Increasing the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017

Report of the planning process

SARI SIVONEN ED.
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Foreword

This report presents the planning actions of the NATNET Life+ project (Increasing the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017), used to create a footing for the other actions of the project, such as the founding of the Metso habitats as well as the restoration and nature management actions. In such an extensive project, the planning process was demanding, yet successful, as the project met all its goals. During the project, Zonation analyses were completed for almost all of Finland which, for its part, will facilitate the preparation and planning process of such projects in the future. The analyses help direct actions correctly.

The primary emphasis of the report is in the actions carried out in the project; the actions are related to the Zonation analyses and presented in the first part of the publication. In the second part, a case example of the utilisation of the Zonation analyses is presented along with other preparatory actions of the project. Part I was written by Ari Nikula, Janne Miettinen and Vesa Nivala. Part II was authored by Jouni Rauhala, Antti Tolonen and Sari Sivonen from Lapland Centre for Economic Development, Transport and the Environment (ELY Centre) as well as Pauliina Kulmala and Mika Puustinen from the Parks & Wildlife Finland unit of Metsähallitus.

We thank all those who took part in the execution of the project, our partners, and those who participated in the publication of this report.

February 2017

Jouni Rauhala
The objective of the NATNET Life+ project was to increase the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017. The actions of the project were based on the actions presented in the report.

In terms of tangible actions, those crucial to the project included Zonation analyses, through which it was possible to map potential ecologic connections within the project area. Based on them, actions could be targeted to areas in which they best advanced the project’s objectives. The role of briefings and counselling on natural values was significant in helping reach the project’s conservation goals, and the various conservation options received multi-channel marketing. A total of 116 permanent, privately owned conservation areas were established during the project under the auspices of the Metso programme. The total area covered by the conserved areas is approximately 2,800 hectares.

The project carried out restoration and nature management actions across more than 1,100 hectares of land used mostly for forestry, improving the biodiversity of the areas. Plans for restoration and nature management covering an area of 1,515 hectares were devised for the actions; these plans determined the aims of the actions as well as outlined the concrete restoration actions, assessed their impacts, calculated the expenses and determined the need for follow-up assessments. Additionally, nature management plans emphasising areal biodiversity values, covering an area of 5,000 hectares, were devised for private forest owners.

An inventory of all known calypso findings within the ecological corridors defined through the Zonation analyses was compiled in the project, and 210 new calypso sightings were made during terrain inventories. Information received from the inventories was utilised to locate potential areas for conservation as Metso habitats.

Summary

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In terms of tangible actions, those crucial to the project included Zonation analyses, through which it was possible to map potential ecologic connections within the project area. Based on them, actions could be targeted to areas in which they best advanced the project’s objectives. The role of briefings and counselling on natural values was significant in helping reach the project’s conservation goals, and the various conservation options received multi-channel marketing. A total of 116 permanent, privately owned conservation areas were established during the project under the auspices of the Metso programme. The total area covered by the conserved areas is approximately 2,800 hectares.

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An inventory of all known calypso findings within the ecological corridors defined through the Zonation analyses was compiled in the project, and 210 new calypso sightings were made during terrain inventories. Information received from the inventories was utilised to locate potential areas for conservation as Metso habitats.
Natural environments that are rich in biodiversity are stable and adaptable. A decrease in biodiversity weakens the ecosystem’s ability to adapt to, for example, climate change. The various forms of land use tend to alter and fragment the habitats of local species, thus causing deterioration in biodiversity. The maintenance and creation of ecologic connections make it possible for species to migrate to more favourable areas, thereby helping endangered species survive.

The NATNET Life+ project was launched in 2012 to increase ecological connections and coherence in South-West Lapland, particularly across conservation areas part of the Natura 2000 network. The ecological connections most suitable for the project’s objectives were mapped with Zonation analyses, through which it was possible for actions to target areas where they could best contribute to maintaining biodiversity. A total of 116 permanent, privately owned conservation areas were established during the project under the auspices of the Metso programme. The total area covered by the conserved areas is approximately 2,800 hectares. This amounts to over a quarter of the Metso programme’s goal in the entire province of Lapland.

The project carried out restoration and nature management actions across more than 1,100 hectares of land used mostly for forestry, improving the biodiversity of the areas. Plans for restoration and nature management covering an area of 1,515 hectares were devised for the actions. In addition to establishing conservation areas and implementing restoration actions, nature management plans emphasising areal biodiversity values, covering an area of 5,000 hectares, were devised in the project area for private forest owners.

The protected calypso flower (*Calypso bulbosa*), listed under appendices II and IV of the Habitats Directive and a Finnish species of special concern, was chosen as the project’s indicator species. An inventory of all known calypso findings within the ecologic corridors defined through the Zonation analyses was compiled in the project.

In addition to extensive briefings, the project gave counselling on natural values to forest owners to provide them with comprehensive and up-to-date information on the various options available for attending to biodiversity in their forests.

The NATNET Life+ project was funded by the European Union Life+ fund, and a majority of the national funding was covered by funds from the METSO 2008–2016 programme. The project was coordinated by the Lapland ELY Centre, in partnership with the Natural Resources Institute, Metsähallitus and the Finnish Forest Centre. The project also cooperated with the Forest owners’ association of Länsi Pohja.
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Part I

Use of Zonation framework in identifying and locating high biodiversity habitats in NATNET project

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VESAL NIVALA
Summary

The aim of the NATNET (Increasing the ecological connections and coherence of the Natura 2000 network in South-West Lapland) project was to identify and acquire high biodiversity value forests for the Forest Biodiversity Programme, Metsähallitus. NATNET’s goals were defined as an area to be protected during the project as follows: ‘Western taiga’ 450 ha, ‘Aapa mires’ 1 000 ha, ‘Bog woodland’ 400 ha, ‘Alkaline fens’ 500 ha, ‘Herb-rich forests’ 100 ha, ‘Natural forests of primary succession stages of land upheaval coast’ 100 ha and ‘Other habitat types’ 250 ha.

The project area is located in South-West Lapland and it covers about 5 715 km² of which 42% belongs to private forest owners and the rest to Metsähallitus (State Forest Enterprise), municipalities and companies. On private land there were more than 145 000 stands or other habitat types in forest planning data. In Metsähallitus’ data there were 43 000 stands or other habitat types, totalling about 190 000 planning units for the NATNET project area.

Due to large number of planning units the Zonation framework for planning was used. Zonation applies a deterministic iterative process to generate a complementarity-based hierarchical prioritization of the landscape (a priority ranking). As a result, Zonation produces priority rank maps that define a hierarchical set of rankings of cells. Every cell in the project area gets a value between 0 and 1 and the higher the value, the higher the biodiversity values it presents in terms of patch quality and landscape structure.

After assessing conservation targets, ecologically based models of conservation values were prepared. Old growth forests with a strong deciduous component were defined as the most valuable ecological targets in mineral soils. In terms of forest planning data, tree species, diameter of tree species and soil type were used as the most important characteristics that are correlated with the biodiversity values of forests. In peatlands, biodiversity was assessed as a function of peatland type and the occurrence of threatened species and features like creeks. In peatlands, unditched peatlands and especially alkaline fens were defined as the most important targets from the biodiversity point of view. From the EU Habitat and Bird directive’s list of protected species, Fairy slipper (Calypso bulbosa), Lady’s slipper (Cypripedium calceolus), Yellow Marsh Saxifrage (Saxifraga hirculus), Black woodpecker (Dryocopus martius) and Three-toed woodpecker (Picoides tridactylus) all exist in the area.

Located data of forests, peatlands and model species occurring in the area were obtained for the Zonation analysis from forest and environmental authorities and compiled into a GIS database. The biodiversity characteristics of forests were further refined and parameterized for Zonation analyses. A total of 26 feature layers of biodiversity specifications were defined for forests based on tree species and site type. In addition, nine layers of peatland data and three habitat models for old-growth forest birds, Fairy slipper and Lady’s slipper were used in the analysis. In addition, information on rocky areas was compiled totalling 37 feature layers that were used in the final analysis. Forest planning data as well as the other feature layers were converted to 50 m × 50 m raster format, totalling about 2.3 million cells in the analysis for each feature layer.

Three final variants were selected to be used for selecting the most important targets. The Best Ecological Variant covered the whole project area and both state-owned and private land. The Private Land Variant covered only private land. In third variant, the Corridor Variant, a special corridor tool was used to link Natura 2000 and other conservation areas with corridors.

All three variants were further combined by selecting cells among the best 2% solution from every variant and by calculating in how many variants and in which combination a cell exists. A combined value as well as prioritization values from all variants were further calculated for every stand and merged into forest planning data. Forest planning data with Zonation ranks as well as Zonation prioritization maps were further delivered to end users to be added to their GIS system.
Introduction

Changes caused by humans due to forestry are among the most prominent causes for the loss of biodiversity in boreal forests, the dominant biome in Fennoscandia (Esseen et al. 1997). For example, in Finland, almost one third (30.8%) of all threatened species are threatened due to changes in the forest ecosystem (Rassi et al. 2010). The more detailed reasons behind the decline of forest species include the lack of decaying wood (Siitonen 2001), changes in tree-species composition, the decrease and small proportion of old forests (Esseen et al. 1997), and the lack of large deciduous trees (Siitonen & Martikainen 1994). In boreal forests, the amount of decaying wood and the proportion of old forests are among the main characteristics which separate commercially utilized forests from natural ones (Esseen et al. 1997, Siitonen 2001). Natural forests are known to differ from commercial forests also in many other respects. For example, stand structural diversity is known to be higher in natural forests (e.g. Lilja & Kuuluvainen 2005). In commercial forests, important forest characteristics, such as decaying wood, appear only in a very fragmented manner. As a result, many habitat specialist species suffer from a lack of suitable habitats, the deterioration of habitat quality or lack connections between suitable habitats.

During the past couple of decades, several concepts for sustainable forest management have been developed and operationalized in Fennoscandia (Angelstam et al. 2004). These actions include retention of live and dead trees in cutting areas (Gustafsson et al. 2010), conservation of large deciduous trees (Martikainen 2001) and preserving habitats of special importance (Finlex 1093/1996). In addition to the actions implemented for sustainable forest management, it has been seen as necessary also to conserve natural old growth forests and other threatened habitats (Heikkinen 2007). As an implementation of the objectives of the UN Convention on Biological Diversity (CBD), a Forest Biodiversity Programme, METSO, was launched in Finland in 2008 with the aim of halting the loss of biodiversity in forest habitats (Heikkinen 2007). One of the main ideas of METSO is bottom up-based conservation, i.e. an incentive for conservation comes from the landowner and, if the target fulfils certain criteria, an agreement on conservation can be made and the landowner gets compensation from the state. The core idea of voluntary-based conservation together with compensation is to increase the political acceptance of conservation. However, in METSO, it is also possible for conservation and forestry authorities to suggest to the landowner an agreement of the conservation of valuable habitats.

From the systematic conservation planning (SCP) paradigm point of view (Margules & Pressey 2000, Kukkala & Moilanen 2013) both landowner-based incentives and those planned by authorities give rise to the same question: How do you use limited resources and select the best possible targets in an area to complement an existing network of conservation areas? According to Margules & Pressey (2000) systematic conservation planning should fulfil several distinctive characteristics to be effective in using limited resources for achieving conservation goals. These include the selection of surrogates for biodiversity, explicit goals for conservation, assessment of the present conservation status in existing reserves, usage of explicit methods for locating new reserves that complement the existing ones, selection of the most important targets of all candidate areas, and maintaining conditions within reserves together with monitoring of biodiversity indicators (Margules & Pressey 2000). Of these, especially locating new reserves that best complement existing ones, is a challenging task due to often large planning areas and numerous candidate targets/habitats. In addition to a systematic conservation scheme, it is obvious that the planning process would benefit from practical tools that can handle large data sets with multiple objectives.

During the last couple of decades several quantitative approaches for selecting the most valuable targets for conservation have been developed (Moilanen et al. 2009). In this report we describe a detailed workflow of a conservation prioritization analysis that was made with Zonation software (Lehtomäki & Moilanen 2013) and which was at the core of the planning process of the NATNET project.
Planning area

Fig. 1 NATNET project area.
The study area is located in South-West Lapland in Finland (65.3–66.3°N, 24.2–26.5°E) and it covers about 5 715 km² (Fig. 1). Most of the area belongs to the mid-boreal vegetation zone, but the northernmost 10% belongs to the north-boreal vegetation zone (Ahti et al. 1968). Due to calcareous soils, alkaline fens and herb rich forests with demanding plant species and mosses are typical to the area. The area belongs to the southern aapa mire zone (Seppä 1996) and, therefore, large treeless plateau bogs are typical for the area.

About 2 406 km² (42% of the project area) of all forestry land belongs to private forest owners and about 2 169 km² (38% of the project area) to Metsähallitus (State Forest Enterprise). The rest of the area comprises water bodies, agricultural land, inhabited areas, roads and forestry land owned by companies, municipalities and parishes. Most inhabited areas are located in the southwestern part of the project area and along the roads following the River Kemijoki that traverses the area in a southwest northeast direction. Most of the forests outside Natura 2000 sites are in commercial use and can be considered as human influenced. For example, the proportion of old, natural or semi-natural forests and the amount of decaying wood is low within the study area. The proportion of peatlands in the forestry area is approximately 58% and 60% of peatlands have been ditched for forestry purposes or for peat production. Typical for the study area are also former sea shores that were formed when the Baltic Sea gradually retreated due to land uplift 8 800 to 10 000 years BP (Kalliola 1973). These ancient shore lines can nowadays be observed as stone belts, beach ridges, cliffs and terraces.

The project area includes 32 Natura 2000 areas, some of them reaching outside the project area. The size of Natura 2000 areas within the project area is 87 800 ha (15.36%). Most of the protected areas are open, non-forested areas and have been protected by the Finnish Mire Protection programme. The sizes of mire protection areas vary from a few hundred hectares up to more than 14 000 ha. The most important natural forest protection areas are the Pisavaara (4 890 ha) and Runkaus (8 960 ha) nature parks. Some habitats outside Nature 2000 areas have been protected by the Forestry Act, and the area of these habitats ranges from a few hundred square metres up to a few hectares.

Of the EU Habitat and Bird directive’s list of protected species, Fairy slipper (Calypso bulbosa), Lady’s slipper (Cypripedium calceolus), Yellow Marsh Saxifrage (Saxifraga hirculus), Black woodpecker (Dryocopus martius) and Three-toed woodpecker (Picoides tridactylus) all exist in the area.
A general overview of Zonation analysis

Zonation is a framework and software for conservation planning (Moilanen et al. 2005, 2009, 2012). Zonation is publicly available at http://cbig.it.helsinki.fi/software/zonation/download/ and it can handle data covering large areas and tens of millions of cells (Arponen et al. 2012). A general framework for Zonation analysis has been described in Lehtomäki & Moilanen (2013) and the details of the software and algorithms can be found in Moilanen et al. (2005, 2009, 2012). For examples of the practical application of Zonation see Lehtomäki (2014) and references there.

According to Lehtomäki and Moilanen (2013), Zonation analysis includes five main stages:

1. Setting of objectives,
2. Data preparation,
3. Computational analysis,
4. Interpretation of the results, and
5. Recommendations.

Some of these steps are common to systematic conservation planning (SCP) and they can also be applied in conservation prioritization planning processes other than Zonation.
(Lehtomäki & Moilanen 2013). Depending on the data and problem in question, each of the steps can also have several substages where goals and connections between data, analysis and analysis outputs are further defined. A typical feature of Zonation planning is that it is iterative, i.e. finding values for a combination of parameters requires that the process is repeated several times with different combinations of parameters and parameter values. In the following, these steps are presented in more detail.

Zonation applies a deterministic iterative process to generate a complementarity-based hierarchical prioritization of the landscape (a priority ranking). The core Zonation algorithm operates by starting from the assumption that the whole landscape is available for conservation, which also maximizes connectivity potential (Moilanen et al. 2005). Then, the algorithm successively removes the landscape element (grid cell or planning unit) that leads to the smallest loss in conservation value aggregated across all features, thereby maximizing the conservation value of the remaining cells (Moilanen et al. 2005). As a result, Zonation produces priority rank maps that define a hierarchical or nested set of rankings of cells. Every cell in the project area gets a value between 0 and 1 and the higher the value, the higher biodiversity values it presents in terms of patch quality and landscape structure.

**NATNET goals**

Setting conservation objectives is area-specific and in NATNET they were derived from project conservation targets. Targets were further defined as an area to be protected during the project as follows: ‘Western taiga’ 450 ha, ‘Aapa mires’ 1 000 ha, ‘Bog woodland’ 400 ha, ‘Alkaline fens’ 500 ha, ‘Herb-rich forests’ 100 ha, ‘Natural forests of primary succession stages of land upheaval coast’ 100 ha and ‘Other habitat types’ 250 ha.

The rationale behind using a spatial conservation prioritization approach was to maximize the ecological benefit in terms of biodiversity values in the limits of the available budget. In theory, it would be possible also to include the costs of the targets into analysis and to rank targets according to cost-biodiversity ratio optimization. In practice, forests and other habitats protected according to METSO criteria (Valintaperustetyöryhmä 2008) also include sub-optimal targets, because METSO seeks areas that are larger than one habitat and, on the other hand, because protection is based on voluntary agreements between a landowner and the state. Therefore, we did not include costs to the analysis, but they were left to be considered in the phase of the practical evaluation of the offered forests. As the goal was to increase the overall biodiversity and ecological connections, the habitat goals mentioned above are only approximate from the point of view of Zonation planning, but they were used as part of the evaluation of the overall validity of the analysis set up.
Defining ecological models for habitats

Defining the ecological model for conservation objectives is one of the most crucial phases in conservation prioritization and it forms the foundation for all later steps in the analysis (Lehtomäki & Moilanen 2013). The ecological model encompasses the entire set of data used for the analysis, the definitions of weights to feature layers and other analysis options, such as the connectivity among habitats and other targets (Lehtomäki & Moilanen 2013). There are seldom, if ever, comprehensive data available for all biodiversity features that are set for conservation objectives, and, therefore, proxy variables for biodiversity features have to be used instead. This was also the case for all habitat types that were set as conservation goals in the NATNET project. Zonation layers in NATNET planning were grouped into three distinct data blocks: forest data block, peatland data block and species data block.

Forests

The biodiversity value of forests increases with increasing age, multi-species tree composition, especially large deciduous trees, and with increasing fertility of soils (see references in the Introduction). In forest planning data, the variables describing these features are present either directly as such (age, tree species, soil type) or can be concluded from other forest structural data parameters such as tree diameter distributions for tree species that are present in a stand. However, a certain combination of variable values does not directly reveal anything about the conservation value of a stand, but it depends also on the distribution of all kinds of forests in the same region. As an example, the structural characteristics of forests of the same age differ among biogeographical regions even at similar types of soils simply because the length of the growing season is different among regions. Therefore, ecological models have to be adjusted to the region where the planning is made. A combination of biodiversity criteria for forests are presented in Table 1.

Peatlands

The most important feature of peatlands from the point of view of biodiversity is whether they are ditched or not. Due to a lowered level of water table in ditched peatlands the vegetation composition both in ground layer and in tree layer gradually changes (Vasander et al. 1997). As a result, typical peatland vegetation disappears. Therefore, the status of ditching was set as the first criteria for potentially valuable peatlands. We also made use of peatland data that were produced by the Finnish Environment Institute (SYKE) (Alanen & Aapala 2015). In this data large >50 ha peatland patches were classified according to their ecological value and ecological condition. Ecological value refers to the morphological features of peatland, peatland type and its conservation status in project area. Ecological condition, instead, is the measure of the naturalness of the peatland patch. Although, the patch itself might be unditched it can be strongly affected if it is embedded in, for example, a heavily ditched peatland landscape. Thus, ecological condition is a combined measure of the patch itself and the surrounding landscape (Table 1).

Out of different peatland types alkaline fens have the most versatile vegetation and, in general, changes in vegetation after ditching are faster in wetter and more nutrient-rich sites (Vasander et al. 1997). Also, almost half of all endangered mire species are rich fen species (Aapala et al. 1996). Alkaline fens are also characteristic of the NATNET project area and, therefore, alkaline fens were defined as another important criterion for peatlands. In addition to forest
Table 1. Feature layers and their weights that were defined for Zonation analysis. Three data blocks, forest, peatland and species were formed and every layer within a block were given a weight for Zonation analysis. Forest layers were further weighted according to the mean diameter of trees at breast height 1.3 m. The larger the diameter was the higher weight was given for a stand.

### Forest data block

<table>
<thead>
<tr>
<th>Tree species</th>
<th>Site type</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scots pine</td>
<td>Herb-rich forests</td>
<td>2.5</td>
</tr>
<tr>
<td>Scots pine</td>
<td>Herb-rich heath forests</td>
<td>1</td>
</tr>
<tr>
<td>Scots pine</td>
<td>Mesic forests</td>
<td>1</td>
</tr>
<tr>
<td>Scots pine</td>
<td>Sub-xeric forests</td>
<td>1</td>
</tr>
<tr>
<td>Scots pine</td>
<td>Xeric forests</td>
<td>1</td>
</tr>
<tr>
<td>Scots pine</td>
<td>Barren forests, rocky and sandy soils etc.</td>
<td>1</td>
</tr>
<tr>
<td>Spruce</td>
<td>Herb-rich forests</td>
<td>4</td>
</tr>
<tr>
<td>Spruce</td>
<td>Herb-rich heath forests</td>
<td>2.5</td>
</tr>
<tr>
<td>Spruce</td>
<td>Mesic forests</td>
<td>1</td>
</tr>
<tr>
<td>Spruce</td>
<td>Sub-xeric forests</td>
<td>1</td>
</tr>
<tr>
<td>Spruce</td>
<td>Xeric forests</td>
<td>1</td>
</tr>
<tr>
<td>Spruce</td>
<td>Barren forests, rocky and sandy soils etc.</td>
<td>1.5</td>
</tr>
<tr>
<td>Birch</td>
<td>Herb-rich forests</td>
<td>4</td>
</tr>
<tr>
<td>Birch</td>
<td>Herb-rich heath forests</td>
<td>2.5</td>
</tr>
<tr>
<td>Birch</td>
<td>Mesic forests</td>
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<tr>
<td>Birch</td>
<td>Sub-xeric forests</td>
<td>1.5</td>
</tr>
<tr>
<td>Birch</td>
<td>Xeric forests</td>
<td>2</td>
</tr>
<tr>
<td>Birch</td>
<td>Barren forests, rocky and sandy soils etc.</td>
<td>1</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>Herb-rich forests</td>
<td>6</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>Herb-rich heath forests</td>
<td>4</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>Mesic forests</td>
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<td>Other deciduous</td>
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<td>1.5</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>Xeric forests</td>
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</tr>
<tr>
<td>Other deciduous</td>
<td>Barren forests, rocky and sandy soils etc.</td>
<td>2</td>
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### Species data block

<table>
<thead>
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<th>Species</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Old forest bird model</td>
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</tr>
<tr>
<td>Fairy slipper model</td>
<td>1</td>
</tr>
<tr>
<td>Lady’s slipper model</td>
<td>1</td>
</tr>
</tbody>
</table>

### Peatland data block

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surroundings of the small ponds and creeks</td>
<td>1</td>
</tr>
<tr>
<td>Bogholes (ponds etc.)</td>
<td>1</td>
</tr>
<tr>
<td>Alkaline fens</td>
<td>4</td>
</tr>
<tr>
<td>Peregrine falcon (Falco peregrinus) nesting locations within unditchted mires</td>
<td>2</td>
</tr>
<tr>
<td>Small creeks within unditchted mires</td>
<td>1</td>
</tr>
<tr>
<td>Unditched mire, forested (amount of trees 2 m²/ha-1 or more)</td>
<td>2</td>
</tr>
<tr>
<td>Unditched mire, treeless (amount of trees less than 2 m²/ha-1)</td>
<td>1</td>
</tr>
<tr>
<td>Unditched mire, size over 50 ha, ecological value</td>
<td>1</td>
</tr>
<tr>
<td>Unditched mire, size over 50 ha, condition</td>
<td>2</td>
</tr>
</tbody>
</table>

### Other data layers

| Rocky areas | 1 |
planning data, we made use of located data that show the occurrence of the vegetation that are typical for alkaline fens (Table 1).

Additional features that increase the ecological value of a peatland patch were the occurrence of small creeks in the peatland patch and the nesting of a Peregrine falcon within 1 km from the patch (Table 1).

**Species**

Forest planning data presents information at the level of forest stand or other types of habitat patches. The size of a single stand in our study area is about 4.4 ha in Metsähallitus forest planning data and 1.5 ha in private forest data, and even the largest patches only cover some tens of hectares. We found it important to include information about landscape structures to the analysis also from scales that are larger than a single patch for several reasons. Many forest dwelling species utilize areas that are larger than a single habitat patch and, therefore, the occurrence of a species in some point indicates that there is enough suitable habitat available also in the larger area surrounding the observation point. Second, comprehensive/complete mappings of the occurrence of species were not available, and observations about a species occurrence represent only a sample of the whole population. By assessing the relationship of observations and habitats around observation points it is further possible to calculate the probability, how suitable the habitat structure is for species in any point in the project area. These so-called habitat suitability models (Gray et al. 1996) can be used as input layers in Zonation analysis (Lehtomäki & Moilanen 2013). We produced habitat suitability index models that covered the whole project area for Fairy slipper, Lady’s slipper and a combined model for old forest bird species (Black woodpecker, Three-toed woodpecker and Siberian Jay, Perisoreus infaustus).
Pre-processing the data

The first steps in data preparation after defining ecological models is the acquisition of comprehensive data for modelling. Typically, data are not available in only a single database but they have to be compiled from several sources. In the NATNET project forest data were acquired from the Forest Centre for private forests and Metsähallitus, the Forest and Park Service, for state-owned forests. Other data sources were the Forest Research Institute for satellite image-based forest and land use data, the ELY Centre and SYKE for species data, and Bird Life Finland for bird observation data. Data from all these sources were compiled into one GIS database.

After assessing conservation targets ecologically based models of conservation values were prepared. In practice, these were defined as forest and other habitat characteristics that correlate with biodiversity features. For example, for forests tree species, diameter of tree species and soil type were used as the most important characteristics that are correlated with the biodiversity values of forests. In peatlands, biodiversity was assessed as a function of drainage status and peatland type.

One step in data preparation is the preprocessing of data for analysis. Preprocessing in NATNET was comprised of converting data to the same projection, updating data, checking for illogical variable value combinations, and defining variables in data that correspond to biodiversity values in ecological models. Although, for example, species data were available for the area, these data were not comprehensive but based on a more or less limited sample of the area. Therefore, in addition to having a direct species data, a link between biodiversity values and data was established by defining the combination of data variables and their values that best describe the development of biodiversity features in the area. In forest planning data, tree species, diameter of trees and soil type were assessed as the most important variables.

The forest planning data from Metsähallitus was up-to-date, i.e. all the forest attributes were less than one year old. About 24% of Forest Centre data were older than 10 years and they were updated for forest growth by using forest growth simulator MELA (Redsven et al 2013). Cuttings for both updated data and for data less than 10 years old were updated by using Forest Centre register of forest cuttings. However, information on cuttings in the register were available only from 2003 on and, therefore, we utilized satellite image-based multi-source national forest inventory data (MS-NFI, Tomppo et al. 2008) to detect cuttings not present in the register. MS-NFI utilizes satellite images concurrently with field plot information and produces estimates of forest variables with the k-nn method for every 25 m × 25 m land area (pixel). Outputs of the MS-NFI method are maps that give a predicted volume of growing stock by tree species, stand age and site fertility, among others (Tomppo et al. 2008).

To assess cuttings with the aid of MS-NFI, we resampled data to a pixel size corresponding to 50 m × 50 m on the ground. Clear-cuts can be directly seen as treeless areas or, as a big difference in total volume of trees between forest planning data and MS-NFI data. The difference was set as 50 m³ha⁻¹, i.e. if forest planning data showed that the total tree volume was >50 m³ha⁻¹ higher than that of the MS-NFI volume, the stand was set as clear-cut or forest plantation. For the rest of the stands, we used a Mela forest simulator (Redsven et al. 2013) to calculate the growth that had taken place after the data were collected and to update volumes of each tree species in a stand.
Both private and state-owned forest planning data consist of standwise information on, for example, soil fertility, age, drainage status and structural variables of trees, such as diameter, height and canopy layers. Patches of non-forest habitats are also included in data and contain information on, for example, soil type and trees, but these data are not as detailed as for forest land.

The data for both private and state-owned forests were imported from respective organizations’ GIS databases. Forest Centre forest planning data covered over 235 000 hectares of land area of which 197 000 hectares were forests. The forest planning data of state-owned forests, Metsähallitus, covered about 217 000 hectares. Together, these data cover 100% of the forests for these owner groups and over 90% of the study area.

We used a separate condition layer (in Zonation terms a penalty raster) to control possible cases where the information of cuts was lacking. This control method does not affect significantly up-to-date forest planning data since those already have low index values, but secures that clearcut areas will not have high data layer values.

As a combination of four tree species and six site types, forest block included 26 feature layers of biodiversity specifications of forests (Table 1). The biodiversity characteristics of forests in terms of tree diameter for each tree species were further defined and parameterized for Zonation analyses. In this work, we utilized the Zupport toolbox (developed at the University of Helsinki). Zupport gives the highest index values to pixels where there exists a combination of high tree mean diameter and high tree volume. This is based on an assumption that the highest potential for the formation of coarse decaying wood increases as the tree diameter and density increase. We adjusted tree diameter parameters (used in Zupport toolbox) according to the typical development of diameter as a function of forest age and other forest characteristics in the project area.

Forest planning data were converted from polygon format to 50 m × 50 m raster format in order to be used in Zonation analyses. For this, we used ArcGIS versions 10.0 and 10.1. Before the conversion of Zonation layers, data reliability checks were made for the data, i.e. cases with extreme values and illogical combinations of variables were explored and corrected.

The first 24 feature layers were formed as combinations of soil fertility and tree species. In addition, one layer locating rocky areas and one layer locating the surroundings of small ponds and creeks were formed. There were about 2.3 million cells in the analysis for each feature layer.
The mire data block includes eight data layers of valuable peatlands in the area. These feature layers include unditched forested mires, unditched treeless mires, ecological importance of the >50 ha-sized unditched mire patches, condition of the >50 ha-sized unditched mire patches, alkaline fens, Peregrine falcon nesting sites, small creeks within unditched mires and bog holes (See Table 1 for all feature layers and their characteristics).

The species data block includes three data layers of habitat suitability index model outputs for Fairy slipper (*Calypso bulbosa*), Lady’s slipper (*Cypripedium calceolus*), and for old forest bird species as a combined layer Black woodpecker (*Dryocopus martius*), Three-toed woodpecker (*Picoides tridactylus*) and Siberian Jay (*Perisoreus infaustus*). The locations of threatened and vulnerable species in the study area were obtained from Metsähallitus, the ELY Centre and SYKE. Habitat models were compiled by using species locations from Hertta and Tiira databases, multisource national forest inventory data and logistic regression (200 m landscape size for the plant species and 500 m for the bird species). By using the resulting models, habitat suitability probabilities were calculated to about 100,000 points over the whole study area and finally interpolated to a 25 m × 25 m grid cell size. For the final analysis, however, a 25 m × 25 m grid was aggregated to a grid size of 50 m × 50 m.
Weights and connectivity settings

To gain the given objectives in spatial conservation prioritization planning, the value of each ecological feature in relation to others has to be evaluated according to the ecological models in question. In Zonation, this is made by assigning first weight to each feature within each feature group (in our case, data blocks) and then by balancing weights among groups (Lehtomäki & Moilanen 2013). In NATNET, the basic priorities for weighting habitat types came from the project plan, i.e. the most valuable habitats were defined accordingly. However, it should be noted that the ecological value is not the same as real goals that were set in the project plan. Ecological value depends on the assessment of whether the habitat type is rare or characteristic to the planning area. The definitions of the weights were based on expert opinions.

In Zonation it is possible to define connectivity between habitats also as spatial measures. Four different methods were used to describe the ecological connections: edge removal, boundary length penalty, matrix connectivity and connectivity to the protected areas (Table 2). The last consists of two parts: connectivity to large protected areas and connectivity to small protected areas.

In our study area, old-growth forests with a high deciduous component and that are growing on the most fertile sites were set as the most important habitats. In technical terms, matrix connectivity calculates the connectivity effect between several feature layers. For this, a similarity matrix was defined based on an expert opinion (see Lehtomäki et al. 2009, Arponen et al. 2012). For forest layers, the similarity matrices for tree species (Table 3) and site type (Table 4) were first defined and then combined to a weight matrix that takes into account both tree species and soil (Table 5).

Edge removal adds some spatial patterns to resulting prioritization maps since it selects the grid cells to be removed only from the edges of the remaining removal area.

### Table 2. Additional Zonation analysis parameters.

<table>
<thead>
<tr>
<th>Criterium</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Length Penalty (BLP) in all three variants (determines the solution cluster size)</td>
<td>0.2</td>
</tr>
<tr>
<td>Condition Layer (i.e. Penalty raster). Bases on the Metsäkeskus data of loggings, corrects the forest planning data in cases where forest planning data has not been updated. Reduces the forest layer values for clear-cuts by multiplier.</td>
<td>0.01</td>
</tr>
<tr>
<td>Hierarchical mask consisting on conservation areas which include: Nature reserves (e.g. nature park, mire protection areas), Areas conserved by forest law and Preserved areas in Metsähallitus landscape ecological planning (classes ‘ecological connection’ and ‘stepping stone’). When using hierarchical mask smallest values will be removed first and the largest values last.</td>
<td>1 No Data</td>
</tr>
<tr>
<td>• In Best Ecological Variant conservation areas</td>
<td></td>
</tr>
<tr>
<td>• In Best Ecological Variant Non-conservation areas</td>
<td></td>
</tr>
<tr>
<td>Hierarchical masks. Smallest values have lowest priority and will be removed first</td>
<td>1 No Data</td>
</tr>
<tr>
<td>• Conservation areas in Best Ecological Variant and Corridor Variant</td>
<td></td>
</tr>
<tr>
<td>• Non-conservation areas in Best Ecological Variant and Corridor Variant</td>
<td></td>
</tr>
<tr>
<td>• State-owned areas in Private Land Variant</td>
<td></td>
</tr>
<tr>
<td>• Private areas in Private Land Variant</td>
<td></td>
</tr>
<tr>
<td>• Conservation areas in Private Land Variant</td>
<td></td>
</tr>
<tr>
<td>Condition Layer (i.e. Penalty raster). Bases on the Metsäkeskus data of loggings, corrects the forest planning data in cases where forest planning data has not been updated. Reduces the forest layer values for thinned stands by multiplier.</td>
<td>0.7</td>
</tr>
<tr>
<td>Connectivity kernels (limited only to the forest layers)</td>
<td></td>
</tr>
<tr>
<td>• Matrix connectivity</td>
<td>500 m</td>
</tr>
<tr>
<td>• Conservation areas</td>
<td>2 km</td>
</tr>
<tr>
<td>• Areas conserved by forest law</td>
<td>100 m</td>
</tr>
</tbody>
</table>
Table 3. Similarity matrix for tree species.

<table>
<thead>
<tr>
<th></th>
<th>Birch</th>
<th>Norway spruce</th>
<th>Other deciduous</th>
<th>Scots pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch</td>
<td>1.0</td>
<td>0.6</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Norway spruce</td>
<td>0.6</td>
<td>1.0</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Scots pine</td>
<td>0.4</td>
<td>0.7</td>
<td>0.2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 4. Similarity matrix for site types.

<table>
<thead>
<tr>
<th></th>
<th>Herb-rich forests</th>
<th>Herb-rich heath forests</th>
<th>Mesic forests</th>
<th>Sub-xeric forests</th>
<th>Xeric forests</th>
<th>Barren forests, rocky and sandy soils</th>
<th>Barren rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herb-rich forests</td>
<td>1.0</td>
<td>1.0</td>
<td>0.7</td>
<td>0.7</td>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Herb-rich heath forests</td>
<td>0.9</td>
<td>1.0</td>
<td>1.0</td>
<td>0.9</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Mesic forests</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td>1.0</td>
<td>0.9</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Sub-xeric forests</td>
<td>0.4</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td>1.0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Xeric forests</td>
<td>0.2</td>
<td>0.4</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Barren forests, rocky and sandy soils</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Barren rock</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 5. Weights for tree species – site type combinations.

<table>
<thead>
<tr>
<th></th>
<th>Herb-rich forests</th>
<th>Herb-rich heath forests</th>
<th>Mesic forests</th>
<th>Sub-xeric forests</th>
<th>Xeric forests</th>
<th>Barren forests, rocky and sandy soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birch</td>
<td>4.0</td>
<td>2.5</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Spruce</td>
<td>2.5</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Other deciduous</td>
<td>6.0</td>
<td>4.0</td>
<td>2.5</td>
<td>1.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Scots pine</td>
<td>2.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

This leads to a modest clustering of the high-ranked areas (see also Lehtomäki & Moilanen 2013). Also boundary length penalty (BLP), which reduces the length of patch boundaries, leads to more compact patches. See Table 2 for details.

For the matrix connectivity, we used distribution smoothing, which is a kernel-type metapopulation connectivity measure (Moilanen & Nieminen 2002, Moilanen et al. 2005) measuring the probability of the dispersal distance of organisms. In practice, this means that the effect of a single grid cell value on surrounding cells, i.e. connectivity effect, decreases by distance. The decrease is calculated with a negative-exponential function and the decrease is radially symmetric around the cell. If the connectivity distance is set to, for example, 500 metres, it means that the connectivity effect has reduced 50% at the distance of 500 metres from the cell and that the effect continues to asymptotically decrease towards zero also after that.

Connectivity to large protected areas was limited to the forest layers (Table 2). This connectivity was determined by multiplying these 24 layers to the Zonation species list and by defining the dispersal value as 2 kilometres. Furthermore, the connectivity to small protected areas was taken into consideration (Table 2). Also this connectivity type was limited to the forest layers. In this case, the dispersal value was set to 100 metres. These small protected areas consist mainly of areas protected by forest law or areas protected by the landscape ecological planning of Metsähallitus. Those are very small ones in comparison to ‘large protected areas’ and therefore their connectivity value was estimated to be small.
Analyses setup: other parameters

All Zonation analyses were done using an additive benefit function, which produces effective conservation performance solutions (DiMinin & Moilanen 2012). Due to a large project area and relatively long computational time needed for every analysis, we set the warp factor at 500, which means that 500 cells were removed at each iteration. Edge removal was also used, which allows cells to be removed only from edges when removing less valuable cells at each iteration. Furthermore, we used group-file, which allows automated production of output for groups of features. In NATNET analysis, layers were divided into six groups. The first group included the 24 forest layers. The second group was the copy of forest layers (connectivity to large protected areas), the third group was the second copy of forest layers (connectivity to small protected areas), and the fourth group included the species model layers, a layer of rocky areas and a layer of surroundings of small ponds and creeks. The fifth group included the mire layers and the sixth group included the Weighted Range Size Corrected Richness (WRSCR) layers for the large and small protected areas. For those, the group value was set as -1 in order to limit their effects only to the connectivity to protected areas.

The first 24 data layers were used three times due to connectivity calculations. We used also WCSCR layers for the connectivity to protected areas. Thus, there were in total 87 layers in the species list table.

Two types of mask rasters were used to take into consideration the present protection areas and the forest ownership (Table 2). In the first one, there were two classes: all the protected areas had value 1, whereas all the other areas had value ‘NoData’. This mask raster included altogether 15.36% of the study area, and it allocates these areas always to the highest ranks. By using this mask, we were able to detect the best unprotected areas over the whole area, independently from forest ownership. The other mask included three classes: value 0 for state-owned forests, value 1 for private forests and value 2 for protected areas. Also this mask allocates the protected areas to the highest ranks, but it also categorizes the state-owned areas to the lowest ranks. Due to that, we were able to detect the best unprotected areas in private forests.
Corridor planning

One of the goals in the NATNET project was to increase connectivity among Natura 2000 sites and other conservation areas. In addition, so that the connectivity among habitats was taken into account by setting several spatial weights in the analyses, concrete corridors were planned with the aid of a corridor tool (Pouzols & Moilanen 2014). The corridor tool has been implemented in the Zonation software and it integrates corridor design and spatial conservation prioritization (Pouzols and Moilanen 2014). Corridor tool in Zonation is based on an extension of the boundary length penalty (BLP) method for generating reserve network aggregation. BLP favours networks that are compact and have a low edge-to-area ratio. According to Pouzols and Moilanen (2014), the Zonation corridor tool does not require a priori specifications of habitat patches or end points, and the resistance definitions of different habitat types are not needed.

Basically, only two parameters are required to define corridor formation: the minimum corridor width and the corridor strength. Several additional parameters can be defined to fine tune the solution (Pouzols & Moilanen 2014). In the NATNET project, the width of the corridor was determined as 1 000 metres (20 grid cells). The corridor strength regulates the trade-off between increased connectivity via corridors and other considerations relevant to conservation. In the NATNET project, a value 0.00005 was used.

We also determined four domain areas within the study area since there were natural breaks that hindered the formation of true corridors (e.g. the River Kemijoki). Inhabited areas and agricultural fields also heavily fragment the most southwestern part of the project area. Therefore, we set higher priorities to areas which have higher potential for corridor formation. For the central and northern area, the domain value was set to 1 and for the western and eastern areas the value was set to 0.5. The domain areas were not overlapping and, therefore, corridors did not cross the boundaries of the domain areas.
When designing the analysis, it is important to take care, on the one hand, of the balance among features used in the analysis and, on the other hand, to adjust weights and other parameters so that desired goals are achieved (Lehtomäki & Moilanen 2013). So far, there are no formal ways to calculate weights for features beforehand based on, for example, structural characteristics of the target area. Therefore, final analyses are usually an outcome of a long iterative process where weights and other parameters are assessed and tested step by step (Lehtomäki & Moilanen 2013). Typically, more and more features are added to the analysis in the course of the process.

NATNET analyses were also started with simple analyses, where only a forest data block was used. In the second step, a species block was added. In the third step, weights were added to the layers. An analysis was continued by adding a new analysis feature one by one. Maps and performance curves for variants were printed at each step and evaluated in co-operation with all the NATNET partners that had experience of the project area and requirements of Metsähallitus habitats. After numerous variants with different parameterization, three variants were finally chosen to be used in locating targets for NATNET. In the first variant, named ‘the Ecologically Best Variant’ or EBV, solutions were not limited by forest ownership (Fig 2). EBV thus takes into account the whole habitat structure in the area. In the second variant, ‘the Private Land Variant’ or PLV, solutions were allocated solely to privately owned land (Fig. 3). In the third variant, ‘the Corridor Variant’ or CV (Fig. 4), corridors were formed among Natura 2000 areas by using a special corridor tool developed for Zonation (Pouzols & Moilanen 2014).
Fig. 3 Private Land Variant.

Fig. 4 Corridor variant.
Fig. 4 Sum of variant priorities.
Post-processing of the Zonation-outputs for end users

Communicating the results to end users deserves attention because the terminology and concepts that were used in Zonation analysis are not necessarily familiar to non-experts. Zonation analysis produces several outputs, like rank maps and performance curves. Out of these, rank maps are perhaps the most easily understood and targets can easily be located with the aid of other data such as forest planning data. Overlaying Zonation and forest planning data with GIS is in principle a trivial task but selecting from numerous alternatives out of high rank targets is necessarily not.

In the NATNET project, the determination of the best target areas was based on the combination of all variants. First, each pixel in all variant output maps was classified according to the criteria, whether it belonged to the best 2% of all pixels. Pixel values were then calculated and, as a result, a combined layer was formed where each pixel was classified according to the following criteria:

1. does it belong to the best 2%, and, if it does,
2. from what kind of combination of variants did it came from? (Fig. 5)

If a certain area received a high priority in all three variants, it gained a high status in the final selection of protection areas.

For pre-field inventories, Zonation rankings were also calculated for each stand and merged into forest planning data both for Metsähallitus data and private forest data (Fig 6). As a result, a planner could retrieve forest planning data by making queries that were based both on Zonation ranks and stand variables.

The parameterization of the Zonation analysis, and resulting outputs, easily remain not understood for non-experts, if not communicated thoroughly during the project. During the NATNET project, ecological models and resulting variants from Zonation analysis were discussed with experts during several joint meetings. A special training day for the end users of Zonation output maps was also arranged.
References


Part II

Actions in Preparation of the Natnet Life+ Project Area
Conservation Network

PAULIINA KULMALA
MIKA PUUSTINEN
JOUNI RAUHALA
SARI SIVONEN
ANTTI TOLONEN
The Zonation analyses undertaken in the project were utilised in selecting the Metso habitats. Our case example comes from Louepalo in the Tervola municipality. In 2014, two separate private conservation areas (YSA areas) were created on the habitats marked with green borders in the Image 3. They are located on the lands of two different estates. The location indicated by the arrow emerged in the preparatory phase of the Natural Resources Institute’s (LUKE) analyses, during which the Institute’s researchers explored the habitat on foot and found it highly suitable. The habitat consisted of, for example, a 200-year-old spruce grove as well as old, sturdy aspens, and its habitat type was that of young heath and grove. There were also several calypso growths within the area.

Following the discovery, the Lapland ELY Centre contacted the landowner and inquired about their readiness to conserve the habitat. After a joint excursion around the area, an agreement was reached to conserve a total of 16 hectares, divided into four sections. Along with the initial habitat, the conservation plans were made to include, for example, wooded peatland and rich fen.

Image 3. Conserved habitats on the Zonation map. Areas richest in biodiversity are marked with red on the map.
Images 4 and 5. Images from the Metso habitat. Photos: Eerika Tapio.
Common planning

The action aimed at creating a plan to combine the project area’s various Natura 2000 sites into a single entity, with the help of ecological connections and green infrastructure. The planning process began with the collection of all the geographical data sets related to the action’s goals. Parties included in the project provided the planning process with any relevant material in their possession. As the project included parties possessing forest data of both privately owned and state forests, a comprehensive understanding of the project area was achieved early on.

The planning process was split into two parts. During the first phase, areas with potential for ecological connections were identified using geographical data. Proposals from forest owners for areas to be conserved were included in the initial assessment. As the project area was host to more than 3,000 different landowners and ownership groups, including them as part of the planning process was a high priority. For this reason, the project emphasised communication with landowners from the get-go. Briefings were sent to each landowner within the project area, and their proposals for conservation areas and interest in nature management plans were inquired after. Indeed, landowners demonstrated their interest in both creating conservation areas as well as devising nature management plans. It was also vital to raise the interest of jointly owned forests and forestry companies in the project. As part of the planning process, a two-stage inventory was initiated at the earliest possible stage, which provided data on the proposed privately-owned habitats.

At the second phase of the planning process, following the assessment of geographic data, the selection of habitats and the planning of actions in detail took place in the field *in situ* in connection with the different actions.

A total of nine more extensive planning meetings took place as part of the planning process, attended by all parties included in the project. In addition to these, over 40 smaller planning meetings were held. The major planning meetings focused on plans covering the entire project area, while smaller meetings usually dealt with planning some individual action or habitat.

The planning meetings prepared the different actions so as to support the project’s aims across the entire project area. The meetings were also important for their role in ensuring that all parties included in the project were kept up-to-date on the progress of the various actions. This also reduced expenses and avoided overlaps in, for example, terrain inventories.

Image 6. Calypso (*Calypso bulbosa*) is a small but, when in blossom, a striking plant, and the only species in its genus. Photo Eerika Tapio.
At the start, a preliminary inventory of the entire project area was made by geographical assessment. Utilising various geographical data sets, it set out to identify the most suitable habitats within the project area in terms of biodiversity and the project’s goals. This initial inventory made use of, for example, aerial photography, forest data sets and the Hertta data set on species.

Actual terrain inventories (II-stage inventories) were made in relation to various actions across an area of approximately 18,000 hectares. These inventories were of varying quality; some of them, for example, were simply visual approximates of the area’s suitability for conservation with no precise measurements. On the other hand, when devising the nature management plans, inventories were made of several factors in all figures: forest cover, distribution of tree species, type of habitat, etc. At the final stage of the project, a Natura habitat inventory was made of all conservation areas formed on privately owned lands.

The project included an inventory of all known calypso findings within the ecologic corridors defined through the Zonation analyses. Old observations, known already before the project, were counted as a total of 49 within the project area between 2012–2016, and they contained approximately 3,400 shoots. In addition to this, new observations were searched for on the private lands located within the ecological corridor. With the help of aerial photography, field work was focused to promising-looking old spruce groves, the vicinities of known calypso findings and to areas known to contain other species favouring calcareous soil, such as the lady’s slipper orchid (*Cypripedium calceolus*).

A total of 210 new calypso growths were discovered during the project’s field inventories, of which 189 are located on private land and 21 on state-owned land. Approximately 2,770 calypso shoots were counted from the new findings. It can be stated that calypso has benefited from the project considerably as the knowledge on the occurrence of the species within the “Lapland triangle” region in South-West Lapland has been significantly improved and the risk of the loss of growths due to loss of information has been reduced. In the calypso inventories, information was collected not only on the numbers of calypso shoots and the total area of the growth but also on the biotopes, tree stand and potential risk factors of the area. The size of the area suited for calypso growths was also assessed. The information was utilised to locate potential areas for conservation as Metso habitats. The information on calypso growths was stored in the Hertta Eliölajit geographic system of Finland’s environmental administration, making it available to the authorities and other operators making decisions on land use.

Two-phased nature Inventories

Image 8. Counting the shoots of a calypso is careful work.
Photo Eerika Tapio.
The objective of the action was to make a nature management plan for the area spanning 5,000 hectares and 200 farms. The purpose of the nature management plans was to create ecological connections in the project area as a part of the other actions of the project. The nature management plans also served as a foundation for establishing conservation areas in an area spanning 709 hectares.

The landowners in the project area were offered the opportunity of receiving a free-of-charge nature management plan for their forest areas. The purpose of the nature management plan was to provide an alternative for the traditional forestry plan where the planning usually focuses on maximal wood production. The nature management plans aimed to take the diversity values of the estate into consideration and provide recommendations to retain and increase these values.

The Finnish Forest Centre was in charge of making the nature management plans. Before launching the planning, the Finnish Forest Centre investigated the prerequisites for drafting a plan. Plans were not made for all the offered locations. In these cases, the reason was usually the fact that the estate primarily consisted of, for instance, seeding stand or clearcutting areas. The aim was to create the plans for areas with more potential for biodiversity.

Making the plan was initiated with a negotiation between the planner and the forest owner to obtain an understanding of the landowner’s wishes and views regarding the plan. After this, the planner performed a terrain inventory at the sites, and soil and tree stand information was defined for each figure. The amounts of decayed wood vital for biodiversity as well as information on tree species were also specified in the tree stand information. The planner also recorded all the endangered vascular plants.

During the planning, the potential conservation areas were also laid out, on the basis of which the landowner was able to start establishing the conservation area. In addition, the planning took into account the sites in need of restoration, and these were also implemented during the project. Nature management plans were drafted for 27 estates with a total area of 5,018 hectares. The finished plans were handed over to the landowners and the planner of the plan also gave the landowner an account on the contents and procedural suggestions of the plan.
The purpose of the action was to create the best possible cooperation with the forest owners. Most of the project area and the different actions of the project were situated in private forests, which is why it was important to inform the forest owners of the possibilities of the project directly as well as make counselling on natural values a part of the forest owner cooperation. Through counselling on natural values, the aim was to provide the forest owners with as much information as possible on the various options available for attending to biodiversity in their forests and on the possibilities of the Metso programme.

The project made a cooperation agreement with the largest forest owner organisation in the project area, the Forest owners’ association of Länsi-Pohja. The association agreed to inform the forest owners regarding the project and its actions. In addition, the association delivered information to the Lapland ELY Centre on potential conservation areas with the consent of the landowner. The association also performed terrain inventories in the conservation areas as a part of the cooperation agreement, and the officials of the association took part in the project’s briefings. The project worked in cooperation with all the other forest owners’ associations in the project area, and all the project’s operators took part in the counselling on natural values.

As a part of the counselling on natural values, training was organised for the forestry officials in the project area on the selection of the Metso habitats, the various actions of the project and the opportunities it presents to forest owners. Counselling on natural values was carried out in a number of methods: sending letters to landowners, organising briefings, keeping in touch via telephone and e-mail, reporting news in social media and having the project workers participate in various events and personally meet the landowners. This also advanced the project’s communications and exposure.

At the end stage of the project, a training package was implemented for the project website to discuss examples of landowners’ experiences and the execution of the project. In addition, the training package answers the frequently asked questions of landowners regarding the foundation of conservation areas. The training package can be found at: www.natnet.fi/kysymyksia-ja-vastauksia.
Planning of restorations, production of decayed wood and controlled burning

The purpose of the action was to draft restoration and nature management plans. The objective of the project was to implement various restoration and nature management work in an area spanning more than 1,000 hectares and consisting of private land, Natura 2000 areas and the forest management areas of Metsähallitus. Some of the restoration plans of the Natura 2000 areas had already been made by Metsähallitus before the project was launched. For most of the areas, the plans were made during the project. Metsähallitus was in charge of drafting the plans for state-owned land, whereas the Finnish Forest Centre was in charge of the plans for privately owned land.

Planning is a vital part of restoring habitats, and all the implemented actions were based on premeditated plans. Restoration planning includes making an inventory of the natural values and endangered species of the area and assessing current state of the area to be restored.

The plan defined the objectives of the actions and laid out the restoration actions, taking into account the effects of the actions on water systems and, in terms of forest restoration, the amounts of decayed wood. The plans assessed the impacts of restoration and calculated the costs of the actions. A requirement to monitor the work in the planned area was specified in the plan.

All in all, restoration and nature management plans were made for an area covering 1,515 hectares. Some of the plans were not executed. Reasons for cancelling the execution included the landowner having second thoughts about restoring their area. In one of the cases, the planned area was not executed due to pending legal proceedings. Any plans that have not been executed as of yet can potentially be executed in the future. Therefore, the cancellations do not necessarily mean the work was wasted.
Image 10. Groups of trees were left in the burnt-over area to diversify the fire continuum area. Photo Antti Tolonen.
Preparation of protection agreements and areal conservation compensation

In Finland, the first practical, large-scale protection programmes were drafted in the 1970s. Such protection programmes included the bog protection programme (19 April 1979 and 26 March 1981), the protection programme of water systems serving as habitats for birds (3 June 1982), the protection programme of eskers (3 May 1984), the protection programme of groves (13 April 1989), the protection programme of beaches (20 December 1990), the protection programme of old-growth forests (27 June 1996) and the Natura 2000 (20 August 1998 and 8 May 2002). Previously, protection was mainly directed towards state-owned land. The systematic implementation of protection programmes did not start until 1996 after a decision in principle from the Council of State. The implementation of the programmes remains partly unfinished, which means that work on the programmes continues to this day. In 2008, the Forest Biodiversity Programme for Southern Finland 2008–2016, i.e. the so-called METSO programme, was launched. The programme period was later continued until the year 2025. The objective of the METSO programme is to stop the regression of wooded nature types and forest species and to establish development favourable to biodiversity (decision in principle from the Council of State on the Forest Biodiversity Programme for Southern Finland 2008–2016). The METSO programme differs from the previous protection programmes as the nature reserves to be established are based on voluntariness.

The national proportion of internal financing of the NATNET Life+ project was mostly collected from the compensations of private conservation areas established in the project that were covered from the METSO programme funds granted to the Lapland ELY Centre. As soon as the project was launched in 2012, diverse marketing of the conservation options was initiated. In February 2012, the landowners in the project area were approached with a letter (2,800 pcs), informing them of the opportunity of making a voluntary nature conservation agreement and/or make a nature management plan for their area. The role of communication in achieving the protection goal was substantial; in addition to the letter campaign, public events and assemblies were organised in the project area, the landowners were taken on excursions and the project was presented in various events and expos. A website and a Facebook page were also opened for the project, and a traditional printed project leaflet was also published. The project received excellent added exposure in regional radio and television broadcasts and newspaper articles.

Forestry operators were included in the project with the METSO training for forestry professionals. Officials from the local forest owners’ association and the Finnish Forest Centre were among the participants of the training. The training highlighted that protection is not a threat to forestry; instead, protection is often the most financially sound solution for low-yielding sites or areas that are difficult to restore. In terms of achieving the goals of the project, it has also been important to bring landowners together to exchange their experiences.

Image 11. In terms of diversity, a naturally revived forest containing decayed wood is an excellent site. Photo Sari Sivonen.
on different protection solutions. Previously, information was mostly available from traditional forestry operators and was mostly based on so-called "hard" forest treatment methods. As a new form of operation, the NATNET Life+ introduced free-of-charge nature management plans in the area. The plans were exceedingly well received among landowners. The NATNET Life+ project also enabled the restoration of vital habitats in the protected areas.

The implementation of a METSO protection programme site usually begins with the landowner making an initiative on placing an area they own or a part of it under protection. After this, a representative from an ELY Centre preliminarily inspects the natural values of the site with maps and areal images and, if necessary, on site. With the landowner’s consent, a tree stand assessment and a more detailed specification of natural values is carried out. After this, a potential protection method, i.e. selling the area or establishing a private conservation area, is negotiated and agreed. In the NATNET Life+ project, the implementation method was, without exception, the establishment of a permanent nature conservation area with the site remaining the property of the landowner. The negotiations also cover the protection regulations and limitations of the conservation area. After the negotiations, the ELY Centre makes the landowner an offer on a protection compensation or purchase price. The compensation is mainly based on the value of the tree stand, and in cases of purchase, the value of the soil is added to the price. The sum is reviewed with a so-called total value adjustment to establish the net value of the site. The total value adjustment is a percentage reduction assessing the costs caused by owning and managing the forest, etc. If the landowner is satisfied with the offer, they will sign a sales contract or a written consent. After the ELY Centre has made a decision on establishing a private nature reserve, the case is forwarded to the administrative court. If appeals regarding the case are not received within the prescribed time, the administrative court will concede that the decision is legally valid. After verifying the legality of the decision, the compensation is paid to the landowner tax-exempt in one installment. The conservation area is recorded in the land register, maps and, if necessary, the terrain.

A total of 116 permanent, privately owned conservation areas were established during the NATNET Life+ project. The total area covered by the conserved areas is approximately 2,800 hectares. Landowners were paid a total of more than EUR 4 million in tax-exempt compensations.
Increasing the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017

Report of the planning process
(Natura 2000-verkoston ekologisten yhteyksien ja yhtenäisyyden lisääminen Lounais-Lapissa; Raportti suunnitteluprosessista)

Abstract
The objective of the NATNET Life+ project was to increase the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017. The actions of the project were based on the actions presented in the report.

In terms of tangible actions, those crucial to the project included Zonation analyses, through which it was possible to map potential ecological connections within the project area. Based on them, actions could be targeted to areas in which they best advanced the project’s objectives. The role of briefings and counselling on natural values was significant in helping reach the project’s conservation goals, and the various conservation options received multi-channel marketing. A total of 116 permanent, privately owned conservation areas were established during the project under the auspices of the Metso programme. The total area covered by the conserved areas is approximately 2,800 hectares.

The project carried out restoration and nature management actions across more than 1,100 hectares of land used mostly for forestry, improving the biodiversity of the areas. Plans for restoration and nature management covering an area of 1,515 hectares were devised for the actions; these plans determined the aims of the actions as well as outlined the concrete restoration actions, assessed their impacts, calculated the expenses and determined the need for follow-up assessments. Additionally, nature management plans emphasising areal biodiversity values, covering an area of 5,000 hectares, were devised for private forest owners.

An inventory of all known calypso findings within the ecological corridors defined through the Zonation analyses was compiled in the project, and 210 new calypso sightings were made during terrain inventories. Information received from the inventories was utilised to locate potential areas for conservation as Metso habitats.

Keywords
biodiversity, conservation areas, ecological corridors, ecological networks, Forest Biodiversity Programme for Southern Finland (METSO), Natura 2000, Zonation

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Hankkeessa toteutettiin yli 1 100 hehtaaria ennallistamis- ja luonnonhoitotöitä joilla parannettiin pääasiassa metsätalouskäytössä olevien alueiden monimuotoisuutta. Toimenpiteitä varten laadittiin ennallistamis- ja luonnonhoitosuunnitelmat 1 515 hehtaarin alueelle; näissä suunnitelmissa määriteltiin toimenpiteiden tavoitteet, suunniteltiin varsinaiset ennallistamistoimenpiteet, arvioitiin vaikutukset, laskettiin toimenpiteiden kustannukset sekä määriteltiin seurannan tarve. Lisäksi yksityisille metsäomistajille laadittiin alueen monimuotoisuusarvoja painottavia luonnonhoitosuunnitelia yli 5 000 hehtaarin alueelle.

Hankkeessa inventoitiin kaikki Zonation-analyysien avulla laadittujen ekologisten käytäväalueiden tunnetut neidonkengäsintymät ja maastoainventoineissa löydettiin 210 uutta neidonkengän havaintopaikkaa. Inventoinneissa saatuja tietoja käytettiin hyväksi potentiaalisten Metso-kohteina suojeltavaksi soveltuvien alueiden etsimisessä.
The objective of the NATNET Life+ project was to increase the ecological connections and coherence of the Natura 2000 network in South-West Lapland 2012–2017. This report presents the planning actions of the NATNET Life+ project, used to create a footing for the other actions of the project, such as the founding of the Metso habitats as well as the restoration and nature management actions. The ecological connections most suitable for the project’s objectives were mapped with Zonation analyses, which is presented in the first part of the publication. In the second part, a case example of the utilisation of the Zonation analyses is presented along with other preparatory actions of the project.