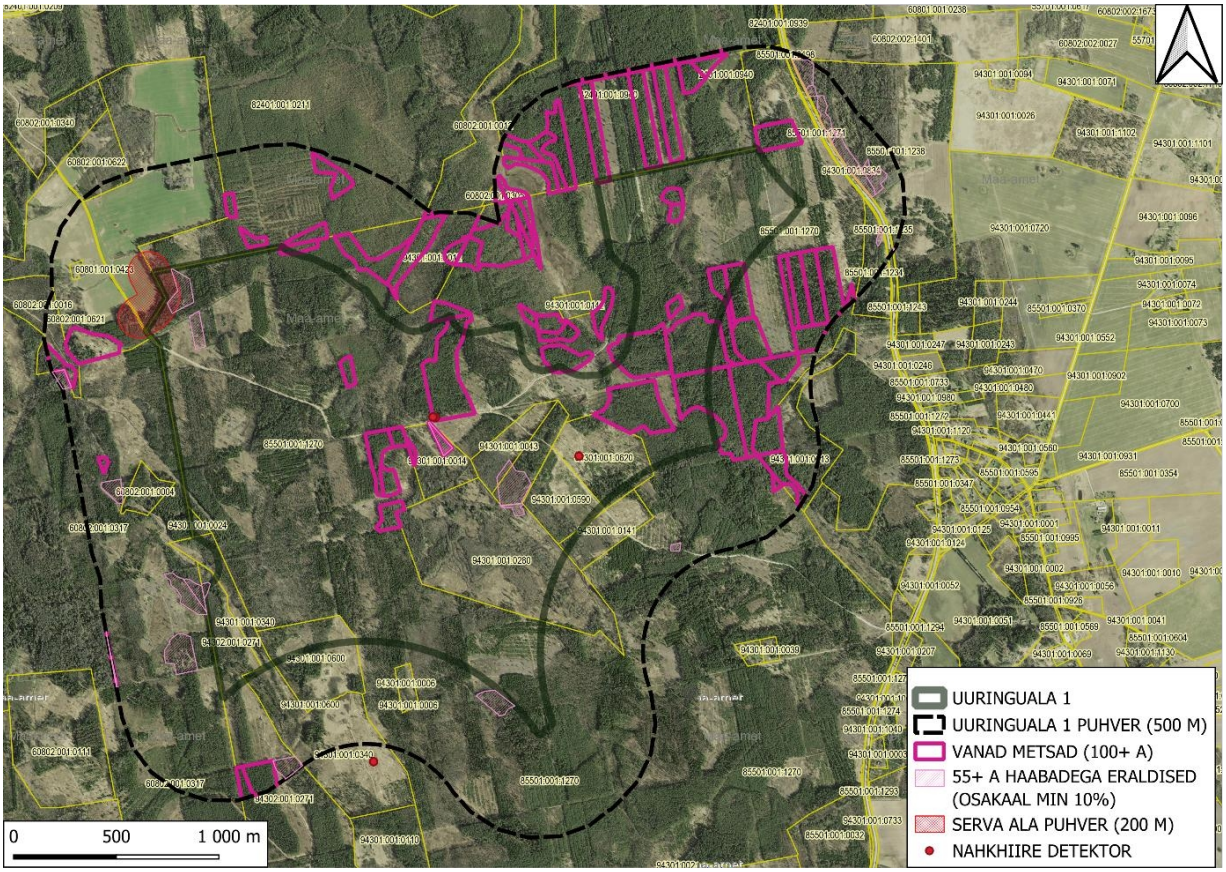


Figure 45. Habitats and feeding areas important for bats in study area 1, where the planning of wind turbines should be avoided.

2.3.2 Study area 2

Based on the distribution of land use, study area 2 was dominated by woody vegetation (84%), with 15% arable land and 1% open areas; there were no wetlands in the study area (Figure 46).

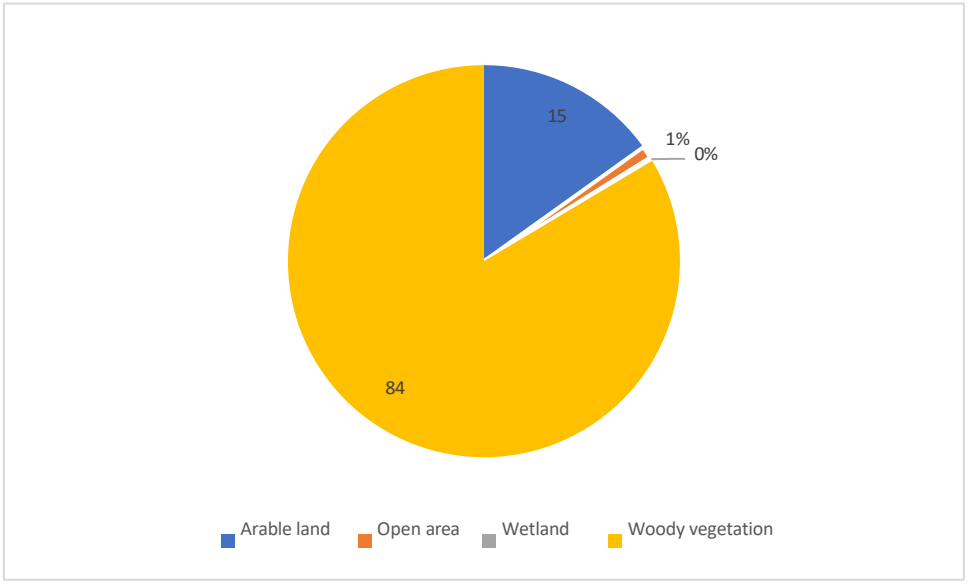


Figure 46. Proportional distribution of land types in study area 2.

Based on the structure of the forest stand, study area 2 has an average of older (57 years) birch forests (42%), followed by middle-aged (50 years) spruce forests (32%). Spruce and birch forests make up approximately ¾ of the forest stand

(74%). Forests important for bats, where the age of aspen trees is at least 55 years and their proportion is 10%, cover 37 ha (Figure 47).

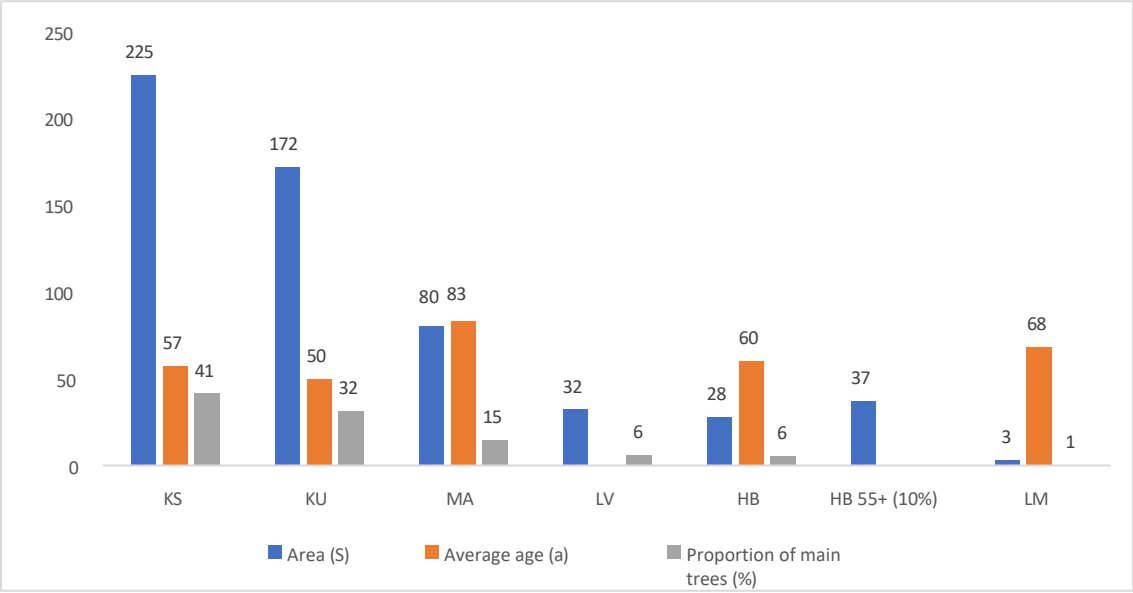


Figure 47. Allocations in study area 2 based on main tree species according to their area and average age and the proportion of tree species. The area of forests with a minimum of 55 ha and a proportion of 10% aspen, which may be important habitats for bats, is also shown. (KS – birch, KU – spruce, MA – pine, LV – grey alder, HB – aspen, LM – black alder, HB 55 plus – forests where aspens are at least 55 years old and account for 10% of the stand).

In the northern part of study area 2, detectors recorded at four points: at location 1, the detector recorded at a tree crown height of 4.08.23-17.08.23; at location 2, the detector recorded at a height of 2 m from 25.05.23 to 13.06.23; at point 3, the detector recorded at a height of 18.08.23-29.09.23, and at point 4, the detector recorded at a height of 2 m from 13.06.23 to 08.07.23 (Figure 48).

In the central part of study area 2, automatic detectors recorded on the following dates: at point 5 at a height of two metres from 25 May to 13 June 2023, at point 6 at a height of two metres from 19 May to 25 May 2023, at point 7 at a height of two metres
at a height of 2 metres from 14 June 2023 to 9 July 2023, at point 8 at the height of the tree canopy from 10 September 2023 to 20 September 2023 (Figure 48).

In the southern part of study area 2, the automatic detector recorded at point 9 on 20.05.23-25.05.23 (Figure 48).

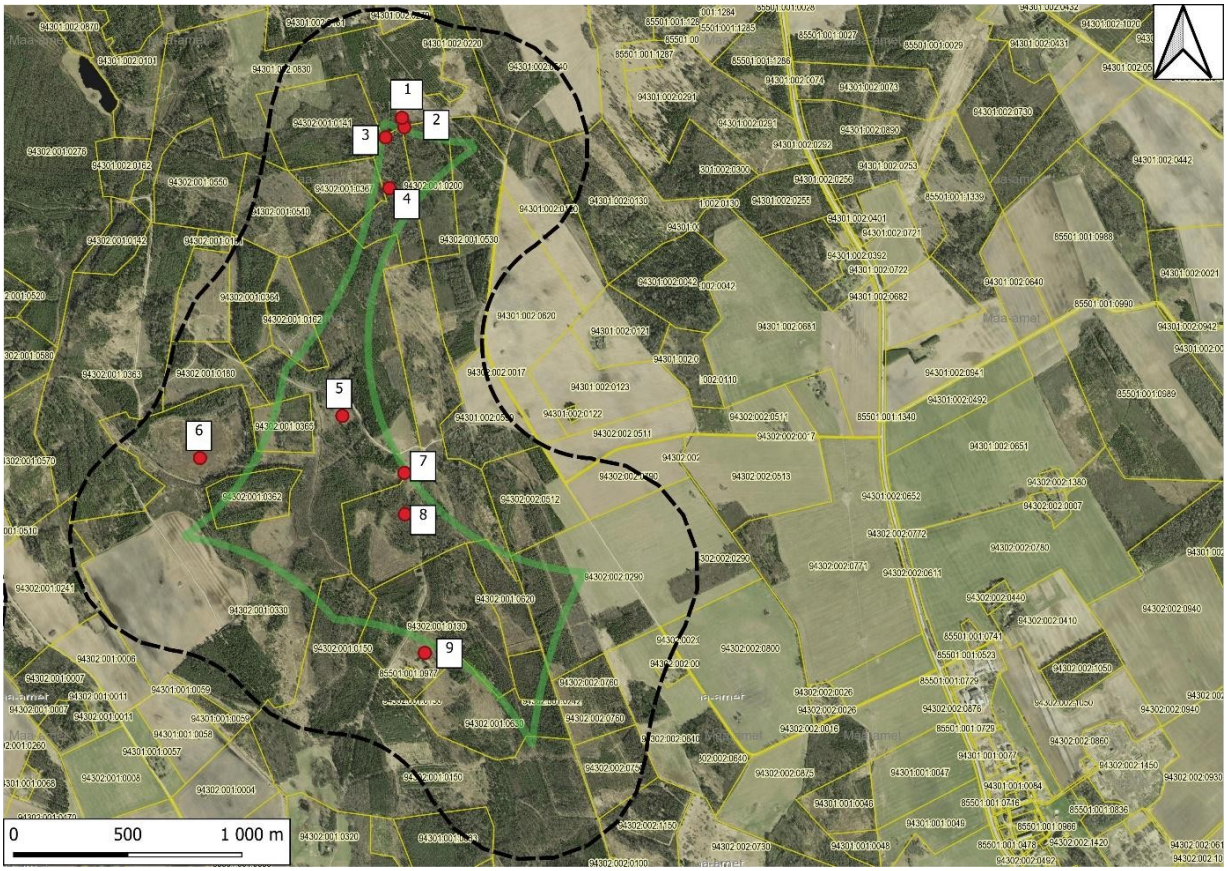


Figure 48. Locations of bat detectors in study area 2 in Valga.

A total of 3,886 bat calls were recorded in the second study area: 267 calls during spring migration (19.05-31.05), 1,486 calls, and during autumn migration (4 August–29 September) 2,133 calls
(Figure 49).

A total of 71.9% of bat vocalisations (2795/3887) were recorded at the northern monitoring points 25.6% of vocalisations (994/3887) in the central part of the area, and 2.5% of bat vocalisations (98/3887) in the southern part.

During the spring migration, there were three major groups of bat species: northern bats (176 vocalisations), greater mouse-eared bats (36 vocalisations) and pipistrelles (24 vocalisations).

During the breeding season, northern bats were the most vocal (1177), followed by greater mouse-eared bats (138 vocalisations) and brown long-eared bats (85 vocalisations).

During the autumn migration, northern bats were recorded most frequently (1943 vocalisations), followed by silver bats (78 vocalisations) and greater mouse-eared bats (45 vocalisations).

On registered immovable 94302:001:0210, located in the northern part of study area 2, there is a 9.36 ha mixed forest dominated by older aspen and birch trees, which is not listed in the Forest Register database. Part of survey area 2 is also covered by property 94302:001:0200, which has 1.65 ha of older alder forest (57 years old).

An elevated activity cycle of northern bats was observed in study area 2 (Figure 50). The recording peaks show a higher activity cycle during the breeding season (20-26 June) and autumn migration (Figure 50, 18-26 August and 7-13 September). **Based on the data, it can be assumed that this location was probably home to a bat breeding colony during the breeding season and may also have been an important feeding site.** The autumn activity period indicates that northern bats may have roosted at this location or that it was a transitional shelter area used by bats during migration to reach their wintering grounds. When installing wind turbines, a minimum distance of 200 m from the northern boundary of the development area must be observed, where no wind turbines may be erected in order to preserve the bat breeding site, and within a radius of 500 m, wind turbines must be stopped during the bat breeding season when the average wind speed is <5 m/s, the temperature is ≥0 degrees and there is no

precipitation (0 mm) (**Figure 51**). As the surrounding area consists of commercial forests on private land, it is not reasonable to prohibit the construction of wind turbines if they are built on the border of the 200 m buffer zone, as the feeding and breeding grounds will be preserved and the measure of switching off the wind turbines during the bat activity period will be additionally implemented.

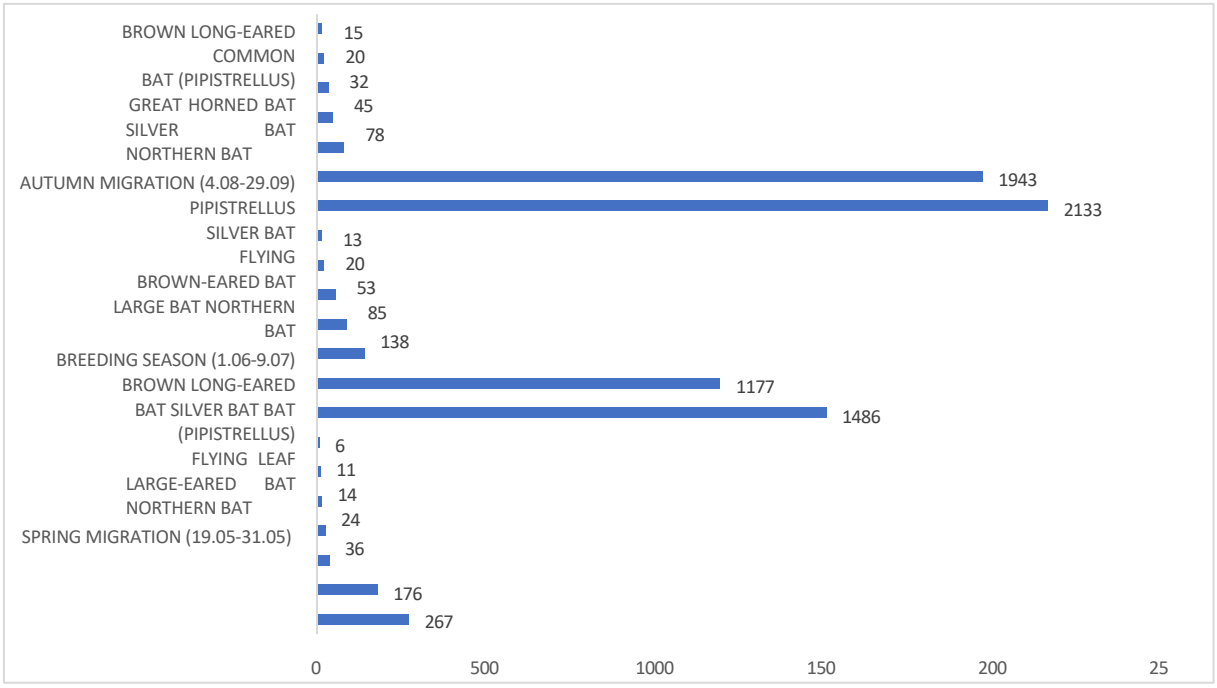


Figure 49. Results of fieldwork on bats in study area 2 during spring migration (19 May–31 May), the breeding season (1 June–9 July) and autumn migration (4 August–29 September).

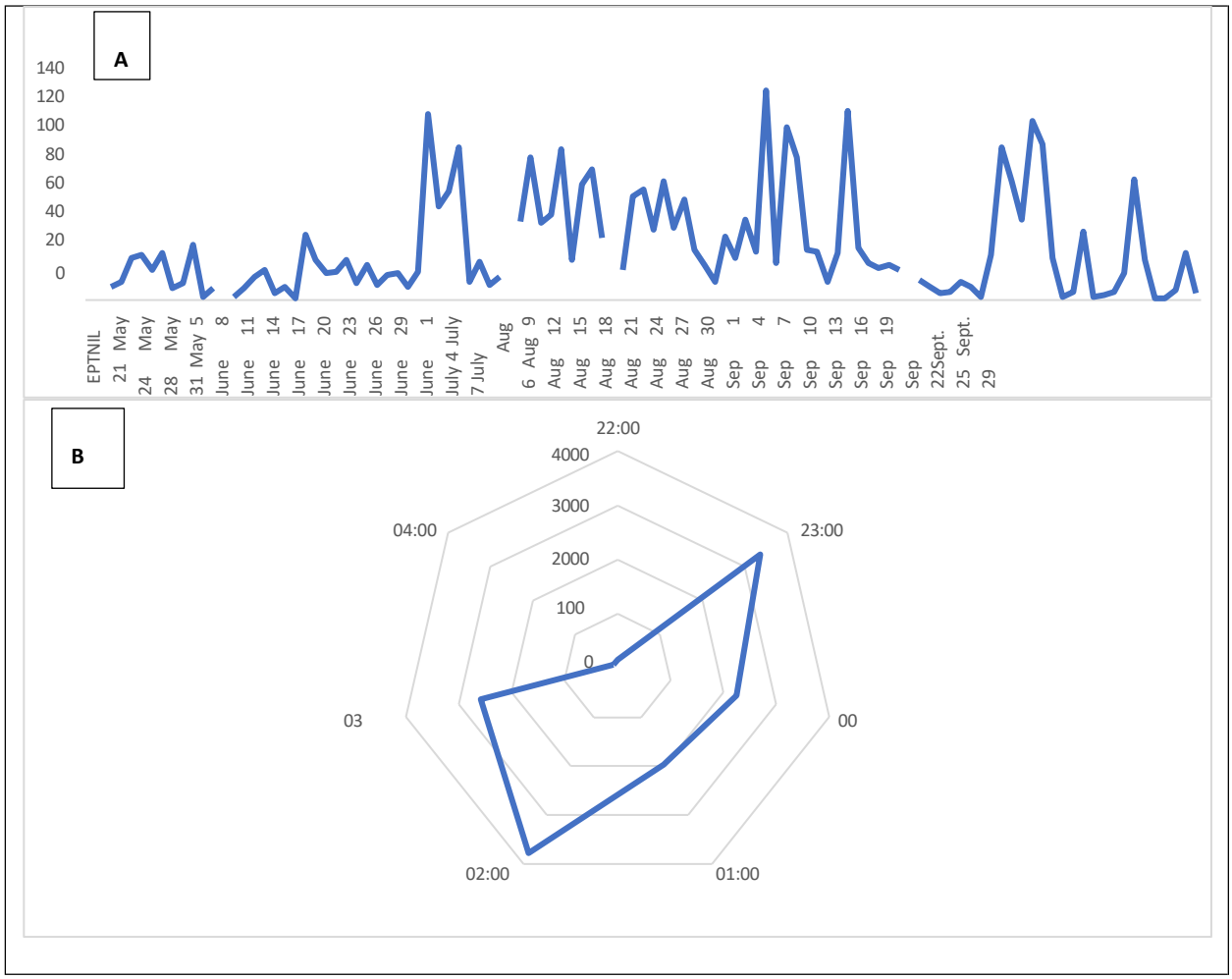


Figure 50. The most common activity cycle of northern bats in study area 2 (A) and the daily activity of bats during the breeding season (B). The peaks indicate higher activity cycles during the breeding season (20–26 June) and autumn migration (18–26 August and 7–13 September). As activity is high immediately after sunset and at midnight, this indicates the proximity of a bat colony in the forest and an important feeding area.

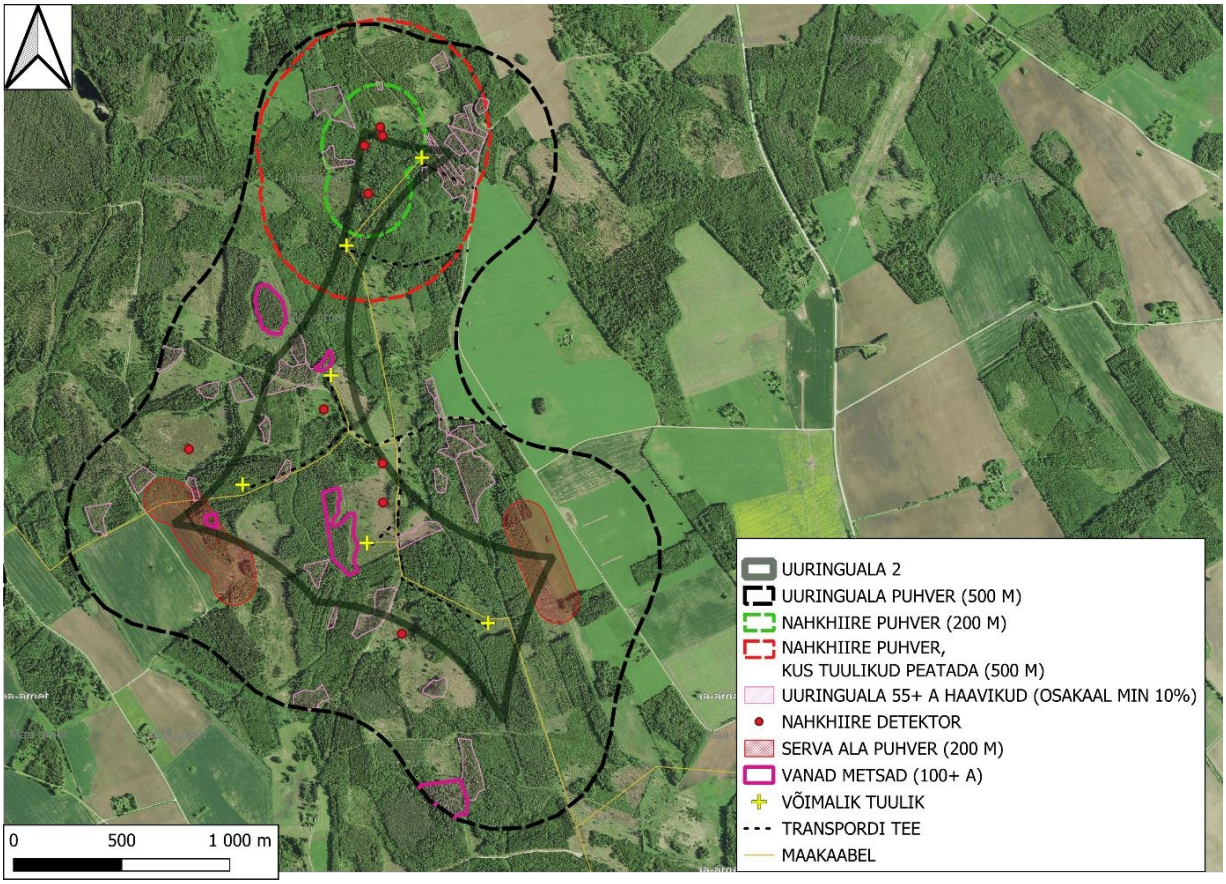


Figure 51. Old (100+ years) forests in the Valga study area 2 – probable habitats and feeding grounds for bats, together with forests aged 55 years or older, where the proportion of aspen is over 10%. The green dotted line marks the northern important feeding and breeding area for bats with a 200 m buffer zone, where a wind turbine can be erected on the border of the 200 m buffer zone and 500 m, where wind turbines must be shut down during periods of high bat activity between 1 May and 15 September, half an hour after sunset in the evening, and may be restarted half an hour before sunrise in the morning, if the wind speed is <5 m/s, the temperature is ≥0 degrees and there is no precipitation (0 mm).

2.3.3 Study area 3

The proportional distribution of land types in study area 3 is shown in Figure 52, which shows that woody vegetation covers 91% of the area, wetlands cover 4% of the land, arable land covers 3% and open areas cover 2%.

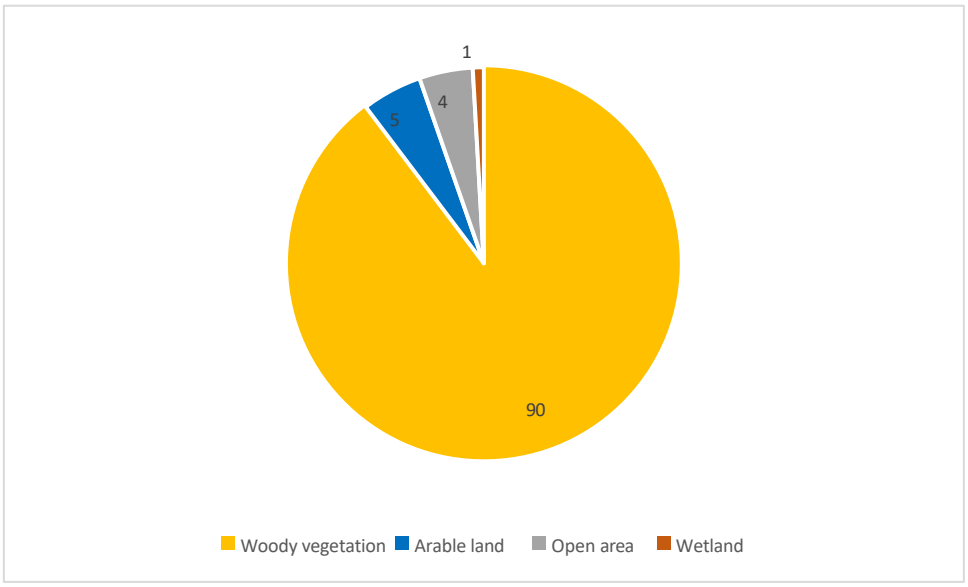


Figure 52. Proportional distribution of land types in study area 3.

The study area 3 is dominated by older (81 years) pine forests, which make up 47% of the total forest area. Older birch forests (average age 55 years) account for 25% of the stands in the area. Forests most suitable for bats, where the age of birch trees is at least 55 years and their proportion in the stand is at least 10%, cover 56 ha (Figure 53).

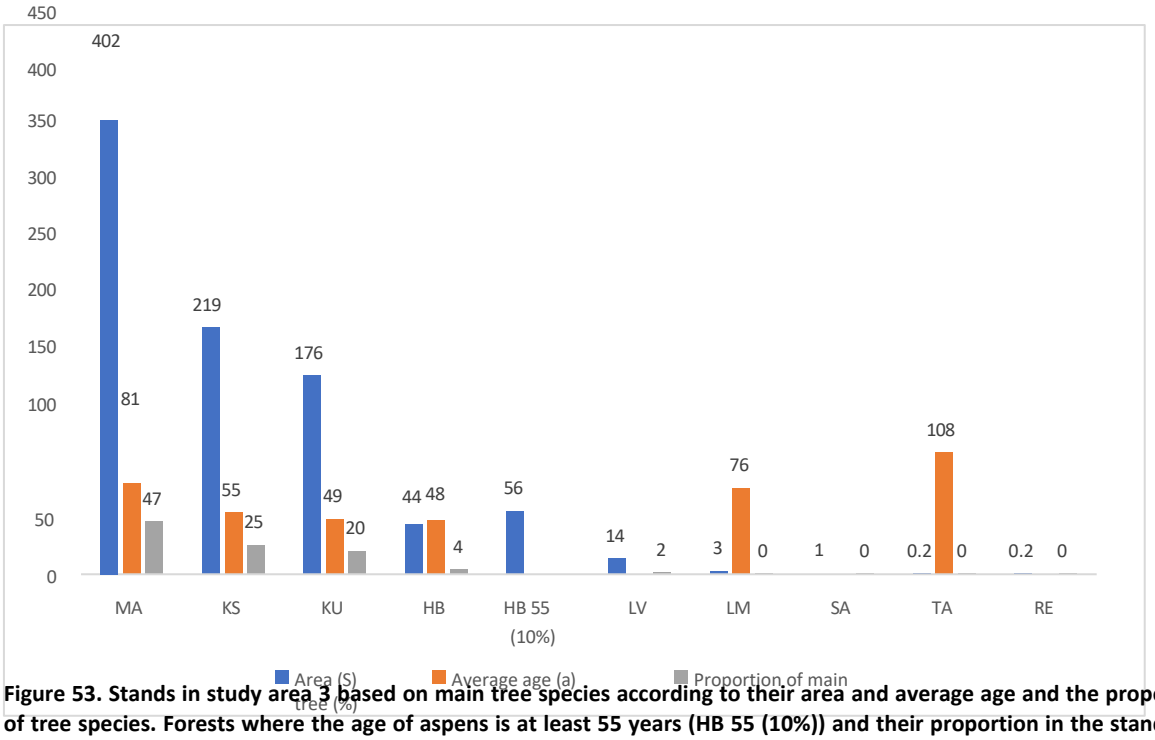


Figure 53. Stands in study area 3 based on main tree species according to their area and average age and the proportion of tree species. Forests where the age of aspens is at least 55 years (HB 55 (10%)) and their proportion in the stand is at least 10%, which may be important habitats for bats, are also shown. (MA-pine, KS-birch, KU-spruce, HB-aspen, LV-grey alder, LM-black alder, SA-ash, TA-oak, RE-alder).

Bat detectors recorded at six different points (Figure 54), divided equally between two observation points in the northern, central and southern parts of the study area. In the northern part of the area, the detector recorded at point 1 at tree canopy height on 18.08-29.09, and at point 2 at a height of approx. 2 m on 17.05-12.06.

In the centre of the area, detector 3 recorded at tree canopy height on 21 August–29 September, and at point 4, the detector recorded at a height of approx. 2 m on 17 May–11 June.

In the southern part of the area, the detector recorded at a height of approximately 1.8 m from 18 May to 8 July, and at point 6, the detector recorded at tree canopy height from 18 August to 29 September.

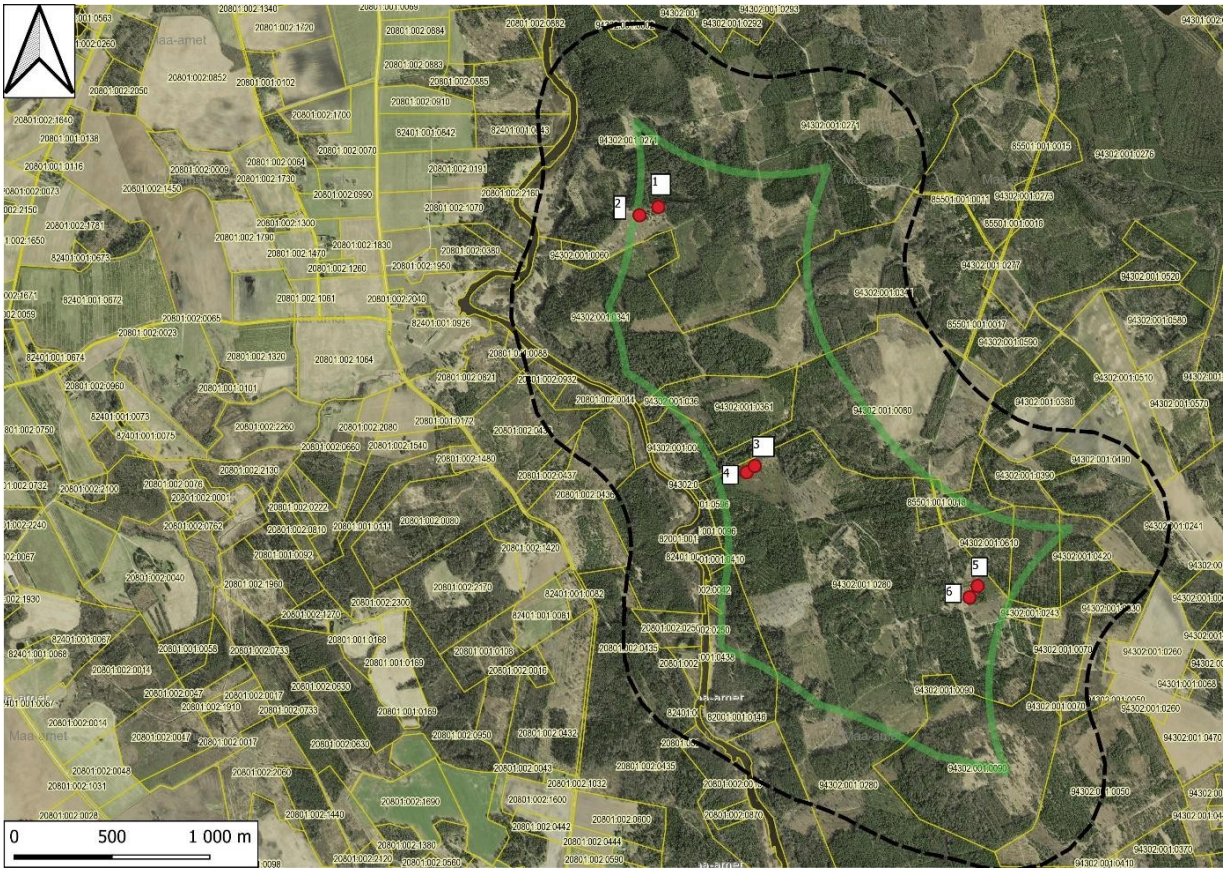


Figure 54. Recording locations 1-6 of bat detectors in study area 3.

A total of 2328 bat vocalisations were recorded in the study area. Approximately 33% (767/2328) of bats were recorded in the northern part of the area, 31.3% (729/2328) in the central part, and 35.7% (832/2328) in the southern part.

During the spring migration (17 May–31 May), a total of 324 bats were recorded, with the largest groups being northern bats (197 recordings) and greater mouse-eared bats (70 recordings, Figure 55).

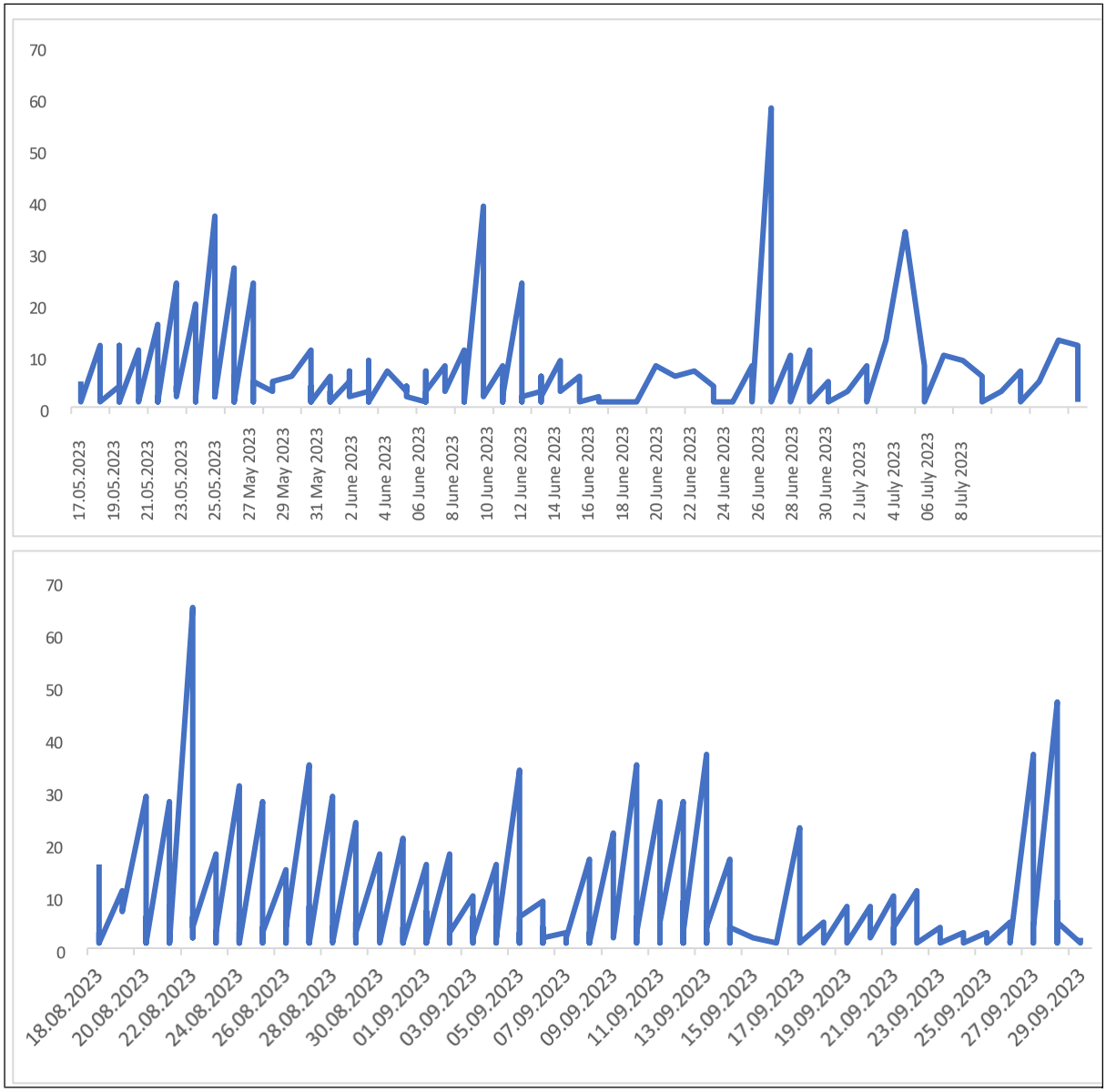
During the breeding season (1 June–8 July), 463 bat recordings were made in the study area, with the northern bat (367 recordings) accounting for the vast majority, followed by the greater mouse-eared bat (56 recordings, Figure 55).

During autumn migration (18 August–29 September), a total of 1,541 bat vocalisations were recorded, 68% of which were northern bats (1,053 recordings), followed by the silver bat (177 recordings) and the greater mouse-eared bat (172 recordings), but a total of 80 recordings were also made of species of the genus *Pipistrellus* during migration (Figure 55).

The distribution of bats was rather similar and representative across the entire study area. The highest number of bats was recorded in the northern part of the area, but bats were found fairly evenly across the entire study area. In the southern part of the study area, at monitoring points 5 and 6, a military bunker was recorded that was inaccessible (the entrance was located approx. 5-6 m above the floor of the bunker), but it may be a suitable shelter for bats.

Based on the activity cycles of bats, an increase in bat activity can be seen in the study area in the last half of May during the spring migration period from 21.05 to 26.05. During the breeding season, there are also increases in activity in the second half of the month, from 22 June to 29 June, when a colony of northern bats, probably originating from older breeding roosts with bat boxes located nearby, was present near point 5, as evidenced by ultrasound pulses

activity map (Figure 56 C). During the migration period, the highest activity was observed between 21.08 and 13.09, but 27-28.09 also saw
more active migration (



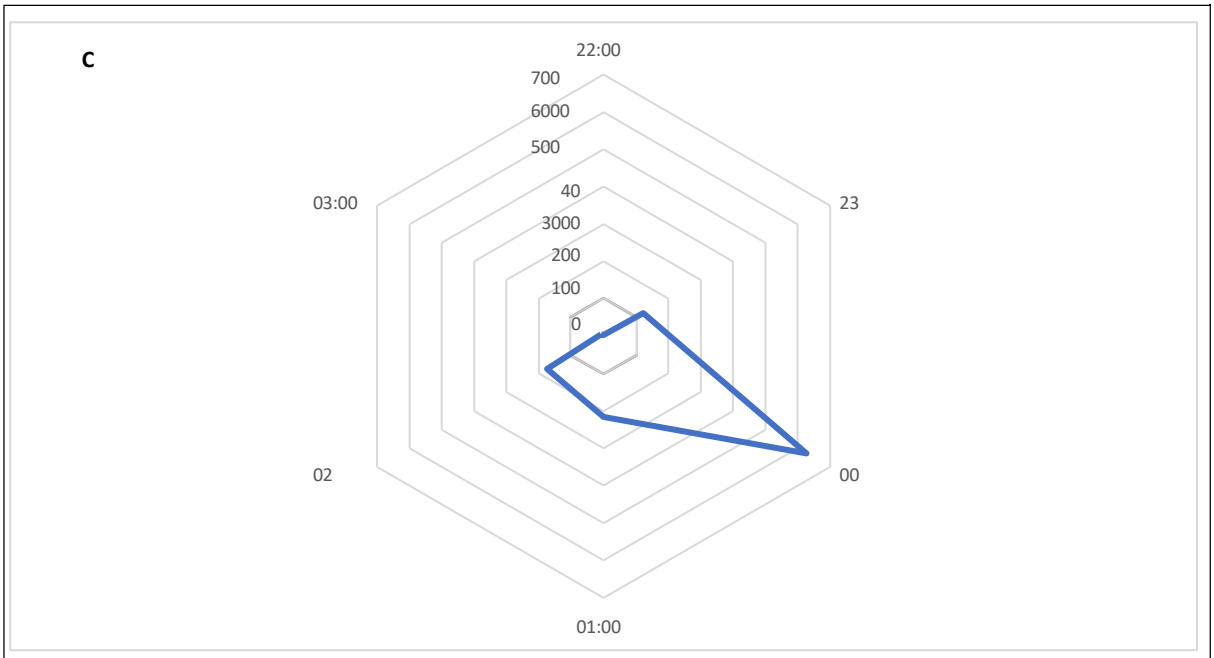


Figure 56. Activity cycles of bats in the study area during spring migration and the breeding season (Figure 56 A) and autumn migration (Figure 56 B). Bat activity peaked at midnight (C), indicating arrival at the feeding area from nearby breeding forests.

).

In study area 3, the Väike-Emajõgi River and its 400 m buffer zone, which includes both older forest riparian communities and forests with old wounds (min. 55 years old) and other hollow trees, which are important roosting and breeding sites for bats.

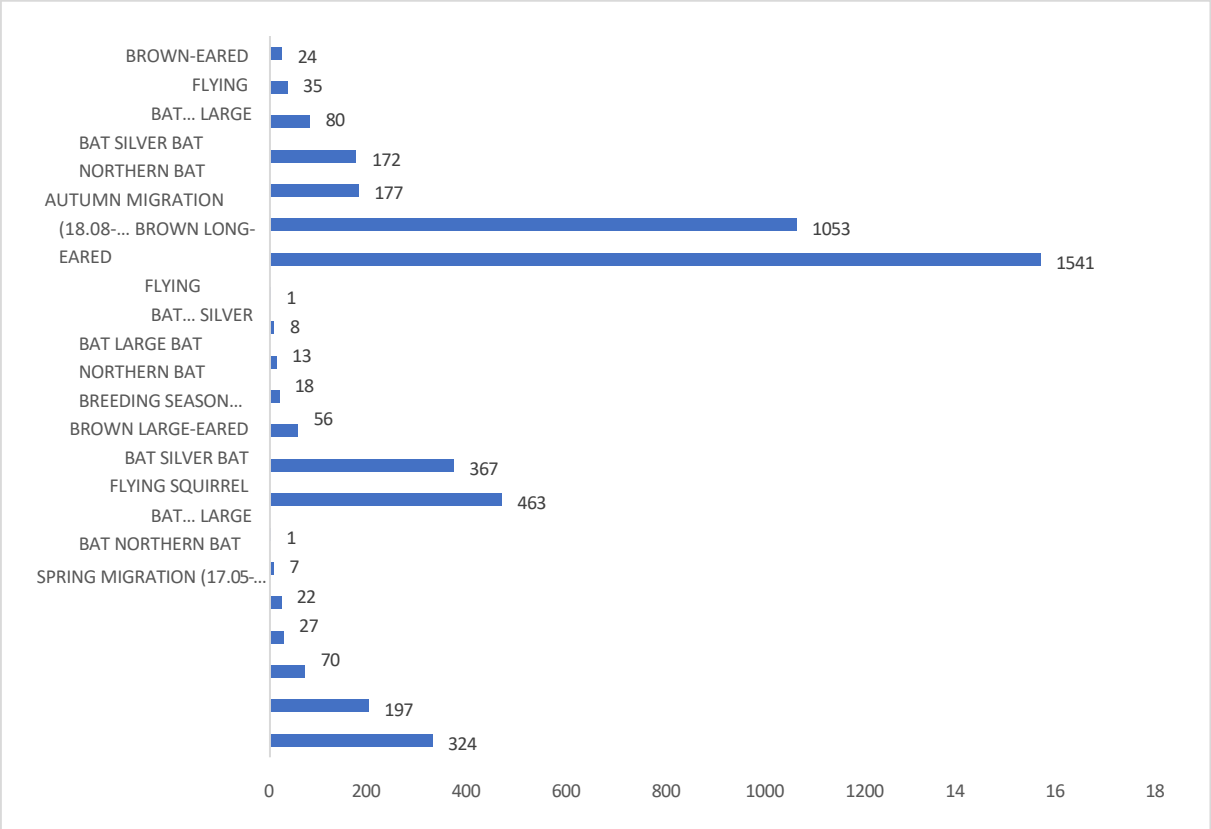
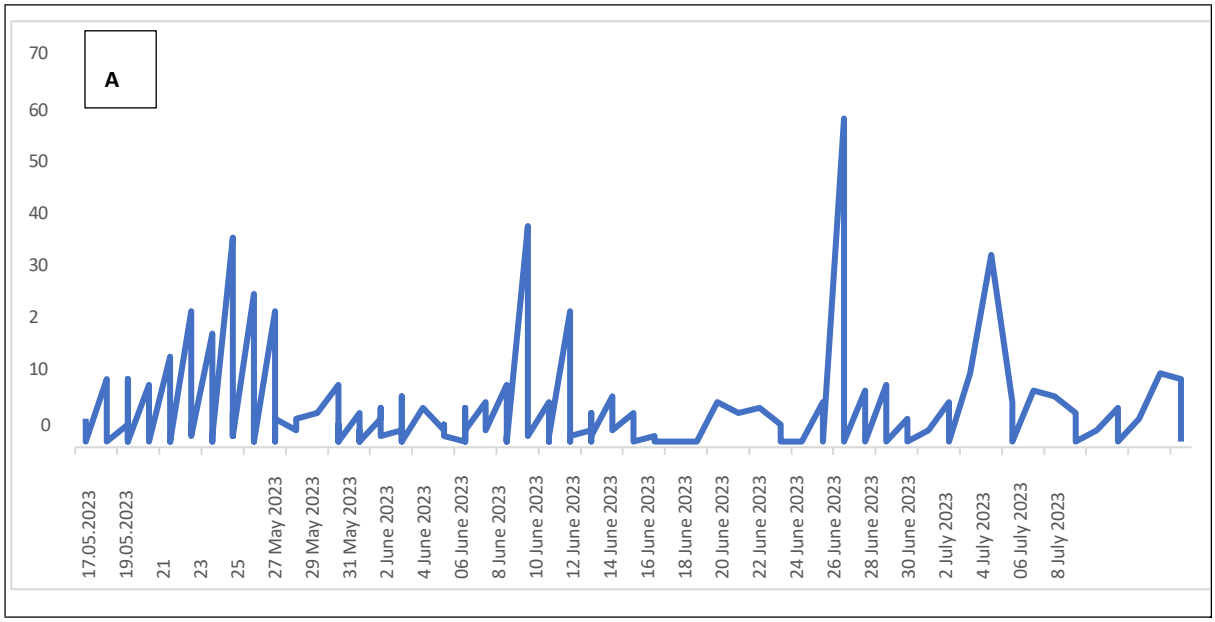


Figure 55. Results of fieldwork on bats in study area 3 during spring migration (17.05-31.05), breeding season (1.06-8.07) and autumn migration (18.08-29.09).



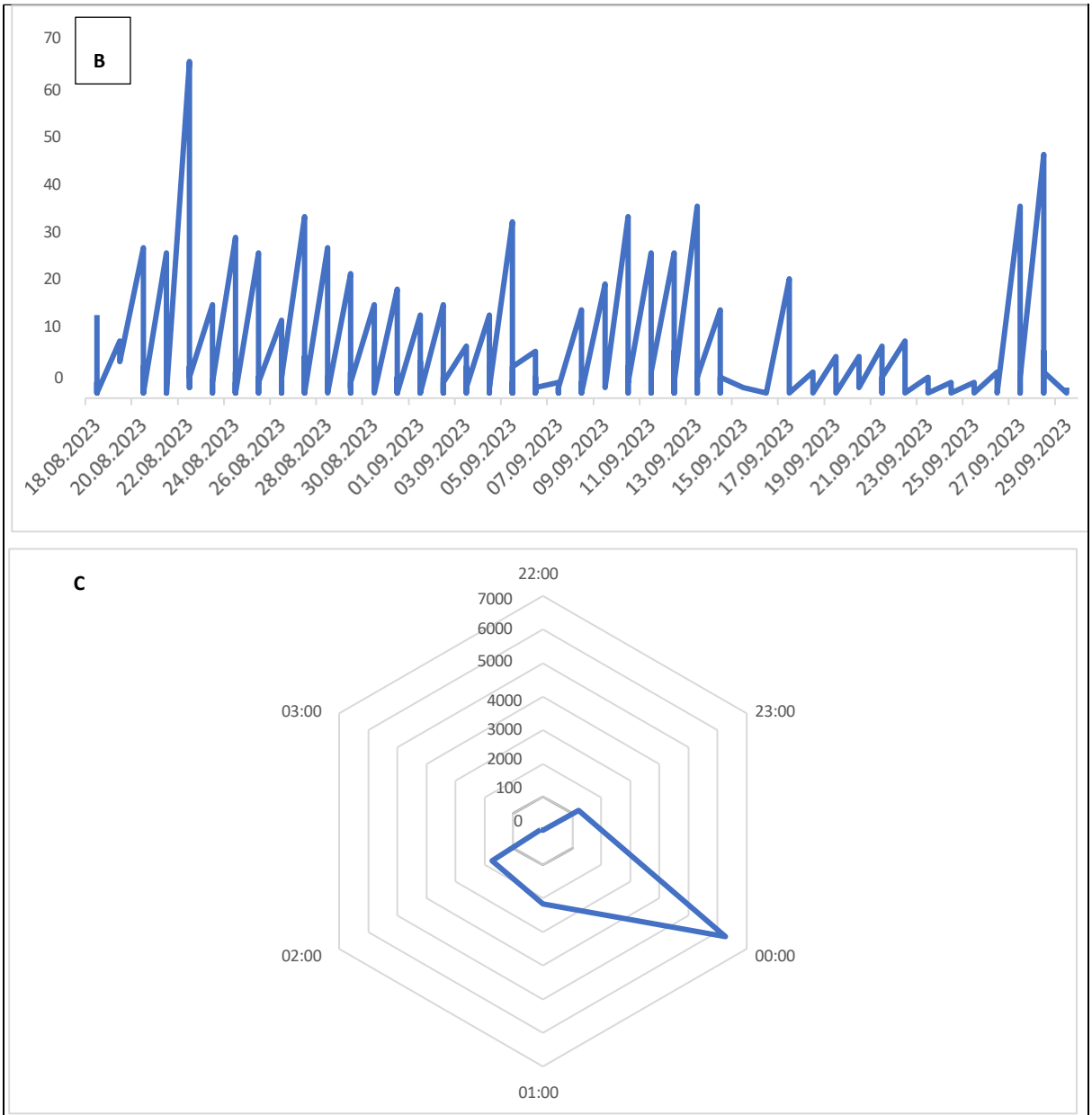


Figure 56. Activity cycles of bats in the study area during spring migration and breeding season (Figure 56 A) and autumn migration (Figure 56 B). Bat activity peaked at midnight (C), indicating arrival at the feeding area from nearby breeding forests.

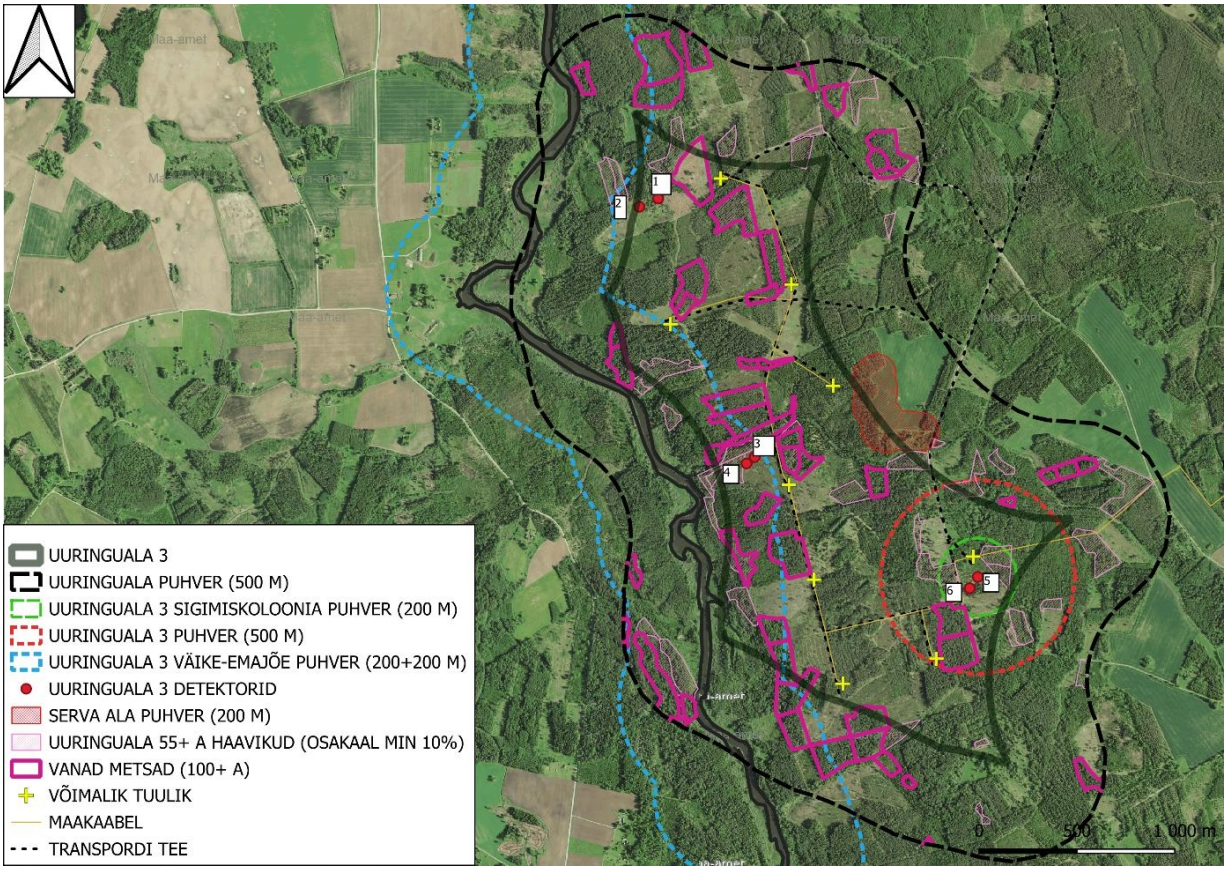


Figure 57. Old (100+ years) forests in study area 3 in Valga – probable habitats and feeding grounds for bats, together with forests where the age of aspen trees is at least 55+ years and their proportion in the stand is 10%. The bright green dotted line marks the important southern feeding and migration area for bats, and the red dotted line marks a 500 m buffer zone where wind turbines must be switched off during the bats' active period.

A suitable roost for bats is located between detector points 5 and 6.

2.3.4 Study area 4

The proportional distribution of land types in study area 4 is shown in Figure 58. The study area consists of 90% woodland, 5% arable land, 4% open land and 1% wetland.

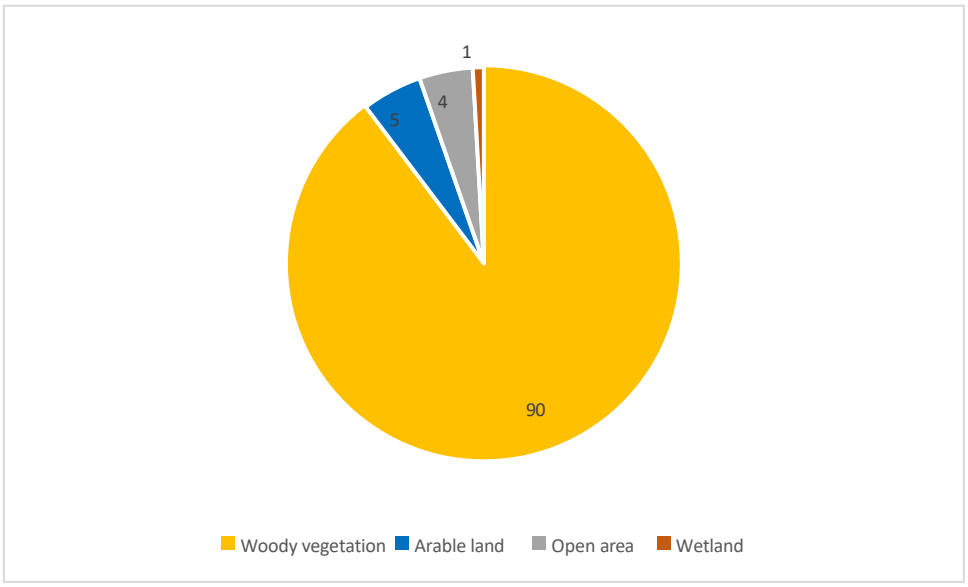


Figure 58. Proportional distribution of land types in study area 4.

The study area 4 is dominated by coniferous forests – older (72 years) pine forests (44%) and spruce forests (56 years, 23%), which together make up 67% of the forests (Figure 43). The most common deciduous trees are older (55 years old) birch forests (21% of the stands in the area). The most suitable forests for bats, where birch forests are at least 55 years old (proportion of at least 10%), cover a total of 37 ha (Figure 59).

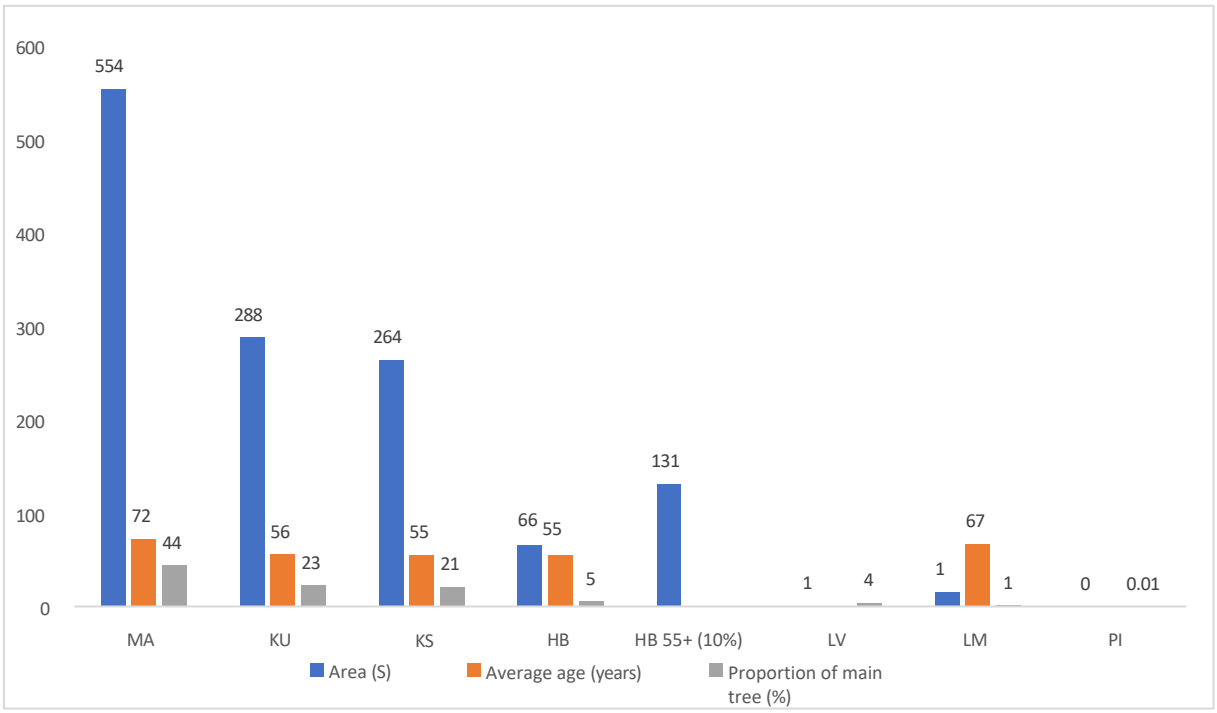


Figure 59. Stands in study area 4 based on main tree species according to their area and average age and the proportion of tree species. The figure shows forests where the age of aspen trees is at least 55 years and their proportion is at least 10% in the stand, which may be important habitats for bats ((HB 55+ (10%)). (MA – pine, KU – spruce, KS – birch, HB – aspen, LV – grey alder, LM – black alder, PI – rowan).

In study area 4, bat detectors recorded at the northernmost point 1 at tree canopy height on 17.08-28.09.23. The southern detectors recorded at point 2 at a height of approx. 2 m on 12.05-1.06.23, at points 3-4

at the height of the canopy from 17 August to 19 September, at point 5, the detector recorded at a height of approximately 2 m from 12 May to 1 June 2023, and at point 6, the detector recorded at the height of the canopy from 17 August to 10 September (Figure 65). The detectors were mainly installed in the north-western part of the study area to assess the possible impact of the proximity of a water body (Väike-Emajõgi) on the presence of bats.

In total, the detectors recorded 2949 bats at 4 points in the study area. Of these, 9.4% of bats (277/2949, Figure 65) were recorded in the northern part (point 1, at tree canopy height, 17.08-28.09.23).

At the southern point 2 (at a height of approx. 2 m, 12.05-1.06.23), 14% (417/2949) of bats were recorded,
at points 3-4, 50% (1478/2949) of bats were recorded (at a height of 17.08-19.09), at point 5, 12% (365/2949) of vocalisations were recorded (at a height of approx. 2 m between 12.05 and 1.06.23), 12% (365/2949) of vocalisations, and at point 6 (at a canopy height of 17.08-10.09) approx. 14% (412/2949) of bats were recorded.

A total of 782 vocalisations were recorded in study area 4 during spring migration (12 May–1 June), the vast majority of which belonged to northern bats (524 vocalisations) and greater mouse-eared bats (Figure 60; 189 vocalisations).

During autumn migration (17 August–20 September), 2,167 bat vocalisations were recorded, most of which belonged to northern bats (1,458 vocalisations), the silver bat (468 vocalisations) and the greater mouse-eared bat (94 vocalisations, Figure 60).

The vast majority of bat calls (64%, 1895/2949) were recorded at monitoring points 2-4 during autumn and spring migration. This is an important migration and feeding area for bats, which probably runs along the Väike-Emajõgi River.

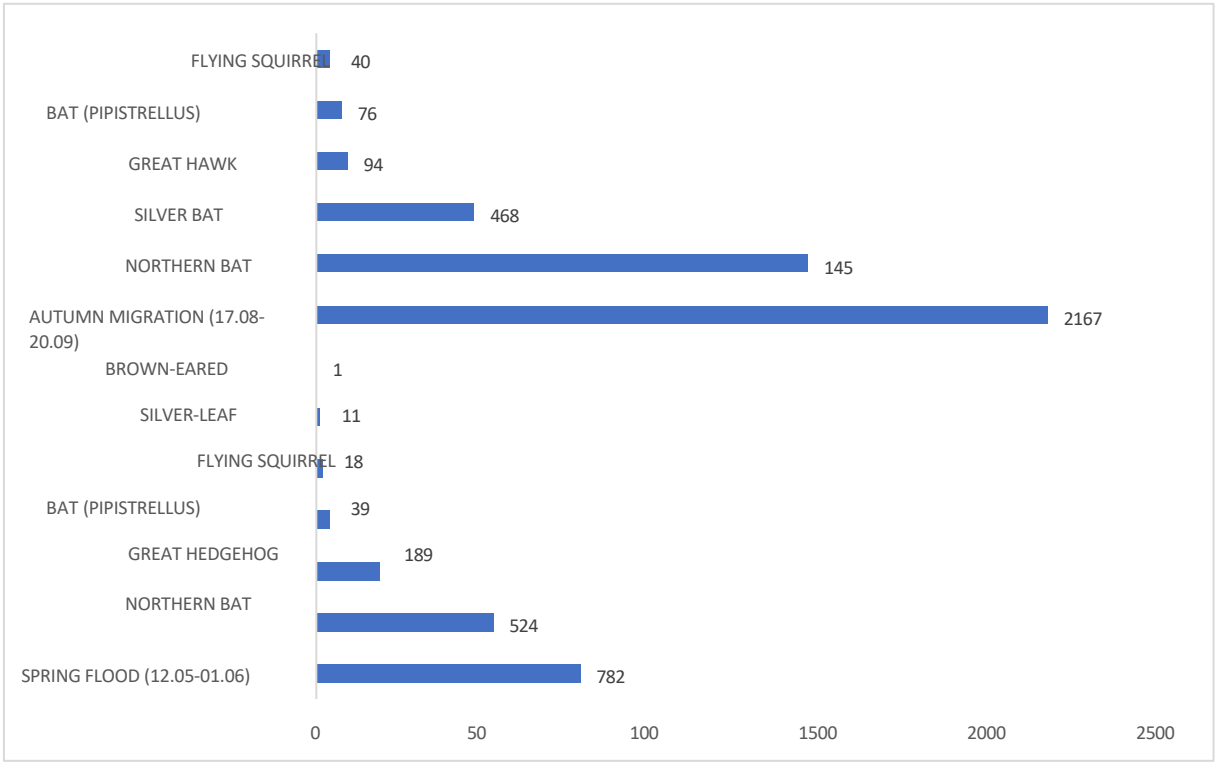


Figure 60. Results of fieldwork on bats in the study area in four different phenophases.

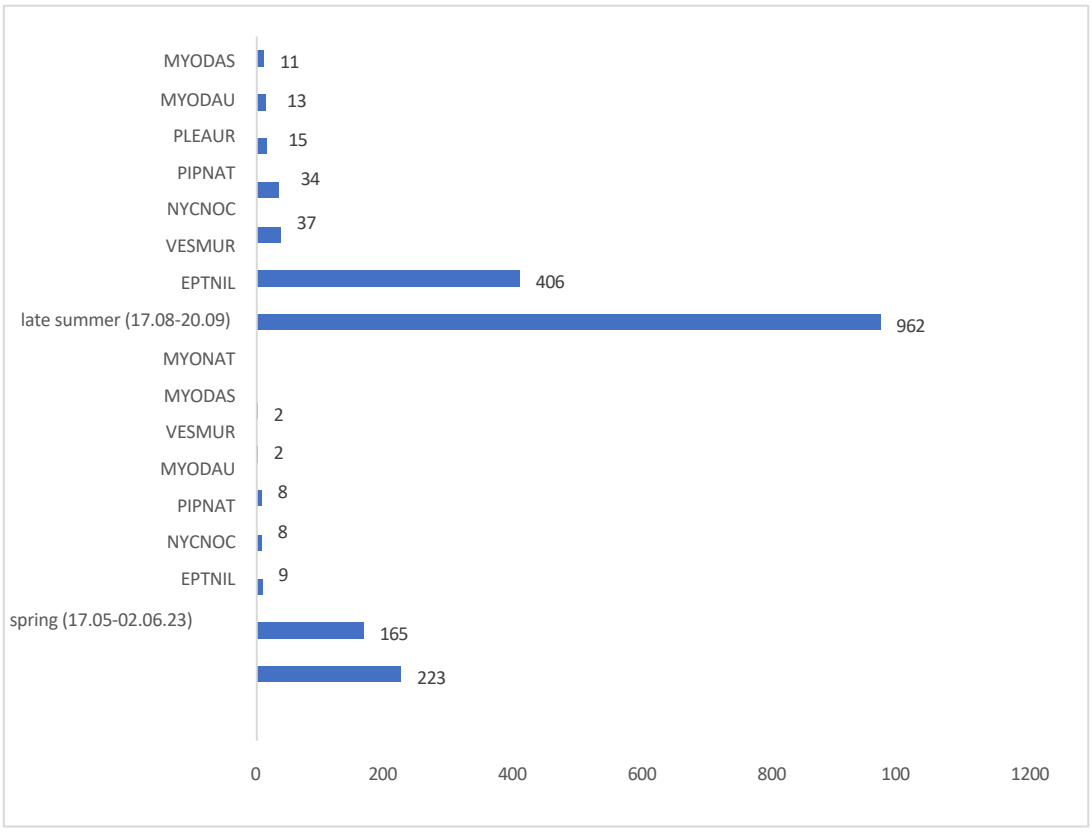


Figure 61. Results of fieldwork on bats in the study area in four different phenophases in the part closest to the river (approx. 70 m from the Väike-Emajõgi River).

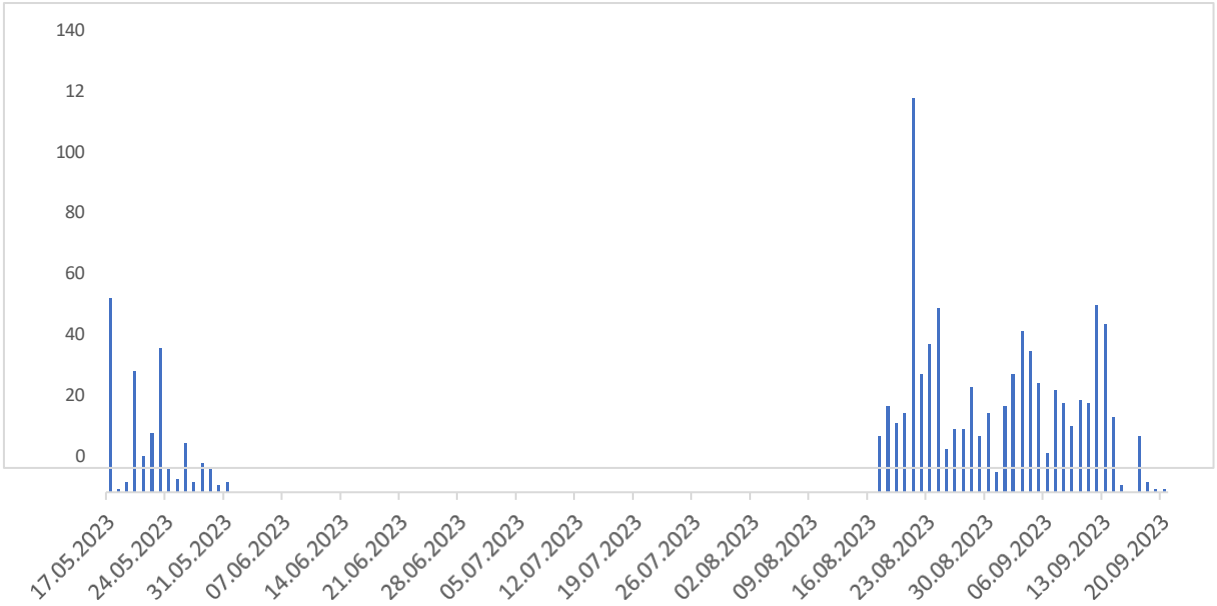


Figure 62. Activity periods of the northern bat (*Eptesicus nilssonii*) in spring and late summer at points 2–6 on the banks of the Väike-Emajõgi River.

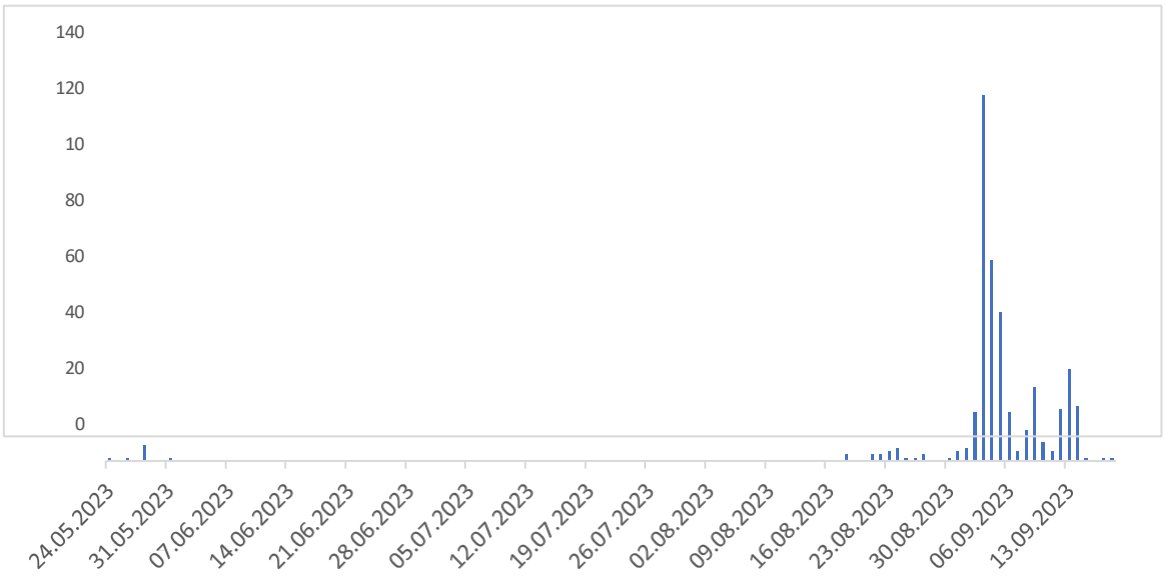


Figure 63. Activity periods of the common pipistrelle (Vespertilio murinus) in spring and late summer on the banks of the Väike-Emajõgi River (points 2–6).

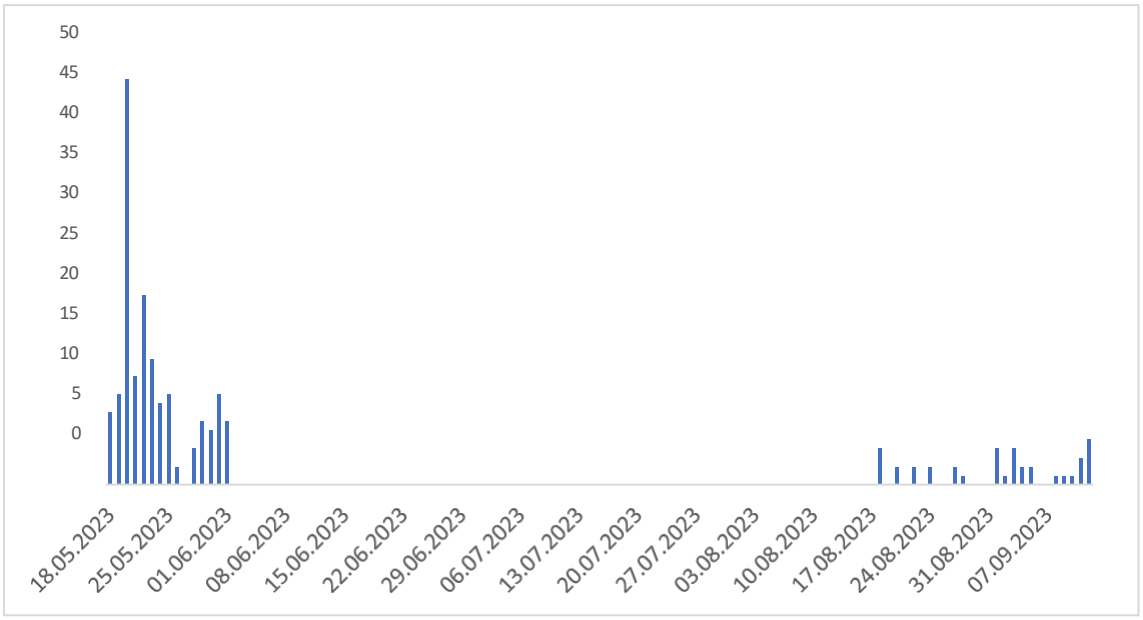


Figure 64. Activity periods of the common noctule (*Nyctalus noctula*) in spring and late summer at points 2–6 on the banks of the Väike-Emajõgi River.

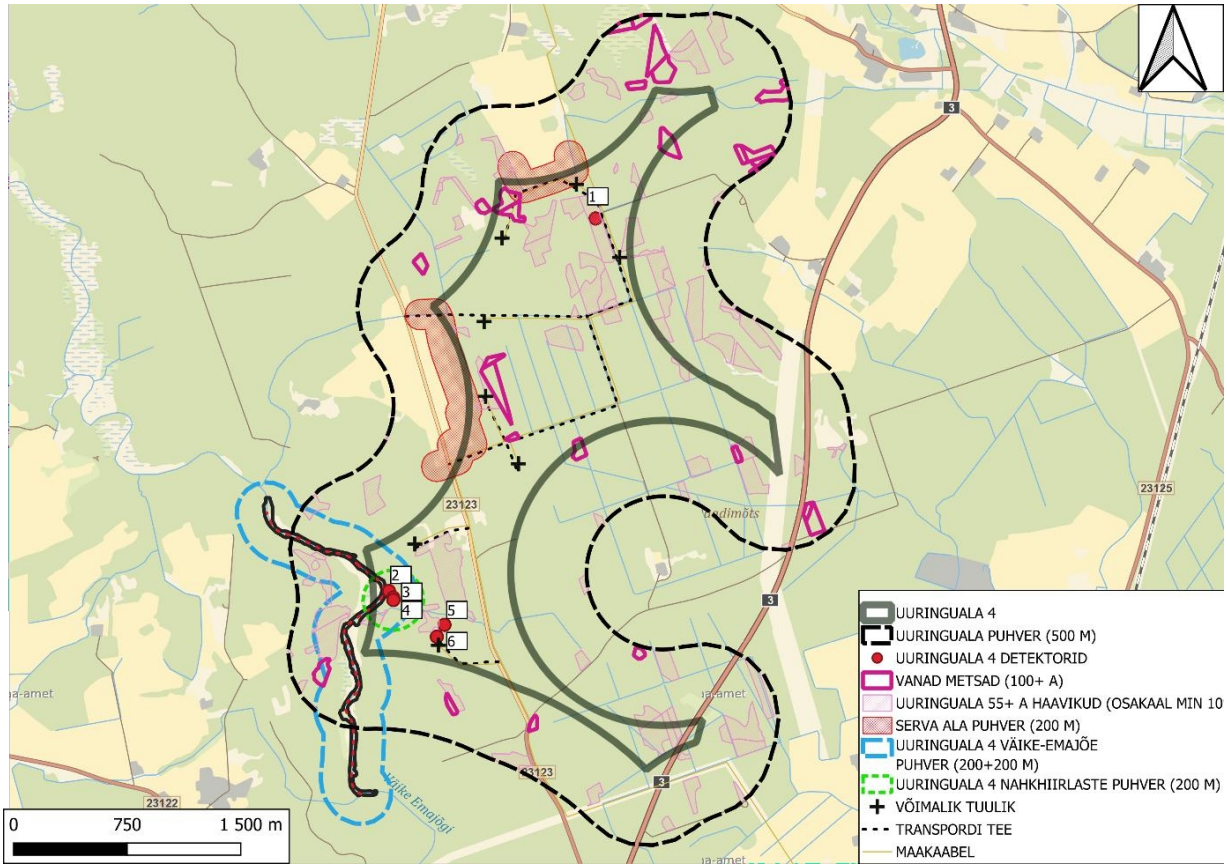


Figure 65. Old (100+ years) forests in the Valga study area 4 – probable habitats and feeding grounds for bats, together with forests where the age of aspen trees is at least 55 years and their share of the forest stand is at least 10%. The southern important feeding and migration area for bats is marked with bright green dots.

2.4 Recommendations for mitigation measures

The following general mitigation measures should be taken into account:

- Prefer locations for wind turbines that are outside areas with old forests (>100 years) and stands with at least 10% aspen trees that are older than 55 years. The habitats important for these bats should be preserved as much as possible and their fragmentation by wind farm infrastructure should be avoided.

Where possible, avoid locating wind turbines in areas that are at least 200 m away from edge areas (areas where the forest clearly transitions into grassland or farmland). If necessary, wind turbines may be installed in a buffer zone, provided that their operation is restricted during the breeding season (1 June to 15 July) and autumn migration period (16 July to 15 September).

- Avoid locating wind turbines within 200 m of small standing water bodies and ditch extensions (firefighting water ponds) in forest landscapes. Also avoid creating new standing water bodies closer than 200 m to wind turbines when establishing a wind farm.

Do not plan wind turbine infrastructure objects (access roads, routes, etc.) in the habitats listed above and use existing roads as much as possible when constructing transport routes.

When installing wind turbines in forest areas, the corresponding cables/lines must be installed as underground cables in order to

reduce forest loss and habitat fragmentation.

When selecting wind turbine locations, take into account existing access roads.

- Avoid logging and clearing of forest stands over 60 years old during the period 01.05-15.09 to avoid the death of bats in their summer roosts.

Mitigation measures by study area:

- In study area 2, the planned wind turbine is located in the northern part of the area, close to a 200 m buffer zone that is a breeding and feeding area for bats. The wind turbine may be built if it is shut down during the active period.
- In study areas 3 and 4, avoid building wind turbines within a minimum distance of 400 m from the Väike-Emajõgi River, which is an important feeding area and migration corridor for bats.
- In study area 3, military objects suitable for bats to shelter in were identified (at points 5-6 at coordinates 57.9338,26.0860 Uniküla missile base facilities), which must be excluded from the development area with a buffer zone of at least 200 m.

All survey areas are forest landscapes where there is an increased risk of bat mortality. The optimal mitigation measure to reduce bat mortality is to stop the wind turbines during the dark period when bats are active (generally from the beginning of May to the end of September). Taking into account the seasonality of bat migration (if migration is seasonal), precipitation and wind speed at which bats fly, it is possible to minimise the loss of wind farm productivity. **In order to avoid significant bat mortality, wind turbines should be stopped during the bats' active period in situations where the wind speed is below 5 m/s, there is no precipitation and the air temperature is above +0 °C.** The effectiveness of mitigation measures based on limiting the operating time of wind turbines has been repeatedly proven in studies. For example, a recently published article points out that location-based mitigation measures have succeeded in reducing the number of bat deaths by 78% ([54]). Based on the results of the study, it is appropriate to suspend wind turbines in the following periods for each area:

- in study area 1, it is important to suspend wind turbines during the breeding season (1 June to 15 July) and migration period (16 July to 15 September), when increased bat activity was observed there;
- in study area 2, a 500 m buffer zone has been designated for the suspension of wind turbines in the northern part of the development area , where wind turbines must be stopped during periods of high bat activity between 1 May and 15.09, half an hour after sunset in the evening and may be restarted half an hour before sunrise in the morning, if the wind speed is <5 m/s, the temperature is ≥0 degrees and there is no precipitation (0 mm);
- In study area 3, bat activity was consistently high across the entire area, which is why wind turbines must be stopped during spring migration (1 May to 31 May) and the breeding season (1 June to 15 July). where, in addition, a breeding colony was likely located near monitoring point 5 in the south-eastern area, and during autumn migration (16.07-15.09);
- In the study area 4, in areas up to 500 m from the Väike-Emajõgi River, wind turbines must be stopped during spring migration (1 May–31 May), the breeding season (1 June–14 July) and autumn migration (15 July–15 September). Restrictions apply in the rest of the area during the breeding season (1 June–14 July).

To reduce the risk of mortality, instead of direct time restrictions, it is possible to use, for example, Wildlife Acoustics' SMART System, which operates the wind turbine in real time according to bat activity and allows the wind turbine to be stopped if necessary. The previously recommended time restrictions may be replaced by operating restrictions based on a corresponding monitoring system, if this is technically and economically feasible.

As it was not possible to carry out monitoring in all bat habitats (forests with trees aged 55+ or 100+), it is important to stop the wind turbines during the period of high bat activity in order to avoid significant bat mortality.

[54] Rnjak, Dina, Magdalena Janeš, Josip Križan, and Oleg Antonić. 2023. "Reducing bat mortality at wind farms using site-specific mitigation measures: a case study in the Mediterranean region, Croatia." Mammalia, February. https://doi.org/10.1515/mammalia-2022-0100

during periods of activity in situations where wind speeds are below 5 m/s, there is no precipitation and the air temperature is above +0 °C. The measure requires the installation of bat detection systems on wind turbines.

Follow-up proposal:

- to clarify the risk of bat mortality and the avoidance rate of wind turbines (spring migration 1.05-31.05; breeding season 1.06-14.07; autumn migration 1.08-15.09);
    - During follow-up monitoring, bats should be recorded at the working radius of wind turbine rotors using automatic bat recorders. Based on the data, it is possible to optimise the operating time restrictions of wind turbines and, if possible, reduce the time during which wind turbines are not allowed to start up or, if necessary, increase the restriction to avoid significant adverse environmental impacts;
    - as the flight altitude of bats is mostly species-specific, it is also necessary to clarify the activity of bats near tree crowns and the ground, as well as at different distances from wind turbines (e.g. up to 100 m, 500 m, 1000 m), taking into account weather conditions (wind direction, temperature, precipitation), which will allow for further analysis of the possible effects of wind turbines on bats
    - if possible, use trained dogs to identify dead bats under wind turbines.

Add observation metadata

Table 11. Locations and times of observations of bird use of airspace, together with weather conditions in the study area 1. The coordinates of the observation points are given in Table 15 and their locations in Figure 9.

Date	Σh	Point 9	Point 8	Point 23	Point 32	precipitation	cloud cover	temperature	wind speed (m/s); direction
03.04.2023	8	13:30:00 16:30	8:00 11:00		11:15 13:15	0	cloudy	-	3.8; northeast
07.04.2023	3	13:20 16:20				0	clear	12	4.2; east
16.04.23	6.02	7:58 11:00	11:14 14:14			0	cloudy	4	1.7; east
22.04.23	6		8:00 11:00	11:10 14:10		0	clear	9.7	2.8; west
3.05.23	6.39	10:00 12:22	7:43 9:43	15:21 17:38		0	clear	7.7	2.3; south-west
11.05.23	2.26	09:14 11:40				0	cloudy with clear spells	17	0.9; southeast
19.05.23	5		14:47 16:47	17:00 20:00		0	Partly cloudy	16	2.4; north-west
1.06.23	3		8:30 11:30			0	Partly cloudy	14	4.5; north-west
10.07.23	8.79	4:51-7:30	8:00 11:00	4:45-7:45		0	Partly cloudy	13	1.6; north
13.07.23	6	4:56-7:56	5:15 8:15			0	clear	9	0.4; northeast
10.09.23	3		9:40 12:40			0	Partly cloudy	15	0.9; southeast
29.09.23	2		17:20 18:20			0	Partly cloudy	21	1.7; southwest
1.10.23	8.7	9:10 12:10	9:20 12:20	9:30 12:00		0	clear	12	2.5; south-west
10.10.23	6	11:00 14:00	10:45 13:45			0	clear	3	1.8; south-west
17.10.23	9.2	11:10 14:30	08:00 11:00		8:00 11:00	0	cloudy	2	2.3; west
9.11.23	7	13:40 16:40	13:22 16:22	17:00 18:00		0	cloudy	6	1.9; south-west
22.11.23	2		12:40 13:40		12:50 13:50	0	Partly cloudy	-4	2; southwest

Table 12. Locations and times of observations of bird use of airspace, together with weather conditions in study area 2. The coordinates of the observation points are given in Table 15 and their locations in Figure 18.

Date	Σh	Point 7	Point 19	Point 6	Point 619	Point 197	precipitation d	cloud cover	temp	wind speed (m/s); direction
07.04.203	4	8:00 11:00		11:10 12:10			0	clear	4	2.5; east
09.04.203	3	8:42 11:42								
6 May	7.23	08:00 0-10:23	11:35 0-14:35	15:07 0-17:07			0	clear	0.7	1.9;lood e
10.05.23	6.41	14:54 15:35	11:48 14:48	08:38 11:38			0	clear	13	1.0; south-west
19.05.23	9	5:14 8:14	11:30 14:30	8:24 11:24			0	clear	1	1.3; north-west
26.05.23	6		10:00 13:00		06:45 -9:45		0	clear	7	0.7; southeast
13.06.23	6		05:11 8:11	8:30 11:30			0	clear	9	0.6; east
11.07.23	6.07			12:13 15:20	09:00 - 12:00		0	clear	17	1; east
13.07.23	8.22	9:15 11:37	12:05 15:16	8:41 11:41			0	clear	19	0.7; southeast
16.09.23	2	16:20 18:20					0	clear	19	3; south-west
29.09.23	2	15:00 17:00					0	half cloud	23	3.6; southwest
10.10.23	6	7:29 10:29			7:45 10:45		0	clear	-	1; south-west
17.10.23	3.3	14:00 15:00				11:25 13:55	0	half cloud	6	2.7; west
23.10.23	6	8:30 11:30			8:40 11:40		0	cloudy	5	2; north
3.11.23	9	7:45 10:45			8:09 11:09	7:47 10:47	0	half cloud	3	2.5; southeast
17.11.23	6	12:40 15:40				12:30 15:30	0	cloudy	-3	2.3; southeast
22.11.23	4	8:11 10:11			8:45 10:45		0	cloudy	-8	0.9; north-west

Table 13. Locations and times of observations of bird use of airspace, together with weather conditions in the study area 3. The coordinates of the observation points are given in Table 15 and their locations are shown in Figure 23.

Date	Σh	Point 5	Point 22	Point 4	Point 224	Point 225	precipitation d	cloud cover	temp	wind speed (m/s); direction
09.04.203	3	12:20 15:					0	clear	10	4; northeast
23.04.23	8.42	12:00 15:00	15:10 17:40	8:00-11:12			0	clear	4.3	1.1; south
10.05.23	6	15:50 18:50	19:00-22:00				0	clear	18	1.7; north-west
11.05.23	9	16:30 19:30	19:40 22:40	12:15 15:15			0	clear	19	2.5; north-west
17.05.23	9.21	05:46 8:46	9:56 12:56	13:06 16:27			0	cloudy	15	5.4; south-west
10.07.203	3					08:00 - 11:00	0	clear	14	2.3; northeast
11.07.23	9		5:04 8:04	12:00 15:00	8:40 11:40		0	clear	7	0.8; northeast
12.07.23	6	11:45 14:45				12:22 - 15:22	0	clear	20	1.8; southeast
18.08.23	2.85			10:50 13:35			0.3	cloudy	18	3.3; northeast
29.09.23	1.99			12:55 14:54			0	clear		3.7; south-west
1.10.23	9	13:30 16:30	13:20 16:20	13:40 16:40			0	half cloud s	15	5.2; west
15.10.23	6		11:30 14:30	11:40 14:40			0.1	light rain	9	6; south-west
25.10.23	6		11:50 14:50	8:30-11:30			0	cloudy	-0.7	2; east
3.11.23	3					14:54 - 17:54	0	clear	10	4.7; southeast
11.11.23	6			11:09 14:09		8:00 11:00	0.1	light rain	4	1.5; southeast
15.11.23	4.1		9:00 11:00	11:10 13:20			0	cloudy	1	1.3; northeast
22.11.23	1					11:30 - 12:30	0	cloudy	-5	1.4; west

Table 14. Locations and times of observations of bird use of airspace, together with weather conditions in study area 4. The coordinates of the observation points are given in Table 15 and their locations are shown in Figure 35.

Date	Σh	Point 1	Point 3	Point 21	Point 2021	Point 20	Point 320	precipitation d	cloud cover	temp	wind speed (m/s); direction
09.04.203	3		16:00 19:00					0	clear	5	0.6; north

12.05.23	3		6:58 10:00					0	clear	8	0.3; southeast
13.05.23	8.46	05:21 -8:35	08:45 11:50		12:13 - 14:47			0	clear	5	0.7; south-west
22.05.23	5.15			13:20 - 15:35			10:05 - 13:05	0	clear	16	1.1; north-west
26.05.23	9	9:50 12:50			16:20 - 19:20	13:10 - 16:10		0	clear	14	1.9; south-west
27.05.23	3			14:30 - 17:30				0	half cloud s	14	4.4; north-west
28.05.23	4	8:00 10:00				5:50 7:50		0	clear	2	0.6; west
18.06.23	2			8:00 11:00				0	cloudy	20	3.2; northeast
12.07.23	12	8:28 11:28		5:12 8:12	8:28 11:28		5:11 8:11	0	clear	15	0.4; northeast
17.08.23	4	10:00 - 12:00				14:00 - 16:00		0	clear	21	1.4; north-west
16.09.23	3					11:00 - 14:00		0	clear	15	2.3; south-west
29.09.203	5	9:36 10:36	10:00 13:00			10:58 - 11:58		0	clear	15	2.3; south-west
15.10.23	9.72	07:40 - 11:12	7:40 10:40		7:55 10:55			0	cloudy	7	4.7; south-west
23.10.23	6	12:15 - 15:15	12:20 15:20					0	cloudy	5	2.2; north-west
3.11.23	9	11:28 - 14:28	11:24 14:24		11:15 - 14:15			0	clear	5	3.1; southeast
17.11.23	6	10:20 - 12:20	9:16 12:16		8:13 10:13			0	cloudy	-2	3.2; southeast

Table 15. Coordinates of observation points for bird airspace use (36+18+36 h) in study areas 1-4.

id	N	E
1	57.878169128728125	26.128821492719695
3	57.889095955402986	26.124492590450846
4	57.95086133818655	26.061534085833777
5	57.93365607655345	26.084897379839255
6	57.944356521462815	26.126460218594026
7	57.940510877309485	26.144884683705435
8	57.986486119329975	26.144389301197673
9	57.9801965899821	26.12454825868879
19	57.937490729914735	26.13395067871809
20	57.89575783071029	26.141350358778336
21	57.90473961346686	26.147025593877043

22	57.93753775515778	26.073212144755633
23	57.99186400855945	26.11335914574465
32	57.99659108011592	26.10593276404944
197	57.951179336071114	26.14224486987477
224	57.94515830789364	26.070745263244422
225	57.9410210582442	26.080640482791793
320	57.89618500535561	26.126849903035698
619	57.93851357592214	26.115374660181217
2021	57.89622248088817	26.151805

Table 16. Monitoring points for cocks in study areas 1–4.

ID	N	E
1	57.9994727434	26.150083849
2	57.9909788838	26.1427306829
3	57.9850785385	26.1463598437
4	57.98847983	26.1245774693
5	57.9941320229	26.1086112992
6	57.9806201243	26
7	57.9540934962	26
8	57.9463301057	26.1186595894
9	57	26.1341100709
10	57.9393028089	26.1143195022
11	57.9331782886	26.1310454453
12	57.933	26.0850158124
13	57.950932927	26.06
14	57.9446176413	26.0860971697
15	57.9384515153	26
16	57.8720597265	26
17	57.8873131572	26.1254654573
18	57.8957859528	26
19	57.9026893152	26.1481908052
20	57.9113923724	26

Table 17. Study area 1: decoy points for woodcock, hazel grouse and black grouse, and nesting bird census points.

id	N	
1	57.99953824428296	26.150066268229
2	58.00049943526545	26.160055898674866
3	57.997442147092315	26.16128936618243
4	57.99581292324308	26.155136545196168
5	57.9955717667598	26.14872113359011
6	57.99126513356169	26.14795888293891
9	57.98511361311546	26.146346980298112
10	57.98852906737694	26.140307182418276
11	57.993124614283545	26.13986534162678
12	57.989007859639145	26.13

13	57.98845625437302	26.124468776157983
15	57.99098922509266	26.117810270387892
16	57.99405252996482	26.108669079336728
19	57.983959116302415	26.123575281179242
20	57.984875417086904	26.132943323082877
21	57.98328051963006	26.114661853237322
22	57.98742765813298	26.11185103789846
23	57.97951735454123	26.124873416845595
24	57.97724446661218	26.11470486494606
25	57.981486626936324	26

Table 18. Study area 2: decoy points for woodcock, hazel grouse and black grouse, and breeding bird census points.

id	N	
1	57.933231060995176	26.143036857546033
2	57.93065911903966	26.14159194152884
3	57.93300556680615	26.137861396297662
4	57.93546432002886	26.13366013984756
5	57.93622658051158	26.128290880708576
6	57.93237244686512	26.130305166811606
7	57.93850255278179	26.134010265426387
8	57.94192742462579	26.134439714651496
9	57.942660538768884	26.14048874336863
10	57.93930923386467	26.124237999885924
11	57.938742617783866	26.118003402626982
12	57.94136797541841	26.1216
13	57.942011541159076	26.12681220507496
14	57.94490325781499	26.124346765928678
15	57.946327169795644	26.118650400077104
16	57.945124798376874	26.13067419278032
17	57.94884595616688	26.12946520550143
18	57.950479720684605	26.1343342698114
19	57.95386742911198	26.138719572116198
20	57.95484361446386	26.13218146018624
21	57.93668559897232	26.145191411566557
22	57.937922846371855	26

Table 19. Study area 3: decoy points for woodcocks, hazel grouse and black grouse, and nesting bird census points.

id	y	x
1	57.93243324976047	26.089044665240003
2	57.927574395330424	26.087396264445935
4	57.92740209895921	26.078926819896694
5	57.92965274941995	26.070529063105173
6	57.9324283666417	26.07934063650943
7	57.93397962247635	26.06654980987272

8	57.93937180387341	26.08268135124874
9	57.93846645196598	26.064012193447464
10	57.93759335149441	26.073563129109
11	57.94635132499075	26.078269829488647
12	57.94434795954458	26.071641465534956
13	57.94295783043022	26.06
14	57.954656959067535	26.07446933137215
15	57.953767123334934	26.064327978762414
16	57.95514825022097	26.06
17	57.95013995812019	26.057259844817462
18	57.946	26.06
19	57.94960866189069	26.07

Table 20. Study area 4: decoy points for woodcocks, hazel grouse and black grouse, and nesting bird census points.

id	y	x
1	57.87096893845015	26.144897604988156
2	57.87345826532946	26.136428272605883
3	57.87655875218752	26.129364080743585
4	57.87604550977272	26.120421706257744
5	57.88072684070116	26.11999149307214
6	57.881639956418766	26.128081399947867
7	57.886586185893805	26.125741998333414
8	57.884695638667814	26.133828924216807
9	57.88886591743122	26.133800954311493
10	57.89042093140377	26.14435679759729
11	57.89198093354717	26.153851399475528
12	57.8890477416961	26.156094816765812
13	57.88950017013407	26.150313264065183
14	57.89511560097766	26.141705039930404
15	57.89366731484364	26.132459400718364
16	57.89816610297112	26.12755328732105
17	57.89863736207655	26.135320606316963
18	57.89938822962134	26.144699037957153
19	57.90454136200548	26.141126819030845
20	57.90383391031358	26.132073195656062
21	57.90736595398967	26.147893588735098
22	57.903503845464364	26.14788070697727
23	57.90694078117144	26.15334454719341
24	57.90982085473198	26.153240996812706
25	57.89357297999467	26.147964998809293