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Luxembourg and the Birds Directive

Analysis of necessity and identification of new SPAs

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Abstract

After the designation of twelve SPAs Luxembourg was asked by the European Commission to evaluate this network by analysing its contribution to the viability of the 64 bird species for which Luxembourg has to select sites. For 34 species which are good or very good covered by the network in a qualitative way the contribution of the designated SPAs was evaluated focusing on the method of site selection. For these species it was concluded that the SPAs and six selected Important Bird Areas (IBAs) include all important sites in Luxembourg. There is no need for selection and designation of additional SPAs to fulfill the obligations of the Birds Directive.

For 30 species which are not or badly covered by the SPA network the model LARCH was used to analyse the spatial conditions of the network providing long term protection in terms of viable populations. The analyses show only a few species which are viable within the existing network. For most species additional sites are needed to reach a sustainable network. Priority areas where additional sites can be found are also analysed. Because additional sites can contribute to the viability of different species priority areas were analysed showing their added value to the viability of a combination of species using the same habitat.

Keywords: Luxembourg, Birds Directive, Special Protection Area (SPA), LARCH analysis, viable network populations, Important Bird Areas (IBAs), second opinion

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Contents

Summary

To implement the Birds Directive Luxembourg has the obligation to select sites for 64 bird species. Luxembourg has selected and designated twelve sites as SPA to fulfil their obligations.

However, the European Commission has asked the Luxembourg government to evaluate the existing network of SPAs, especially looking at bird species which are not sufficiently covered by the designated sites.

To evaluate the existing network of SPAs the Ministry (Ministère du Développement durable et des Infrastructures, Département de l'Environnement) requested a study focusing on two questions:

1. Do the designated SPAs fulfil the obligations of the Birds Directive, in terms of a sustainable population network, for the survival of the bird species of Annex I, as well as migratory species as referred to in Article 4.2?
2. If the designated SPAs as a population network do not fulfil the obligations of the Birds Directive where can priority areas be analysed to become part of the Natura 2000 network?

To answer the questions for all 64 bird species they were divided in two groups. One group of 34 bird species (see Annex 1) of which the distribution and their habitat are considered to be well covered by the SPA network were analysed in a qualitative way (second opinion). This analysis focused on the method of the site selection. Selected and possible new sites were evaluated as well as their contribution to the protection of the species. For the second group of 30 species (see Annex 2) a (quantitative) spatial analysis was carried out using the model LARCH (see Annex 3). This model analyses the habitat and the viability of their populations within the protected network.

For the LARCH analysis the 30 bird species were categorised in three ecological groups representing species using more or less the same habitat: forest, wetland and farmland species. For all species separately areas (based on grid cells of 500 x 500 m) were analysed which contribute mostly to the viability of the population of a species in terms of estimates of breeding pairs (see Annex 3). In addition priority areas were analysed which contribute mostly to all forest species and farmland species (Figures 27 and 60). For wetland species priority areas could not be analysed at group level because of wide differences in their habitat preference.

Based on the viability of species populations in Luxembourg realistic viability targets were defined to identify priority areas additional to SPAs.

An analysis was done of the contribution of additional sites to realise the targets within the protected areas network. The analysed priority areas show as ' searching areas ' where sites can be selected and protected which will contribute mostly to the Favourable Conservation Status of a species in Luxembourg and how many species within an ecological group will benefit of these measures.

Especially for the farmland species it is stressed that the management of the areas is crucial to improve their habitat quality, contributing in this way to an increase in their reproduction and survival.

The analysed priority areas are additional to the existing Natura 2000 network in Luxembourg (including SPAs and SACs) and have been compared to other proposed areas to become a SPA (e.g. Important Bird Areas: IBAs).

All species in the first group of 34 species of which the distribution is already good or very good covered by the designated SPAs, are in the Annex I of the Birds Directive and/or are a wetland species and/or are on the national or European red list.

The second opinion on the species in this group focused on the method for site selection as illustrated by the selection of Important Bird Areas (IBAs). It was analysed if for these species the most important areas were selected.

The second opinion shows five or more sites have been selected for the protection of twelve species. For only four of them these sites include one or two not protected SPAs reaching a situation in which their whole distribution area will be protected.

For many species less than five sites are selected because the sites where they regularly occur are less than five. So also for these species their entire populations will be protected.

For all species in the second opinion it was concluded that the existing SPAs in combination with a few IBAs represent the most important sites in Luxembourg. No new and additional sites have to be selected to fulfil the obligations of the Birds Directive.

Using LARCH the viability of the 30 species in the second group was analysed for all suitable habitat in the country as well as only habitat present in the existing Natura 2000 network (including SPAs and SACs). These viability results are shown in the species descriptions in Chapter 4.1.

The results of separate species show 18 of them having viable populations taking into account all suitable habitat in Luxembourg. However, most species do not have viable populations if only considering habitat within the existing Natura 2000 network. This illustrates the need for additional areas to be protected.

The LARCH analyses show a lot of species having their habitat in protected SACs within the Natura 2000 network indicating the protection of these species will improve if these areas are also designated as SPA, or otherwise these species are explicitly included in the site objectives. However, most species will benefit if the protected habitat will be expanded. This protection can be realised by extending sites within the Natura 2000 network or by selecting new and additional sites to the network. The analysed priority areas illustrate were sites can be selected which will benefit the viability of species and species groups.

For most of the 30 species within Luxembourg a viable population can be reached by expanding the protected area network (Table 1). For some viability is achieved under the condition of regular exchange with protected areas in neighbouring countries (e.g. Goshawk, Hazel grouse and Grey-headed woodpecker). Luxembourg is too small for a number of species to reach a sustainable situation. Their habitat is rare, too small and/or isolated illustrating their viability has to be guaranteed in a wider region and the need to look for viability targets in a wider region. Maybe even at the European level (e.g. Black stork, Corncrake, Quail and Lapwing).

Table 1

Viability and possible viability targets of the bird species included the LARCH analyses, based on all suitable habitats in Luxembourg, in the existing Natura 2000 network or in a wider region.

	Current Viability	**Possible viability target Luxembourg**	**Species**
1	Viable within Natura 2000 Luxembourg	Maintain viability	Green woodpecker*; Wood warbler*; Reed warbler; Sky lark; Linnet*
2	Viable in all suitable habitat in Luxembourg	Viable situation in Natura 2000	Honey buzzard; Middle-spotted woodpecker; Little owl; Red-backed shrike
		Key population, not viable in Natura 2000, but viable in Region	Black woodpecker; Water rail*; Black kite; Red kite; Quail; Meadow pipit; Great grey shrike
		Small population, not viable in Natura 2000, but viable in Region	Woodcock*; Common redstart*
3	Probably viable in Greater Region	Key population, not viable in Natura 2000, but viable in Region	Goshawk; Hazel grouse; Wryneck; Grey-headed woodpecker
		Small population in Natura 2000	Black stork; Kingfisher*; Lapwing; Eagle owl*; Peregrine falcon*
4	Probably not viable, not even in Greater Region	Small population	Corncrake

* No viability target, see species description

All analyses in the project are scientific based and most updated information on the distribution of the species and their habitats is used. The results show that Luxembourg has fulfilled or is closely to fulfill its obligations regarding the Birds Directive for most of the 64 bird species. The results also show the species which need additional protection, and at a strategic level where sites can be selected for protection.

1 Introduction

1.1 Background of the project and project questions

All EU Member States following the Birds Directive have to select and designate sites as a Special Protection Area (SPA) to protect a number of European bird species as mentioned in the Annex I from the Directive. Luxembourg has a specific responsibility for a number of these species, following the selection criteria of Article 4.1 of the Directive. This holds also for migratory bird species not mentioned in the Annex I, which, however, have a regular occurrence in Luxembourg taking into account their breeding, moulting and wintering places (Article 4.2). Based on the Articles 4.1 and 4.2 Luxembourg has to select sites for 64 bird species.

For the selection of sites some criteria are formulated in the Birds Directive, however a selection method is not prescribed by the EC. For bird species BirdLife International has designed a method to analyse Important Bird Areas which are used in a lot of Member States as the basis for SPA selection. This is also the case in Luxembourg, where the Luxembourg Bird Society (LNVL) has analysed nineteen IBAs based on bird distribution data and other information and following the criteria and method of BirdLife International

The Luxembourg government has already twelve of these sites selected and designated as SPAs.
Six of these IBAs are proposed by LNVL to be designated as additional SPAs encompassing about 28,625 hectares (Biver et al., 2010). The result of this analysis is mainly based on the habitat needs of specific species like the Hazel grouse (*Bonasa bonasia*) or bird species of open landscapes.

Given the analysis of the LNVL the European Commission has asked the Luxembourg government to evaluate the existing network of twelve designated SPAs and the importance of the proposed six IBAs becoming a SPA to fulfil their obligations following the Birds Directive.

For this evaluation the Ministry (Ministère du Développement durable et des Infrastructures, Département de l'Environnement) has started a project focusing on two questions:

1. Do the designated SPAs fulfil the obligations of the Birds Directive, in terms of a sustainable population network, for the survival of the bird species of Annex I, as well as migratory species as referred to in Article 4.2?
2. If the designated SPAs as a population network do not fulfil the obligations of the Birds Directive where can priority areas be analysed to become part of the Natura 2000 network?

1.2 Aim of the project

To implement the Birds Directive Luxembourg has to select sites for 64 bird species. Of these species 34 species show to be well covered by the designated SPAs as based on earlier analyses. For 30 species the coverage seems not to be sufficient.
Based on the questions mentioned in 1.1 the aim of this project is:

1. to analyse the sustainable population networks for 30 selected bird species which seem not sufficiently to be covered by the designated SPAs;
2. given the results of the analyses under 1, to analyse if the existing SPAs for Luxembourg fulfil the spatial conditions (in size and number) providing long term protection as a sustainable population network for those species listed in Annex I of the Birds Directive and which are known to be

insufficiently covered by the designated SPAs. Some bird species are included which have been selected according to the Article 4.2 of the Birds Directive (migratory birds);
3. to present, based on the results of the analyses under 2, a second opinion on the method and criteria used to select additional sites (IBAs) in Luxembourg, and based on that recommendations for improvement of the selection.

The strength and weaknesses of the existing SPA network in combination with proposed SPAs were analysed as a population network for the survival of the selected bird species (30) using the landscape–ecological model LARCH[1]. The interpretation of the model results focused on the effectiveness for the long-term protection, and whether there is a need for additional areas or, if necessary, for additional (management) measures.

A detailed description of the methods used for the analyses is presented in Chapter 2, the results are presented in Chapter 4.

For bird species of which the population viability was not analysed using the model LARCH (34 species), a second opinion was carried out on the method and criteria used for the IBA selection focusing on their sustainable network requirements in a more qualitative way. For this the best expert knowledge and experiences in Luxembourg and the Netherlands regarding the selection of SPAs was used. The results for the second opinion are presented in Chapter 3.

All analyses of the model LARCH and the second opinion will make clear how Luxembourg can fulfil its obligations coming from the Birds Directive. Conclusions and recommendations of the analyses in terms of priority areas and specific measures for species are presented in Chapter 5.

1 LARCH is a tool to visualise the viability of wildlife populations in a fragmented environment. LARCH is designed as an expert system, used for scenario analysis and policy evaluation. LARCH is widely used in the Netherlands (e.g. to evaluate the effectiveness and progress of the implementation of the Dutch Natura 2000 policy) and abroad (e.g. in Belgium, Italy, UK, France, Spain etc.; for details see Chapter 2 and Annex 3).

2 Methods

2.1 Viable population analysis

The Luxembourg government has, based on information and experience from LNVL, selected 30 bird species, which are not sufficiently covered by the designated SPAs in Luxembourg (Annex 2), to be analysed using the model LARCH (see Annex 3 for a short description of the model) to show their sustainable population networks (Chapter 4).
For 3 species (Peregrine falcon *Falco peregrinus*, Eagle owl *Bubo bubo* and Yellow wagtail *Motacilla flava*) it was decided later on not to include them in the group of the LARCH analysis. The Eagle owl and the Peregrine falcon are important and should be covered within the protected area network, however, the habitat is difficult to model. So it was decided to include only the known breeding sites and only an assessment was done of a few very specific breeding places.

The landscape-ecological model LARCH is based on the habitat requirements of species producing habitat suitability maps. In addition off all bird species population parameters are used which have been tested for the Dutch situation and which are calibrated for the Luxembourg situation using expert knowledge (from LNVL) and distribution data of the species.
The LARCH model analyses whether key populations can persist in the designated SPAs, and whether the populations together function as a sustainable network. For some bird species it is impossible to achieve a 'sustainable' population network, since the needed area for such a network is limited by the national territory and French, German or Belgian populations are crucial for the Luxembourg bird population. In these cases the viability assessment was based on expert judgement of ornithologists in Luxembourg and the Netherlands, using the best available data and knowledge of the species.
The results of the analyses of the model LARCH were compared to the designated SPAs in Luxembourg. In this way it became clear for which species a sustainable situation will not be reached within the designated SPAs and which additional suitable areas can supplement the current population to reach a more viable network population.

Description of species habitat requirements
For all species included in the LARCH analyses, information on their habitat requirements in general and in Luxembourg specially was selected. For most species this information, coming from international literature and websites and Luxembourg experts, describes their habitat use in a qualitative way (e.g. biotopes used). For some species this information was presented by LNVL and other experts in a more quantitative way e.g. as a habitat model described by the model MAXENT (Box 1) or based on a grid map showing suitability, or a map with points or polygons, indicating distribution for one or more years or a statistical tested relationship. To generate habitat suitability maps by LARCH using all this information on habitat requirements, the 27 bird species can be categorised into four groups. Table 2 shows the approaches for each species to generate habitat suitability maps, i.e. the basic habitat data on which the analysis was done. Most species are modelled with standard LARCH parameters (i.e. parameters which were used before). The parameters were adjusted if necessary after discussing with the ministry and LNVL the first modelling results showing the distribution of a species and its habitat.

Table 2

Selected bird species for LARCH analysis and four categories of information used to describe habitat suitability (see text).

1: LARCH standard	2: LARCH adjusted	3: LARCH- Lux habitat suitability map	4: LARCH- Lux distribution map
Goshawk	Reed warbler	Black kite	Lapwing
Sky lark	Black stork	Red kite	Kingfisher
Meadow pipit	Green woodpecker	Water rail	Corncrake
Hazel grouse	Grey-headed woodpecker	Middle spotted woodpecker	Partridge
Linnet		Black woodpecker	Little owl
Quail			Great grey shrike
Wryneck			
Red backed shrike			
Honey buzzard			
Redstart			
Wood warbler			
Woodcock			

1: LARCH standard

Usually it is possible to model with LARCH the habitat of a species based on its known habitat preferences and the descriptions of the habitat map (OBS-map). Sometimes the map has to be adjusted for a proper description and spatial selection of the species habitat. For that reason other maps refining the OBS-habitat are used e.g. the forest map for the Wryneck *(Jynx torquilla)*. It should be kept in mind that the combination of the OBS-map and other maps describe the *POTENTIAL* habitat. This will not always fit entirely the (current) distribution of a species, for various reasons. It should be reminded that using models the actual situation has to be simplified.

2: LARCH adjusted

If the OBS-map has to be refined to describe a species habitat suitability in a proper way the habitat models can be improved using additional maps showing:

- additional geographical data (e.g. vicinity to water or streams, presence of floodplains, altitude, slope or high- or lowland).
- additional habitat data (quality parameters) like land use intensity or management etc.
- spotted birds or known territories (sub-selection of areas).

For some species it was decided to use additional data on:

- Wetlands (Feuchtgebiete) and Reed beds (Schilf) for Reed warbler *(Acrocephalus scirpaceus)*.
- Maps of rivers, floodplains and river valleys was used with MAXENT (Box 1) for the Black stork *(Ciconia* nigra) and the Kingfisher *(Alcedo atthis)* (see also Group 4).
- Land use intensity for the Corncrake *(Crex crex)* (see also Group 4).

3: LARCH-Lux habitat suitability map

For some species the habitat can be described in a more quantitative way (based on e.g. a statistical analysed relationship) or using distribution data (Table 2). In the case of statistical analysis the habitat suitability is expressed by the chance of occurrence of a species (which is described on a scale from 0-1 for each grid cell from the map).

If such analysed relationship is not available, the occurrence of breeding sites or observation points was used, which will be linked to the vegetation polygon in the immediate neighbourhood to describe the 'suitable' habitat. However, in this case the question is how complete the observations are. If they are incomplete, it

may be better to use the standard modelling with LARCH, which is for potential habitat for the whole country. As an example the Water rail *(Rallus aquaticus)* can be mentioned having a habitat based on limited distribution observations (Information by LNVL).

4: LARCH- Lux distribution map
For some species their distribution data was used in combination with the OBS-map and additional data. This is illustrated by the Luxembourg Woodpecker species for which the forest classification is very important. Other thematic maps can be used to improve the habitat suitability description, such as rivers, floodplains or extensively used grassland or farmland (e.g. Corncrake).
For modelling the habitat suitability of some species the model MAXENT was used (Box 1). The MAXENT modelling results qualify in more detail the selected land cover polygons taken from the Luxemburg OBS land cover map. MAXENT modelling was done in detail by LNVL (G. Biver) and for some species more indicatively by Alterra. Inventory data from the period 1997-2009 was used, as well as environmental data like climate and land cover (OBS).

MAXENT (MAXimum ENTropy) is (freely available) software that is used to predict the potential distribution (habitat modeling) of animal or plant species on the basis of point-like distribution data combined with a set of environmental factors http://www.cs.princeton.edu/~schapire/maxent/
The knowledge about the distribution of species and the understanding of their habitat requirements is important, for example, if suitable conservation areas should be selected. The delineation of the appropriate area by just species distribution data alone or a simple vegetation(structure) or land use map is very often limited. The MAXENT model can be used to do a statistical distribution modeling (Phillips et al., 2006)
As input variables MAXENT uses spatial data:

- distribution data of the modeled animal or plant species
- appropriate environmental data (e.g. environmental factors such as soil type, altitude and/or topography)

MAXENT is based on the maximum entropy method. The model delivers as a result a map, showing the predicted probability of the potential occurrence in a given area, ranking from high to low values. Secondly, additional statistical interpretation tools, such as an indication of the relative contribution of the input variables, can be given to interpret the model output and to to select variables which are directly relevant to the species modelled.

Box 1
The MAXENT model.

The results of the modelling exercises were evaluated and calibrated based on the data on the species distribution (Melchior et al., 1987). This distribution atlas was used and additional spatial data (point observation data) which was provided by LNVL. All information on species distribution was used to check the accuracy of parameters, e.g. the carrying capacity of habitat used in LARCH (see Annex 3).

It should be noted that no field data was collected for this research. The work is based on existing information, distribution data, maps, etc. from LNVL, which forms the most extensive and up-to-date information for Luxembourg.

2.2 Developing viability targets for species

The LARCH analysis focuses on the development and maintenance of viable populations. This is based on species-specific parameters, or characteristics, as well as empirically defined parameters for birds (Verboom et al., 2001). LARCH uses viability norms as shown in Table 3 which are related to the principles of metapopulation ecology.
The most viable situation of a species population is one large area of optimal habitat, which is large enough for a Minimum Viable Population (MVP). A MVP is defined as a population for which the chance of extinction is less than 5% in 100 years. Such a population is considered to be 'viable' in the long term. Slightly less viable is a key population, which is defined as a population which is viable under the condition of one immigrant per year. Otherwise, we consider an area as a 'small population' if the area within the home range of a species is large enough for at least one breeding pair (Verboom et al., 2001).

A fragmented population occupies different habitat patches which, however, can still be viable. Viability norms in LARCH are depending on the presence of a key population and the total size of the population as shown in Table 3. In principle, larger and more connected habitat is more viable than small fragmented habitat of the same size. As a consequence to achieve viability, more habitat is required in a situation which is very fragmented and less habitat in the case that one extensive natural area exists which is large enough for a Minimum Viable Population (Figure 1).

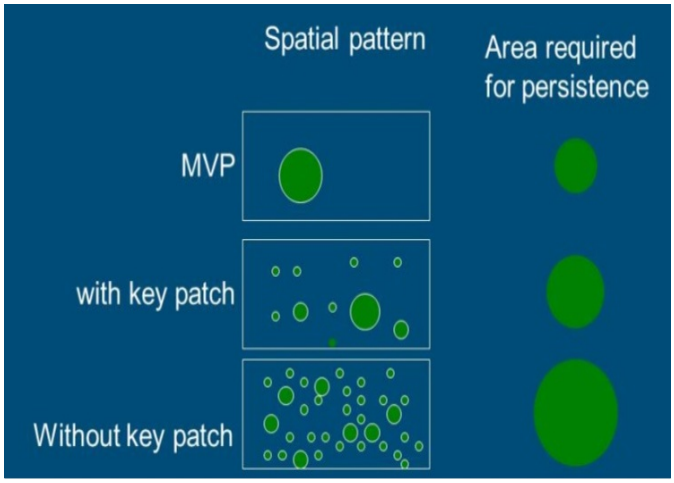

Figure 1
Sustainability of fragmented populations in relation to the distribution (spatial pattern) and total area of required habitat.

However, also a key population can be a good basis for conservation in Luxembourg assuming that neighbouring countries like Germany, Belgium and France protect similarly populations and areas for those species, resulting in the exchange of necessary immigrants to sustain the key populations.

Table 3

Viability norms in terms of Breeding Pairs (BP) (based on Verboom et al., 2001).

Bird group	key population(KP)	viability with KP	viability without KP
Small sized species	100	150	200
Medium sized species	40	120	200
Large sized species	20	80	120

Based on the viability principles we have formulated viability targets for each analysed species having in mind:
- the current viability of the species in Luxembourg
- how is the target related to other land use

The targets were formulated using a step-wise approach following a number of decisions (Figure 2). However, in the case the modelling results or the knowledge of a species do not justify such targets, no target is formulated (e.g. Peregrine falcon and Eagle owl in par. 4.1.2).

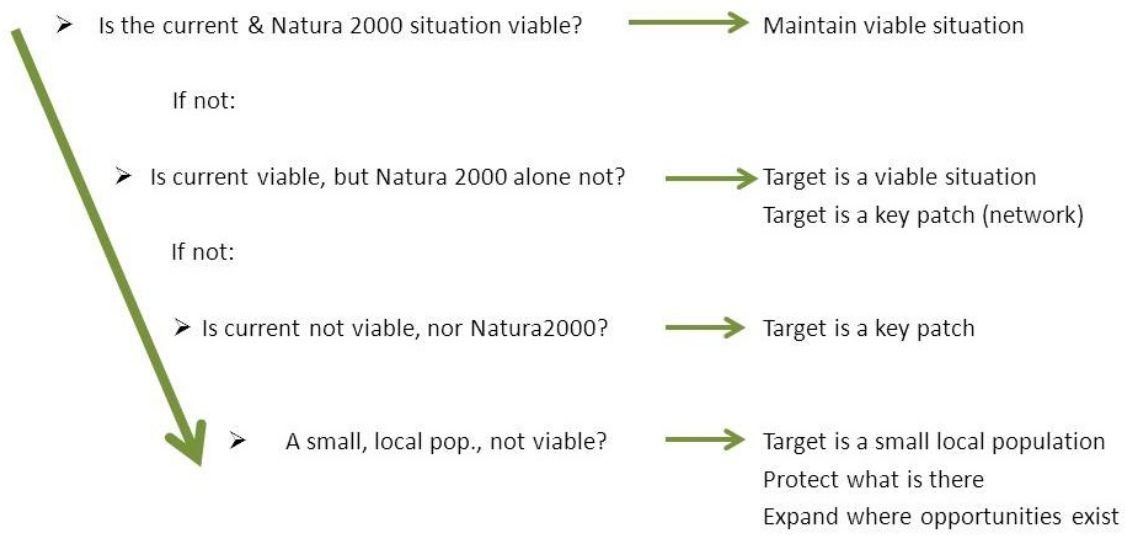

Figure 2

Decision tree - stepwise approach for defining targets for area protection.

2.3 Identification of important areas using groups of species

Habitat suitability maps for each species were generated by LARCH at a grid size of 500 X 500 m (half-kilometre square). These maps could be compared with other maps e.g. showing the protected areas in Luxembourg (Natura 2000 and other protected areas) and areas proposed to be protected (IBAs). Using overlays in this way it can be shown at the species level which areas of suitable habitat are or are not protected (Figures showing optimal areas for all species in Chapter 4). Based on such a comparison it can be shown that a large area of Luxembourg representing suitable habitat is still not protected. However, this does not make clear which areas contribute most to the survival of a selected species. Otherwise the need for some areas to become protected overlap for species because they use the same type of landscape. So it was decided to group species based on their ecological needs as represented by their combined habitat

preference or biotope (Figure 3 and Tables 4, 5 and 6) and to analyse the areas (grids) which contribute most to the survival of all species within a group.

Grouping of species

The modelled species share certain forest habitat preferences (Figure 3), however, they also differ in habitat use at a more detailed spatial level. For instance eleven species using the forest habitat type do not use the same 'forest biotope'. Some prefer dense old and interior forest, whereas other species may depend on forest edges, more open forest, forest plantations or alluvial forests (Table 4).

Using species groups it can be made clear which species may equally benefit from certain protection or management measures as is presented in the results (Chapters 4.1.2, 4.1.4 and 4.1.6).

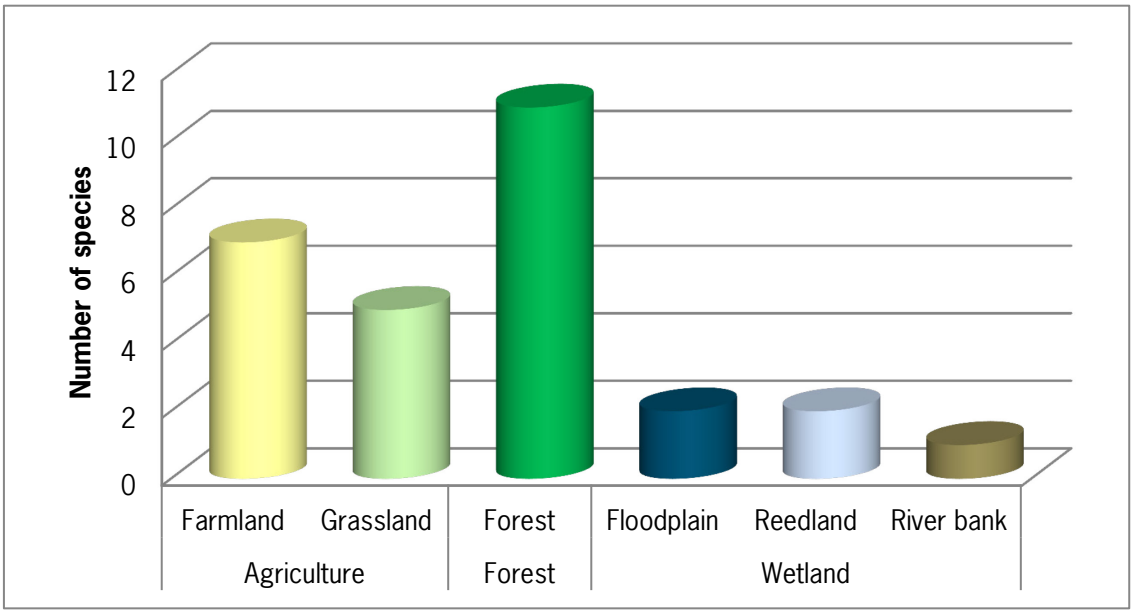

Figure 3

Biotope preference of the modelled species.

The five species associated with wetlands are presented in Table 5. Species like Corncrake and Black stork are mostly associated with the floodplains. The Black stork feeds in shallow water (but breeds in forest areas), the Corncrake breeds in natural riverine grassland. Reed warbler and Water rail live in reed land, the Water rail in particular in dense reed land. The Kingfisher breeds in riverbanks and feeds in rivers, streams and ponds. Although all are considered to be wetland species, they form a rather diverse group regarding their habitat preferences.

Eleven species are typical farmland species (Table 6). Some use in particular cropland, others mainly grasslands, and some species use a combination of both habitats. The modelling of habitat in LARCH for these species is complicated because of the important role of the management of agricultural fields for their population survival and its mapping (compare intensive versus extensive ways of management). Also the presence of linear elements can be important, which are not well mapped. E.g. the Little owl *(Athene noctua)* uses a small-scale landscape, with rich invertebrate fauna, just like the Grey partridge *(Perdix perdix)* or the Quail *(Coturnix coturnix)*.

Table 4

Forest species modelled with LARCH.

Common name	Species	Forest type
Grey-headed woodpecker	Picus canus	Alluvial
Goshawk	Accipiter gentilis	Interior
Black woodpecker	Dryocopus martius	Interior
Wood warbler	Phylloscopus sibilatrix	Interior
Woodcock	Scolopax rusticola	Mixed
Middle spotted woodpecker	Dendrocopos medius	Old
Wryneck	Jynx torquilla	Open
Honey buzzard	Pernis apivorus	Open
Green woodpecker	Picus viridis	Open
Redstart	Phoenicurus phoenicurus	Open
Hazel grouse	Bonasa bonasia	Coppice

Table 5

Wetland species modelled with LARCH.

Common name	Species	Wetland type
Corncrake	Crex crex	Floodplain
Black stork	Ciconia nigra	Floodplain
Reed warbler	Acrocephalus scirpaceus	Reed land
Water rail	Rallus aquaticus	Reed land
Kingfisher	Alcedo atthis	Riverbank

Table 6

Farmland species modelled with LARCH.

Common name	Species	Forest type
Linnet	Carduelis cannabina	Cropland
Grey partridge	Perdix perdix	Cropland
Lapwing	Vanellus vanellus	Cropland
Sky lark	Alauda arvensis	Cropland
Quail	Coturnix coturnix	Cropland
Black kite	Milvus migrans	Grassland
Meadow pipit	Anthus pratensis	Grassland
Little owl	Athene noctua	Grassland
Red kite	Milvus milvus	Crop/Grassland
Red-backed shrike	Lanius collurio	Grassland
Great grey shrike	Lanius excubitor	Grassland

Important areas

To analyse important areas for the survival of bird populations the potential carrying capacity of a grid cell (500 x 500 m) for a species in terms of breeding pairs (BP) was used, which is an outcome from LARCH (see Annex 3). These values were made comparable for the species in a group (see below). In this way the grid cells which contribute most to the survival of all species of a group can be calculated and mapped and areas important for the protection of these species can be identified and selected. In this way maps and tables are produced and presented showing the (priority) areas where the highest number of species benefit from the habitat present (e.g. Figure 27 for forest species and Figure 60 for farmland species). However, to decide if a grid cell should be included in such an area or not a decision criterion has to be used. For this reason a survival target was formulated for each species in terms of the minimum condition for the species to survive (e.g. one key population with x breeding pairs or a number of small patches with y breeding pairs; Table 10, 13 and Table 14 in Chapter 4).

Summarising the way of working in analysing the priority areas the following steps can be identified:

a) Define the area of suitable habitat for a specific species in each cell.
b) Multiply the area by the carrying capacity (cc) of a species for each habitat type (showing the potential population or number of breeding pairs in each cell).
c) Extract the relative population of each cell, and calculate the share of the total population based on the LARCH results.
d) Normalize the total (1-100) and standardize it using the standard deviation for scaling (standard deviation -1 to 1 with an average value of 0).
e) Sum the values for each cell for a specific biotope, e.g. for forests species (eleven bird species).
f) Overlay the grid map with the Natura 2000 sites, to identify clusters of cells which are currently outside Natura 2000 sites.
g) Delineate areas with a high summarized value for a species group and calculate the total contribution for each species. These areas show as searching areas the opportunities to select new areas or additional areas adjoining existing Natura 2000 sites.

All steps can be described in more detail:

Ad a. For each habitat polygon in a cell the area is defined.

Ad b. The area is multiplied by the carrying capacity (cc) and summarized for the cell. This is done for all suitable habitat types in the cell, for not suitable types cc= 0 (see example: cell 2: area of Habitat A = 70,000m2, Habitat B = 110,000 m2, cc resp. 2 BP/100 ha= 0.5/cell and 0.2 BP/100 = 0.05/cell. (70000/250000 * 0.5)+(110000/25000*0.05)=0.14+0.022=0.162 breeding pairs.

Ad c. To calculate the relative importance (population) of each cell its population is divided by the total population (In the example above, if the total population is 162 breeding pairs, the share of cell 2 = 0.162/162= 0.001).

Ad d. To make all results comparable for different species, the results are normalized by setting the minimum value at 0 and the maximum value at 100. To define what the least or most contributing cells are, the standard deviation is defined, to show cells which contribute more or less than average.

Ad e. For each cell the sum for subsets of species is calculated. E.g. for forest birds (eleven species), the normalized value is summed up and the maximum value can be 762. The highest value is achieved in cells which consist entirely of optimal habitat for all species. The grouping is done for forest species, for wetland species and farmland species.

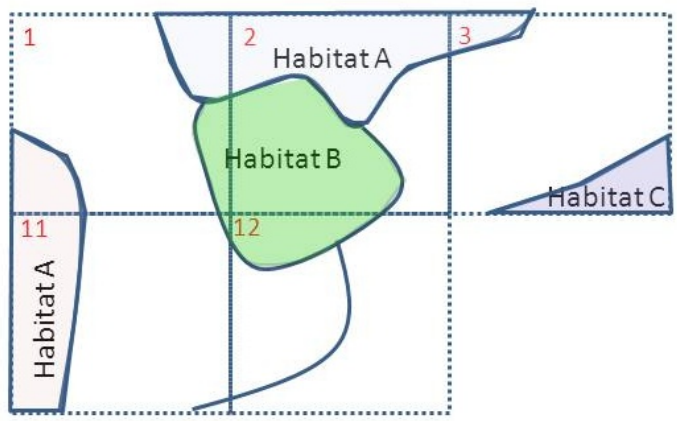

Figure 4

Calculation of the relative importance of grid cells; see text for explanation.

Ad f. The Natura 2000 map is converted to a grid. Since the polygons are rather irregular, this results in many cells with only a small share of Natura 2000. Therefore a threshold is used of 40%, if more than 40% of the cell consists of Natura 2000 the cell is included in the subset of Natura 2000. This allows for visual comparison of areas in Luxembourg. Cells which contribute much for a specific species or group of species and are outside the Natura 2000 can now easily be identified.

Ad g. Grid cells are clustered with a high contribution for a species group (based on standardized values). These clusters are visually identified. These clusters are transformed into polygons (areas) for which the potential population for all species has been calculated.

However, at the end of the analyses it was concluded for one forest species (Common redstart *Phoenicurus phoenicurus*) and all wetland species that grids contributing most to the survival of a species did not fit the results at group level (areas analysed to protect at species level do not fit the areas at group level). For these species conclusions will be based on the analysis at species level. This means that possible additional areas for protection are based on their contribution to the survival target for this species.

3 Second opinion

3.1 Introduction

As stated in the Introduction (Chapter 1) Luxembourg has the responsibility to designate areas of ornithological interest under the Birds Directive (SPAs) for 64 bird species. In 2010 the status of twelve SPAs already designated in 1997 was evaluated and six Important Bird Areas (IBAS) as additional areas were proposed to become SPA, based on the method of BirdLife International (Biver et al., 2010; Table 7).

Table 7
Sites and their status (SPA and/or IBA; numbers according to Biver et al., 2010).

nr	status	name area
1	SPA/IBA	Aspelt- Lannerburg am Kessel
2	SPA/IBA	Dudelange Haard
3	SPA/IBA	Esch-sur-Alzette Sud-est-Anciennes minières/Ellergron
4	SPA/IBA	Haff Réimech
5	SPA/IBA	Minières de la région de Differdange- Giele Botter, Tillebierg, Rollesbierg, Metzerbierg et Galgebierg
6	IBA	Région de Junglinster
7	IBA	Région de Mompach, Manternach, Bech et Osweiler
8	IBA	Région de Schuttrange, Canach, Lenningen et Gostingen
9	IBA	Région du Lias moyen
10	IBA	Région Kiischpelt
11	SPA/IBA	Vallée de la Syre de Moutfort à Roodt/Syre
12	SPA/IBA	Vallée de la Trëtterbaach et affluents de la frontière à Asselborn
13	SPA/IBA	Vallée de la Woltz et affluents de la source à Troisvierges
14	IBA	Vallée de l'Attert
15	SPA/IBA	Vallée de l'Ernz Blanche de Bourglister à Fischbach
16	SPA/IBA	Vallée supérieure de la Sure et affluents de frontière Belge à Esch-sur-Sure
17	SPA/IBA	Vallée supérieure de l'Alzette
18	SPA/IBA	Vallée supérieure de l'Our et affluents de Lieler à Dasbourg

This evaluation of the existing SPA network covers 34 bird species of which the distribution and habitat are considered to be covered or very well covered by the designated SPAs (Table 8, 5th column).

The selection of species and areas in Luxembourg is strongly based on information and analyses of the local partner of BirdLife International in Luxembourg the Centrale Ornithologique Luxembourg (LNVL).
However, there is the need for a second opinion focusing on the site selection of the 34 bird species mentioned above because the first selection of sites for these species is based on relatively poor data sets. Recent monitoring data makes it possible to evaluate the results of the first selection process and the results of the IBA analysis.
So, the second opinion focused on the question if the SPA network and selected IBAs for these species are sufficient for Luxembourg to fulfil its obligations coming from the Birds Directive.

3.2 Species and site selection

The formal obligations of the Member States in Europe for protecting bird species can be found in the Birds Directive:

- Article 1 states that the Directive relates to the conservation of all species of *wild birds occurring naturally* in the European territory of the Member State, in this case Luxembourg, and that it applies to bird, their eggs, nests and habitats.

- Article 2 requires Member States to take measures to *maintain the population* of the species referred to in Article 1 at a level that corresponds in particular to ecological, scientific and cultural requirements, while taking into account economic and recreational requirements, or to adapt the population of the species to that level.

- Article 4.1 requires Member States to take special *habitat conservation measures* to ensure the survival and reproduction in their area of distribution of species listed in Annex I that are: (a) in danger of extinction; (b) vulnerable to specific changes in their habitats; (c) considered rare, because of small populations or restricted local distribution; or (d) in need of particular attention, due to the specific nature of their habitat.

In particular, Member States are required to classify the *most suitable territories in number and size as special protected areas* (SPAs) for the conservation of these species, as well as for *regularly occurring migratory species* (Article 4.2).

To fulfill the obligations coming from the Birds Directive Member States require a method and criteria to identify species for which a Member State has a responsibility and to select a number of areas or 'sites' to protect. Regarding site selection, however, the Birds Directive does not present such a method and criteria. Nevertheless The European Court has judged that a list of 'important bird areas' will be acknowledged as the authoritative, scientific basis in declaring SPAs.

To select Important Bird Areas (IBA) a program was launched by - a predecessor of - the bird protection organization BirdLife International. Twenty criteria were set for Europe which should make it possible to analyse and select IBAs of international importance (Grimmett and Jones, 1989). Experiences with this method for site selection in the Netherlands and the Czech Republic reveals that the number of categories and criteria can be reduced:

1. A site which is regularly used by at least one percent of that country's population of that species named in Annex I of the Birds Directive, at any time of the year. The five best locations will be selected for each species for breeding and/ or not breeding.
2. A site regularly used by at least one percent of the biogeographical population of a migratory species, regularly found there at any time of the year. Special attention should be given to wetlands, especially wetlands of international importance (according to the 'Wetlands Convention').
3. A site regularly used by large congregations of water birds, storks, raptors and/or cranes.

However, criteria for the selection of species and areas cannot easily be separated. For instance the Birds Directive asks Member States to take the same actions for non-migratory birds (Annex I) as well as migratory species not listed in this Annex I, taking into account endangered species, species vulnerable to specific changes in habitat, rare species or species with a restricted local distribution and other species requiring special attention. That is why several states also used the IUCN national red list as a selection criterion. In addition, migratory species whose status can be described as 'unfavourable' in Europe (BirdLife International, 2004) and whose distribution is concentrated in Europe can also be selected.

Species from Annex I always qualify for the national list if present, but if there are no (known) sites where the species regular stays in numbers larger than one or two, no site can be selected. For species possibly qualifying for site selection, according to the Article 4.2, in the Netherlands the 1%-criterion is followed stating that a site qualifies if at least 1% of the biogeographical population stays there (Roomen et al., 2000). If there are no such sites the species does not qualify. Another criterion in the Netherlands states that a site qualifies if at least 100 ha has a conservation status.

Additional criteria for the selection and delineation of areas have been published by Grimmett and Jones (1989) and Heath and Evans (2000): an area of ornithological interest can be described as part of a landscape or region in which selected species are present in a number and density higher than average, in which important habitats are abundant and where conservation measures can be taken to ensure the maintenance of the species.

All criteria mentioned above show that making an appropriate selection of species and areas need reliable information on:

1. Official status of the bird species in the country.
2. Knowledge of the distribution of the species.
3. Size of the breeding population and the numbers of a species which visit the country.
4. Information about the habitat requirements of the species.
5. Information about the distribution of the habitat and the population.

3.3 Results

To evaluate the existing SPA network and the necessity to designate extra IBAs as SPAs for the 34 species mentioned above the method and criteria applied by LNVL were compared to the criteria mentioned above using new monitoring information on some species and the best expert knowledge in Luxembourg and the Netherlands on the ecology of bird species and experiences in selecting SPAs in the Netherlands.
Because the selection of species and areas cannot completely be separated as stated above (par. 3.2), the whole process described in Biver et al. (2010) is followed and also attention is paid to the selection of species. It is clear the 34 species of the second opinion are selected because of they are either in the Annex I (Article 4.1) or are a wetland species (Article 4.2), or they are on the European red list and/or the national red list. However, in Biver et al. (2010) no bird counts or population estimates and other quantitative data is presented what makes it difficult to use some criteria such as the 1% criterion. Also quantitative information at site level is missing making it impossible to judge if the best sites are selected.

From the information presented in Biver et al. (2010) it was concluded that it apparently was not possible to select species and sites in a systematic way, making it difficult to conclude that for the 34 selected bird species the distribution and habitat is covered well enough by the already designated SPAs.

For the second opinion additional information about locations and observed numbers of the 34 species was collected during November- December 2011 with the help of LNVL. All information showing the relation between species and designated SPAs and selected IBAs is presented in Table 8 (also in Annex 1).
According to the guidelines of BirdLife International the five most important sites for a species will be selected. Table 8 shows for sixteen species at least four sites are selected. For seven species less than three sites are selected. For many species less than five sites are selected because there are less than five sites where a species regular occurs. For these species it is not useful to select more sites.

Table 8

The 34 species, protection status, information about population (numbers or breeding pairs) and distribution, existing and proposed protection by SPA/IBA, necessity to select at least five areas and their category assigned in the second opinion (see text). RL= red list, b= breeding, nb=not breeding (wintering and/or staging).

Annex I	Species	4.2 Other EU conservation status	Population & distribution	coverage of the population	N SPA/IBA	Top 5	category
	Acrocephalus arundinaceus	RL	b; 6-10 on only one site	very high	3	No use	B
X	*Acrocephalus paludicola*	SPEC 1	nb; 3-10 on 3 sites	high	3/1	No use	B
	Acrocephalus schoenobaenus	Non-SPEC E	nb; 1-5 on existing SPAs	high	3	No use	B
X	*Aegolius funereus*	SPEC 3	b; 0-1; not regular	unknown	3	No use	0
	Anas querquedula	SPEC 3 RL	b; nb; 1-2 on existing SPAs	very high	5	Fine	A
	Anser fabalis	Non-SPEC E	nb; 50-15 on only one important site	very high	3	No use	B
X	*Asio flammeus*	SPEC 3	nb; 3; not regular	unknown	4/2	Fine	0
	Aythya ferina	SPEC 2	b	very high	1	No use	B
	Aythya fuligula	SPEC 3 RL	b, nb; 5-7 on existing SPAs	very high	3	No use	B
X	*Aythya nyroca*	SPEC 1	nb; rare only on one site	very high	1	No use	B
X	*Botaurus stellaris*	SPEC 3	nb; 5 on only one important site	very high	2	No use	B
X	*Caprimulgus europaeus*	SPEC 2	b,nb; 1-5; not regular	unknown	2	No use	0
X	*Ciconia ciconia*	SPEC 2 RL	b,nb; not regular	high	4	No use	A
X	*Circus aeroginosus*		b,nb; not regular	unknown	6	Fine	0
	Circus pygargus	Non-SPEC E	nb; not regular	unknown	3	No use	0
	Corvus corax	RL	b; 1>>10 increasing	unknown	3	No use	C
	Gallinago gallinago	SPEC 3 RL	b, nb; regular dispersed	high	6	Fine	A
X	*Grus grus*	SPEC 2	nb; two important sites	very high	2	No use	B
X	*Ixobrychus minutus*	SPEC 3 RL	b; 5-7; on only one site	very high	1	No use	B
X	*Lullula arborea*	SPEC 2	b, nb; 25-30 on 3 main sites	high	7	Fine	A
X	*Luscinia svecica*	RL	nb; regular on 4 sites	high	5	Fine	A
X	*Mergus albellus*		nb; 10 regular on only one site	very high	1	No use	B
	Motacilla flava	RL	b, nb; 50-70 on several sites	low	5/1	Fine	A
X	*Pandion haliaetus*	SPEC 3	nb; regular on several sites	high	4	No use	B
	Parus cristatus	SPEC 2	b; 2500-3000, widely spread	medium	3	No use	C
X	*Philomachus pugnax*	SPEC 2	nb; regular on 5 SPAs	high	7	Fine	A
X	*Pluvialis apricaria*	Non-SPEC E	nb; regular and widespread	high	4	Not possible	A
	Podiceps cristatus	RL	b, nb; 18-20 regular breeding on 2 sites	high	6	Fine	A
X	*Porzana porzana*	Non-SPEC E	nb; regular on 3 sites	high	3	No use	B
	Remiz pendulinus	RL	b, nb; 1-2 breeding on only 1site	very high	2	No use	B
	Riparia riparia	SPEC 3 RL	b, nb; 30-40 on 3-4 sites	high	3	Not possible	C
	Saxicola rubetra	Non-SPEC E RL	b, nb; 1-10 on regular sites?	high	6/1	Fine	A
X	*Tringa glareola*		nb; regular on one rare on 3 sites	high	6	Fine	A
	Tringa totanus	SPEC 2	nb; regular on one rare on 3 sites	high	5	Fine	B

To evaluate the number of selected sites for a species all 34 species were distributed over four categories (O, A, B and C) representing their occurrence in Luxembourg and protection (number of designated sites and Article 4.1 or Article 4.2):

- O: no regular staging, wintering or breeding bird in Luxembourg.
- A: four or more sites designated.
- B: mostly the best and only one to three sites designated.
- C: special cases.

Table 9

Number of species in each category.

Criterion	Category:	O	A	B	C	Total
Art. 4.1		4	8	5	0	17
Art. 4.2		1	6	7	3	17
	SUM	5	14	12	3	34

For each category the site selection will be discussed.

0 Species which do not occur regularly in Luxembourg

From the list of 34 species five species *(Aegolius funereus, Asio flammeus, Caprimulgus europaeus, Circus aeroginosus and Circus pygargus)* do not occur regularly in Luxembourg. They show a dynamic use of space (do not occur on the same sites each year) and have small numbers. The coverage of their distribution by the SPAs is quite unknown. Most of the species are Annex I species. Despite their uncertain occurrence two to six sites are designated for the species including their whole populations. In fact they could have been skipped for site selection.

A Regular species for which four sites or more are designated

Because Luxembourg is a small country it is not likely to have many areas where species from Annex I occur or where one percent or more of the biogeographical population of a bird stays during migration or in the winter. Nevertheless for sixteen regular occurring species at least four sites or more are selected. For at least seven species more than five sites are selected resulting in a high coverage of their distribution. Only the coverage of *Motacilla flava* is low because of a dispersed distribution. So for most species these sites cover almost their whole population and the designated sites protect these species in a sufficient way.

B Species for which one to three sites are selected

For twelve species one to three sites are selected. These species are on Annex I as well as on red lists. For four waterfowl en two wetland species only one or two suitable sites are present which can be selected. The distribution of the nightjar (*Caprimulgus europaeus)* is not very well known. Maybe it can also be considered as an irregular visitor.

Also for these species the maximum number of sites is selected. The populations of two third of the species are very highly covered. There is no need to select more sites because, according to the given information, the most important sites are already selected and protected as SPA. Besides, related to Luxembourg as a small country the survival of these species is almost completely dependent on other countries.

C Special Cases

Although on the red list, *Parus cristatus* is not threatened at all in Luxembourg and it can be considered as an exotic species because it is mainly bound to exotic coniferous forest. In Biver et al. (2010) the selection of 'five nuclei at the highest density' is mentioned. For this species three sites are selected from which one is a new proposed IBA.

There are two other special cases. One is *Corvus corax*, a species on the red list but recently recovering very well. It is spread over a large forest area in low densities. In the present state it would not have been selected to be on the red list. For three sites it is assigned as a resident.

Another special case is *Riparia riparia*. Its natural habitat occurs on steep riverbanks, however in Luxembourg it is mainly breeding in temporary sandpits etc. It is adapted to a dynamic habitat. Protection of breeding sites during the breeding season is feasible and there is no reason for a permanent protection of these sites, because most are in use for just a few years. Protection can be arranged in other ways than by site designation. Three sites are selected for this species, from which one is for breeding.

4 Results LARCH analysis

4.1 Habitat model and population analysis

4.1.1 Forest biotopes

The current situation of the habitat of most forest species shows viable populations as analysed by LARCH (Table 10, current situation). This is under the assumption that all habitat contributes, irrespective if it is protected or not. Based on the reasoning that the Natura 2000 network should provide long-term protection for the species which are listed in the Birds Directive, the current habitat situation and population viability is compared to the situation with only habitat on the protected Natura 2000 sites (par. 2.2 and Table 10). On average some 29% of the populations would be sustained within these protected areas. Table 10 shows that protecting habitat only on Natura 2000 sites results in a serious decline of the viability of many forest species. Even most species have no viable population anymore, as a result of the decrease and the fragmentation of their habitat. Based on this outcome for each species a viability target is formulated. For most species this target aims at the development or maintenance of a key population.

Table 10

Population viability of forest species based on LARCH (current situation) compared to Natura 2000, and proposed viability target (BP= breeding pairs; MVP= minimum viable population, KP= key population, SP = small population, v= viable, nv= not viable [2]).

Common name	Current situation	Natura 2000	Viability target (par. 2.2)
Goshawk	KP 56 BP (nv)	SP 16 BP (nv)	key population
Honey buzzard	MVP 163 BP (v)	KP 54 BP (nv)	key population, viable
Hazel grouse	KP 71 BP (nv)	SP 15 BP (nv)	key population; protect all habitat
Woodcock	MVP 360 BP (v)	SP 101 BP (nv)	*
Wryneck	KP 198 BP (v)	SP 45 BP (nv)	key population
Grey-headed woodpecker	KP 64 BP (nv)	SP 20 BP (nv)	key population
Green woodpecker	MVP 796 BP (v)	KP 253 BP (v)	key population, viable
Black woodpecker	KP 138 BP (v)	SP 45 BP (nv)	key population
Middle spotted woodpecker	KP 384 BP (v)	SP 161 BP (nv)	key population, viable
Wood warbler	MVP 5549 BP (v)	KP 1918 BP (v)	*
Common redstart	SP 563 BP (v)	SP 77 BP (nv)	*

* No viability target, see species descriptions

The assessment of each species is discussed in the following sub-paragraphs using maps showing the (LARCH) viability based on all habitat present (current situation) and only habitat present within the Natura 2000 network. The survival target is explained. Based on this target areas are identified which contribute to the

2 Note: explanation of terms in par. 2.2.

survival of each species. These priority areas include only not protected areas, so these are additional to the Natura 2000 network.
At the end of this Chapter a map (Figure 27) is presented showing the location of the priority areas in relation to the Natura 2000 sites.

4.1.1.1 Goshawk *(Accipiter gentilis)*

The Goshawk is a resident bird species. Its numbers declined dramatically as a result of hunting pressure and pesticide use, with the lowest numbers in the 1970s, however, since then the population has recovered in all northern European countries.
The Goshawk is present in almost all larger, quiet (beech) forests of Luxembourg with dispersed open areas. The nest is usually built in tall forest, conifer forest but also beech forest. Hunting usually takes place in a range of up to 6 km from the nest. In winter it is also hunting above open fields. The species feeds mainly on birds (pigeons, sparrows) and to some lesser extent on mammals (rabbits, hares, squirrels, mice and voles). Important for the Goshawk are the designated SACs Vallées de la Mamer and l'Eisch and Bois de Herborn (personal communication G. Biver).
The LARCH model predicts 56 breeding pairs at the moment. In reality there are some 40-50 breeding pairs (Lorgé and Melchior, 2010), which shows a good fit with the model. The population is well connected and forms a key population (for definitions see par. 2.2 and Figure 1). It depends however on neighbouring countries to be viable in the long run.
Looking at the potential carrying capacity of the Natura 2000 sites, the population will be reduced to several small populations, totalling some sixteen breeding pairs and will not be viable under these conditions. This leads to the conclusion that the Goshawk population is not well covered by the existing SPA network.
It appears that the most important populations are in SPAs. The model predicts highest densities for the south of the country. In particular Grünewald and Muellerthal are import priority areas.
Viability target: For large birds like the Goshawk, at least 20 birds are required for a key population (par. 2.2). The population within Natura 2000 sites is just below the size of a key population. The minimum target for conservation could be to realise a key population (par. 2.2). A higher target aiming at a viable population based on all habitat in Luxembourg is not feasible. A key population will be augmented by individual coming from forest areas in neighbouring countries resulting in a viable situation in Luxembourg.
Since the density is low, and the Goshawk occurs all over the country, there are not many particularly good areas. The two small populations in the north and south would ideally be linked by connecting them. Potential suitable forest areas currently not protected are near Buchholz and Canach, southeast of Luxembourg city. Also west of Vallée de l'Ernz (Bourglinster) is some relatively important forest habitat for the Goshawk. Finally, west of Colmar are some important forest areas. The potential contribution of these areas would be some seven breeding pairs.

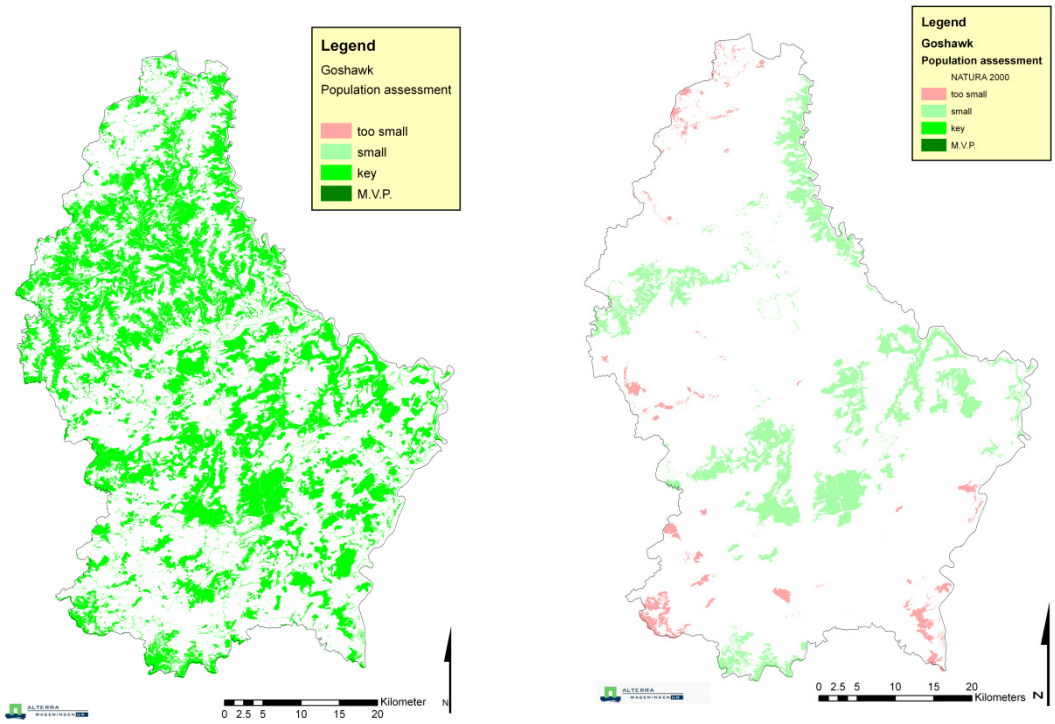

Figure 5

Viability of the Goshawk population within all habitat (left) and Natura 2000 (right).

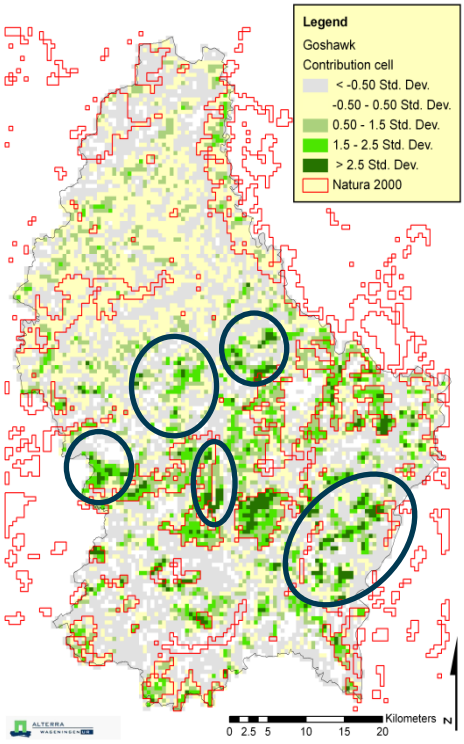

Figure 6

Most suitable areas for the Goshawk outside Natura 2000.

4.1.1.2 Honey buzzard *(Pernis apivorus)*

The Honey buzzard is an insufficiently known raptor species. It uses a variety of habitats. Main threat to the Honey buzzard is hunting, but also the decline of insect populations and impoverishment of the countryside. The species, which is breeding in almost all forest rich regions of Luxembourg, can be seen foraging almost everywhere, but it avoids the urbanized areas. It breeds mostly in high quality mixed and broadleaved forests. Optimal habitat seems to be wooded valleys with a rich biotope structure (Melchior et al., 1987). Foraging flights are up to 7 km from its nest. It feeds primarily on insects, and in addition on amphibians and fledglings of other bird species. The species is mostly foraging in open, light forests, forest edges and clearings, extensive meadows and fallow land.

Based on LARCH the population may consists of some 163 breeding pairs resulting in a minimum viable population (Figure 7). Based on field observations the population is estimated at some 150-180 breeding pairs (Lorgé and Melchior, 2010), showing highest densities in the broadleaved forests in the south of the country (Weiss and Paler, 2006). Field data and modelling results fit quite well illustrating model results are quite reliable. If only the habitat within Natura 2000 sites is taken into account in the model, this will reduce the population to 54 breeding pairs, representing still a key population. Most important areas are within the SPAs. The important areas which contribute most to the population are situated in the south and in the north of the country.

Viability target: The minimum viability aim could be to ensure a viable population requiring at least 80 Breeding pairs (Table 3 in par. 2.2). Important areas to consider are forest areas near Buchholz and Canach, southeast of Luxembourg city and west of Colmar (Figure 8). Expansion of the existing Natura 2000 site Vallées de la Mamer and l'Eisch on the eastside would ensure the protection of important habitat. In the north of Luxembourg the most important area is the Kiischpelt. The potential contribution of these areas would be some sixteen breeding pairs resulting in a population of 70 breeding pairs in Luxembourg.

4.1.1.3 Hazel grouse *(Bonasa bonasia)*

The Hazel grouse has an insular distribution in north-western Europe and occurs mostly at higher altitude. It inhabits broadleaved mixed and coniferous forest. The species has shown a decline, probably due to hunting pressure and change in forest management. The species is highly sedentary.

The Hazel grouse prefers well developed dense spruce, fir and larch forests or dense birch. The species found refuge in the oak coppices of the northern forests of Luxembourg on steep slopes. Most recent observations were in this area. In particular the Our valley (SCI) is interesting for the Hazel grouse. Luxembourg holds 25% of the population of the Ardennes' Hazel grouse population, following to population estimates for this region (personal communication G. Biver).

LARCH predicts a potential population of some 71 breeding pairs (Figure 9). At the moment there are some estimated 60-100 pairs (Lorgé and Melchior, 2010), showing the modelling results are reliable. The most important areas for the species are the Kiischpelt, the upper parts of the Our Valley, and upper parts of the Sûre Valley. The number occurring in protected areas (Natura 2000) would be fifteen only, showing that most of the territory is outside Natura 2000 sites.

Viability target: Luxembourg has a high responsibility for this species as is illustrated by the foreseen action plan for the species in the national Biodiversity Strategy document. A viability target to protect a key population (40 breeding pairs) is consistent with this intention. It is recommended to include all known distribution areas in the Natura 2000 network. The area around the Kiischpelt should be added (Figure 10). Also the upper valley of the Sûre (SPA) can be extended northwards (north of Bavigne) to include some valuable forest areas between Wiltz and Clervaux. The potential contribution of these areas would be some 27 breeding pairs resulting in a population of some 42 breeding pairs in Luxembourg.

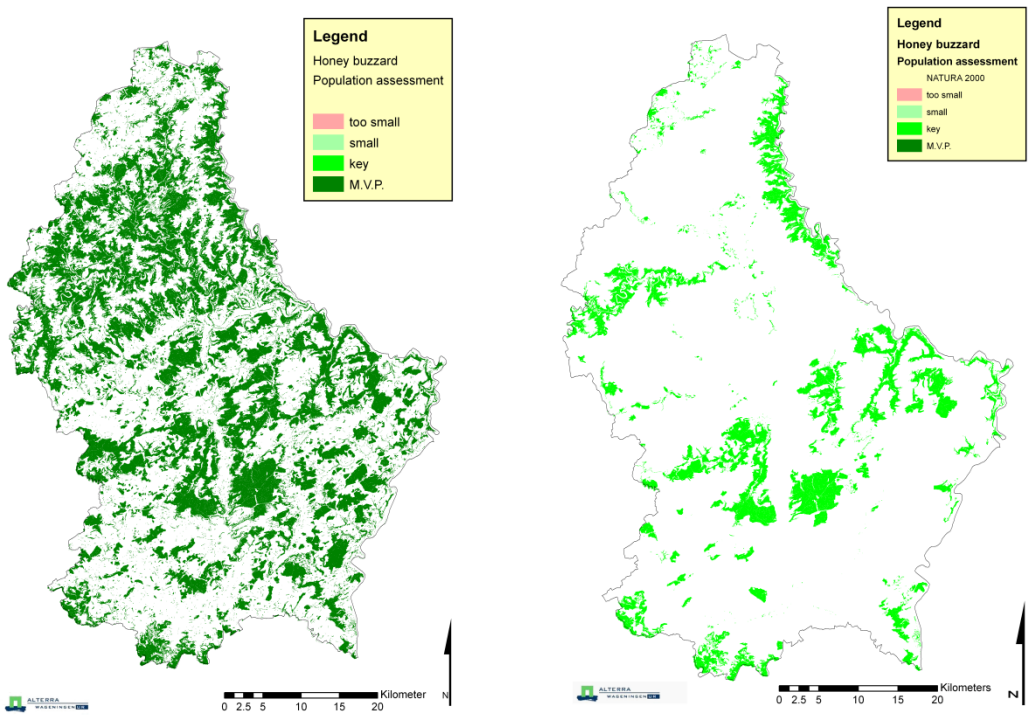

Figure 7

Viability of the Honey buzzard population within all habitat (left) and Natura 2000 (right).

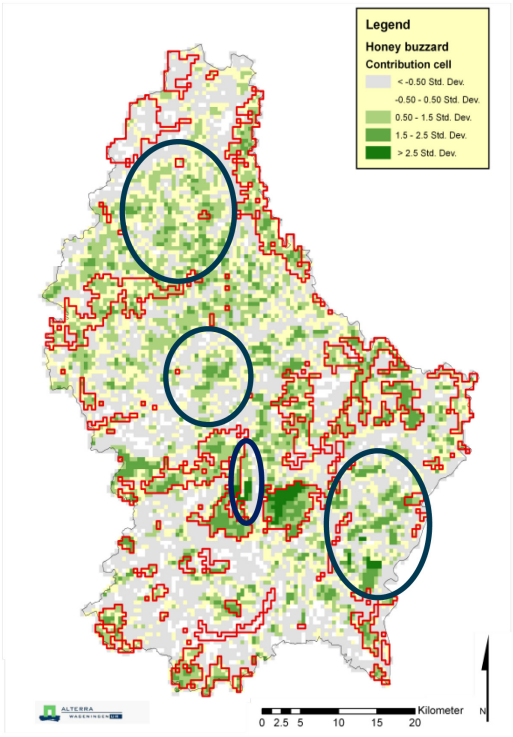

Figure 8

Most suitable areas for the Honey buzzard outside Natura 2000.

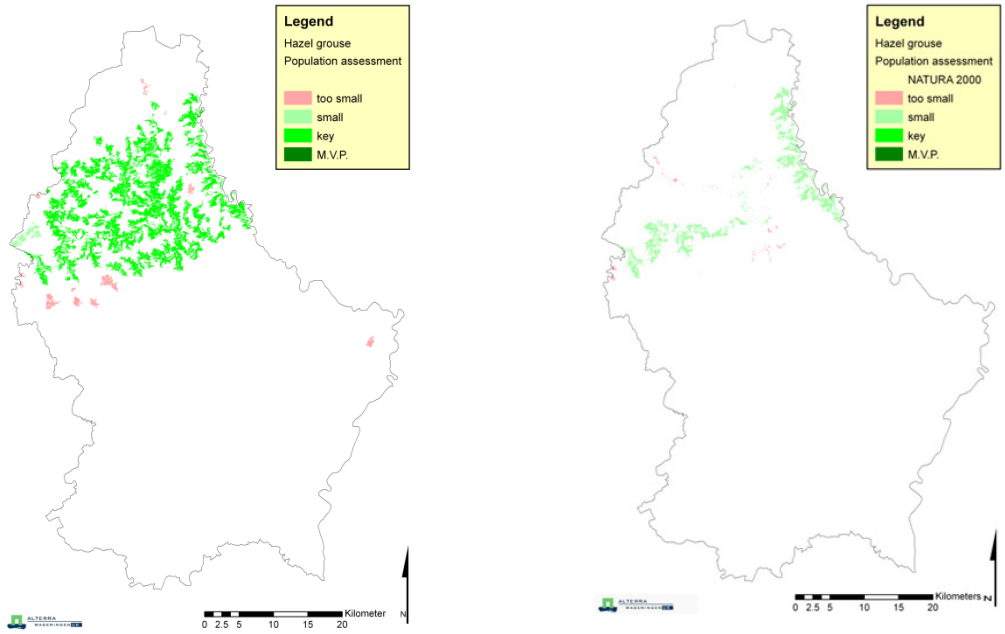

Figure 9

Viability of the Hazel grouse population within all habitat (left) and Natura 2000 (right).

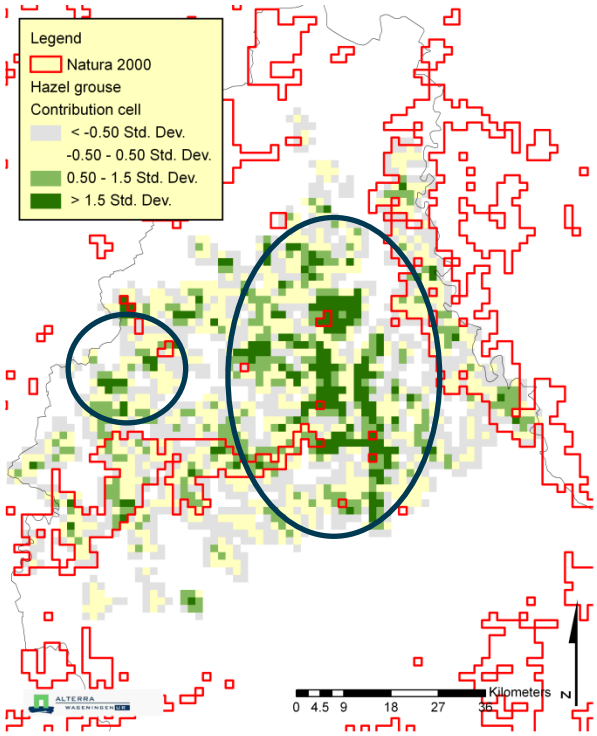

Figure 10

Most suitable areas for Hazel grouse (selection of the map, north Luxembourg) outside Natura 2000.

4.1.1.4 Woodcock *(Scolopax rusticola)*

The Woodcock is a typical forest species, breeding in dense, moist forest. It is a game bird, which has been hunted intensively in the past. It is a polygamous species and therefore breeding territories are counted instead of individuals. It feeds on insects from the soil.
The Woodcock occurs at different places, mainly clearings, windfall, light forests and/or forest edges. Its breeding habitat is mostly moist, broadleaved forests with dense undergrowth, but also young conifer plantations. It uses forests but it also depends on pastures for feeding. The species is listed in Luxembourg as 'data deficient', because of relatively poor knowledge about numbers and distribution of this species. Only some 32 breeding pairs were reported 25 years ago, of which only ten have been confirmed (Melchior et al., 1987).
LARCH predicts a potential population of 360 breeding pairs (Figure 11). The modelling is based on parameters which were calibrated in other regions or taken from literature. In the absence of more distribution data the forest map and the habitat requirements of the woodcock do not allow for a more reliable modelling. However, only looking at the Natura 2000 sites the population would be reduced to 101 breeding pairs illustrating only small populations on areas which are too small in size and, without a key population, resulting in a not viable situation.
Viability target: Since more reliable data on the species is lacking it is not possible to set realistic conservation targets for this species. However, conservation measures foreseen for species inhabiting the same habitat, like the Hazel grouse, will definitely benefit the Woodcock. For that reason to conjunct an area in the north with the forests along the Our will increase the overall viability of the species. Areas most suitable for the Woodcock are shown in Figure 12.

4.1.1.5 Wryneck *(Jynx torquilla)*

The Wryneck is a Woodpecker species which occurs mainly high up in the trees, or on the forest floor. The habitat consists of orchards, very open forest habitats, forest edges and felling areas. The species is mainly an ant eater. The Wryneck prefers warm and dry areas. In addition, they occur often in old woods, orchards, and open country with trees and hedges (Melchior et al., 1987). The Wryneck's was a common breeding species in Luxembourg in the past. Its main distribution nowadays is southeast to southwest and the eastern region of Luxembourg with orchard rich landscapes, dry meadows with structures and/or very light forests and forest edges.
LARCH predicts a population of some 198 breeding pairs. It would be a viable population within one network (Figure 13). In the southeast of the country a key population could be found. Based on field data the total number of breeding pairs is estimated to be 50-100 breeding pairs (Lorgé and Melchior, 2010).
However, within the Natura 2000 sites the population would be reduced to some 45 breeding pairs, representing a not viable network. This network represents only small local populations scattered over the whole country. One SPA, 'Haff Réimech', seems to be important in this network, but the potential distribution is mostly outside the existing SPAs.
Viability target: To maintain the species viability a minimum target of a key population of 40 breeding pairs in the south of the country should be formulated. In particular the forests between Haff Reimeich, Grünewald and Grevenmacher contribute relatively much to this population (Figure 14). The potential contribution of these areas would be some 20 breeding pairs resulting, in a total of 65 breeding pairs within protected areas.

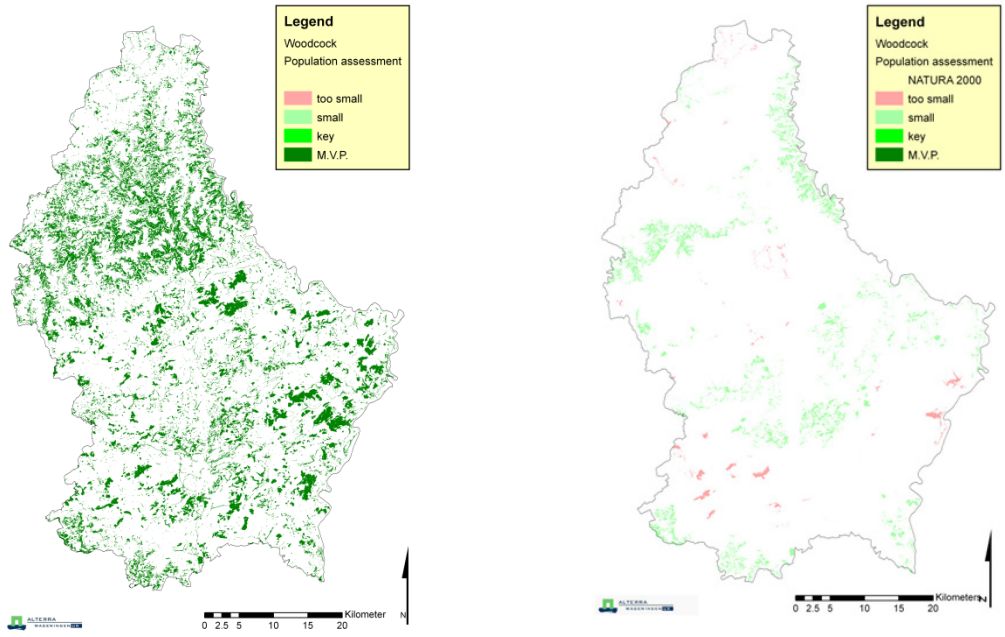

Figure 11

Viability of the Woodcock population within all habitat (left) and Natura 2000 (right).

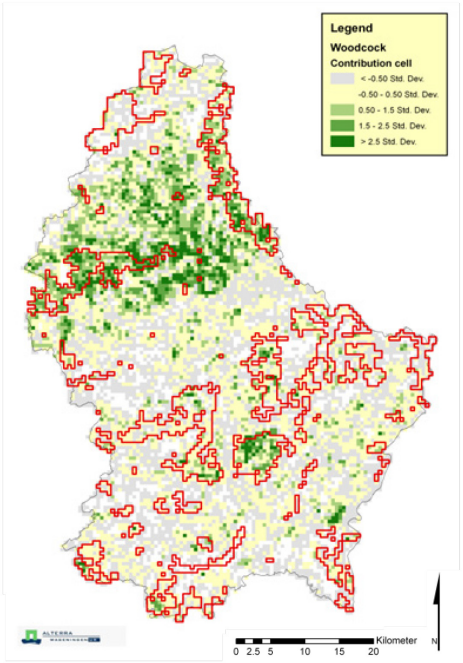

Figure 12

Most suitable areas for the Woodcock (no selection was made).

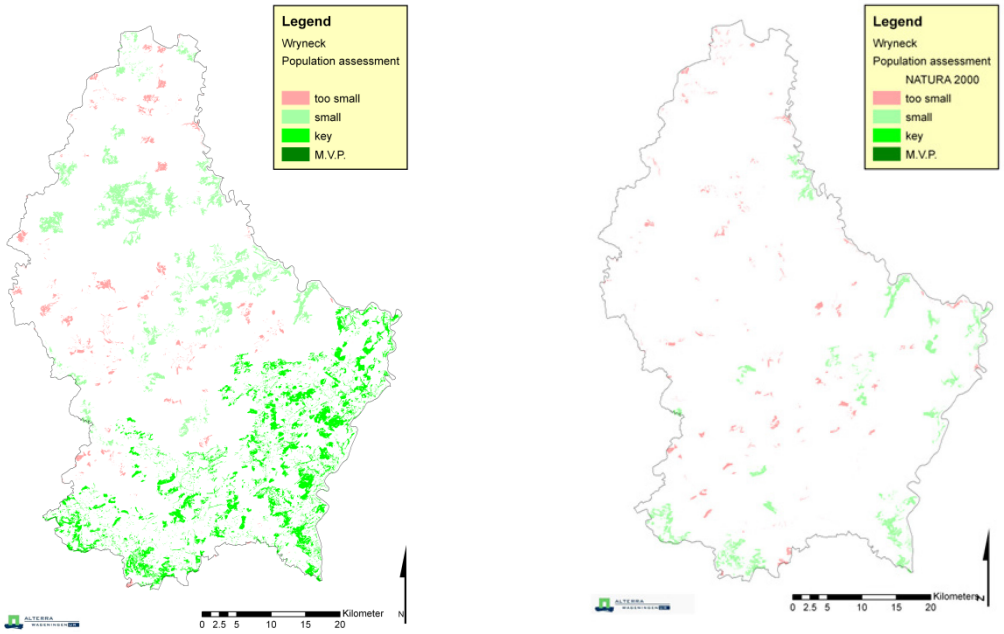

Figure 13

Viability of the Wryneck population within all habitat (left) and Natura 2000 (right).

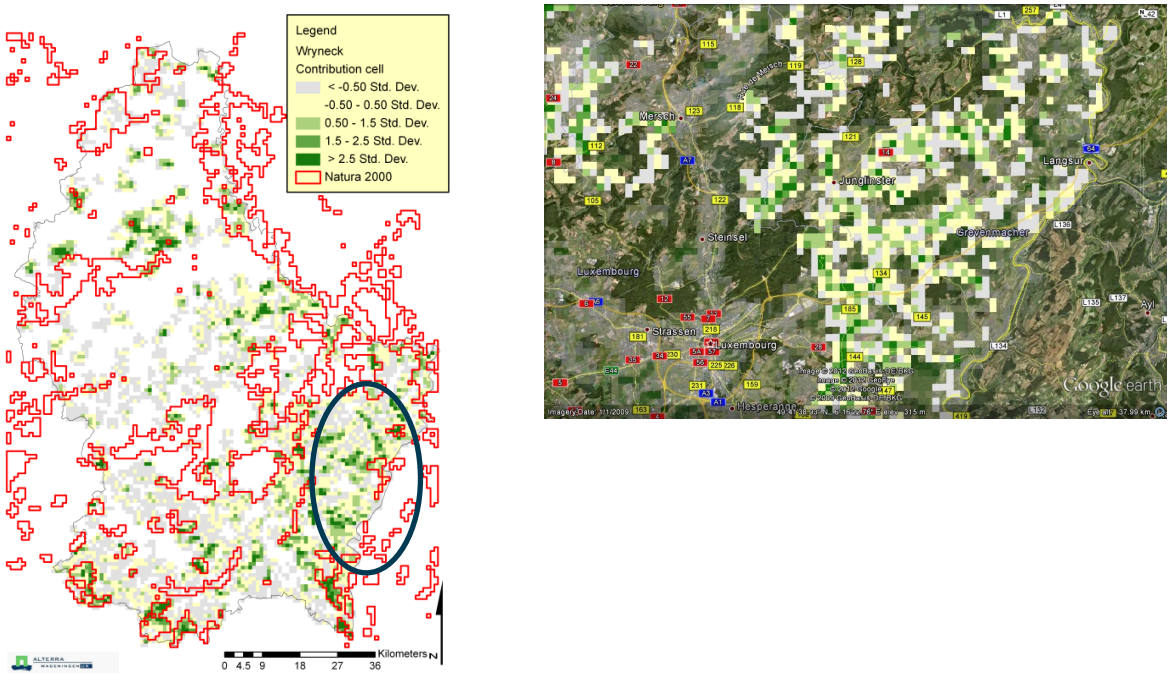

Figure 14

Most suitable areas for the Wryneck outside Natura 2000 (left) and detail for the southeast of Luxembourg, projected on Google Earth Imagery (right).

4.1.1.6 Grey-headed woodpecker *(Picus canus)*

The Grey-headed woodpecker is a typical forest species. The species is very sedentary with a very slow expansion rate. It is an indicator of natural climax forests. It feeds on ant hills (summer) and insects from e.g. oak trees. Its decline is related to intensified forest management and increased nitrogen deposition (related to increased undergrowth development at the detriment of ants) (Hagemeijer and Blair, 1997).
The Grey-headed woodpecker is not very common in Luxembourg, and has a clear gradient form north to south and from west to east. It is more common in the southeast than in the centre and almost absent in the north. Primary habitat is natural forest, secondary habitat is orchards, parks and riverine forest. The woodpecker favours alluvial forests. It nests in old deciduous trees, like Aspen, Alder, Oak and Beech. Its breeding habitat is adjacent to its feeding habitat. It uses sympatric habitat with the Green woodpecker.
LARCH shows some 64 breeding pairs within a key population. Field data shows the population to be estimated at some 30-50 breeding pairs (Lorgé and Melchior, 2010). Field data and model results fit very well. Figure 15 shows the potential distribution for the species.
The population within only Natura 2000 sites represents some 20 breeding pairs, resulting in small local populations together with, many smaller 'vacant' areas as a result of fragmentation. This 'Natura 2000 population' is not viable. Specific Natura 2000 sites (SACs) are important for the species, e.g. Vallée de la Mamer and l'Eisch, Haff Réimech and Grünwald.
Viability target: Also for the Grey-headed woodpecker a minimum viability target of a key population (40 breeding pairs) can be formulated. Potential additional areas which contribute much to a key population are situated between Haff Réimich and Grünewald, the area between Mamer and l'Eisch and Tal der Schwarzer Ernz, as well as the area adjoining the Upper Alzette (Figure 16).
The potential contribution of these areas would be some 20 breeding pairs resulting in a total 40 breeding pairs in Luxembourg.

4.1.1.7 Green woodpecker *(Picus viridis)*

The Green woodpecker is the most common woodpecker and having the widest distribution. The species occurs especially in forest edges and open woodlands and avoids conifer forest. It is as a resident breeder and sensitive to severe winters, which may decimate populations. The Green woodpecker is highly territorial. The species is quite common in Luxembourg, but seems to have hotspots at sites with well-structured landscapes like orchards, parks, gardens and edges of forests. The Green woodpecker favours broadleaved forests for breeding, and feeds mostly in grassy areas nearby open grasslands, parks, large gardens, groves, orchards and open woodlands. It is highly specialised in its feeding on insects, in particular ants.
LARCH predicts some 796 breeding pairs in Luxembourg representing a MVP (Figure 17). This estimated number of breeding pairs is high compared to the estimated number based on field data (25-400 breeding pairs; Lorgé and Melchior, 2010). Orchard rich regions and the well-structured oak-rich forests seem to be the most appropriate sites for this species. The Ösling region (in the north) seems to be less occupied by this species.
Looking only at the Natura 2000 sites a population of some 253 breeding pairs will remain, which is still viable.
Viability target: Aiming at a viable population within the Natura 2000 network and assuming that the proposed measures for other forest species like the Black woodpecker or Hazel grouse will also benefit the Green woodpecker, additional areas to protect are not necessary. Most suitable habitat is shown in Figure 18.

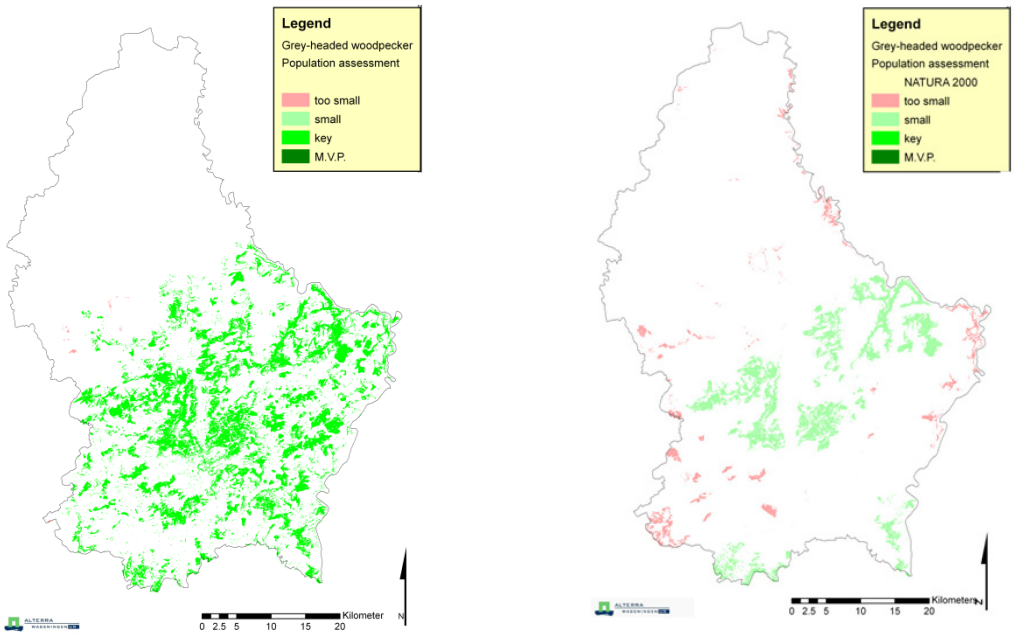

Figure 15

Viability of the Grey-headed woodpecker population within all habitat (left) and Natura 2000 (right).

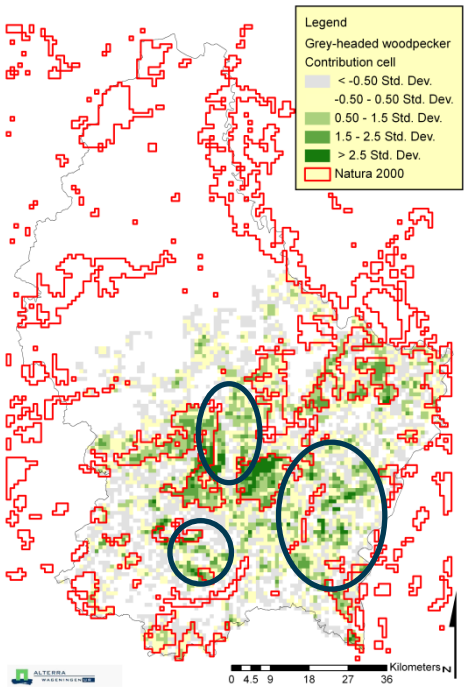

Figure 16

Most suitable areas for the Grey-headed woodpecker outside Natura 2000.

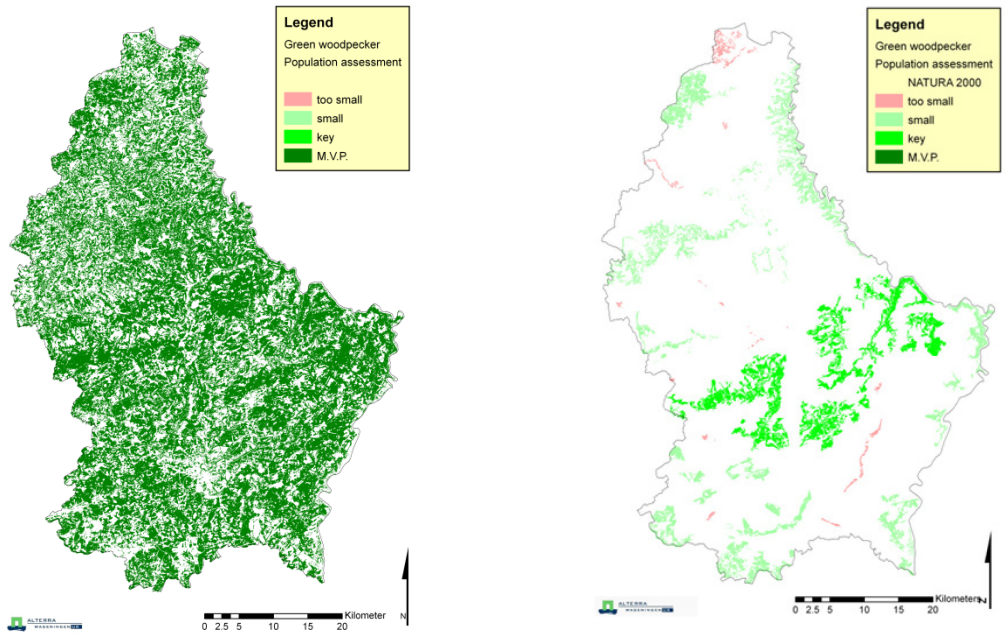

Figure 17

Viability of the Green woodpecker population within all habitat (left) and Natura 2000 (right).

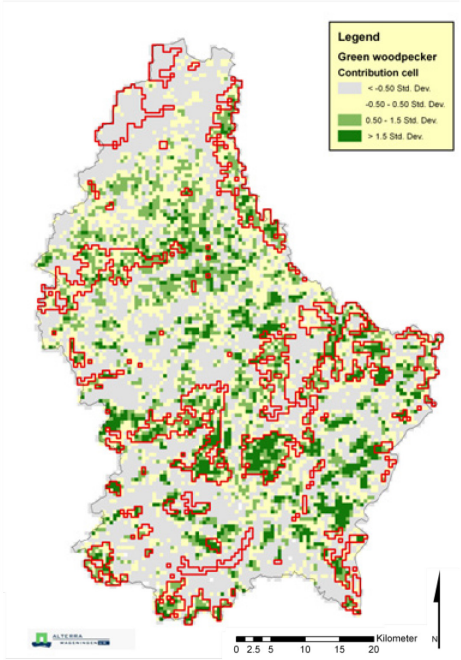

Figure 18

Most suitable areas for the Green woodpecker (no selection was made).

4.1.1.8 Black woodpecker *(Dryocopus martius)*

The Black woodpecker prefers beech forests. However, it also occurs in mixed and conifer forest provided that it is not too dense. The species is a good disperser despite its limited home range. The LARCH estimate for the population of the Black woodpecker in Luxembourg is some 138 breeding pairs. This estimation fits real numbers and also the predicted habitat distribution fits the actual distribution of the species very well (Melchior et al.,1987). The population represents one key population which is viable (Figure 19).
If only the suitable habitat in the Natura 2000 sites is used to model the population approximately 45 breeding pairs will remain representing a highly fragmented population (six local populations; Some areas are only (part of) SACs which should be listed as SPA as well, such as de 'Vallée de la Mamer and l'Eisch', or 'Grünewald'. Some habitat patches are too small to sustain a local population (pink areas on the map) and do not contribute to the Black woodpecker population. As a network, the population is too fragmented and not viable and the species is likely to go extinct.
Viability target: A minimum viability target to protect the species would be a key population (40 breeding pairs). There would be exchange of individuals with populations in neighbouring countries resulting, in a stable situation. The areas in the north of the country contribute relatively little to a sustainable population of the species. The best areas are situated in the southern half of the country. Priority areas for the Black woodpecker occur in the Canton Remich and the forests to the north, up to Grevenmacher (Figure 20). Also between Grünewald and Vallées de la Mamer and l'Eisch and north of Mamer are priority forest areas, as well as the Attert. Finally, the area northwest of the Eisch may also be important for this species, but currently no breeding is observed here, so this should be checked with field experts. These areas would contribute some 25 breeding pairs resulting in a total of 70 breeding pairs representing a large key population.

4.1.1.9 Middle spotted woodpecker *(Dendrocopus medius)*

The Middle spotted woodpecker occurs in all of central Europe except for the mountains. It is most common in the old broad leaved forest stands and primeval forest. It is a resident species in Luxembourg. Prime habitat comprises old deciduous forests (minimum 40 year old) with trees of diameter of more than 40 cm. The Middle spotted woodpecker selects for feeding dead thick branches with heavily scratched or furrowed bark. The preferred trees are: oak, poplar, willow, maple, ash, lime, elm. It avoids movements in the open landscape. Observations are mostly in the southern part of Luxembourg ('Gutland') and less in the north, ('Ösling'). Important forests areas are in the southwest region of 'Lias moyen' (some are SAC), further the Vallée de la Mamer and l'Eisch and forests in the Centre and East. Most of the observations are outside of the existing SPA-network (personal communication G. Biver).
LARCH estimates a large and viable key population of some 384 breeding pairs in the southern half of the country (Figure 21). The population as estimated using field data shows some 200-300 breeding pairs (Lorgé and Melchior, 2010). Numbers and distribution based on LARCH and field data fit very well, illustrating reliable outcomes of the LARCH model. If only Natura 2000 sites are taken into account some 161 breeding pairs remain representing a not viable population.
Viability target: The minimum viability target for this species could be to ensure a viable population of 120 breeding pairs within the Natura 2000 network including a key population on one site. This can be reached by a rather small extension of already existing Natura 2000 sites. Suitable habitat is located north of the Vallée de l'Ernz blanche, Bois de Herborn, north of the Vallée de l'Alzette (Bertrange) and west of the Vallées de la Mamer and l'Eisch (Figure 22). These areas will contribute some 65 breeding pairs resulting, in a total of 126 breeding pairs, representing a viable population.

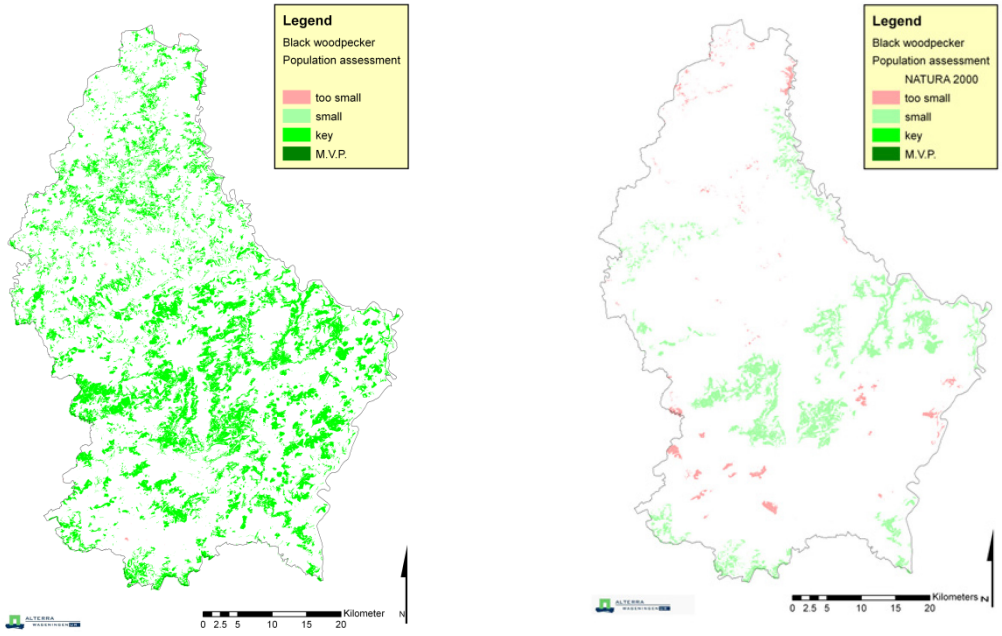

Figure 19

Viability of the Black Woodpecker population within all habitat (left) and Natura 2000 (right).

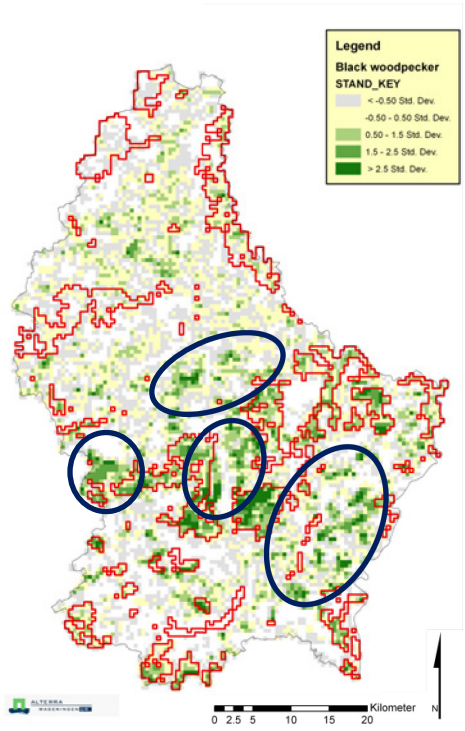

Figure 20

Most suitable areas for the Black woodpecker outside Natura 2000.

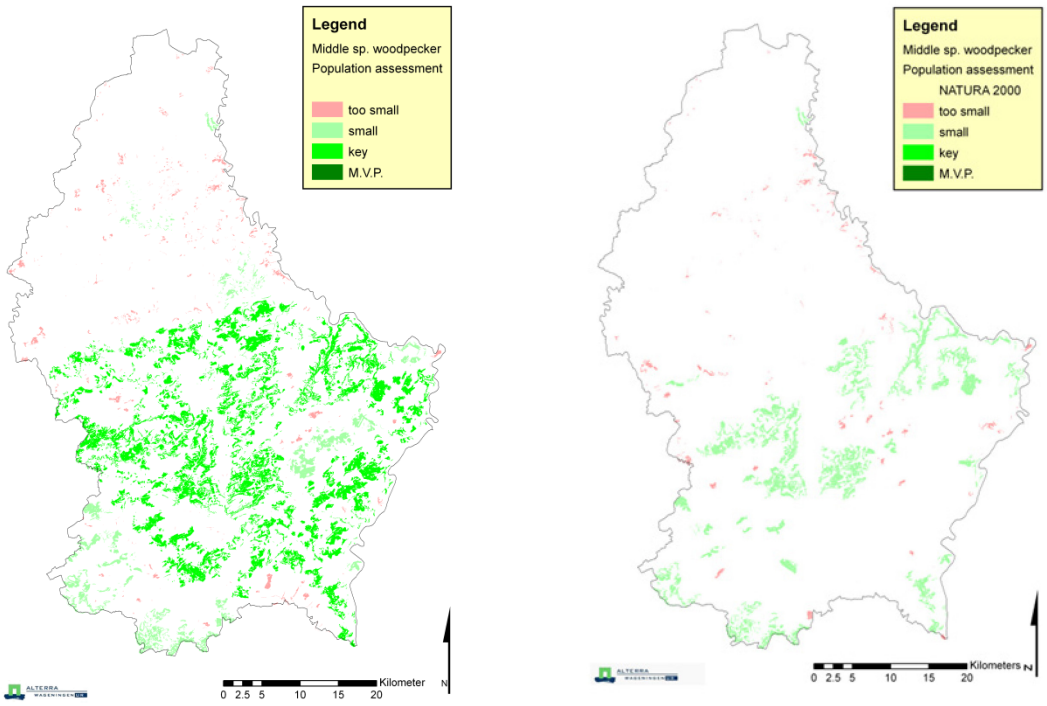

Figure 21

Viability of the Middle spotted woodpecker population within all habitat (left) and Natura 2000 (right).

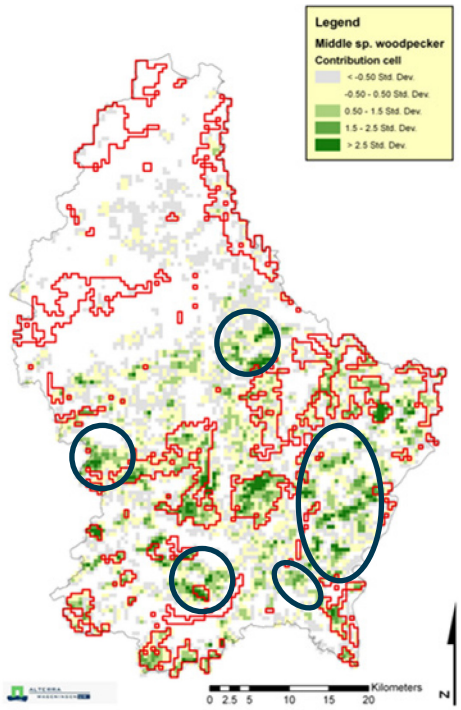

Figure 22

Most suitable areas for the Middle spotted woodpecker outside Natura 2000.

4.1.1.10 Wood warbler *(Phylloscopus sybillatrix)*

The Wood warbler is a bird exclusively restricted to woodland. The Wood warbler population underwent a large decline, but since a few years, the population size is increasing. The habitat of the Wood warbler consists of broadleaved forests with certain grass structure for breeding. The species has a preference for mature beech-oak or mixed forests and often uses slopes and hilly terrain. The species avoids coniferous forests. Knowledge on the ecology and distribution of the species in Luxembourg is restricted (personal communication G. Biver). LARCH estimates the population of the Wood warbler to be some 5549 breeding pairs (Figure 23). However, the population estimate for all of Luxembourg is 1000-1500 (Lorgé and Melchior, 2010). The knowledge of the species is rather limited, and this is about the best result for modelling (personal communication G. Biver). Because of the species' limited home range the result is a network of local populations representing, however, a MVP.
Within the Natura 2000 sites only some 1918 breeding pairs will occur. Priority areas for the species are the Valley of the Ernze noire, Vallées de la Mamer and l'Eisch and Grünewald (both designated as SAC), the Vallée de la Sûre and Vallée supérieure (SPA) and de l'Our in the north (the northern part is a SPA). Despite the mentioned decline, still there exist some six key populations representing together a viable situation.
Viability target: The existing Natura 2000 network in Luxembourg will ensure a viable population of the Wood warbler based on the actual number of breeding pairs. The protection of additional areas is not necessary for this species. Management measures taken for other forest species will equally benefit the Wood warbler. Priority areas to carry out such measures are the same as for the Middle spotted woodpecker but the Kiischpelt can be added. Most suitable habitat is shown in Figure 24.

4.1.1.11 Common redstart (*Phoenicurus phoenicurus*)

The Common redstart is a migratory species and uses parks and open canopy forests. It prefers forest edges (in particular oak forests) and forest clearings, with open undergrowth. Other important habitat for this species can be found in orchards, parks and gardens, landscapes with hedges, heaths, areas along streams and half open landscapes. Some hotspots are the iron ore mines in the south of Luxembourg (three sites designated as SPA) and the orchard rich regions in the East.
LARCH estimates the population to be 563 breeding pairs, which fits very well the estimated number of 400-500 breeding pairs based on field data (Figure 25). Because of the many small territories this number represents a fragmented but viable population. It should be noted that because of the linear and small size of some biotopes and the use of forest edges and hedges the habitat is not well mapped.
Within the Natura 2000 network some 77 breeding pairs will occur representing a not viable population because it is built up by small local populations. Priority areas in this network are the iron ore mines from Dudelange Haard, Differdange and Esch-sur-Alzette.
Viability target: For a small bird like the Common redstart, a key population would be based on 100 breeding pairs (par. 2.2). To realise this target of 100 breeding pairs in one site (Table 3) is not possible for the existing situation within the Natura 2000 network (Table 11). The small home range and low carrying capacity of the species make it difficult to realise a viable population without a key patch (200 breeding pairs). Therefore no target is formulated for this species. It will, however, benefit from management measures taken for forest species and farmland species (Figure 26).

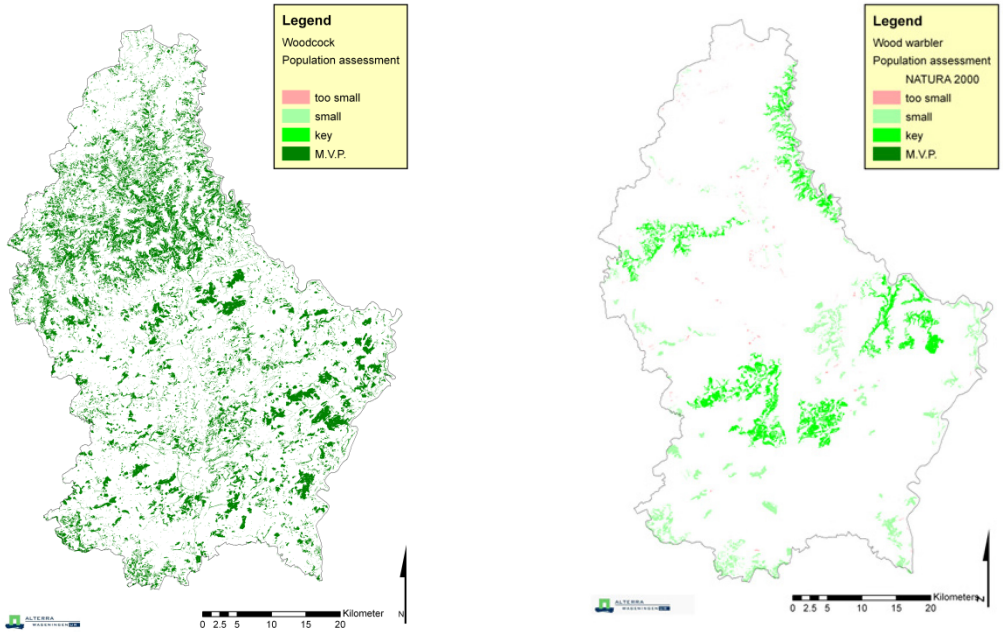

Figure 23

Viability of the Wood warbler population within all habitat (left) and Natura 2000 (right).

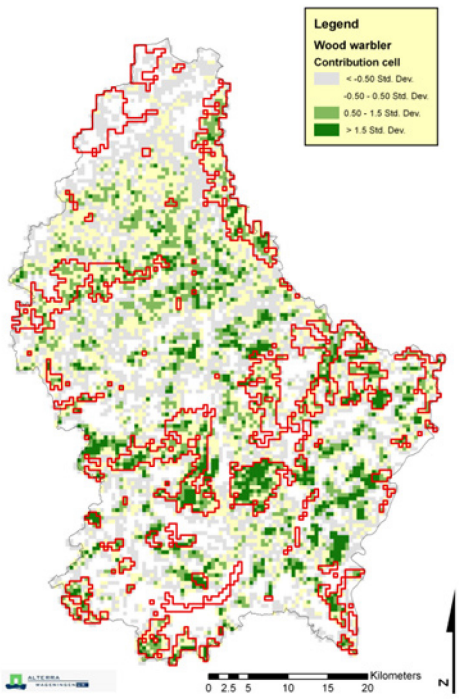

Figure 24

Most suitable areas for the Wood warbler (no selection was made).

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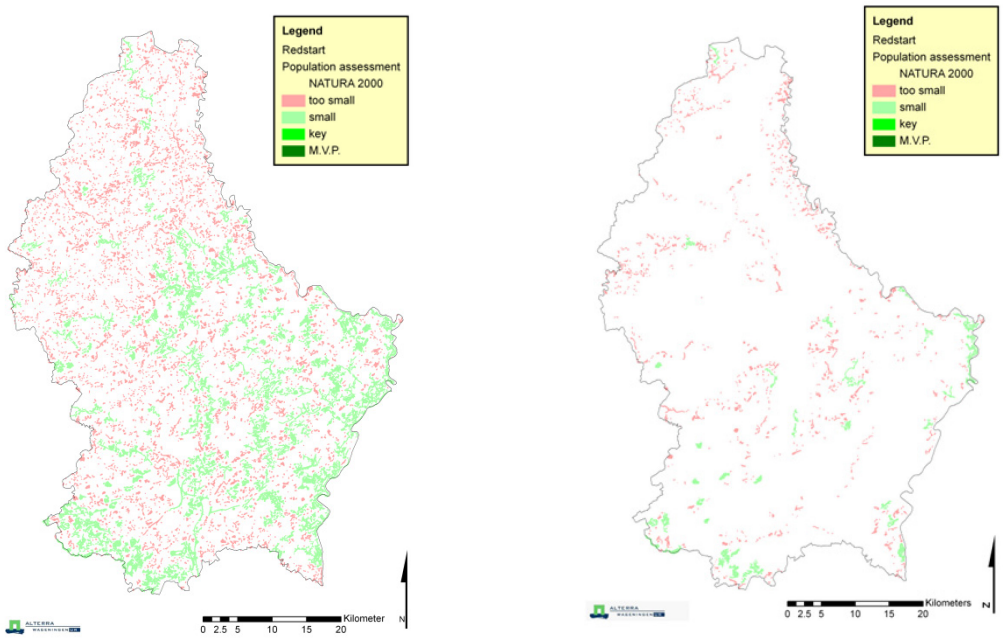

Figure 25

Viability of the Common redstart population within all habitat (left) and Natura 2000 (right).

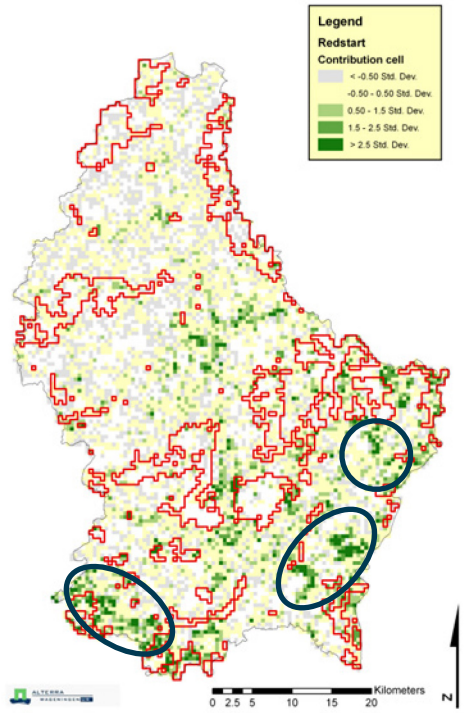

Figure 26

Most suitable areas for the Common redstart outside Natura 2000.

4.1.2 Priority areas for forest species

The results of the analysis of the contribution of a grid cell to the viability of all species within the ecological group of forest species (par. 2.3) are summarised in Table 11 and represented in Figure 27. This figure shows the priority areas which contribute most to the survival of all forest species. The priority areas for each separate species are given in the maps with optimal habitat (and often circles indicating discussed areas).
Forest species with similar habitat requirements or a similar distribution pattern are the Black woodpecker, the Middle spotted woodpecker, Wryneck and Green woodpecker.
The Hazel grouse occurs only in the north of Luxembourg. However, protection measures here will likewise benefit the Black woodpecker.
Table 11 shows the contribution of the numbered areas as shown in Figure 27 to the viability of a species. The numbers represent estimated numbers of breeding pairs which are modelling results. They are depending on different factors related to the quality of maps (compare also the role of factors influencing habitat quality of a species) and cannot be used in an absolute way for this reason (par. 2.3). The number for all Natura 2000 and SPAs is indicative of what is currently protected under the Birds Directive. Table 12 shows the realised target for each forest priority area (% of total target, formulated in the species descriptions above).

Table 11

Estimated contribution of the priority forest areas of Luxembourg to species viability. Numbers represent LARCH estimates of breeding pairs.

Area number	**1**	**2**	**6**	**7**	**8**	**9**	**12**	**13**	**14**	**15**	**16**	**SUM**	**Total number of BP in:**	
Area size (km²)	*29*	*19*	*89*	*9*	*10*	*16*	*29*	*31*	*28*	*21*	*101*	*382*	**Natura2000 network**	**all SPAs**
Species														
Goshawk	1	-	4	-	-	1	1	1	1	-	2	11	16	2
Honey buzzard	2	1	7	1	1	2	3	2	2	2	9	32	15	6
Hazel grouse	-	-	-	-	-	-	-	-	-	4	26	30	54	10
Woodcock	3	2	13	1	1	1	4	5	3	8	48	89	101	29
Wryneck	4	4	20	1	3	1	1	2	6	2	15	59	45	11
Grey-headed woodpecker	2	1	6	1	-	1	2	1	1	-	-	15	20	1
Green woodpecker	17	9	57	7	6	12	14	15	19	9	50	215	253	46
Black woodpecker	3	2	10	2	1	3	4	4	2	1	7	39	45	5
Middle spotted woodpecker	18	5	41	4	5	10	10	9	16	-	3	121	161	15
Wood warbler	132	58	397	46	45	92	108	112	148	68	380	1586	1918	344
Common redstart	6	9	39	5	1	-	3	8	3	1	13	88	77	24

Table 12

Estimated contribution of the priority forest areas of Luxembourg to species viability. Numbers represent ***percentages of viability target*** *realised.*

Area number	1	2	6	7	8	9	12	13	14	15	16	SUM
Species												
Goshawk	20	0	80	0	0	20	20	20	20	0	40	220
Honey buzzard	8	4	27	4	4	8	12	8	8	8	35	123
Hazel grouse	0	0	0	0	0	0	0	0	0	16	104	120
Woodcock	0	0	0	0	0	0	0	0	0	0	0	0
Wryneck	27	27	133	7	20	7	7	13	40	13	100	393
Grey-headed woodpecker	13	7	40	7	0	7	13	7	7	0	0	100
Green woodpecker	0	0	0	0	0	0	0	0	0	0	0	0
Black woodpecker	30	20	100	20	10	30	40	40	20	10	70	390
Middle spotted woodpecker	42	12	95	9	12	23	23	21	37	0	7	280
Wood warbler	0	0	0	0	0	0	0	0	0	0	0	0
Common redstart	0	0	0	0	0	0	0	0	0	0	0	0

Six priority areas contribute to the population of ten bird species (areas 1, 6, 12, 13, 14 and 16). However, looking at the estimated number of breeding pairs the areas 1 (north of the Upper Alzette valley), 6 (southeast along the border) and 16 (the Kiisschpelt) contribute the highest numbers and show to be the most important priority areas. Also the area 2 and 15 are important priority areas.
The areas 6 and 2, near Haff Rémich show numbers of breeding pairs above average population numbers. In particular the Woodpecker species may (potentially) reach high numbers here, but also the Goshawk and Honey buzzard benefit. Finally, Woodcock and Common redstart find potentially very suitable habitat here.
Area 16 (and to some extent area 15), the Kiischpelt, are the only suitable areas for the Hazel grouse and represent important priority areas. These areas also substantially contribute to the populations of Honey buzzard, Woodcock, Wryneck, Green and Black woodpecker, Wood warbler and Common redstart.
Area 1, north of the Upper Alzette Valley is very important for the Middle spotted woodpecker, Wryneck, Wood warbler and Common redstart.
Area 7, finally, is adjoining the Natura 2000 area Valley of the Mamer and l' Eisch being a rather small extension on the east, but the area holds important habitat for the Woodpecker species, as well as the Common redstart.
For the Eagle owl and the Peregrine falcon no LARCH analyses were carried out because of a lack of good maps describing their habitat preferences. Based on their distribution in Luxembourg their viability target will be described separately in 4.1.2.1 and 4.1.2.2.

In paragraph 4.2.2 the priority areas are compared to the IBAs and the value of these sites for this group of species is shown.

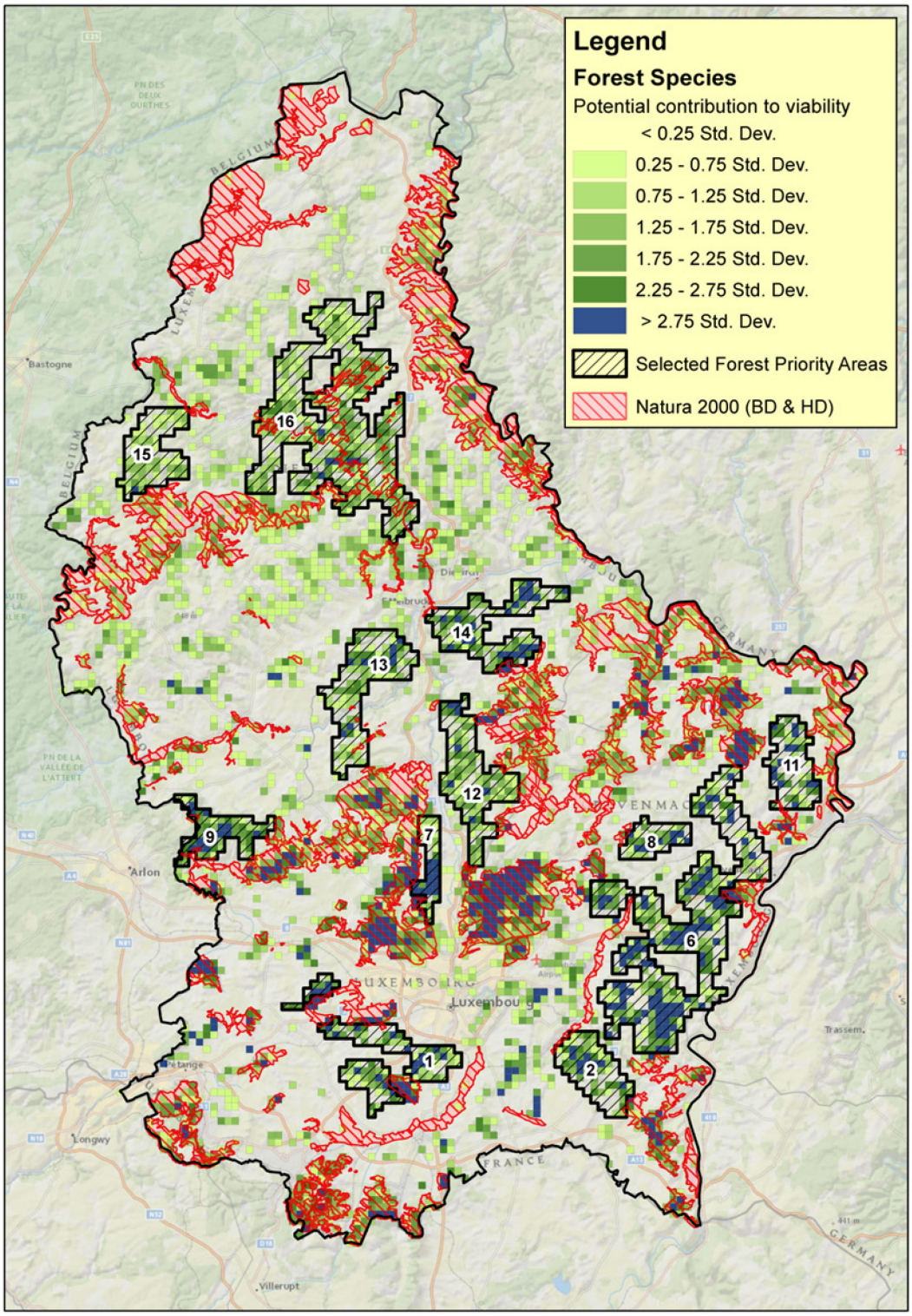

Figure 27

Priority areas for forest species with high potential value. The map is based on accumulation of standardized values for all forest species (par.2.3).

4.1.2.1 Eagle owl *(Bubo bubo)*

The Eagle owl is a rather rare bird. The species requires breeding sites on undisturbed cliffs or steep slopes. However, sometimes they breed in valleys without rocks (Penteriani et al., 2002). Their habitat use is strongly influenced by the availability of prey, but they have some preference for open habitats. Eagle owls are known to hunt medium sized and large mammals, however, nowadays more and more small mammals become important (Penteriani et al., 2002). Even recently they are found exploiting new sources of food, like rats on rubbish dumps.

The Eagle owl is known to breed in Luxembourg on natural cliffs as well as rock-faces of open mines. The species went locally extinct in the 1930's and no further nesting was observed until 1982. The species has become again a regular breeding bird with a stable population estimated at 15-20 pairs, which have a total of eight to twelve clutches per year (Lorgé, 2007). The owl is breeding even in the city of Luxembourg. Based on the distribution of the breeding pairs priority areas are: Vallée de la Mamer and l'Eisch, Mersch and Fischbach, Vallée de l'Ernz noire, Machtum / Pellembierg, Dudelange Haard & Esch/Alzette/Ellergronn, Vallée de l'Our. In total some 25 observations are found within Natura 2000 sites. Other observations are almost entirely within the priority areas of forest species (Figure 28): eleven observations in area 16, five observations in area 12 and one in area 14. Only two observations were outside these priority areas: one is in the City of Luxembourg and one is on the border of France.

Viability target: To protect nearly all breeding sites for the Eagle owl it is important to include area 12 and to a lesser extent area 16 in the Natura 2000 network as SPAs.

4.1.2.2 Peregrine falcon *(Falco peregrinus)*

The Peregrine falcon is a rare bird of prey, using steep cliffs and rocky areas. In the 19th and 20th century some ten breeding pairs occurred in Luxembourg. For decades the species was absent, but since 1998 three breeding pairs have been spotted and numbers are steadily increasing. The current population is some fifteen breeding pairs (Lorgé and Melchior, 2010). There is competition between the Peregrine falcon and Eagle owl. In Luxembourg most falcons breed in natural habitats, mainly sandstone and limestone cliffs. Only two pairs breed on artificial structures, such as highway bridges and schist quarries. Nesting facilities were constructed in the city of Luxembourg on the bridge (Conzemius, 2006). In other countries it is also breeding on tall chimneys of power plants. The breeding sites can be rather near to each other, in some cases the distances between nests are only 1200 m apart. The species requires open habitats for hunting and will avoid dense forested areas (Génsbøl, 1997).

The site with a high density of the Peregrine falcon is in the Müllerthal, the most important core area in the country. Further also the SAC Vallée de l'Ernze noire /Beaufort / Muellerthal (not designated as SPA) with some five to six territories a year on average. Another important region is around the city of Mersch (with three to four territories). Most observations are within the (forest) priority area 12 (Figure 29).

Viability target: Based on its distribution for the Peregrine falcon it would be recommended to include priority area 12 in the Natura 2000 network as a SPA.

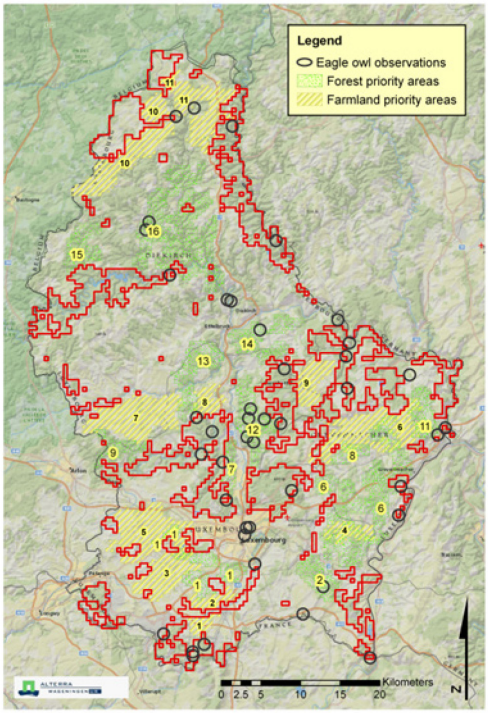

Figure 28
Eagle owl observations in view of Natura 2000 areas and identified forest priority areas.

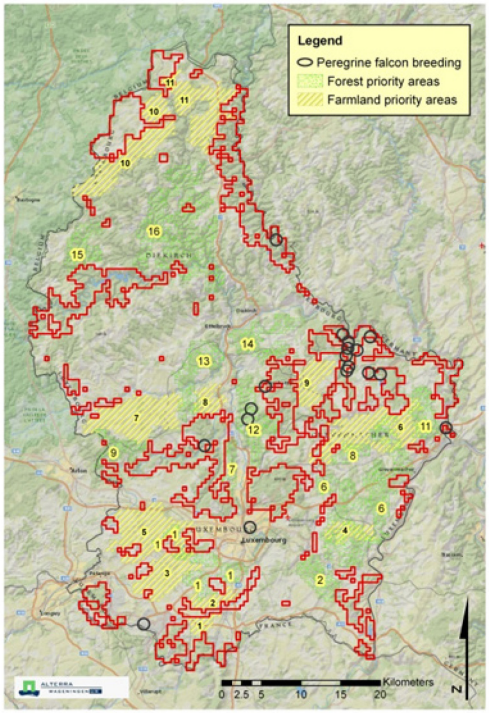

Figure 29
Peregrine falcon breeding sites in view of Natura 2000 areas and identified forest priority areas.

4.1.3 Wetland biotopes

The current situation of the habitat of wetland species shows only a viable population (built up by small populations) for the Reed warbler (Table 13), as analysed by LARCH. This conclusion is under the assumption that all existing habitat contributes to the population of the species, irrespective of a possible influx from populations in neighbouring countries and the protection status of habitat patches. So, under current conditions for most species their populations are not viable and this is the same even regarding the Reed warbler when only looking at the habitat within the Natura 2000 network (Table 13).

Table 13

Population viability of wetland species based on LARCH (current situation) compared to Natura 2000, and proposed viability target (BP= breeding pairs; MVP= minimum viable population, KP= key population, SP = small population, v= viable, nv= not viable).

Common name	Current situation	Natura 2000	Viability target (par. 2.2)
Corncrake	SP 5 BP (nv)	0 (nv)*	protect all habitat
Black stork	SP 23 BP (nv)	SP 1 BP (nv)*	maintain current situation, 10-12 BP
Reed warbler	SP 266 BP (v)	SP 118 BP (nv)	1 area, viable
Water rail	SP 59 BP (nv)	SP 12 BP (nv)	**
Kingfisher	SP 110 BP (nv)	SP 47 BP (nv)	**

* In reality several pairs would probably be included in Natura 2000, this discrepancy is due to the scale of the grid, which gives some distortions for narrow river valleys

** No viability target, see species description

4.1.3.1 Corncrake *(Crex crex)*

The Corncrake feeds on insects and snails. While during recent years a recovery was observed, still on a long-term basis - through centuries- there has been a steady decline in spite of some adaptations to breed in agricultural fields e.g. recently in rape fields. The Corncrake has a huge dispersal distance: breeding one year in the Netherlands and next year in the UK.

Optimal breeding habitat of the Corncrake is represented by moist and unfertilised grassland, mown hay-meadows in wetlands and can be found in open or semi- open landscapes e.g. along rivers and streams with scarce shrubs and in alluvial floodplains. The Corncrake habitat is difficult to model since it requires meadows under a specific management regime (e.g. late mowing of tall grasses) combined with natural dynamics. All this kind of information is not included in the land cover maps. In Luxembourg occurs a small population, representing a 'sink population', that only can exist because of the 'overflow' by individuals from surrounding populations.

LARCH estimates a population of only some five breeding pairs scattered over separated habitat patches (Figure 30). The numbers in the modelled population fit very well with the situation in the field, although breeding pairs fluctuate averaging three pairs over the last years. This situation is obviously not viable. Suitable habitat is located in the south, in open habitats and grasslands. There is good knowledge of the distribution of the species.

Viability target: The Corncrake is a priority species, an action plan for the Corncrake is foreseen in the national Biodiversity Strategy document (AEWA action plan). All known locations with breeding pairs should be protected. However, some locations are outside the Natura 2000 network. Once all locations are protected the population may increase and spread out to other areas where suitable habitat (grasslands) is available.

Crucial to the survival of the species is the management of grasslands, that is, late mowing of grasslands. In combination with the target to protect all sites where the species occurs a proper management has to be implemented. Because some locations are outside the Natura 2000 network a limited extension of grassland areas is necessary north and south of the Natura 2000 area 'upper valley of d' Alzette' and north of Bertrange (Figure 31).

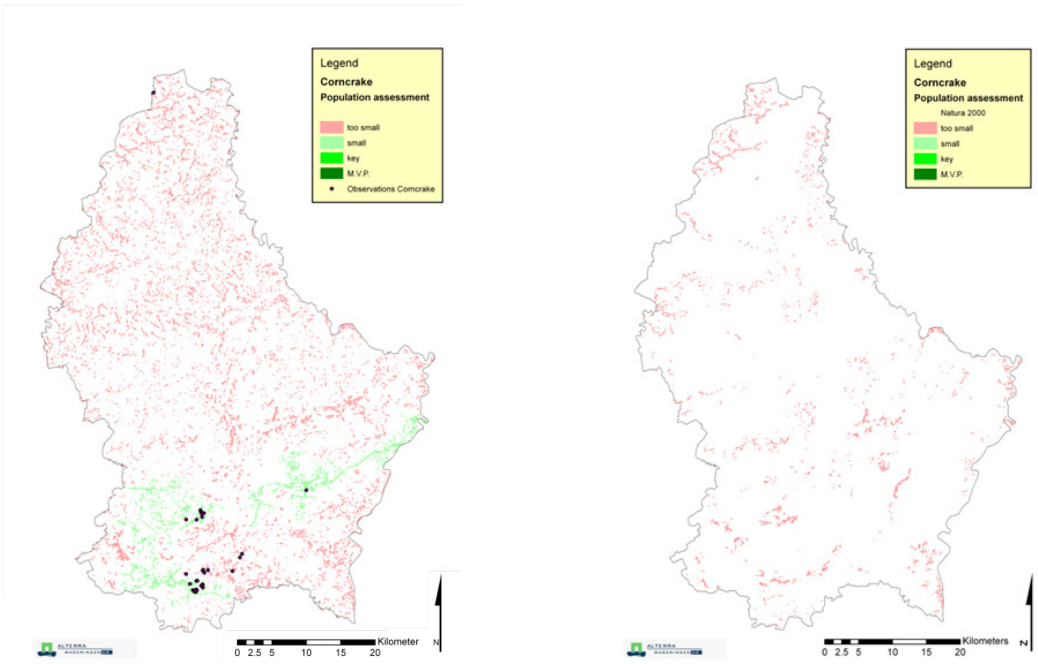

Figure 30

Viability of the Corncrake population within all habitat (left) and Natura 2000 (right).

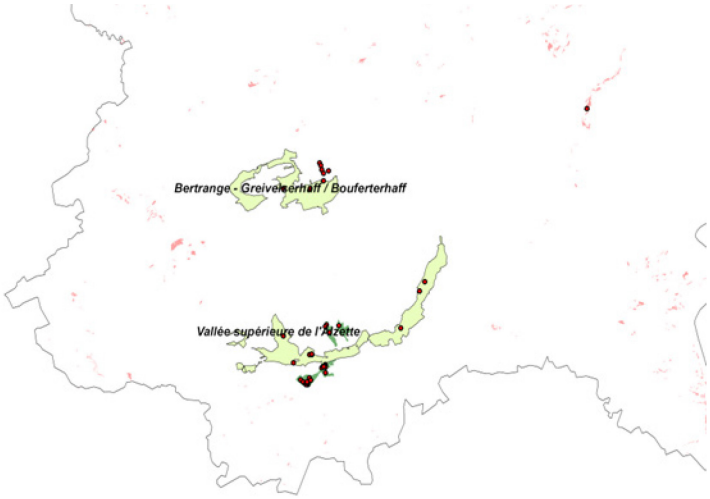

Figure 31

Corncrake observations within and outside Natura 2000 sites.

4.1.3.2 Black stork *(Ciconia nigra)*

The Black stork is a highly migratory species. Although the species has disappeared from most West European countries, since the 1930s numbers have increased again. The species is negatively affected by lowering of the ground water level and by fragmentation of forest habitats. Recent observations indicate the adaptation of Black storks to human presence and the utilization of transformed forests. Still the species, avoids all densely urbanized areas.
Prime breeding habitat comprises deciduous and coniferous woodland interspersed with rivers, creeks, lakes and other wetlands. It breeds as a solitary nester in the oldest trees beside watercourses or by clearing edges. Black storks feed in shallow waters and the diet is composed of fish, supplemented with invertebrates. In Luxembourg foraging distance may be as much as 5-10 km, depending on the quality of the habitat (personal communication G. Biver).
LARCH estimates a small population of some 23 breeding pairs (Figure 32). Based on field data lower numbers of some ten to twelve breeding pairs occur (Lorgé and Melchior, 2010). This can be explained by disturbance, poor water quality and insufficient food and/or poor food quality.
Based on the habitat within Natura 2000 sites the population would be very small, just one breeding pair. The species distribution is not well covered by the Natura 2000 network. Vallée de la Tretterbach is the site which seems most important for the Black stork.
Viability target: A minimum viability target is to protect the current population size (ten to twelve breeding pairs). A key population is not possible.
Priority areas in addition th Natura 2000 sites are the 'Vallée de 'l Attert' and 'Vallée de la Mamer and l'Eisch' and the Valley of the Syre (Figure 33). Another area which seems important, potentially, is along the river Wark, near Mertzig. The potential contribution of these areas to the breeding pairs within the Natura 2000 network would be some seven breeding pairs resulting in a total of eight breeding pairs in Luxembourg. Because of the importance of critical factors related to habitat quality, habitat suitability of all additional priority sites should be checked by experts.

4.1.3.3 Reed warbler *(Acrocephalus scirpaceus)*

The Reed warbler is a species typical for wetland areas and requires in particular reeds *(Phragmites australis)* for breeding and feeding habitat. It is more or less common in many of the wetlands with reed beds in Luxembourg.
LARCH uses for modelling maps showing wetlands and reed beds, however, these maps do not cover all reedland. Densities of the species can be quite high resulting in fragmented reed lands which can still harbour small populations. LARCH estimates some 329 breeding pairs in the population representing a viable population, although it consists of many small populations (Figure 34). The number of breeding pairs based on field data is some 200-300 (Lorgé and Melchior, 2010).
Most reed beds are within the protected Natura 2000 network and the potential population includes 118 breeding pairs. Relatively large numbers of breeding pairs are observed in Haff Réimech, Vallée de la Syre, Vallée de l'Alzette, Vallée de l'Ernze blanche and the Aspelt-Lannebur, am Kessel. Outside the Natura 2000 sites small fragments of reed beds occur which are currently not protected.
Viability target : The minimum viability target for this small species as represented by a viable population, includes at least 200 breeding pairs. Relative small reed lands of good habitat quality can make the population viable, since the species can reach high densities in optimal reed land. North and west of the existing SPA.

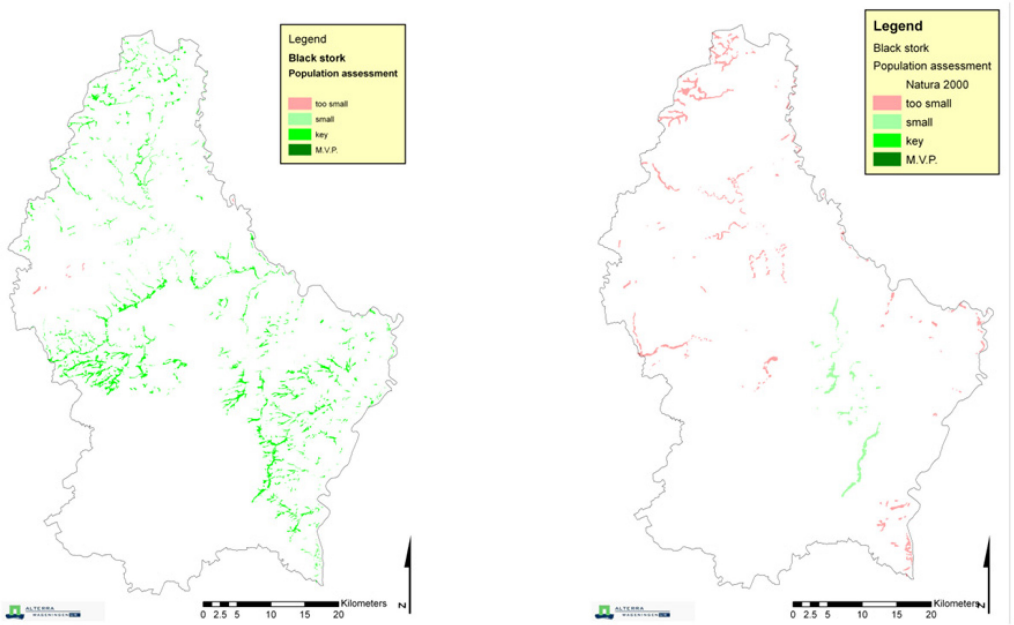

Figure 32

Viability of the Black stork population within all habitat (left) and Natura 2000 (right).

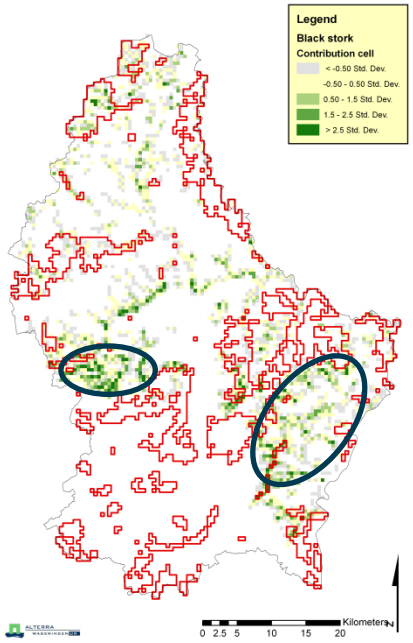

Figure 33

Most suitable areas for the Black stork outside Natura 2000.

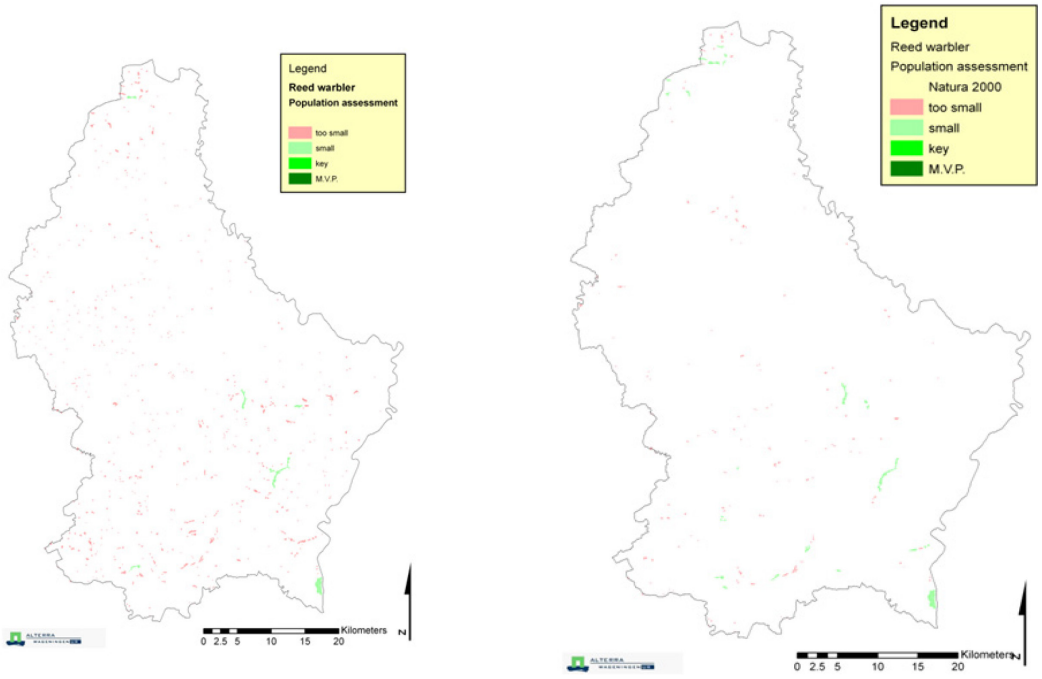

Figure 34
Viability of the Reed warbler population within all habitat (left) and Natura 2000 (right).

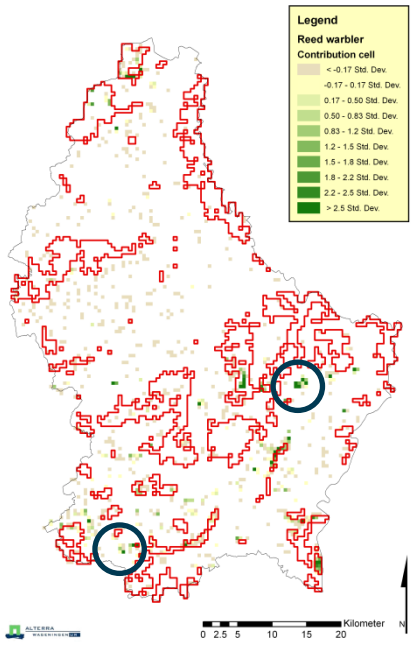

Figure 35
Most suitable areas for the Reed warbler outside Natura 2000 areas.

'Vallée de l'Alzette' some areas could be added to the Natura 2000 network (Figure 35). Also at Haff Réimech and in Vallée de la Syre has to be looked for opportunities to increase the area of reed land. These areas will contribute some 35 breeding pairs resulting in a total of 153 breeding pairs in Luxembourg. Still this is not sufficient for a key population. However, a more detailed modelling is not possible because of the scale of reedland on the maps. In addition to the area protected good management of the sites is important to reach high densities.

4.1.3.4 Water rail *(Rallus aquaticus)*

The water rail is a secretive, medium-sized bird and occurs mainly in wetlands offering at least wet reed but preferably a dense and tangled vegetation. Preferred vegetation represents reeds, sedges, rushes, reed mace and Salix thickets. Preferred water depth is 5-30 cm. Even boggy forest and sewage ponds can be used, provided they are well vegetated.
Maximum numbers seen on one site represent six pairs (1983, Melchior et al., 1987). The slowly increasing numbers in Luxembourg are maybe due to conservation measures and the protection of wetlands.
For estimating the population size the MAXENT model was used (par.2.2).
The estimated population size will be some 59 breeding pairs, representing small populations scattered over the country (Figure 36). Based on field data the population is estimated to consist of some 30-40 breeding pairs (Lorgé and Melchior, 2010). These estimates may not be reliable because of the very secretive way of living of the species and numbers seem to be 'notoriously underestimated' (Hagemeijer and Blair, 1997). Nevertheless estimated numbers by the model and numbers based on field data show a good fit. However, the population would not be viable on its own.
Using only the habitat present in the Natura 2000 network it is estimated that just twelve breeding pairs would remain. This illustrates that the distribution of suitable wetlands is insufficient covered by the Natura 2000 network. This has also to do with the scale of reed beds and wetlands on the maps.
The most important sites in the current network are Haff Réimech, Vallée de la Trëtterbaach and Dudelange Haard.
Viability target: Because of insufficient knowledge on the distribution and ecology of the Water rail a proper analysis of areas which contribute to the viability of the species and which should be protected is difficult. A viability target has not been formulated for that reason. However, management measures that benefit the Reed warbler will equally benefit the Water rail due to similar habitat requirements.

4.1.3.5 Kingfisher *(Alcedo atthis)*

The Kingfisher is a small bird and a territorial breeder, nesting in excavated holes in steep earthen banks. The species inhabits various aquatic habitats: rivers, lakes and ponds. Individuals hunt for small fish species and large invertebrates near the shore so the presence of trees, shrubs and steep banks is important. The biggest threat facing Kingfisher populations is the destruction or alteration of habitat by logging and water pollution. Distribution data is quite good, however, it seems biased for urban areas because of the large number of observers there. LARCH uses data on steep banks and aquatic habitat to model the habitat. LARCH estimates some 110 breeding pairs in the population. Based on field data the population estimate is some 50-80 breeding pairs (Lorgé and Melchior, 2010). The estimated populations will not be viable since its distribution is very scattered over different streams and rivers in Luxembourg (Figure 37).

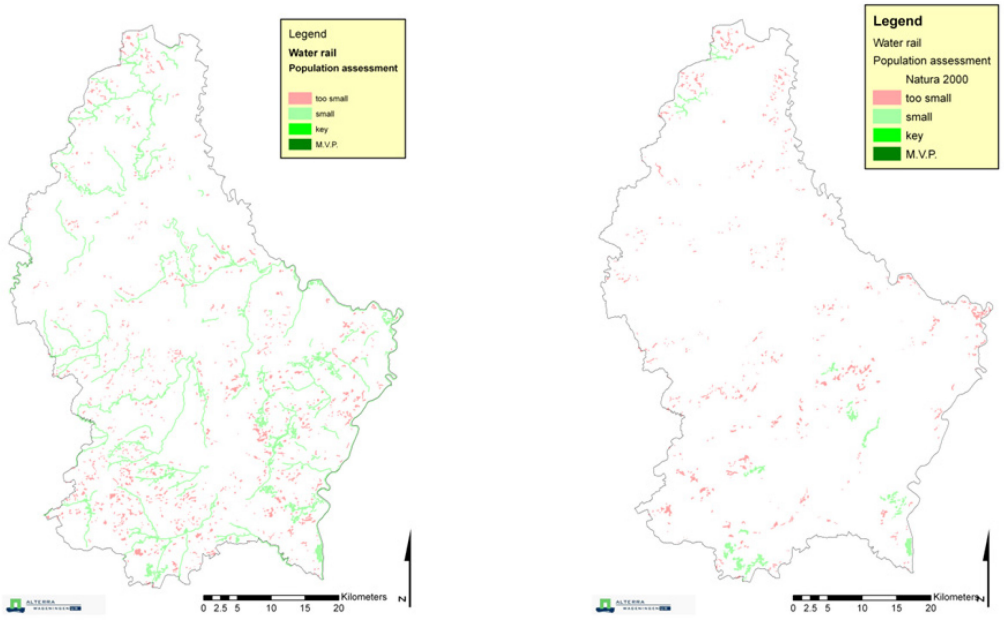

Figure 36

Viability of the Water rail population within all habitat (left) and Natura 2000 (right).

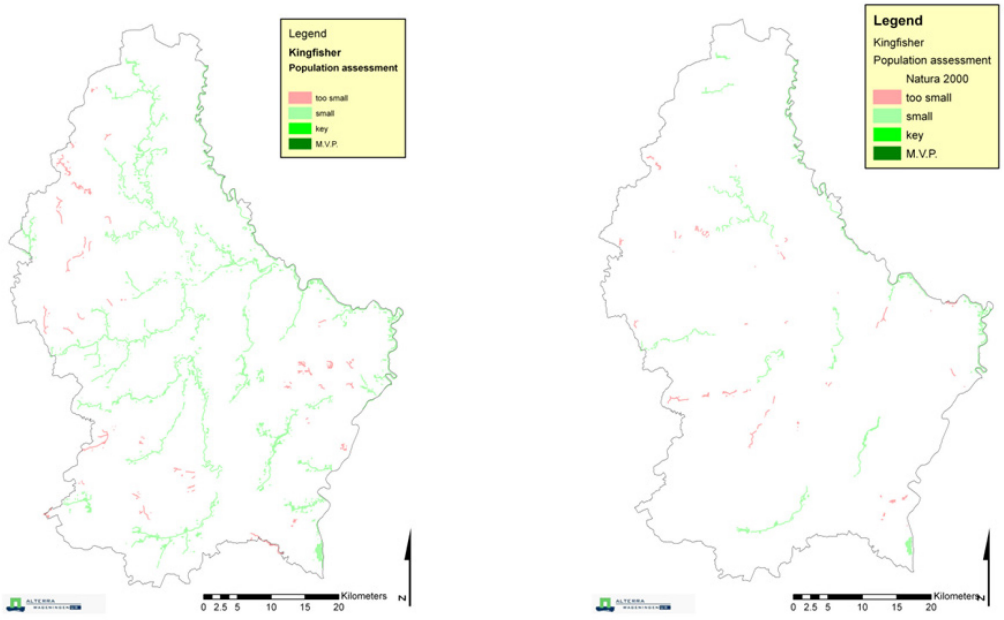

Figure 37

Viability of the Kingfisher population within all habitat (left) and Natura 2000 (right).

Based on the habitat present within only the Natura 2000 network the population would encompass some 47 breeding pairs.
Viability target: Because of the habitat structure along rivers it is difficult to find areas large enough for a key population (100 breeding pairs). Only small (local) populations which are not viable can be expected. For this reason no viability target has been formulated.
However, some areas may be of interest for the species: the area south of Vallée de la Sure, along the river Alzette north to Luxembourg and the Wark river, an area with a potential for some fifteen breeding pairs. The river from Ettelbrück to Colmar represents a corridor in an urban area, connecting different populations. Some good rivers seem to be in the Kiischpelt Clerve, Wiltz and in particular the area west of Bleesbreck.

4.1.4 Priority areas for wetland species

The wetland species differ widely in their habitat requirements and suitable habitat patches for the species do badly overlap. Because of the required habitat (reed lands, river valleys wet grassland and shallow water) a combination of maps and selection of priority areas is not possible. Only for the Black stork priority areas could be analysed.
In fact only for a species like the Reed warbler a viable population is achievable, due to its low habitat requirements and high densities.

4.1.5 Farmland biotopes

The current situation for the farmland species is viable for most species, except for the Quail and the Lapwing (Table 14). However, the management of farmland is crucial for the condition of populations of all species. The Natura 2000 network causes much smaller populations for all of the species and most populations are not viable. In fact, on average only 11% of the populations of the selected species would be sustained within these protected areas (Table 14). Based on this outcome, and regarding the potential viability of those species, a viability target is formulate which could be aimed for by the Luxembourg government. This target is set off against the potential for viable populations, but also in line with the approach in other European countries. All species depend on farmland, and extensive land use is a prerequisite for their long term persistence. Provided that management measures are taken, the designation of Natura 2000 areas will result in long-term viable populations.

Table 14

Population viability of farmland species based on LARCH (current situation) compared to Natura 2000 and proposed viability target (BP= breeding pairs; MVP= minimum viable population, KP= key population, SP = small population, v= viable, nv= not viable).

Common name	Current situation	Natura 2000	Viability target (par. 2.2)
Black kite	KP 95 BP (v)	SP 18 BP (nv)	key population
Red kite	MVP 102 BP (v)	SP 11 BP (nv)	key population
Grey partridge	KP 130 BP (v)	SP 7 BP (nv)	key population
Quail	SP 58 BP (nv)	SP 3 BP (nv)	maintain all areas where species occurs
Lapwing	KP 65 BP (nv)	SP 1 BP (nv)	maintain all habitat where species occurs***
Little owl	MVP 500 BP (v)	KP 64 BP (nv)	other measures**
Sky lark	MVP 4740 BP (v)	KP 356 BP (v)	3 key pops, viable
Meadow pipit	KP 414 BP (v)	SP 14 BP (nv)	key population
Red-backed shrike	MVP 1325 BP (v)	KP 167 BP (nv)	2 key populations, viable
Great grey shrike	KP 114 BP (± v)	SP 5 BP (nv)	key population ***
Linnet	MVP 6600 BP (v)	KP 2300 BP (v)	*

* No viability target, see species description

** With other measures is meant: additional measures to enhance the species; for Little owl nest boxes are important, and if located in the suitable areas this can result in a viable population

***Important species, aim is to protect 60% of the population

4.1.5.1 Black kite *(Milvus migrans)*

The Black kite occurs in most of northwestern Europe, but in low densities. A range expansion northwards of some 100 km was noted for the period from 1970-1980 (Doumeret in Hagemeijer and Blair, 1997).
The species prefers open water habitat such as lakes, stagnant waters wetlands, and presence of rivers and adjoining forest areas. The species requires softwood riverine forest as breeding area. It is a semi colonial species and the nests are located near to each other, most near water. It is frequently found in wooded valleys, feeding on farmland, watersides and rubbish tips. It hunts on small mammals, birds, reptiles, (dead) fish, insects but also on carrion.
LARCH estimates a population of about 95 breeding pairs. It would be a viable key population (Figure 38). The main part of its distribution is in the south of the country. In Luxembourg some 39 territories occur, of which eight are breeding territories (Lorgé, 2007). The population based on field data is estimated to be 60-65 pairs (Lorgé and Melchior, 2010). Field data and modelling results fit well Looking only at the habitat within the Natura 2000 sites the population would be some eighteen pairs representing a small population which is not viable.
Viability target: For a medium sized species as the Black kite a key population of 40 breeding pairs is a minimum viability target. To reach this the protected areas has to be enlarged. Most important are: Echternach-Grevenmacher-Junglister and south of Diekirch (Figure 39). Several areas could contribute to a total of 50 breeding pairs: region of Clémency (colony of at least seven breeding pairs), region of Limpach-Pissange-Sanem-Mondercange (seven pairs), region of Niederpallen (six to seven pairs), region Flaxweiler-Mompach (seven pairs) and southeast of Diekirch (four pairs) (personal communication G. Biver.).

4.1.5.2 Red kite *(Milvus milvus)*

The Red kite prefers open extensively used agricultural landscapes such as cultivated steppe landscapes. It breeds in forest habitat with a preference for open woodland edges (Hagemeijer and Blair, 1997). Over the last decades it has shown a decrease due to habitat destruction and intensification of agriculture. The species is very sensitive to poisoning but seems also sensitive to human disturbance (recreation, wind energy parks) (Lorgé, 2007).

Using MAXENT for modelling suitable habitat, LARCH estimates a Minimum Viable Population of some 102 breeding pairs. Based on field data the population is estimated at 60-65 breeding pairs (Lorgé and Melchior, 2010). The predicted distribution pattern reflects fairly well the actual distribution of the species (Figure 40). Looking at the habitat within the Natura 2000 network just eleven breeding pairs would remain in scattered and small populations.

Viability target: A minimum viability target for the Red kite will be a key population (20 breeding pairs). To reach this target areas where the species occurs has to be protected. Priority areas are southeast of the Valley of Trëtterbaach, the southern part of the Valley of l'Attert, the region between Diekirch and Consdorf, the region of Heinerscheid as well as the area around Canach-Flaxweiler-Mompach (Figure 41). The potential contribution of these areas would be some 20 breeding pairs, resulting in a total of 38 breeding pairs within protected areas.

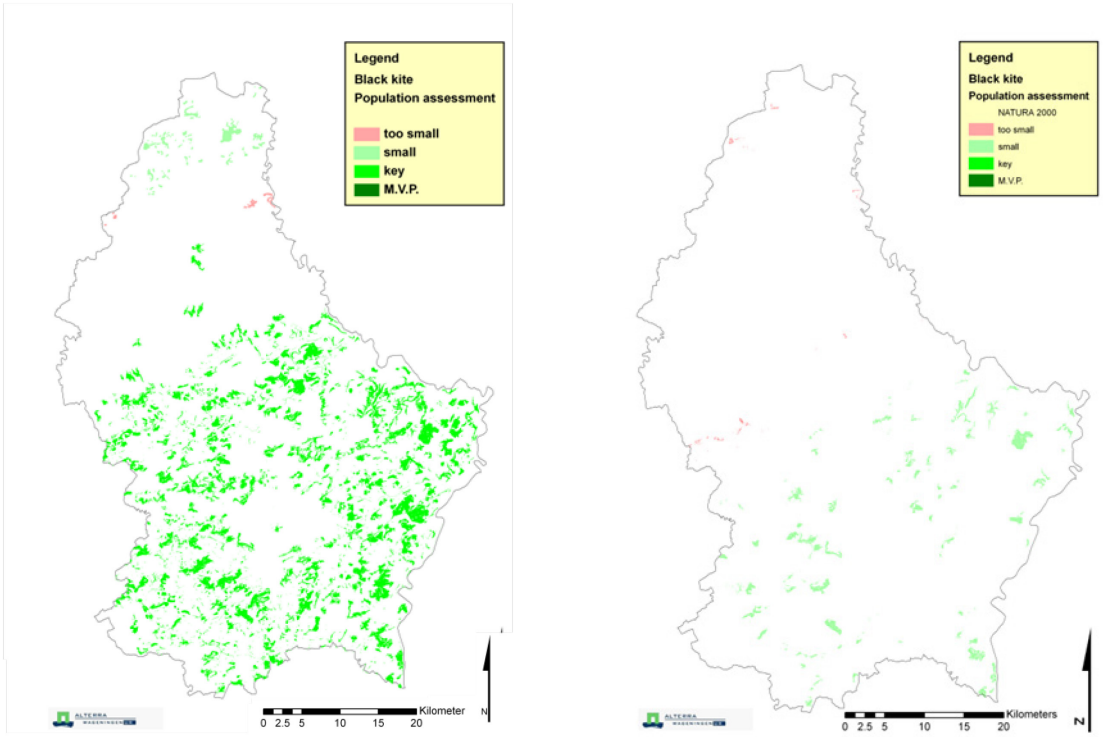

Figure 38
Viability of the Black kite population within all habitat (left) and Natura 2000 (right).

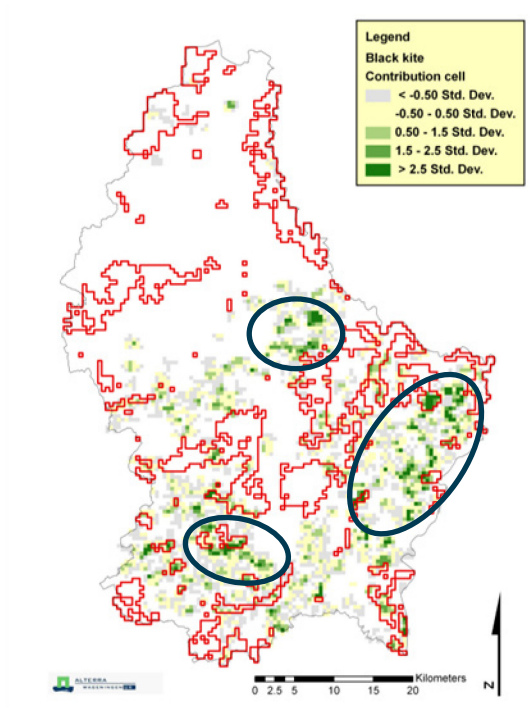

Figure 39
Most suitable areas for the Black kite outside Natura 2000 areas.

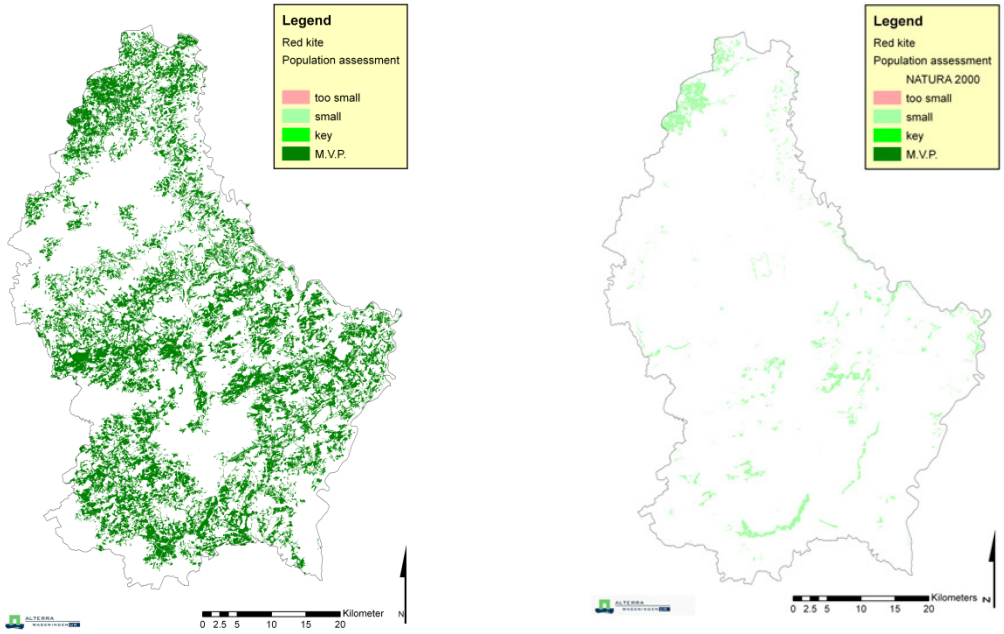

Figure 40

Viability of the Red kite population within all habitat (left) and Natura 2000 (right).

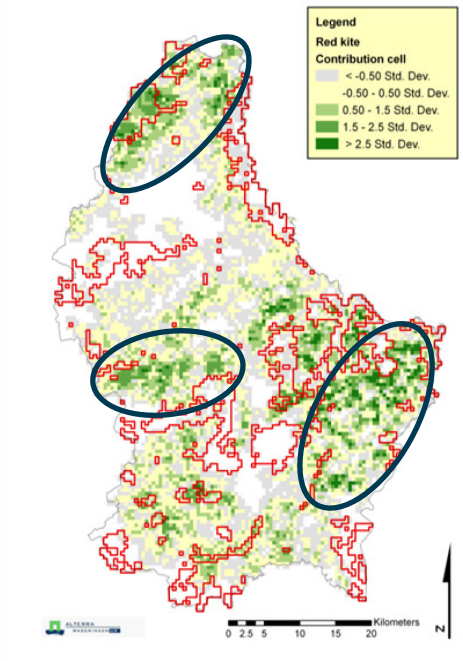

Figure 41

Most suitable areas for the Red kite outside Natura 2000 areas.

4.1.5.3 Grey partridge *(Perdix perdix)*

The Grey partridge is a sedentary bird of lowland arable areas. It eats seeds and insects. It has undergone a serious decline in most of its range, due to intensification of farming practices and disappearance of hedges and wood rows.
The species prefers open farming areas, treeless hills and (stony) moorland areas. It breeds and winters on farmland, grassland and arable fields. Very important is the mosaic of different habitats, i.e. wood rows, hedges, herb-rich field edges, and set-aside or ruderal areas. In Luxembourg the population underwent a large decline after the 1960s but it seems more or less stable in the last years.
The species has a limited distribution in the southeast. Only six territories were counted in 2008 (Klein and Biver, 2008). LARCH estimates some 130 pairs representing a viable population due to the presence of a key population in the south-west (Figure 42). The difference between estimates based on LARCH and field data is caused by the relatively poor quality of the species' habitat in reality as a result of intensive farming, which information is not included in data on the maps that were used.
The biggest part of the population seems to occur outside the existing Natura 2000 network, since modelling based on the habitat within Natura 2000 sites shows only seven breeding pairs representing just two small populations in the south- west.
Viability target: It is recommended to enlarge the protected area in the southwest to the extent of a key population (40 breeding pairs). This can be done by increasing the protected area or by improving the quality of the habitat as illustrated by extensive farming and providing structures such as hedges, strips with herb-rich vegetation etc. Priority areas can be found just north and south of the 'upper valley of the Alzette', in addition areas occur between Junglinster and Mompach and potentially the Valley of the l'Attert (Figure 43). The potential contribution of these areas would be some 60 breeding pairs resulting in 77 breeding pairs in total. With little effort the result will exceed 40 breeding pairs.

4.1.5.4 Quail *(Coturnix coturnix)*

The Quail uses extensively farmed agricultural areas with hedges and wood rows for cover. The species shows a decline due to the onset of intensive agriculture with chemicals and fertilizers. The species breeds in open areas with cereals, but also in grassland with a taller herbaceous vegetation, clover and vetches.
Based on field data the population in Luxembourg is estimated to be some 10-25 breeding pairs.
Most observations are coming from the north, Vallée de la Trëtterbaach, and partly in the Vallée de la Woltz et affluents de la source à Troisvierge. LARCH estimates a small population of some 58 breeding pairs, which is not viable (Figure 44). As for the Grey partridge the habitat quality in reality is much lower than represented by the data on maps causing LARCH to give an overestimate. Within the protected Natura 2000 sites only some two breeding pairs would remain. The sites do not offer enough suitable habitat for this species.
Viability target: The minimum target is to protect the areas where the Quail currently occurs. Here specific measures should be taken to enhance the quality of the habitat by extensive farming without agro-chemicals and artificial fertilizer. This could increase potential populations at least tenfold. Priority area seem to be the Region de Junglinster-Mompach, Lias moyen, the southern part of the Attert valley and just north of the Valley of the Alzette (Figure 45). These areas may under current management measures result in an increase by fifteen breeding pairs, in the case of extensive farming a viable population of more than 200 breeding pairs seems possible.

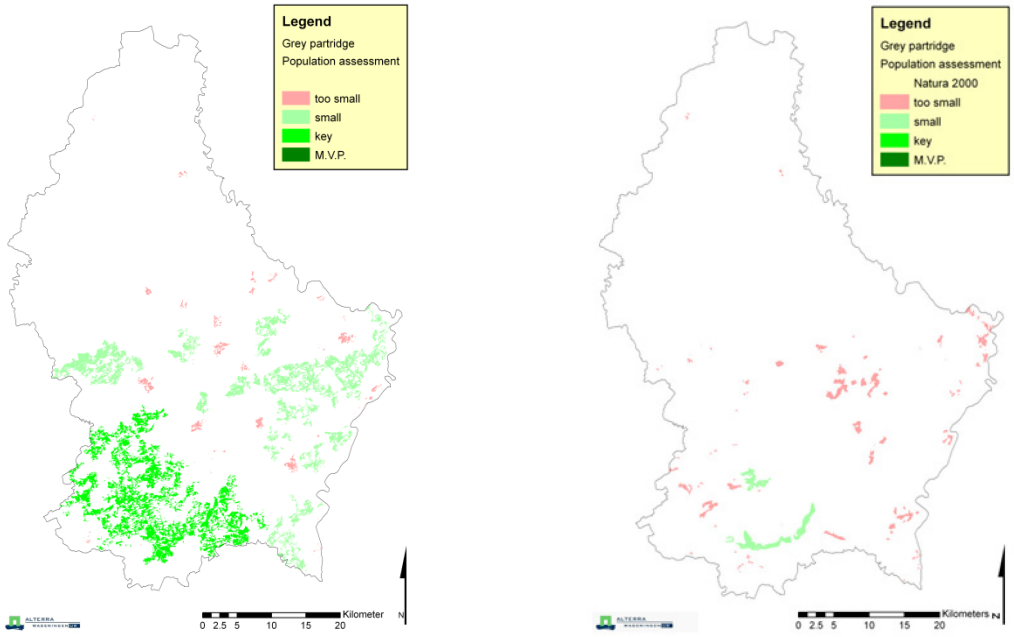

Figure 42

Viability of the Grey partridge population within all habitat (left) and Natura 2000 (right).

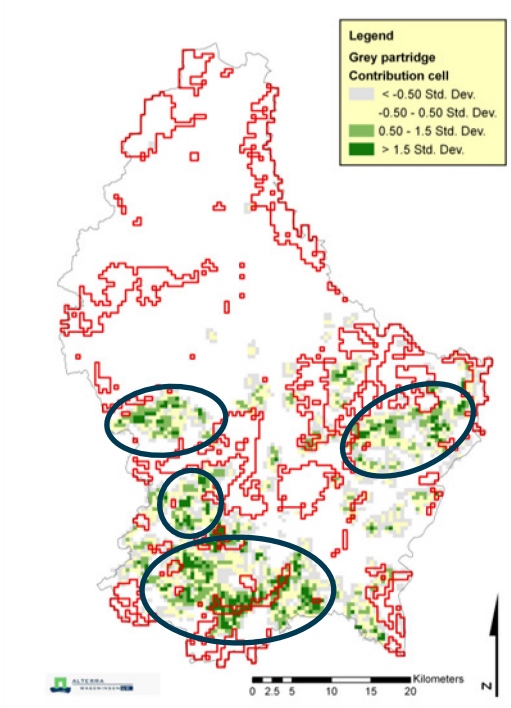

Figure 43

Most suitable areas for the Grey partridge outside Natura 2000 areas.

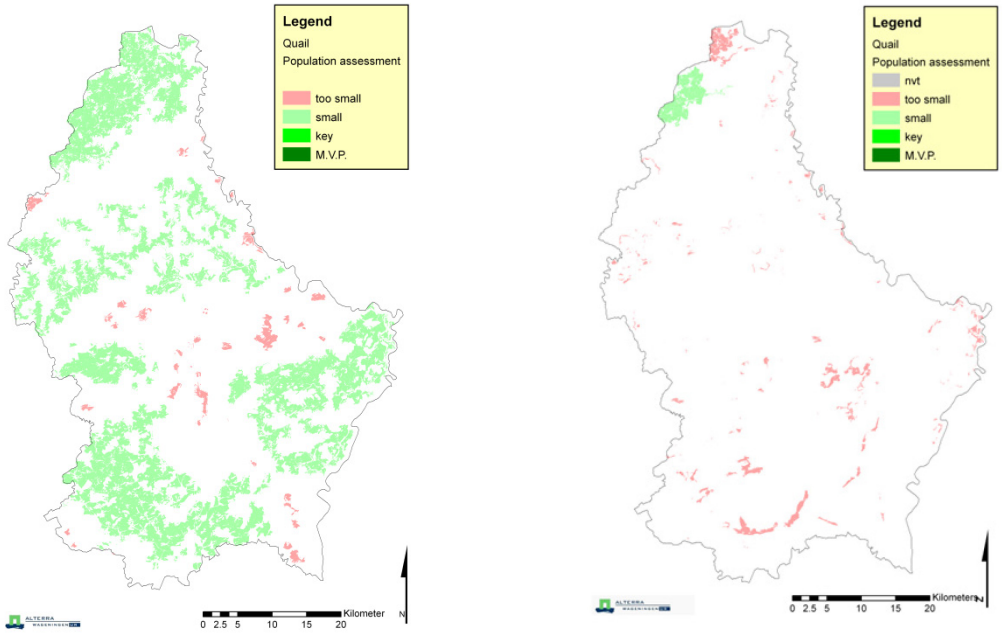

Figure 44

Viability of the Quail population within all habitat (left) and Natura 2000 (right).

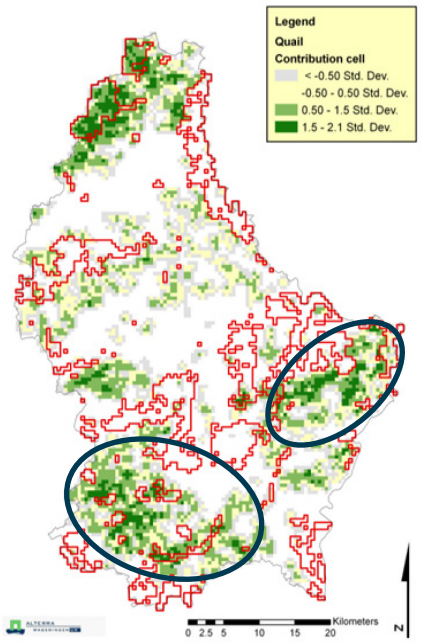

Figure 45

Most suitable areas for the Quail outside Natura 2000 areas.

4.1.5.5 Lapwing *(Vanellus vanellus)*

The Lapwing occurred in Luxembourg until the 1920s. It disappeared, but returned in 1960s. It is very much influenced by changes in management measures for grasslands related to intensification of agriculture (e.g. early mowing in the season will destroy nests). The application of fertilisers and chemicals has also resulted in a further decline of the species.
The species uses open wetlands, wet meadows and floodplains. Wet grassland represents important habitat, however, extensive management is required. Breeding success of the species on arable farmland is often low. In Luxembourg some 20-25 breeding pairs have been counted, illustrating a decline of 50% of the population. Only in the south of the country breeding takes place, in the north and east suitable habitat does not occur nowadays. LARCH estimates the population to be some 65 breeding pairs, which represents a key population, which however, is not viable (Figure 46).
Within the Natura 2000 network, only one breeding pair is estimated to occur illustrating the habitat included in this network does not meet the requirements of the Lapwing because the grassland management is too intensive.
Viability target: A minimum viability target is to protect all sites where the Lapwing occurs. It is to expect that a population recover in the south will be followed by a comparable recovery in the north.
Priority areas in the west are in 'Upper Alzette' and Lias moyen, and in the east around Région de Mompach, Manternach, Bech and Osweiler (Figure 47). The potential contribution of these areas would be six breeding pairs which is still negligible.

4.1.5.6 Little owl *(Athene noctua)*

The Little owl is a medium-sized bird of prey and a rather sedentary species. The species declined as a result of habitat destruction caused by an industrial way of farming. In Luxembourg numbers dropped from 3400-4200 breeding pairs in the 1960s to 80-150 nowadays.
The species hunts on small mammals, such as mice, as well as amphibians, lizards etc. The species inhabits a wide range of open (traditional) agricultural landscapes and prefers areas of extensive agricultural farming practices. Breeding takes often place in hollow trees, in the crown of pollarded willows or old barns. In intensively managed landscapes breeding sites are scarce and alternatives are provided through nest boxes. In Luxembourg there is a successful nest box program, which more or less defines the distribution range of the species.
LARCH estimates the population to be some 500 breeding pairs based on the availability of feeding habitat, which represents a Minimum Viable Population (Figure 48). This estimate fits historical numbers. However, in reality the population is much smaller representing some 20-40 breeding pairs. This illustrates nest sites are limited and land use is probably too intensive. Within the Natura 2000 network the potential population would be some 64 breeding pairs, large enough for a key population, which however, is not viable.
Viability target: Because there seems to be enough feeding habitat the viability target is to increase the number of breeding sites. The Little owl can expand if more nest boxes are placed or willows will be planted in river valleys in areas with extensive farming practices. The population could double with appropriate measures especially in the areas south of the Attert valley, at the Lias moyen region and around Mompach-Manternach (Figure 49). However, the LARCH model results in this case are considered less reliable since the breeding areas are the limiting factor. Therefore, it is best to develop a conservation plan in close collaboration with species' experts.

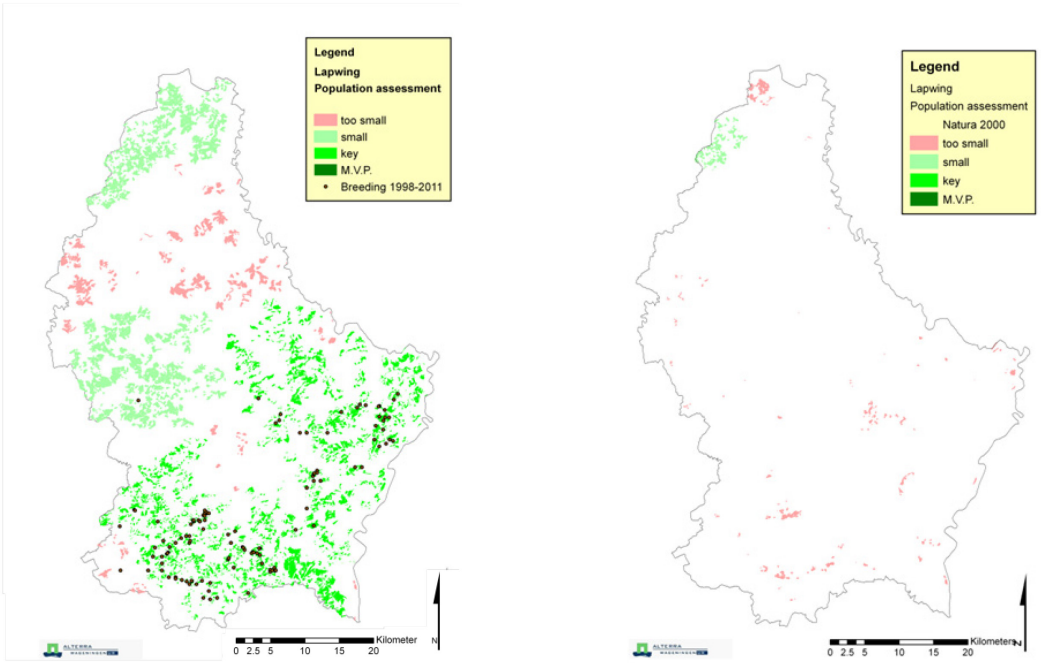

Figure 46

Viability of the Lapwing population within all habitat (left) and Natura 2000 (right).

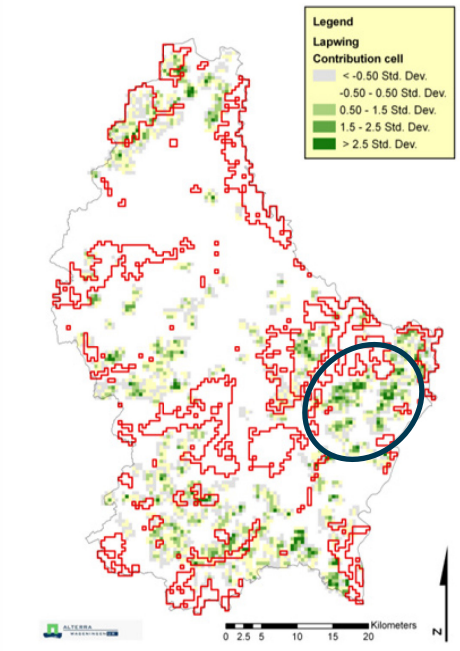

Figure 47

Most suitable areas for the Lapwing outside Natura 2000 areas.

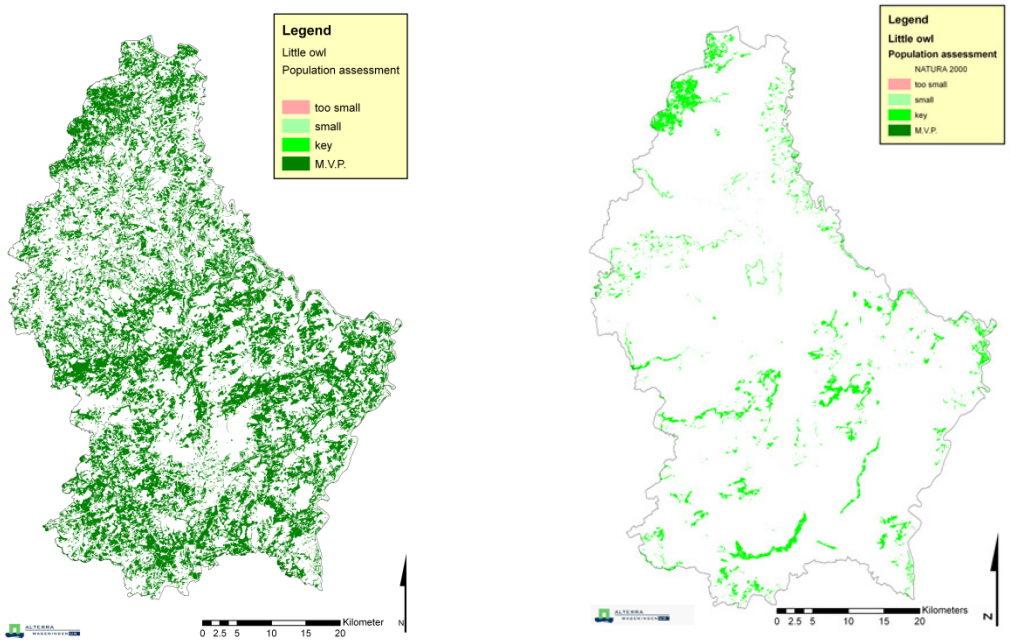

Figure 48

Viability of the Little owl population within all habitat (left) and Natura 2000 (right).

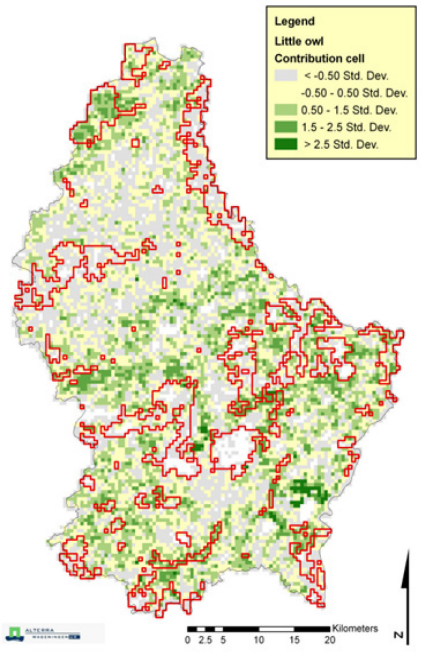

Figure 49

Most suitable areas for the Little owl (no areas selected).

4.1.5.7 Sky lark *(Alauda arvensis)*

The Sky lark is a small song bird, eating insect species and inhabiting open grassland and heather. The species prefers open vegetation and tolerates taller vegetation than other Lark species but will avoid tall, up-going structures. It is common in all open landscapes from Luxembourg. The species has shown a serious declines (close to 50%) over the last decades (personal communication G. Biver). This is caused by a more intensive way of farming and changes in formerly open, semi-natural landscapes such as heathers.
LARCH estimates a MVP of 1325 breeding pairs, which is highly viable (Figure 50). Within the Natura 2000 network some 356 breeding pairs are estimated to occur representing a key population in the north and mostly small local populations elsewhere. This illustrates the population of the Sky lark occurs mainly outside the protected SPA-network.
Viability target A viability target will be to protect at least three key populations. Priority areas for this are Vallée de la Trëtterbaach, the Valley of the Attert and the areas around Mompach and Junglinster (Figure 51). These areas can contribute potentially some 356 breeding pairs increasing the number of breeding pairs to 1250.

4.1.5.8 Meadow pipit *(Anthus pratensis)*

The Meadow pipit is a small songbird and its ecology is very similar to the Sky lark. It favours open 'cultural landscapes' with limited up going woody vegetation.
It breeds in open, not too dry to rather wet meadows with a vegetation structure providing cover (Biver, 2008). For feeding it requires an open vegetation, not taller than 10 cm and also stubble will do (Hagemeijer and Blair, 1997). Also ruderal and set-aside land is used. Due to more intensive land use the species declined by 69% (Biver, 2008).
LARCH estimates a population of 414 breeding pairs representing a key population in the south, which is viable (Figure 52). An estimate based on field data shows some 250-350 breeding pairs. Both estimates fit quite well and also the modelled distribution of habitat fits with the actual distribution of the species. Looking at only the Natura 2000 network the small number of fourteen breeding pairs will persist, representing a small percentage of the actual number. This illustrates appropriate breeding habitat is not included in the Natura 2000 sites. Priority areas are the upper Valley of the l'Alzette, and the Valley of Trëtterbaach which are designated as SPAs.
Viability target: A minimum viability target for the Meadow pipit will be to protect at least a key population, including some 100 breeding pairs. To reach this target some areas south of the Upper valley of de l'Alzette (SPA) should be added (Lamidden) representing a link with Lias moyen (Figure 53). Other priority areas are Mompach, southern part of the Attert valley and the Valley of Trëtterbaach in the north and east. Also the SPAs 'Vallée de la Syre' and 'Vallée de l'Ernze blanche' hold some breeding pairs. The potential contribution of all these areas would be some 90 breeding pairs, increasing the total number to 105 breeding pairs.

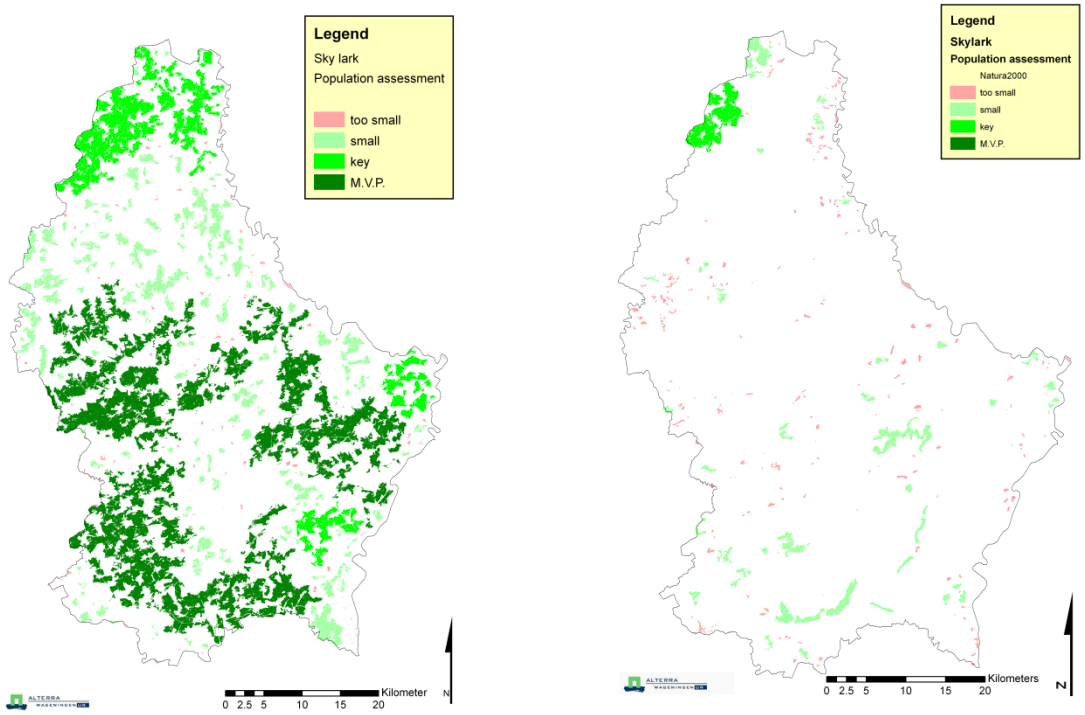

Figure 50

Viability of the Sky lark population within all habitat (left) and Natura 2000 (right).

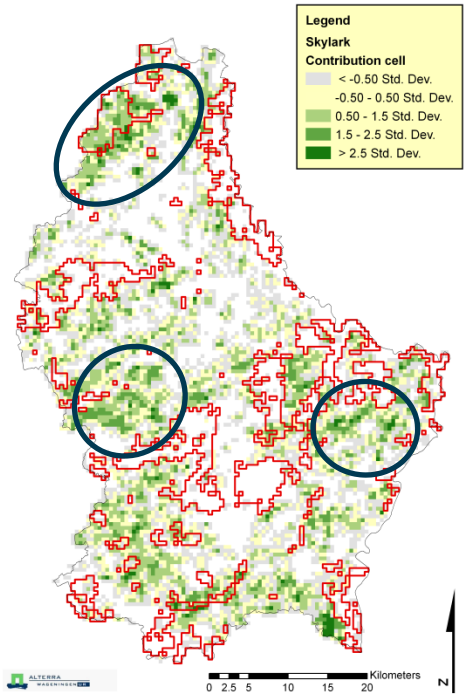

Figure 51

Most suitable areas for the Sky lark outside Natura 2000 areas.

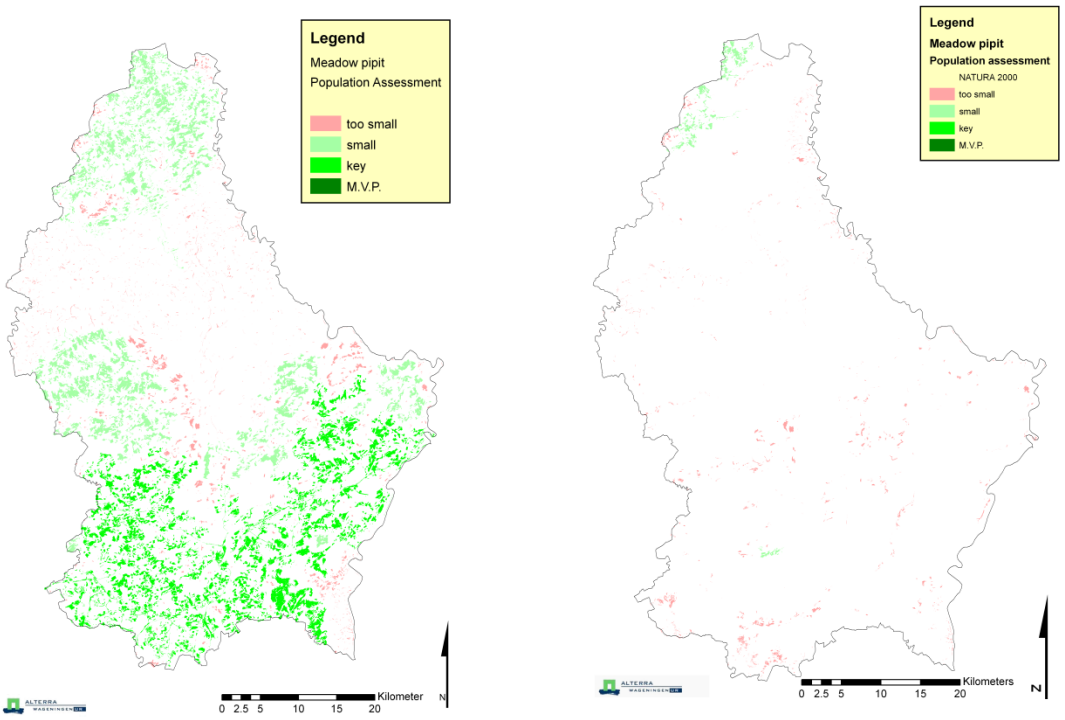

Figure 52

Viability of the Meadow pipit population within all habitat (left) and Natura 2000 (right).

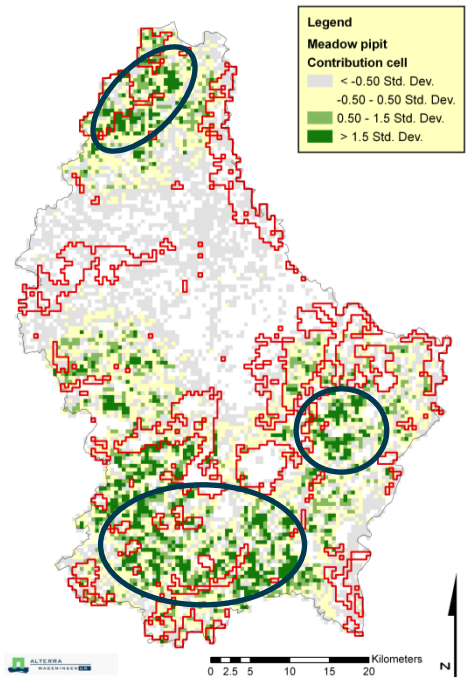

Figure 53

Most suitable areas for the Meadow pipit outside Natura 2000 areas.

4.1.5.9 Red-backed shrike *(Lanius collurio)*

The Red-backed shrike is a species of small-scaled agricultural landscapes. The species preys on insects and sometimes small animals like mice. Birds like to perch prominently on the tops of bushes, fence posts and telephone wires, where they have a good view of potential prey. The prey is often pinched on thorns from shrubs or barbed wire. Favoured habitat is waste land, shrubby habitat and heathers and moors.
The Red-backed shrike has a wide distribution through-out Luxembourg. LARCH estimates a population of some 1325 breeding pairs, representing a MVP with key populations in the centre and north of the country (Figure 54). Field data shows some 1500-2000 breeding pairs, illustrating the LARCH estimate may be too low. Within the Natura 2000 network some 167 breeding pairs will survive based on a key population in the north and smaller local populations elsewhere. Most sites where the species occurs are outside the existing Natura 2000 network.
Viability target: A viability target for the Red-backed shrike will be to protect a viable population with at least two key populations (100 breeding pairs each). Priority areas to reach this target are Mompach in the centre-east, the Valley of the Attert, the areas of Canach and Junglinster (Figure 55). The potential contribution of these areas would be some 220 breeding pairs, increasing the total number to almost 400 breeding pairs.

4.1.5.10 Great grey shrike *(Lanius excubitor)*

The Great grey shrike is the largest European shrike. It is a sedentary species from marginal landscapes with structured vegetation and a good fauna diversity like the Red-backed shrike. The species shows a decline all over Europe due to habitat destruction. It has gone extinct in several countries and is on the verge of extinction in some European regions.
Great grey shrikes prefer open areas including heathland, farmland, peatbogs, clear-fell and open cultivated land. They use scrub with solitary trees, shrubs, and fence poles as fence posts searching for food. The species feeds mainly on voles but also larger prey like birds.
LARCH estimates a key population of some 114 breeding pairs, which is more or less viable (Figure 56). The breeding population, based on field data, fluctuates between 90 and 120 breeding pairs. This shows a good fit between the LARCH estimation and the actual situation in the field. Looking at the Natura 2000 network only some five breeding pairs will occur representing a not viable situation.
Viability target: A minimum target is to protect a key population of 40 breeding pairs. To reach the target priority areas are in particular Vallée de l'Attert, Lias moyen, regions of Junglinster and Mompach (Figure 57). These areas can contribute some 23 breeding pairs to the population, reaching a total of 28 breeding pairs. Still this represents a small vulnerable population. To realise a key population of 80 breeding pairs seems not feasible.

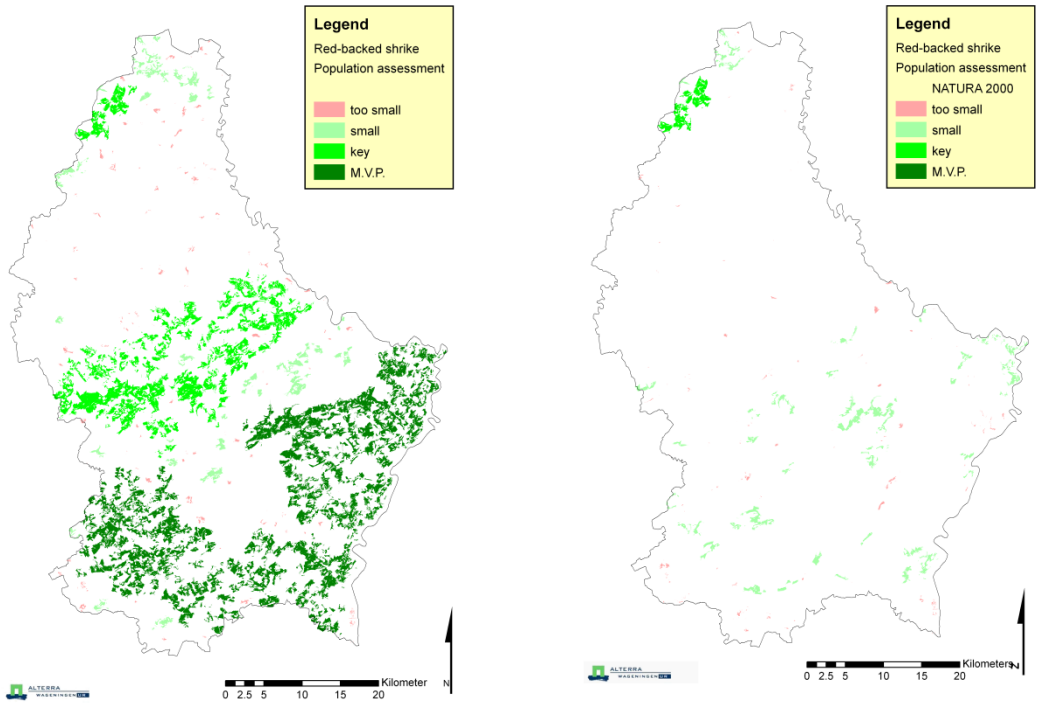

Figure 54

Viability of the the Red-backed shrike population, within all habitat (left) and Natura 2000 (right).

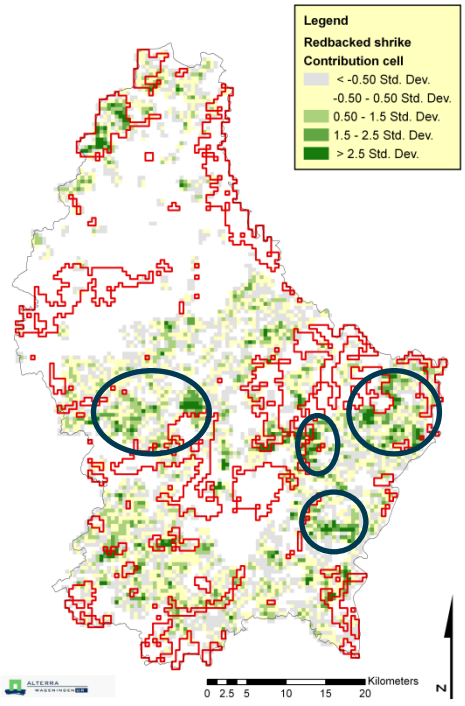

Figure 55

Most suitable areas for the Red-backed shrike outside Natura 2000 areas.

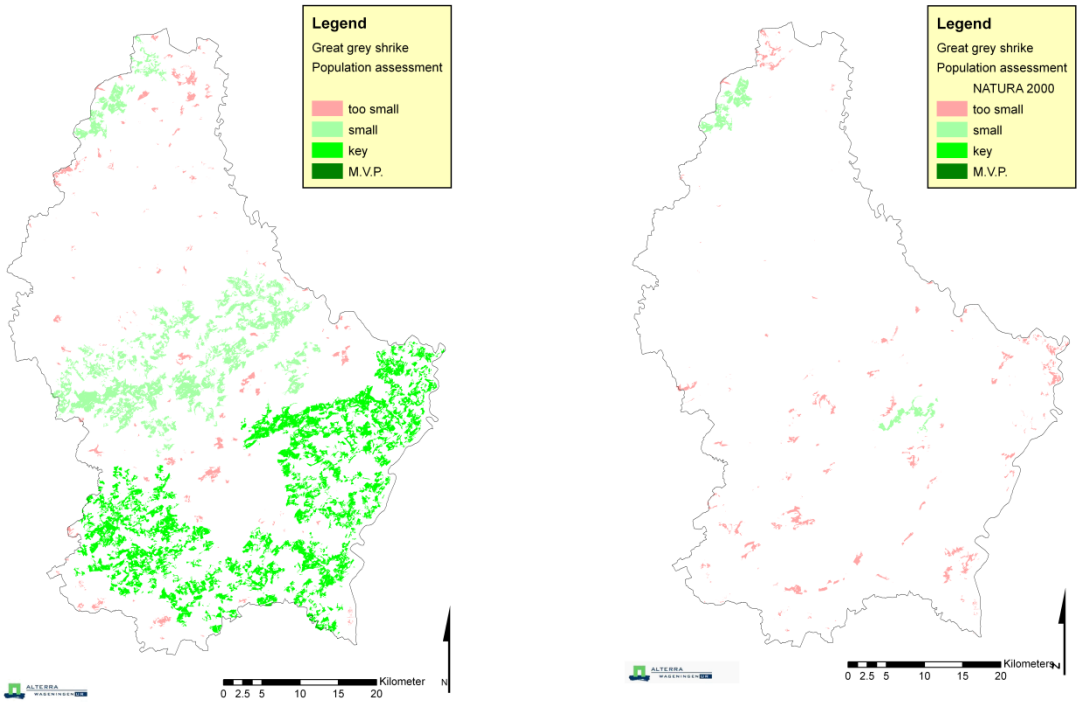

Figure 56

Viability of the Great grey shrike population, within all habitat (left) and Natura 2000 (right).

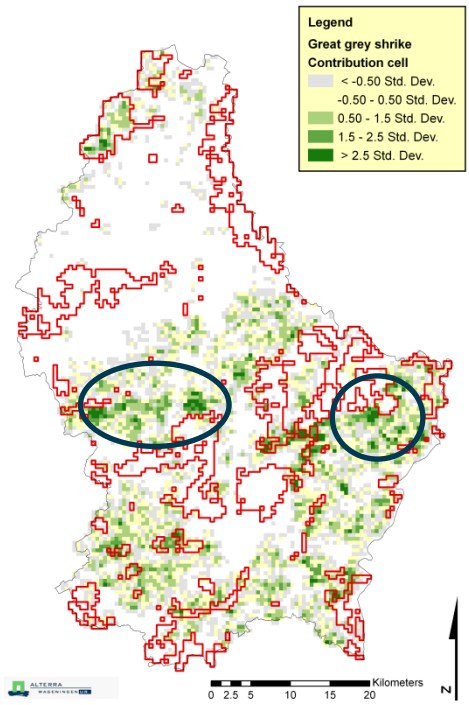

Figure 57

Most suitable areas for the Great grey shrike outside Natura 2000 areas.

4.1.5.11 Linnet *(Carduelis cannabina)*

The Linnet is widely distributed over Europe and a typical species of low-intensity farmland and lowlands. The Linnet has shown a large decline due to changes in farming practices, in particular chemical weed control has been detrimental for the species.

The Linnet inhabits in Luxembourg also open landscapes with hedges and other landscape structures, as well as fallow land. It occupies a variety of open habitats containing shrubs or young plantations, such as overgrown heathland, woodland edges, forest clearings and fragmented farmland. The species avoids dense forests (Hagemeijer and Blair, 1997).

LARCH estimates some 6600 breeding pairs representing a viable population of which the habitat is spread all over Luxembourg (Figure 58). However, there are some areas with high numbers, in particular the open landscapes of the Vallée de l'Attert, Region de Junglinster and the two SPAs Vallée de la Trëtterbaach and Woltz. Within the Natura 2000 network the population would be some 2300 breeding pairs representing also a viable population.

Viability target: The Linnet is viable within the existing Natura 2000 network. For that reason no additional areas are needed for its protection. Best habitat for the Linnet is shown in Figure 59.

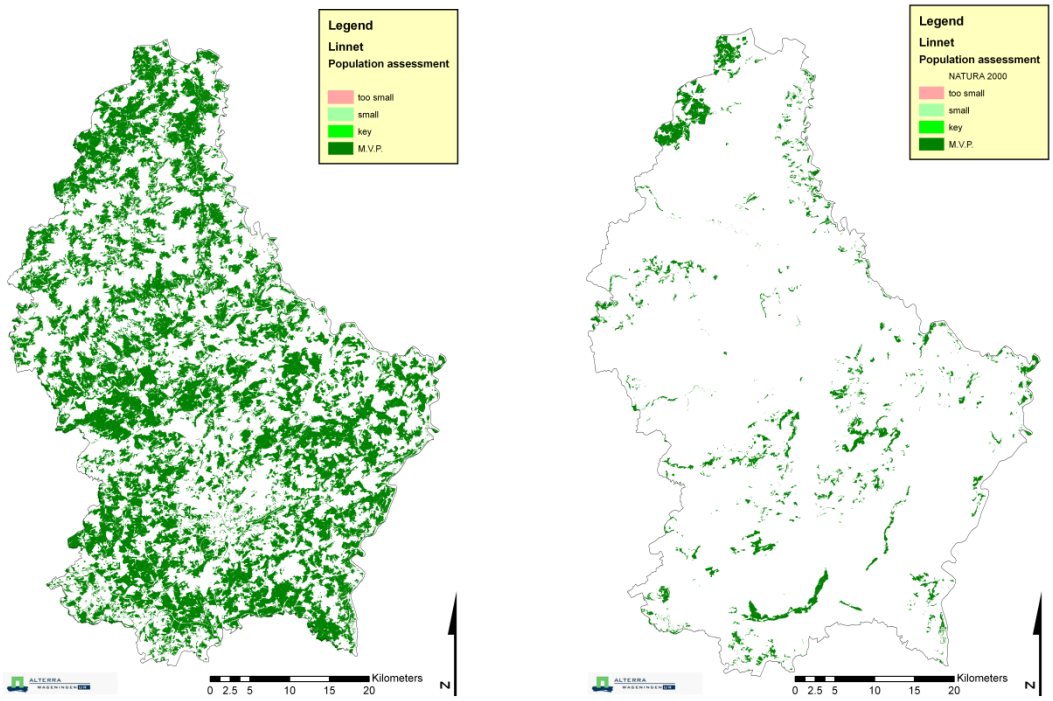

Figure 58

Viability of the Linnet, within all habitat (left) and Natura 2000 (right).

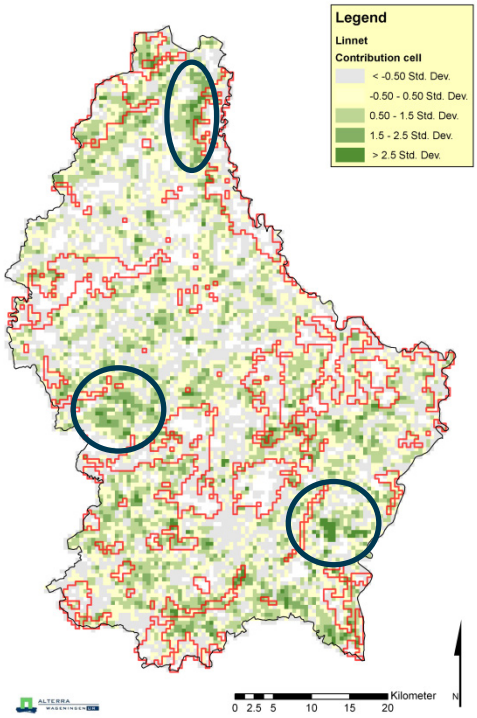

Figure 59

Most suitable areas for the Linnet outside Natura 2000 areas.

4.1.6 Priority areas for farmland species

The results of the analysis of the contribution of a grid cell to the viability of all species within the group of farmland species (par. 2.3) are summarised in Table 15 and represented in Figure 60. This figure shows the priority areas contributing most to the survival of all farmland species. The priority areas for each separate species are described in the paragraphs above. For the farmland species it is clear that all species in the group will benefit from enlarging the Natura 2000 network. The main reason is the restricted area of farmland included in the existing network.
Table 15 shows the contribution of the areas in Figure 60 to the viability of a species in terms of the number of breeding pairs. The number for all Natura 2000 and SPAs is indicative of what is currently protected under the Birds Directive. Table 16 shows the realised target for each farmland priority area (% of total target, formulated in the species descriptions above).

Table 15

Estimated contribution of the priority farmland areas of Luxembourg to species' viability. Numbers represent LARCH estimates of breeding pairs (BP).

Area number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**SUM**	**Total number of BP in:**	
Area size (km²)	*7*	*10*	*34*	*14*	*45*	*54*	*50*	*11*	*20*	*50*	*41*	*336*	**Natura2000 network**	**all SPAs**
Species														
Black kite	-	-	3	1	3	3	2	-	-	-	-	12	18	2
Red kite	-	1	2	1	3	6	5	1	2	4	3	28	11	5
Grey partridge	3	5	12	2	9	16	14	1	4	-	-	66	7	3
Quail	-	1	2	1	2	3	2	-	-	3	2	16	3	1
Lapwing	-	1	3	-	2	6	3	-	2	2	3	22	1	1
Little owl	3	3	9	7	11	17	16	4	6	14	10	100	64	25
Sky lark	40	50	145	58	175	240	260	55	95	240	190	1548	356	219
Meadow pipit	2	6	16	4	21	20	14	-	4	19	16	122	14	7
Red-backed shrike	6	14	42	31	52	100	69	28	20	23	21	406	167	75
Great grey shrike	1	1	4	1	5	9	7	2	1	1	1	33	5	2
Linnet	42	44	140	100	175	225	245	60	70	210	200	1511	2300	989

Four priority areas contribute to the viability of eleven species (numbers 6, 7, 5 and 3). Two areas contribute to ten species (2 and 4) and the others to seven to nine species.
Area 6 (northwest of Grevenmacher) and 7 in combination with 8 (Valley of the l'Attert) are important areas, in particular for the Partridge, Lapwing, Little owl, Sky lark, Red-backed and Great grey shrike and Linnet. These areas contribute relatively the highest numbers of breeding pairs to these species.
Area 3 and 5, in the triangle of the cities of Luxembourg-Arlon-Petange, are close to each other and contribute also relatively high numbers of breeding pairs to eleven species. They are adjoining small fragmented Natura 2000 sites like Hautcharage/Dahlem/Asselborn and Sanem-Groussebech, Bertrange, Grass-Moukrebrill. The farmland habitat in both areas would make an important contribution to the populations of Black and Red kite, Grey partridge, Quail, Lapwing, Little owl, Meadow pipit and both Shrike species.

Table 16

Estimated contribution of the priority farmland areas of Luxembourg to species viability. Numbers represent ***percentages of viability target*** *realised.*

Area number Species	1	2	3	4	5	6	7	8	9	10	11	SUM (%)
Black kite	0	0	150	50	150	150	100	0	0	0	0	600
Red kite	0	11	22	11	33	67	56	11	22	44	33	311
Grey partridge	20	33	80	13	60	107	93	7	27	0	0	440
Quail	0	2	4	2	4	5	4	0	0	5	4	29
Lapwing	0	2	5	0	3	9	5	0	3	3	5	34
Little owl	5	5	16	13	20	30	29	7	11	25	18	179
Sky lark	80	100	290	116	350	480	520	110	190	480	380	3096
Meadow pipit	2	7	18	5	24	23	16	0	5	22	18	139
Red-backed shrike	43	100	300	221	371	714	493	200	143	164	150	2900
Great grey shrike	3	3	12	3	15	27	21	6	3	3	3	100
Linnet	0	0	0	0	0	0	0	0	0	0	0	0

Area 1 and 2 are adjoining the SPA 'Upper valley of the l'Alzette and will extend this SPA. These priority areas would be of particular importance for the Grey partridge, Meadow pipit and Red-backed shrike.
Area 4, the area of Canach, is especially important for some of the smaller species like Sky lark and Linnet, but also for Little owl or Red-backed shrike. Area 9, the area in between l'Ernz blanche and l'Ernz noire, may have also good potential for the same species.
Area 10 is adjoining the Valley of Trëtterbaach, and area 11 is adjoining the Valley of the Woltz. Both priority areas are important in addition to protected sites in the north. They represent plateaux with farmland and with a relative good potential for farmland species. In particular the Red kite, Quail, Sky lark, Meadow pipit, Red-backed and Great grey shrike will benefit if current Natura 2000 sites are extended to include these areas.
Once more, it is important to keep in mind that habitat quality, and in particular **land use** and **landscape structure** will be crucial for the population viability of species in these areas. If the right management is implemented (e.g. late mowing, banning herbicides and limited use of fertilizer), and landscape quality is enhanced (e.g. maintaining wood rows and hedges, set-aside areas where seeds and insects are available), the effect may exceed expectations since the densities were much higher in the past for some species than estimated by LARCH.

In paragraph 4.2.2 the priority areas are compared to the IBAs and the value of these sites for this group of species is shown.

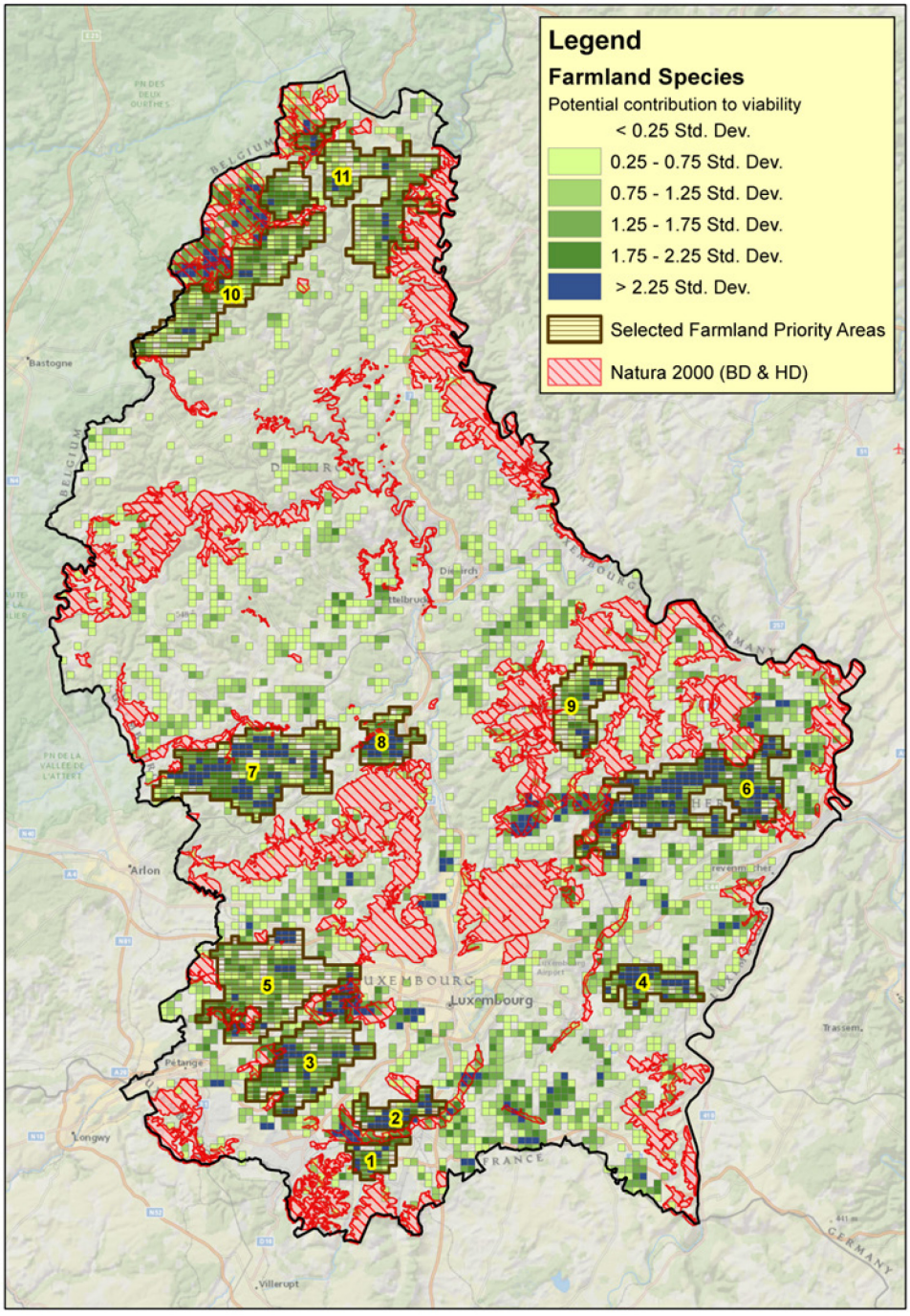

Figure 60

Priority areas for farmland species with high potential value. The map is based on accumulation of standardized values for all farmland species (par. 2.3).

4.2 Discussion of results

4.2.1 General remarks

The LARCH analyses show clearly the priority areas contributing the highest numbers of breeding pairs to the population of a species and populations of species using the same habitat. To use the LARCH results one should keep in mind that the provided information is indicative and relative, because based on estimated numbers (e.g. Tables 7 and 8). Estimated numbers are based on maps which illustrate directly habitat and indirectly habitat quality of the selected species in combination with the best knowledge about the ecology and habitat use of the species.
Nevertheless, these precautionary remarks it is shown for most species that LARCH estimates fit very well with known distribution areas and numbers of breeding pairs based on field data.
Still it is important that the priority areas will be considered by experts if they represent good habitat quality and are considered suitable areas for breeding.
For all species, apart from the area, the right management measures influencing habitat quality directly will influence populations, as is the case especially for farmland birds. For this reason estimated numbers may be conservative and larger populations can be expected possible if the right management measures can be carried out as is illustrated by more extensive grassland management.

4.2.2 Comparison of priority areas

The analysed priority areas for forest and farmland species show to be located almost entirely outside the Natura 2000 network and only for a small part they overlap (Figures 27 and 60 and Tables 11 and 15)

For forest species eleven priority areas were analysed (Figure 27). These areas contribute significantly to the population viability of eight to ten bird species depending on the forest habitat they prefer and have added conservation value for these species compared to the Natura 2000 network including SPAs and SACs.

Table 17

Priority areas for forest and farmland species (area numbers as in Figure 61).

Forest species	Additional Priority areas	Forests between Trintange-Canach–Herborn (6) North of Grevenmacher (1) Bois de Biwer (8) West of Mamer & Eisch valleys (9) Forest between Bissen-Colmar (13) Kiischpelt (16)
	Expanding existing Natura 2000 sites	Lias moyen (1) Groussebësch / Trintange (2) East of Mamer & Eisch valleys (7) North of Grevenmacher (11) West of l'Ernz noire (12) North of l'Ernz noire (14) Bavigne (15)
Farmland species	Additional Priority areas	Canach (4) Regions of Junglinster and Mompach (6) Valley of the Attert (7 and 8), Between l'Ernz blanche and l'Ernz noire (9).
	Expanding existing Natura 2000 sites	Upper valley of the l'Alzette (1and 2) Lias moyen (3 and 5) South and east of the valley of the Trëtterbaach (10) Region of Heinerscheid-Weiswampach-Binsfeld (11)

Priority areas for forest species are mainly found in and close to the centre of the country (e.g. the area known as the Kiischpelt) and in the southeast along the border. Here several areas are more or less connected functioning as a network and linked up into a larger area.
Also for bird species living in agricultural landscapes eleven priority areas were analysed (Figure 60).
It is to be expected that priority areas for forest and farmland species will rarely overlap, due to the different nature of the habitat these species use (Figure 61).
However, an area which seems to combine different habitat types is located south of Luxembourg city. The priority areas Lias moyen (number 1 in Table 11) for forests species and the priority areas Upper valley of the l'Alzette and Lias moyen (numbers 1 and 2 in Table 15) for farmland species will in combination with the Natura 2000 sites Upper Alzette valley, Bertrange and Sanem Groussebesch constitute a large territory that will contribute to the population viability of both farmland and forest species.

Important Bird Areas (IBAs) were analysed by LNVL (Biver et al., 2010) and there is to some extent overlap between some of the IBAs and some proposed extensions of Natura 2000 areas (Figure 61). This is illustrated for the farmland priority area 7 and 8 (Upper valley of the l'Alzette) and the IBA valley of the l'Attert and farmland priority area 6 (Regions of Junglinster and Mompach) compared to IBA Région de Mompach, Manternach, Bech and Osweiler. Also the farmland priority areas 3 and 5 (Lias moyen) overlap partly with the IBA Région du Lias moyen.
In the north of Luxembourg the analysed forest priority areas 15 and 16 (Bavigne and Kiischpelt) are very important for the Hazel grouse and the Woodpecker species, of which priority area 16 coincides largely with the IBA the Kiischpelt (although the proposed priority area extends further south).
Considering the overlap of priority areas and IBAs it can be concluded that IBAs are important sites for the protection of species of forest and farmland habitats. However, the analysed priority areas show also additional sites for the protection of species in all three groups.

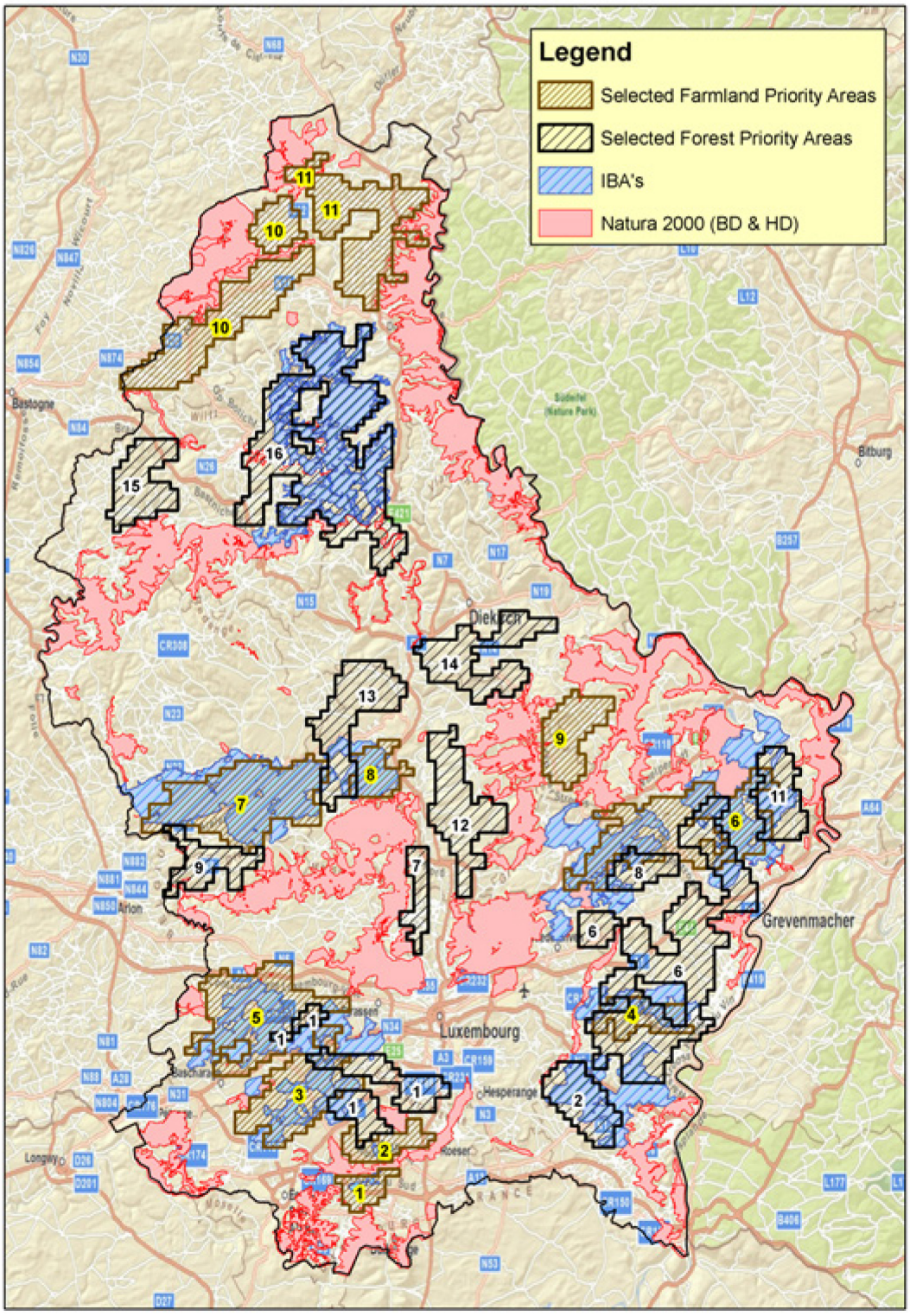

Figure 61

Priority areas for forest and farmland species, with regard to Natura 2000 areas and (proposed) Important Bird Areas (IBAs).

5 Conclusions and recommendations

- Luxembourg has the obligation to select sites for 64 species. The distribution of 34 bird species and the distribution of their habitats are well covered by the existing SPA network. A qualitative second opinion was carried out on their site selection represented by the existing SPA network and proposed Important Bird Areas (IBAs) as possible new protected sites (SPA) (Chapter 3). The second opinion shows that the existing SPAs and selected IBAs include all the important sites in Luxembourg of the species in this group. The ambition to select the five most important sites for a species is too high for more than half of the species based on their occurrence. There is no need to protect five sites for each species to fulfil the obligations of the Birds Directive. Almost the entire populations of species for which one to four sites have been selected as SPA or proposed SPA will be protected.

- The LARCH analyses on the population viability of 30 bird species, which species are in the Annex I of the Birds Directive, show their populations to be covered only to a (very) limited extend by the existing Natura 2000 network. All 30 species can be categorised as forest, wetland or farmland species.
  When their populations are covered by the network they occur (partly) within sites protected as a SAC under the Habitats Directive. For that reason it is recommended to designate such sites also as a SPA.

- On average 29% of the (national) population of forest species is protected within the Natura 2000 network. For most species this is not enough to maintain a viable population. Only the more common Green woodpecker and Wood warbler would thrive. It is therefore recommended to add for specific species new SPAs to the network to ensure an adequate protection of these species.
  Priority areas have been analysed and mapped where additional sites can be found. Priority areas which stand out for some forest species are near Haff Rémich (areas 6 and 2; numbers see Chapter 4.1 and Figure 27), the area north of the Upper Alzette Valley (area 1). Also a rather small extension east of the Valley of Mamer and l' Eisch (area 7) will contribute to the viability of some species. The Kiischpelt (areas 16 and 15) is the only priority area with suitable habitat for the Hazel grouse, however this area will also substantially contribute to the population viability of other forest species.

- None of the populations of species living in wetlands is currently viable within the Natura 2000 network. Only for the Reed warbler a viable population is occurring within the Natura 2000 network or such a situation seems to be achievable.
  The wetland species show rather diverse habitat requirements compared to forest and farmland species and therefore recommendations on priority areas cannot be made for the whole group of species. For all species specific recommendations are separately made in Chapter 4.1.3.
  Because of the spatial characteristics of some wetland habitats (small scaled, linear) the habitat of some species is not well covered by maps. For instance grid cells of 500 x 500 m used in the analyses are larger than most reed lands and borders of rivers so they are not sufficiently covered by the maps that were used. For this reason conclusions on priority areas for some species (e.g. the Reed warbler and the Kingfisher) could not be made at the preferable detailed level.

- The farmland biotopes used by bird species living in agricultural landscapes are not well covered by the Natura 2000 network. This is illustrated by the Sky lark and the Linnet, the only species which show viable populations in the protected network (Table 14).

On average some 11% of the selected species living on agricultural land would be sustained within the Natura 2000 network. It is therefore strongly recommended to add new SPAs which include valuable farmland biotopes.
Priority areas for the species can be found northwest of Grevenmacher (area 6 in Table 15 and Figure 60), in the Valley of the l'Attert (areas 7 and 8), and as extensions of the SPA Upper valley of the l'Alzette (area 1 and 2), the Valley of Trëtterbaach (area 10) and of the Valley of the Woltz (area 11). In the triangle of the cities of Luxembourg, Arlon and Petange (areas 3 and 5) important extensions of fragmented Natura 2000 sites can be found. Priority areas are also found near Canach (area 4) and the area in between l'Ernz blanche and l'Ernz noire (area 9).

- Because all protected sites (SPAs) have to contribute to the Favourable Conservation Status (FCS) of bird species in the Annex I of the Birds Directive it will be helpful to show in what way sites contribute to this status (in terms of the population viability) and their relative relationships. For this reason it is recommended to formulate clear quantitative conservation objectives for species at the national and site level.

- To reach the FCS of species, besides the conservation of sites (area and spatial distribution), site management is a key factor. Therefore it is recommended to prepare management plans for SPAs and SCAs. The management plans should include the site objectives of species and the management measures focusing on the enhancement of habitat quality based on species requirements.
  This is illustrated by the habitat requirements of forest bird species. Some need old, pristine forest, others forest with dense undergrowth or forest edges. The management plans should focus on the specific target species selected for forest areas

- Some of the proposed SPAs (analysed as IBAs) show overlap with proposed extensions of Natura 2000 sites for farmland species (areas 7 and 8 coincide with the IBA valley of the l'Attert and area 6 coincides with IBA Région de Mompach, Manternach, Bech and Osweiler). Areas 3 and 5 overlap partly with the IBA Région du Lias moyen. Also for forest species there is some overlap. Forest priority area 16 coincides largely with the IBA the Kiischpelt (although the proposed area extends further south and includes area 15).

- There is a strong need for quantitative information to carry out the site selection and formulation of conservation objectives in a more systematic and scientific sound way. For specific species data is insufficient and monitoring recommended: Water rail, Woodcock, Honey buzzard, Hazel grouse, and a number of species from the second opinion especially from the categories A and C (irregular species and special cases).

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Annex 1 Species selected for Second opinion

*Species and sites (see for numbers Table 7). Information on the use of sites (r=resident, b=breeding, w=wintering, s=staging) as mentioned in the standard data forms or in Biver et al. (2010); *= not in standard data forms/added information for site selection.*

Species / site nr	1	2	3	4	5	6	9	10	11	12	13	14	15	16	17	18
Acrocephalus arundinaceus				b					s*						s*	
Acrocephalus paludicola *				s*					s*			s*			s*	
Acrocephalus schoenobaenus				s					sb*						s	
Aegolius funereus										b				b		b
Anas querquedula	s			sb*					s*	s					bs	
Anser fabalis *	w			s											s	
Asio flammeus				w		w*				w	w	w*	w*			
Aythya ferina *				b*												
Aythya fuligula				bws							s*			b*		
Aythya nyroca *				sw*												
Botaurus stellaris	s			w												
Caprimulgus europaeus		s														s
Ciconia ciconia	s			s					bs						s	
Circus aeroginosus				bs					s	bs	s			s	s	
Circus pygargus	s			s											s	
Corvus corax *								r*						r*		r*
Gallinago gallinago	bw*			s					s*	bsw*	bw*				ws	
Grus grus	ws*														s	
Ixobrychus minutus				b												
Lullula arborea		b	b	s	b									s	s	s
Luscinia svecica				s					s		s		s		s	
Mergus albellus				ws												
Motacilla flava	s			bs			b*			b	b				b	
Pandion haliaetus				s							s			s		s
Parus cristatus *								r*						r*		r*
Philomachus pugnax	s			s					s*	s	s		s		s	
Pluvialis apricaria	s									s			s		s	
Podiceps cristatus				br						s	s			ws	s	s
Porzana porzana				s					s*						s	
Remiz pendulinus				bs											bs	
Riparia riparia				bs						s						s
Saxicola rubetra				b			b*		s	s	s			b	bs	
Tringa glareola	s			s					s	s	s				s	
Tringa totanus	s			s*						s*	s				s	

Annex 2 Selected species for LARCH analysis

The species to be analysed by LARCH were mainly selected because of the bad coverage between their occurrence in Luxembourg and the designated SPAs.

Species	Common name	Coverage by existing SPAs
Accipiter gentilis	Goshawk	low
Acrocephalus scirpaceus	Reed warbler	high
Alauda arvensis	Sky lark	low
Alcedo atthis	Kingfisher	low
Anthus pratensis	Meadow pipit	low
Athene noctua	Little owl	low
Bonasa bonasia	Hazel grouse	low
Bubo bubo	Eagle owl	low
Carduelis cannabina	Linnet	low
Ciconia nigra	Black stork	low
Circus cyaneus	Hen harrier	low
Coturnix coturnix	Quail	low
Crex crex	Corncrake	low
Dendrocopos medius	Middle spotted woodpecker	low
Dryocopus martius	Black woodpecker	low
Falco peregrinus	Peregrine falcon	low
Jynx torquilla	Wryneck	low
Lanius collurio	Red-backed shrike	low
Lanius excubitor	Great grey shrike	low
Milvus migrans	Black kite	low
Milvus milvus	Red kite	low
Perdix perdix	Partridge	low
Pernis apivorus	Honey buzzard	low
Phoenicurus phoenicurus	Redstart	low
Phylloscopus sibilatrix	Wood warbler	low
Picus canus	Grey-headed woodpecker	low
Picus viridis	Green woodpecker	low
Rallus aquaticus	Water rail	medium
Scolopax rusticola	Woodcock	low
Vanellus vanellus	Lapwing	low

Annex 3 The model LARCH

To assess and evaluate the functioning and viability of the ecological network of a bird species the landscape ecological model LARCH (Landscape ecological Analysis and Rules for the Configuration of Habitat, developed at Alterra) can be used. LARCH is designed as an expert system, used for scenario analysis and policy evaluation. The model has been fully described elsewhere (Bruinderink et al., 2003; Van der Sluis and Chardon, 2001; Van der Sluis et al., 2007; Verboom et al., 2001; Verboom and Pouwels, 2004). The principles of LARCH are simple: the size of a habitat population determines the potential number of individuals of a specific species it can contain. The distance to neighbouring patches determines whether it belongs to a network. The size of the network determines whether it can contain a viable population. If so, the habitat network is in potential sustainable for the species. The evaluation of the sustainability of an ecological network is based on total network area, on habitat quality, and on the spatial cohesion of the habitat patches. Different steps in LARCH are illustrated in Figure A (next page).

LARCH provides information on the metapopulation structure and population viability of a species in relation to habitat distribution and carrying capacity (of habitat patches). It assesses spatial cohesion of potential habitat, and provides information on the best ecological corridors in the landscape. The model LARCH uses a land use map or vegetation map as it basis, which describes and represents the habitat of a species habitat. Habitat quality of patches is expressed in classes. In addition to information on the species habitat, the LARCH database contains the spatial characteristics of the species (e.g. dispersal distances, home range, densities, spatial requirements for sustainable populations). The database with habitat and spatial characteristics is based on extensive literature studies, field studies, and on elaborate population dynamic modelling. In each case all parameters are checked with (local/national) experts with the help of LNVL.

The model LARCH uses a set of rules based on metapopulation theory. The output of the model consists of a map which outlines the ecological networks of the species of interest and visualizes the sustainability of the networks and the spatial coherence of the habitat. Effects of barriers (like roads and urban areas) can be included but are not relevant for most birds.

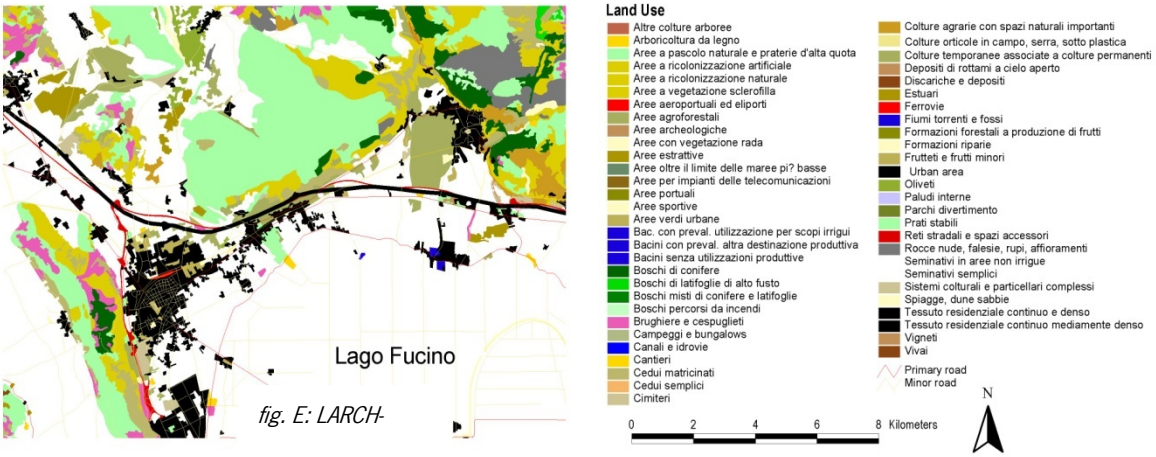


fig. E: LARCH-

fig. A-a: Input for LARCH is the OBS land cover map

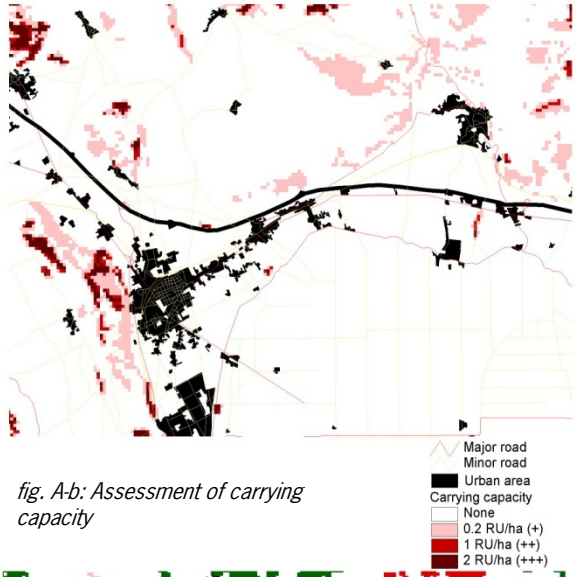


fig. A-b: Assessment of carrying capacity

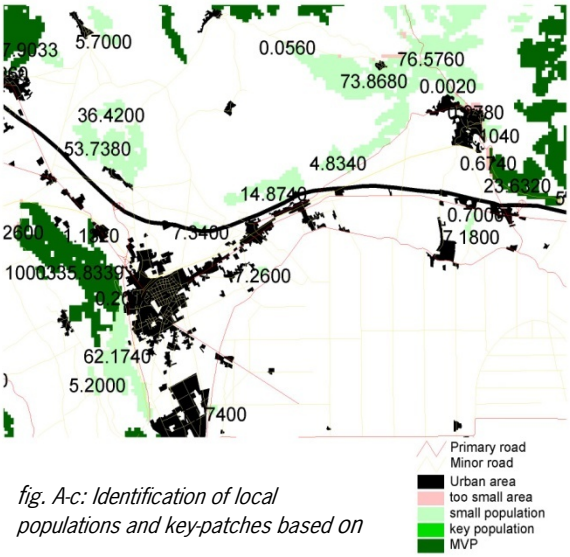


fig. A-c: Identification of local populations and key-patches based on

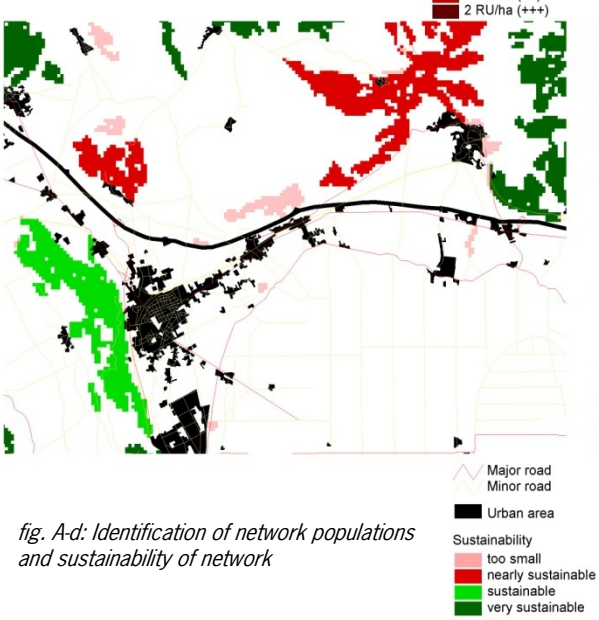
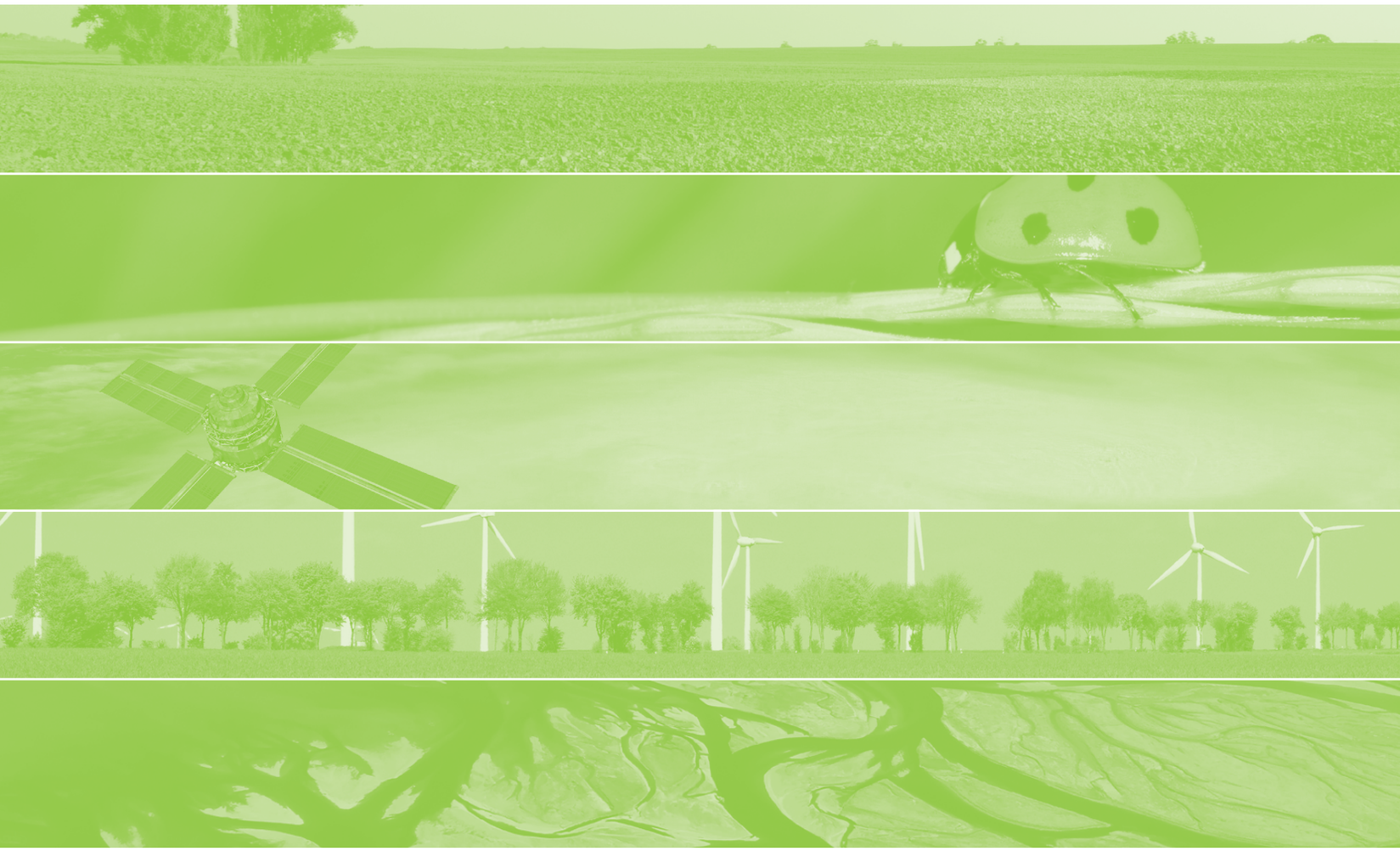


fig. A-d: Identification of network populations and sustainability of network

Figure A:

LARCH analysis procedure; fig. A-a to A-d illustrate the steps in LARCH to assess the viability of a population network based on the habitat map. See text for further explanation of steps.



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