Summary of the Flying Squirrel LIFE project's effects on Forest Ecosystem Function

31.3.2025

Eija Hurme (Metsähallitus Parks & Wildlife Finland, MHPWF), Jani Pellikka (Natural Resources Institute Finland, LUKE) & Tõnu Laasi (Estonian Environmental Board, EEB)

Flying Squirrel LIFE, LIFE17 NAT/FI/000469: Action D3 Ecosystem function restoration

D3 Deliverable: Summary of the Project's Effects on Forest Ecosystem Function

Disclaimer: The project has received funding from the LIFE Programme of the European Union. The material reflects the views by the authors, and the European Commission or the CINEA is not responsible for any use that may be made of the information it contains.

Content

Summary

The highest threat for an endangered flying squirrel (*Pteromys volans* L.) is habitat loss. The ecosystem effects in the Flying Squirrel LIFE project were evaluated using a flying squirrel as an example of a forest dwelling species that needs a network of mature spruce-dominated forests. Flying squirrels prefer mature forests, which typically have high monetary value, so conflicts of interest are inevitable. In addition, as it takes many decades for forests to reach maturity, decisions made today have long-term effects on space and time.

In Finland, the flying squirrel is vulnerable and its range cover about two thirds of the country, whereas in Estonia, it is critically endangered and exist only in a corner of the North-East Estonia. Thus, studies were designed specifically for both situations. In Finland, it was possible to study future scenarios with example landscapes for how to tackle trade-offs between timber production and forest management, contributing suitable habitats for the flying squirrel. In Estonia, it was essential to understand the availability of all potential habitats and forested moving connections between them so that the tiny flying squirrel population can be kept alive.

In Finland, a cost-efficiency of maintaining and increasing suitable habitats for the flying squirrel was analyzed using a set of three example landscapes with different future scenarios. The results indicated that some forest management scenarios were more cost-efficient than others in maintaining habitat suitability and connectivity for the flying squirrel. Adjusted cutting removals, due to other restrictions such as recreation, were found to be more cost-efficient in creating suitable habitats. The study shows that it is possible to design and study adaptive forest management strategies that consider both ecological and economic factors. However, it often is challenging.

In Estonia, a predictive habitat mapping study aimed at identifying, evaluating and mapping both existing and potential habitats (such as younger age classes) and forested connections between them using various methods. The primary objective of the study was to enhance understanding of the habitat requirements of flying squirrel by integrating observational data with detailed environmental information to develop a comprehensive predictive habitat network model.

A draft for a qualitative barometer based on an expert group's reports of the state of the flying squirrel was also developed. Continuity of exchange of knowledge between Finland and Estonia could be maintained after the Flying Squirrel LIFE project, but a funding seems essential for it. Possibilities of using volunteers in gathering monitoring data could be investigated further: raising environmental awareness and participation of people could serve both data collection and human welfare.

To conclude, it is evident that forest use is the most important factor affecting the availability of suitable habitats for the flying squirrel at large scales, both spatial and temporal. This underlines the need for finding sustainable forest management strategies. In that work, various predictive modelling techniques can be helpful. Flying squirrel conservation in the future also calls for continuous exchange of knowledge between experts and monitoring the efficiency of conservation practices in both countries.

Introduction

The ecosystem effects were evaluated using a flying squirrel as an example of a forest dwelling species that needs a network of mature spruce-dominated forests. The aim of Action D3 in the Flying Squirrel LIFE project was to summarize the effects of the project to ecosystem function addressing both Finland and Estonia. As the coverage of project sites in hectares was moderate compared with the flying squirrel (*Pteromys volans* L.) range in Finland and Estonia, wider perspectives were used instead.

The flying squirrel is strictly protected in both Estonia and Finland, and its highest threat is habitat loss underlying the importance of sustainable forest management. In Estonia, the flying squirrel is critically endangered, and its conservation is managed by conservation authorities. The species is vulnerable in Finland, where flying squirrels mostly live outside protected areas. Flying squirrels prefer mature forests, where essential resources such as safe nesting sites, shelter and food are often found. Mature forests typically have high monetary value, so conflicts of interest are inevitable. The responsibility of taking the species into account in Finland is on a landowner or her/his representative: consideration of the flying squirrel in managed forests is done by following official guidelines but designed case by case at forests stands in question.

Future perspective was used because management practices at focal forest stands will in time cumulate to large scale effects. In addition, as it takes many decades for forests to reach maturity, decisions made today have long-term effects. For example, as flying squirrels prefer cavities in large aspens as safe nesting sites, growth of an aspen large enough may take event 80 years in Finland. As an arboreal rodent it also needs forested areas for moving between suitable habitats. Flying squirrels effectively move within forests: every individual has many nesting sites in use, and some may utilize feeding areas within some distance from a nest. In addition, young individuals need to find their own home ranges and find a mate. Therefore, maintaining availability of suitable habitats and moving connections between them in the long-term needs large-scale planning at both spatial and temporal scale.

There were differences in how the studies were designed for Finland and Estonia, mostly due to the different structures of landownership and the size of the flying squirrel range affecting forest use. In Estonia, the flying squirrel range cover only a small part of the North-East Estonia, whereas in Finland, it covers about two thirds of the country. **In Finland**, a cost-efficiency of maintaining and increasing suitable habitats was analyzed using a set of three example landscapes with different future scenarios. **In Estonia**, availability of suitable habitats was estimated by using predictive habitat network analyses. In addition, **a draft of an idea for a qualitative barometer** was designed together to serve as a novel approach in evaluating and planning effective conservation strategies in both countries by including expert knowledge in the process.

This paper combines information from two demonstrations for estimating habitat availability carried out in Finland and Estonia during the Flying Squirrel LIFE project (08/2018-03/2025). It seems that a combination of habitat quality enhancement and landscape connectivity can be illustrated using predictive analyses as a tool, which can be applied for effective conservation of flying squirrel habitats and forest planning processes. It also presents a draft of a qualitative barometer approach that means possibilities to apply wide expert knowledge and discussions to understanding the flying squirrel situation and effects of underlying factors. The barometer could be further developed as it could partly help to find better conservation practices in the future. Perspectives presented in this paper can be used in improving conservation practices.

Referred studies are described in detail in specific project publications, which are in the list of References at the end of this document and available in project's website (https://www.metsa.fi/projekti/liito-orava-life/liito-orava-lifen-hankejulkaisut/).

Future scenarios in Finland

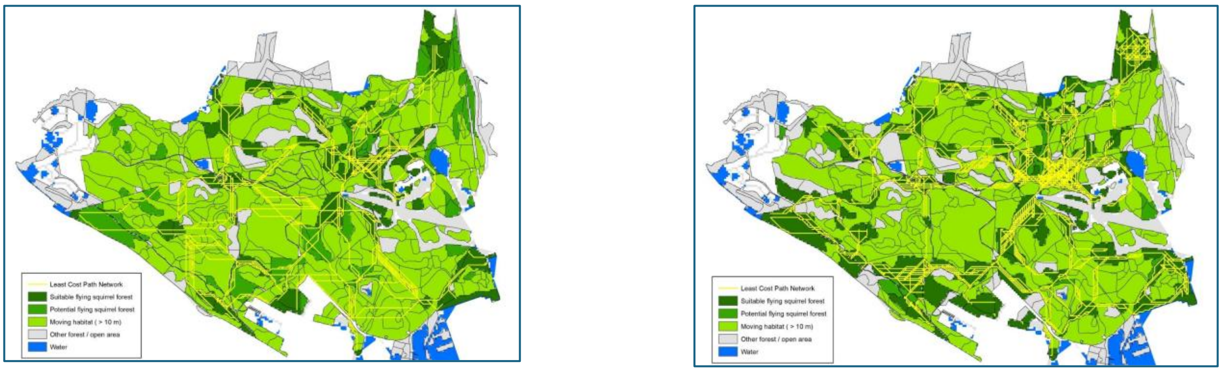
The analysis made in Finland focused on developing and evaluating forest management strategies that balance timber production with the conservation of habitats for the flying squirrel (Ahtikoski et al. 2023, Ahtikoski et al. 2024). The primary goal was to create cost-efficient forest management scenarios that protect and enhance habitats for the flying squirrel in three demonstration landscapes.

The first landscape Laajavuori (550 hectares, Ahtikoski et al. 2023a, Picture 1) represented municipal recreational forest area located within a city of approximately 100 000 inhabitants. The second landscape Syrjävaara (4299 hectares, Ahtikoski et al. 2023b), consisted of mainly of privately-owned commercial forests. The third landscape, Sipilänperä (2057 hectares, Ahtikoski et al. 2023c) was partly of state-owned and partly private forests. Site types varied from barren to nutrient rich with spruce or pine as the main tree species.

Landscape-level modelling of the habitat suitability for the flying squirrel (predictive models built in action A3: LUKE 2023, Juutinen & Pellikka 2024) with analyses for habitat connectivity (Least Cost Path) were combined with stand-level simulations to demonstrate how different management regimes maintain and generate suitable habitats for the flying squirrel, and how they affect timber revenues. Alternative forest management methods were simulated using a Motti simulator that includes predictions for forest growth, and suitable habitats for the flying squirrel were estimated using a predictive habitat model (built in Action A3, Flying Squirrel LIFE). Several indexes were used to describe suitability of habitat in forest parcels, for example, over 50% of spruce at least 60 years, with deciduous component over 1%. In addition, as FS occurrence is known to be linked to habitat availability in the neighborhood, such as the amount of habitat and forested connections between them, connections to other suitable habitats were estimated using a least cost path analysis.

The results indicated that some forest management scenarios were more cost-efficient than others in maintaining habitat suitability and connectivity for the flying squirrel. Adjusted cutting removals, due to restrictions other than flying squirrel habitat-related (mainly recreation), were found to be more cost-efficient in creating suitable habitats for the flying squirrel. One may conclude that effective conservation of flying squirrel habitats requires a combination of habitat quality enhancement and landscape connectivity. The study highlights the need for adaptive forest management strategies that consider both ecological and economic factors.

a) **b)**

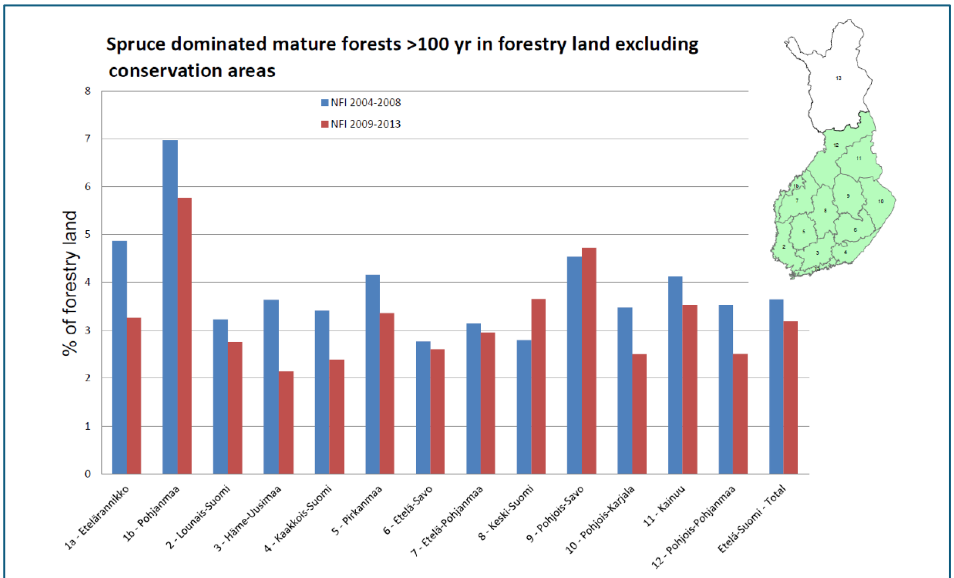


Picture 1. Illustration of the change in habitat potential at the start (a) and after 30 years (b) in the Laajavuori site in one of the management scenarios (Ahtikoski et al. 2024).

Future potential of spruce-dominated forests in Finland

As an additional task, a rough potential of spruce-dominated forests in Finland was estimated in the Flying Squirrel LIFE using a National Forest Inventory (NFI) data that is regularly collected and analyzed by the Natural Resources Institute Finland (LUKE). Although the category of spruce-dominated forests is very broad, it includes those forests which would be suitable habitats for the flying squirrel. This means spruce-dominated forests with a deciduous mixture. Unfortunately, aspen *Populus tremula* is not recognized in detail in NFI.

In 2017, the recent change in coverage of over 100 years old spruce-dominated forests in Finland was illustrated in a project proposal for the Flying Squirrel LIFE by LUKE (Picture 2). Comparison of coverage of the forestry land (%) without conservation areas (and excluding Lappi and Ahvenanmaa regions where the species is not seen) based on two NFI data sets, years 2004-2008 and 2009-2013, shows a decrease in time in 12 of 13 regions. This illustration reflects the use of older spruce-dominated forests in time and may also show an underlying general pattern behind the continuous decline in the flying squirrel trend in Finland - that is, habitat loss.



Area delineations 1-13 represent Finnish Forest Centre’s divisions in Finland. Coverage of spruce-dominated mature forests in % of forestry land is calculated and illustrated by LUKE (Research Institute of Natural Resources Finland)

Picture 2. Illustration of spruce-dominated mature forests (>100 years old) in forestry land during 2004-2008 (blue) and 2009-2013 (red) as an annex for a Flying Squirrel LIFE project proposal 2017 by LUKE. National Forest Inventory (NFI) data is used as a data source, and coverage as a % of forestry land is shown for regions (conservation areas, Lapland and Ahvenanmaa are excluded).

Now we can roughly illustrate the future potential of spruce-dominated forests by looking at age classes across Finland based on the updated NFI data. Using NFI 12 data covering years 2014-2018 (web service: vmilapa.luke.fi), we can make a calculation of forest areas including wasteland in Finland on the flying squirrel range (excluding Lappi and Ahvenanmaa regions). Yet, the NFI 13 data covering the years 2019-2023 is not open, so we cannot cover the project’s activity period.

In Table 1, the age classes are listed starting from 61 years old forests. When spruce-dominated forests at the age 60-100 years now get older, a part of them will include characteristics typical for flying squirrel habitats. In addition, coverage of both deciduous forests and spruce-dominated is larger in younger age classes of 61-100 years than in older age classes (age 101- years). These observations may lead to a rough estimate that in the future, there exist potential forests which could fill characteristics for new flying squirrel habitats.

However, it is good to keep in mind that a national summary does not show the spatial configuration of the forests, so true availability of potential forests for flying squirrels cannot be estimated. In addition, forests reaching the age of about 80 years and more start to face the final felling stage in forestry: their management is thus crucial to ensure that at least some of them are just maintained without management to get aged towards much older age classes. Thus, **the importance of careful forest management is highlighted**. Maintenance of forests in age classes over 100 years, but also careful forestry planning for age classes now being 60-100 years is needed in safeguarding suitable habitats for the flying squirrel in space and time.

Table 1. A rough estimation of forest coverage (km^2) in Finland (excluding Lappi and Ahvenanmaa regions) using an open National Forest Inventory (NFI) data from 2014-2018 by the Natural Resources Institute Finland (vmilapa.luke.fi). Only a summary of forests with tree species dominance is shown as numbers of spruce-dominated forest do not directly refer to suitable habitats for the flying squirrel.

	Age class area based on NFI 12 data (years 2014-2018). Coverage in km^2 on forestry land and wasteland in Finland (Lappi and Ahvenanmaa regions excluded)						
Dominant tree species	**Age 61-80**	**Age 81-100**	**Age 101-120**	**Age 121-140**	**Age 141-160**	**Age 161-**	**Total km^2**
Pine	18490	12055	6595	3136	1464	1420	43161
Spruce	6881	4654	2499	1119	671	1072	16897
Birch	1978	404	96	16	9		2503
Other deciduous	230	68	4				301
Total	27578	17181	9193	4272	2145	2493	62862

Future scenarios in Estonia

Studies related to ecosystem effects in Estonia focused on predictive habitat mapping and habitat connectivity. Both aspects aimed to illustrate the potential habitats of the flying squirrel via forested moving corridors between them. Future scenarios were not studied because flying squirrels' existence in Estonia is critical and the first goal (EEB 2023), and all existing suitable habitats and potential habitats must be recognized to safeguard them.

The predictive habitat mapping study aimed at identifying, evaluating and mapping potential habitats for the flying squirrel in the north-eastern part of Estonia (also applying a model updated in Action A3, Flying Squirrel LIFE). The primary objective of the study was to enhance understanding of the habitat requirements of flying squirrels by integrating observational data with detailed environmental information to develop a comprehensive predictive habitat model.

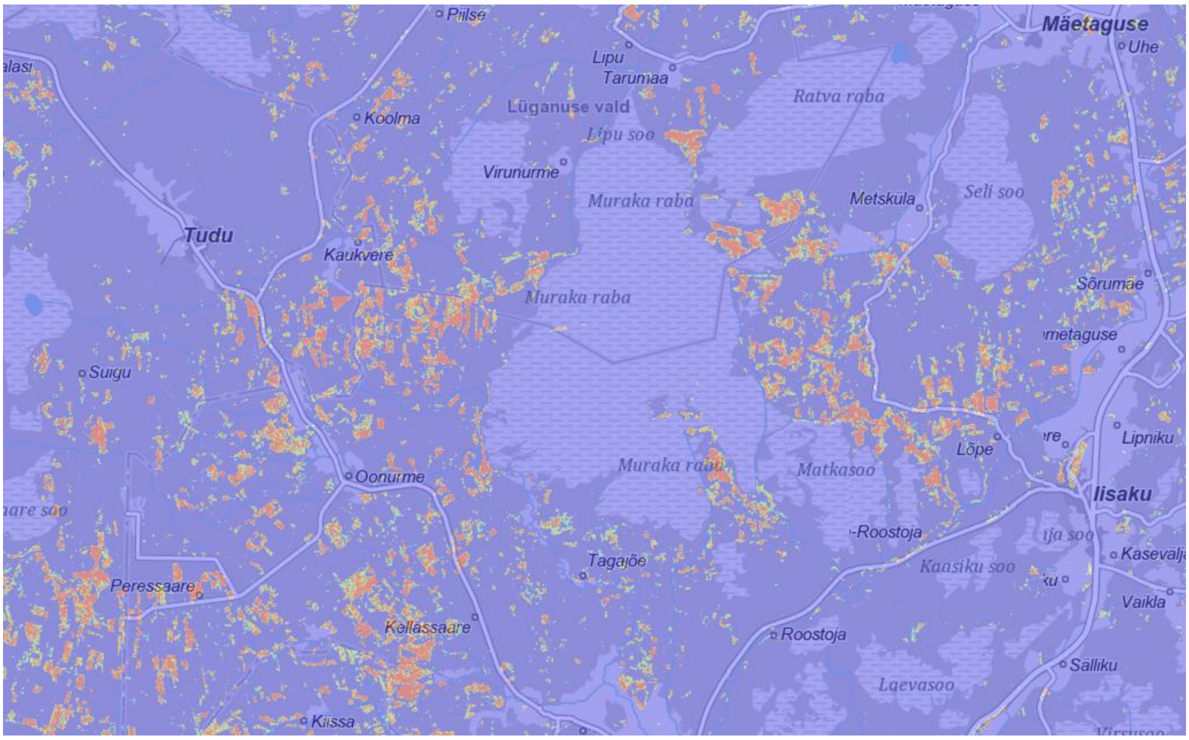
To create this model, researchers utilized multiple environmental datasets, each providing different insights into the characteristics of potential flying squirrel habitats. One key dataset was derived from the Estonian National Forest Register, which contains detailed information on forest properties, including forest age, reserve status, dominant tree species, and other essential attributes. However, because not all forests in Estonia are included in the register, significant gaps existed.

To address these data gaps and enhance habitat characterization, remote sensing technologies were extensively employed. Multispectral satellite imagery from the Sentinel-2 satellite platform, captured in multiple spectral bands, was utilized to distinguish various forest types, age classes and compositions. Additionally, aerial laser scanning data provided detailed structural metrics about forest height, canopy density and connectivity.

The analytical process involved establishing statistical correlations between existing flying squirrel occurrence records and the environmental attributes extracted from these remote sensing datasets. For training purposes, a robust dataset consisting of known flying squirrel nest tree locations (2091 observations collected up to 2022) was used as positive habitat occurrences. Simultaneously, a large number of randomly generated background points (10 000) across the study area provided a representative baseline of general environmental variability.

Several machine learning algorithms including Maxent, Generalized Boosting Models, and CatBoost were applied to analyze the relationships between the environmental variables and flying squirrel occurrences. Each algorithm contributed uniquely by capturing various aspects of habitat preferences and producing predictions on habitat suitability.

The final output was a detailed predictive habitat map, visualized using GIS software, which represented varying degrees of habitat suitability across north-eastern part of Estonia. The accuracy and reliability of the habitat model were validated through field assessments conducted during flying squirrel monitoring (Action A1 in Flying Squirrel LIFE), where habitat suitability predictions were tested against actual forest compartment evaluations.



Picture 3: A sample image of the predictive habitat map (red – suitable; blue – not suitable areas for the flying squirrels).

The habitat connectivity study explored the structural connectivity of flying squirrel habitats in Estonia, where the species inhabits a patchy network of forest areas. These habitat patches are often separated by open areas that the species cannot. Maintaining genetic flow between subpopulations through movement between habitat patches is crucial for the long-term viability of the species, making habitat connectivity a key conservation focus.

Since direct tracking data (e.g., telemetry) is limited in Estonia, connectivity was modeled using the "least-cost path" principle, which assumes that animals prefer energetically efficient routes through suitable forested landscapes. The modeling process relied on predictive habitat maps derived from remote sensing and machine learning, combined with environmental resistance maps that estimate movement difficulty based on forest height and canopy structure.

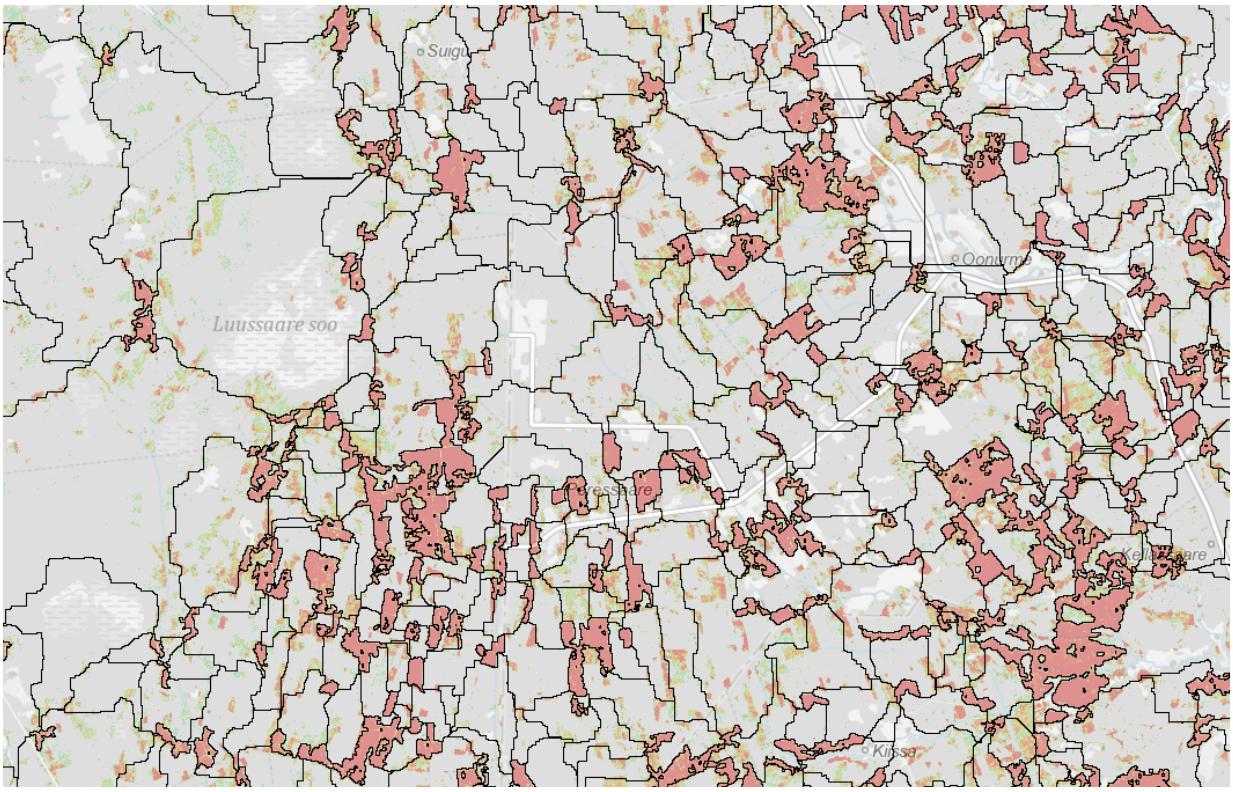
A graph-based model was developed where habitat patches function as nodes and the most cost-effective movement paths between them as edges. Patches were classified based on predicted suitability and minimum area requirements. Patches over 8 ha were considered suitable for breeding, while patches over 3.5 ha were classified as “stepping stones” that may facilitate movement but not necessarily support reproduction.

To determine functional corridors, landscape resistance values were calculated based on canopy height and the presence of open areas. Raster values indicated either accessible or inaccessible forest. Corridors were then mapped according to the cumulative resistance across a given path. Various thresholds were tested to define what constitutes a "connected unit," or a cluster of patches functionally linked by traversable corridors.

Key findings

- The total modeled flying squirrel habitat area was approximately 16 348 ha.
- Of this, 12 016 ha consisted of large patches (≥8 ha), while 4331 ha were identified as stepping stones (≥3.5 ha).
- Under defined movement constraints, the landscape was divided into 796 discrete connectivity units.
- Only 54 of these units were confirmed to be inhabited (based on nest tree data from 2021–2023), containing 5005 ha of habitat.
- 276 uninhabited units comprised 8721 ha, indicating **potential** but currently unused habitat.
- Habitat patches were frequently isolated due to clear-cuts and other landscape disruptions, forcing squirrels to use indirect, energetically costly routes.

This study in Estonia shows that it is possible to estimate the existing habitat network in detail. This analysis can serve as a tool in developing conservation practices in Estonia, but also in planning forest use in the region. For the flying squirrel that is critically endangered, it is essential first to maintain all potentially available habitats for the species and ensure ways to reach habitat patches via forested moving connections.

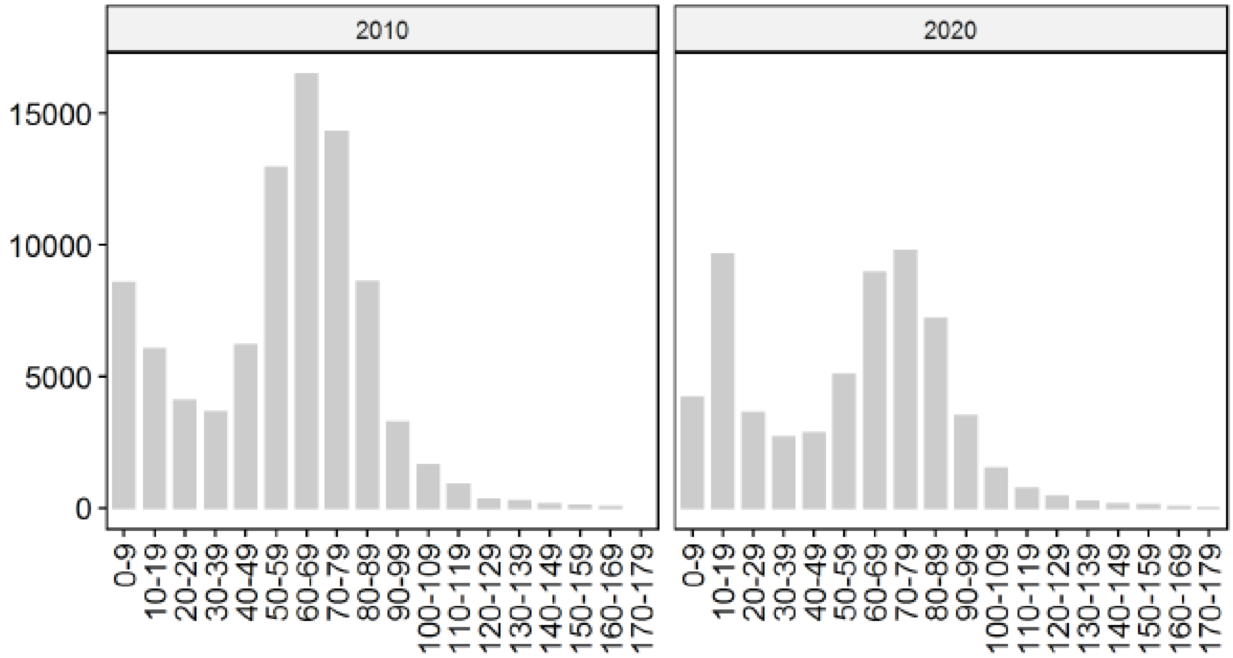


Picture 4: A sample image of the result of habitat connectivity study.

In addition to the predictive habitat mapping and connectivity analysis, **Estonian forest registry data** were also examined to assess long-term trends in the availability of suitable habitats for the flying squirrel. The analysis focused on forest compartments containing aspen in Ida- and Lääne-Virumaa. The results revealed a significant decline in the area of older aspen-containing forest compartments between 2010 and 2020, particularly in age classes of 50-90 years. These older forests provide essential nesting trees and structural continuity for movement and are ecologically the most suitable for the flying squirrel.

Currently, only about 3% of Virumaa's forested area still meets the species' habitat criteria - stands over 80 years old with at least 5% aspen. While some younger forest age classes have increased slightly, this growth does not compensate for the rapid loss of older forests, and regeneration is too slow to restore habitat functionality within the necessary timeframe.

In the Alutaguse forest massif alone, approximately 10–20 km^2 of mature aspen and aspen-dominated mixed forests (around 1,000 forest compartments) are clear cut each year – these are forests that in a few decades could have developed into highly suitable habitats for the flying squirrel. Over the past ten years, roughly one-third of mature aspen stands have cut from Ida- and Lääne-Virumaa.



Picture 5: Results of the forest-register analysis of aspen-containing forests with stand age classes and areas.

These findings emphasize that logging pressure is not only reducing the amount of current habitat but also systematically eliminating forests that would have served as critical future habitats for the species. This highlights the urgent need for conservation policies that prioritize both the immediate protection of existing suitable habitats and the strategic safeguarding of regenerating forest areas with high potential value for flying squirrel conservation.

In the absence of meaningful protective measures, the remaining suitable habitats may in the near future be confined to protected areas and unmanaged private forests only.

Qualitative barometer

A qualitative barometer was planned to be developed during the Flying Squirrel LIFE project. The original idea was to use data from project actions A1 (flying squirrel inventory data in Finland and Estonia), D1 (monitoring data from project sites), and specific project performance indicators gathered during 2019-2024. In addition, expert knowledge on biodiversity related variables was planned to be used, as well as available data from national flying squirrel surveys in Finland.

Unfortunately, barometer development did not start at the beginning of the project as expected. This was partly because people behind the idea had moved to other tasks and partly due to hectic project years, but also due to delay in management of project actions so that their monitoring started later. However, after learning flying squirrel related issues in more detail during the project period of six years, a draft of a barometer was possible to design at the end of the project.

A qualitative barometer could be developed as a systematic evaluation process related to the flying squirrel situation. It could be an expert group in co-operation with conservation authorities that analyses and discusses existing data, evaluates risks, and regularly formulates educated estimates of the flying squirrel situation. The group and its educated reports could assist decision making when improving conservation practices.

The input would be quantitative data such as knowledge of flying squirrel occurrence at monitoring sites, drafts of the population trends, availability of suitable habitats (habitat models, forest data on mature forests and specifically on aspen), and various risks in the environment or practices, for example. The original data could be analyzed and further discussed regularly within an expert group. **The output** would be a report formed as an educated description of an understanding of the flying squirrel situation and existing risks based on the relevant measures. Results of analyses and discussions on the observed patterns would lead to deeper understanding of the situation, recognizing relevant risks, and ideas for better conservation practices to be developed for both countries.

The group could join Finnish and Estonian experts and approaches together. Experiences from the co-operation within the Flying Squirrel LIFE project underline the importance of keeping close contact between countries. Naturally, nation-wise meetings could be held. Working together with Finnish and Estonian professionals from various organizations was found fruitful in the Flying Squirrel LIFE project. AN expert group, gathered around a work of a qualitative barometer, might be one way to continue flying squirrel related exchange of knowledge as the problematics are similar between Finland and Estonia.

Regular meetings with an expert group joined with analyses of several key variables would increase understanding of the ongoing processes in nature. With continuous follow-up and documented conclusions, changes to the prevailing practices could be better justified and further discussions could be started. **Reports** by the expert group could be made at suitable intervals and delivered to e.g. ministries of the environment/climate, conservation authorities or other stakeholders, which need updated information about the flying squirrel situation. Now, there are national evaluations of the endangerment every six years (reporting of the habitats Directive & evaluations for the Red Data Book). This is a relatively long period when a short-lived species is in question; the average age of a flying squirrel is about two years.

The leader of an expert group could be a suitable conservation authority responsible for flying squirrels in either country. Members could at least partly be representatives of stakeholders, which are closely related to flying squirrel issues both in Finland and Estonia. When different perspectives are represented in an expert group, noticing various threats or possibilities in question might be recognized better. Now, there are unfortunate challenges in public organizations partly responsible for flying squirrel issues: the coordination of a group would need special funding for it.

Volunteers in gathering monitoring data

Monitoring data from many years is challenging to get as it is rather laborious work. Ideally, gathering data should be followed by analyzing the data, so that the underlining patterns between the numbers can be recognized.

Regular monitoring of the flying squirrel has already been arranged by conservation authorities. Sample sites are monitored almost annually in Finland, and a part of all known flying squirrel sites are monitored annually in Estonia. During the flying squirrel LIFE project, monitoring data was gathered during five years from project sites, and in Estonia, the known range of the species was possible to cover once. In Finland, further analyses and official estimates of the population trend of flying squirrel are done by the Finnish Environment Institute (SYKE) while in Estonia, Environmental Agency together with Estonian Environmental Board analyze the population estimates.

As resources used by conservation authorities for monitoring are scarce, one way to increase availability of temporal data could be to improve possibilities to encourage volunteers to participate.

In Finland, for example, 4H volunteers are used in gathering data for blueberry harvest predictions, and hunters have gathered data from game species for decades using a triangle survey (LUKE). As flying squirrel droppings are relatively easy to distinguish, volunteers might be used to increase the number of regularly followed forest sites. Besides nature conservation, this activity could be seen as environmental education for people of any age, but also to improve public health when people spend more time outside walking in the forests. There already was an interesting experience on this 04/2024 in Nuuksio National Park, when a "poop hunt" event was organized together with the Flying Squirrel LIFE project. With a short education, small groups of people checked several old regions in the park and learned to report their findings with mobile application iNaturalist to Laji.fi.

In Estonia, volunteer approach was used in the Flying Squirrel LIFE project. With support from the project and in cooperation with the Estonian Fund for Nature (ELF), two volunteer work camps have been held each year in Estonia (2019-2024). Their goals have been to carry out flying squirrel inventories and monitoring and to build nest boxes for the species. Over the course of the project more than one hundred volunteers took part, contributing a total of over 1000 working hours. The flying squirrel monitoring camps will remain in ELF's work-camp program after the project. In spring 2025 two such camps were held, and the same pace is planned for the coming years. Besides helping to discover new habitats, involving volunteers also serves a broader nature-education purpose and brings in potential new people willing to contribute to flying squirrel conservation.

Conclusions

Ecosystem effects can be defined in many ways, but with the approach concerning flying squirrels, the perspective can be broadened to cover large landscapes in space, and at a temporal scale, for decades. A network of suitable habitats and moving connections between them is crucial for the species' existence, as young flying squirrels need to search for their own home range and find a mate. Estimating the availability of forest habitat in the long term is very important from the flying squirrel perspective. As suitable habitats typically have a high monetary value, their existence is threatened, and that risk directly continues to the flying squirrel using those forests. Availability of essential resources for the species to thrive in the future could be better planned across the species range using suitable analyses and methods as tools.

References

Ahtikoski, A., Nikula, A., Nivala, V., Haikarainen, S. & Juutinen, A. 2023: Cost-efficient forest management for safeguarding Siberian flying squirrel (*Pteromys volans*) habitats in Central Finland. **Scandinavian Journal of Forest Research**. Published online 4.5.2023.

Ahtikoski, A., Nikula, A., Nivala, V. & Haikarinen, S. 2024: Metsänkäsittelyn vaikutus liito-oravalle suotuisiin elinympäristöihin. In Finnish with a summary in English. 22 pages. D3 Description of the part Future ecosystem function via scenarios in Finland. Flying Squirrel LIFE publication.

Ahtikoski, A. 2023a: D3 Deliverable Habitat probability and corridor maps, habitat probability GIS layers (first landscape). Case Laajavuori, 8 pages. Flying Squirrel LIFE publication.

Ahtikoski, A. 2023b: D3 Deliverable Habitat probability and corridor maps, habitat probability GIS layers (second landscape). Case Syrjävaara, 6 pages. Flying Squirrel LIFE publication.

Ahtikoski, A. 2023c: D3 Deliverable Habitat probability and corridor maps, habitat probability GIS layers (first landscape). Case Sipilänperä, 6 pages. Flying Squirrel LIFE publication.

Hurme, E. 2023. A3 report of two deliverables 1st and 2nd sets of habitat maps for field checks in Finland and Estonia, 5 pages. Sensitive Flying Squirrel LIFE report, not published.

Juutinen, A. & Pellikka, J. (editors) 2024: Liito-oravan suojelu. Luonnonvara- ja biotalouden tutkimus 103/2024. Luonnonvarakeskus. Helsinki. 54 pages. D2 Report on LUKE's tasks in the Flying Squirrel LIFE project.

LUKE 2023: A3 Deliverable Predictive habitat maps on potential Flying squirrel habitat network in Finland and Estonia ready and available. 16 pages. Flying Squirrel LIFE publication.

EEB 2023: Action Plan for the Conservation of the Flying Squirrel (*Pteromys volans*) 2023-2028. Lendorava (*Pteromys volans*) kaitse tegevuskava. Estonian Environmental Board, 50 pages.