107

LARCH Status A

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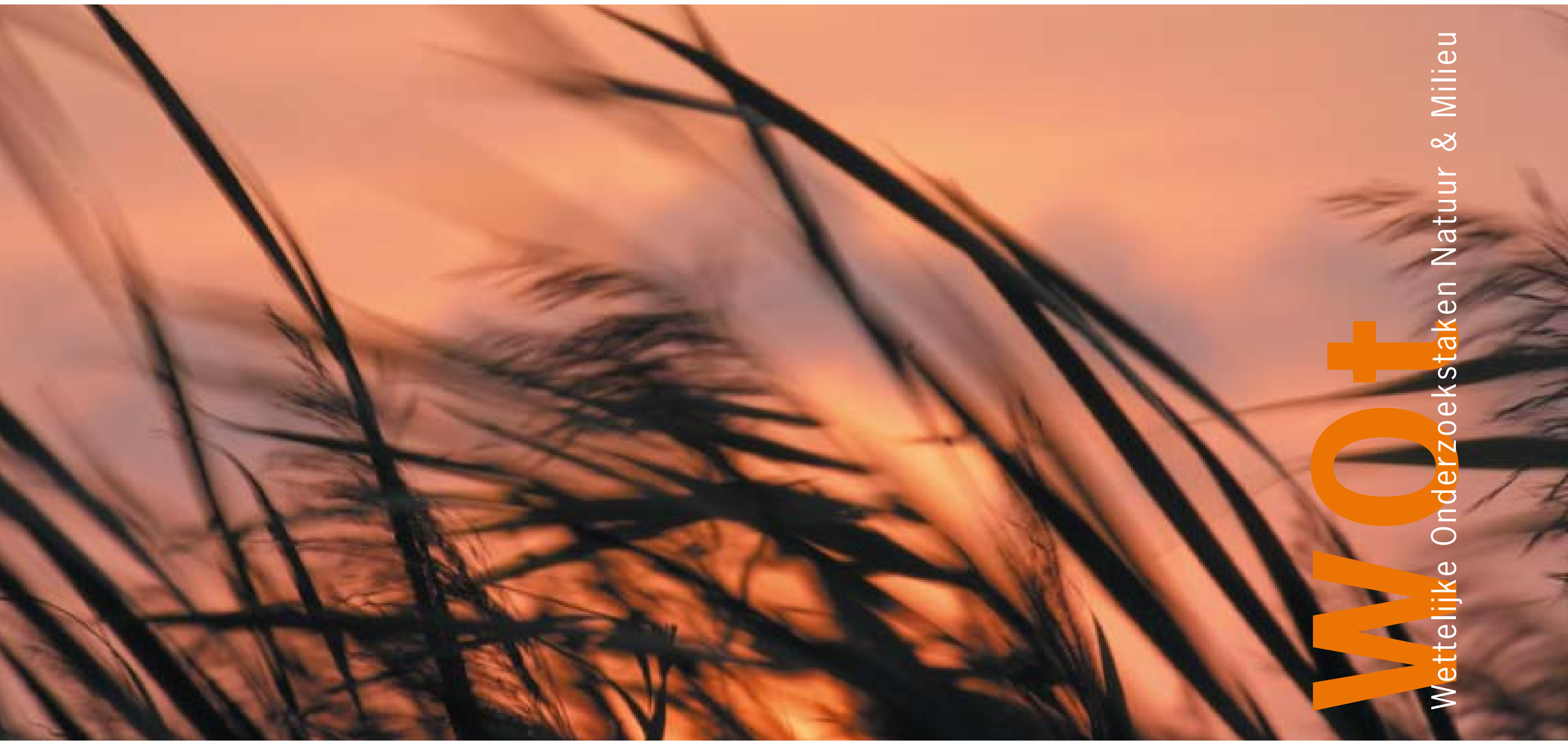

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Wettelijke Onderzoekstaken Natuur & Milieu

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For quality of life

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Index

1 Introduction

1.1 History of LARCH

LARCH[1] has been developed since 1994. First the method was applied by using a GIS (for example: Reijnen *et al.* 2001*)*. In 1997 LARCH 1.0 was developed for the Netherlands Environmental Assessment Agency (PBL) to assess the Dutch National Ecological Network (Bal and Reijnen 1997). Since then numerous projects have used LARCH. The development was mainly stimulated by the PBL and RIZA-RWS. These developments included adding species parameters to the database, developing specific components for single applications as well as underpinning research for standards and thresholds. In Chapter 2.1 in Pouwels *et al.* (in prep) an overview is given of studies using LARCH until 2005. At this moment we use LARCH 4.5.

1.2 Problem definition

LARCH is a model that is used by the Netherlands Environmental Assessment Agency (PBL) for ex-ante and ex-post evaluations of Dutch nature policies. The models that are used by the PBL have to meet the criteria for status A. These criteria are set to show that the models achieve a basic level of quality. This document contains information for all the criteria for status A (Appendix 1).

1.3 Contents

In this report LARCH 4.5 will be described together with two applications of LARCH that have used this version (Reijnen *et al*. 2006, Pouwels *et al.* 2007). The theory of the model will be described in Chapter 1. Technical aspects, tests and user interface of the model will be described in Chapter 2. In Chapter 3 the two applications (together with the used parameters of the model) will be described. Sensitivity analysis, calibration and validation will be described in Chapter 4. Chapter 5 will contain management details and future developments of the model. Most of the report is in English, because the model is used for foreign applications as well. Some of the Appendices and species names will be in Dutch.

[1] LARCH stands for Landscape ecological Analysis and Rules for the Configuration of Habitat.

2 Theory

2.1 LARCH in a nutshell

In Western Europe ecosystems are often severely fragmented. Due to fragmentation, populations of animals have become isolated and are, at least locally, threatened by extinction. In these highly developed regions the conservation of biodiversity is highly rated. However, nature conservation is only one of the functions that compete for space. This calls for careful planning. Alterra therefore developed LARCH, a tool which is able to assess the potential biodiversity in the landscape (Opdam *et al.* 2003, Verboom and Pouwels 2004).

Important landscape characteristics for species persistence are habitat quality, the amount and configuration of habitat and the permeability of the landscape matrix (Appendix 2). LARCH links these landscape characteristics to the persistence of animal populations at the landscape level. It uses the concept of habitat networks (Hobbs 2002, Opdam 2002).

LARCH generates the potential habitat networks of a species. LARCH will not predict the actual distribution of a species. Furthermore it simplifies the landscape by assuming it will not change. Also, in most studies only infrastructure and large urban areas are considered as barriers and the rest of the matrix is not taken into account.

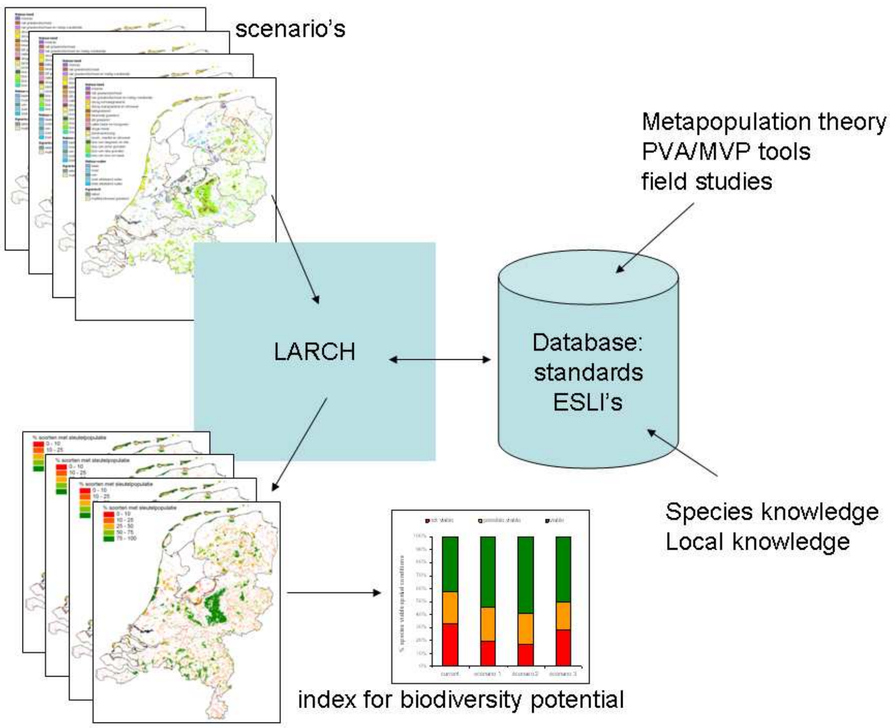

Figure 1. The use of LARCH in a nutshell. PVA stands for population viability analyses (Lande 1988, Lankester et al. 1991, Lindenmayer and Possingham 1995). ESLI stands for ecologically scaled landscape index (Vos et al. 2001).

LARCH is used to evaluate different scenarios (Figure 1). In these scenarios landscapes will differ in habitat quality, habitat amount, configuration or infrastructure (matrix permeability). For a set of selected species LARCH will assess whether the habitat networks in the landscape will be sustainable. If needed, the results can be aggregated into a single index so it can be used in the interactive process (Robertson and Hull 2001). LARCH uses a database containing species specific parameters which are based on years of metapopulation research and/or local knowledge.

2.2 Habitat networks

2.2.1 Fragmented landscapes

LARCH has been developed for ecological assessments of fragmented landscapes. If the landscape is not fragmented (Figure 2 and 3) other assessment tools should be considered. Above the first threshold the amount of habitat is still large and the landscape is considered not to be fragmented. There are no processes like local extinction and local colonization within the landscape. The second threshold depends on the species and the size of the landscape. Below this threshold the landscape is so fragmented a population will never by viable. In between the thresholds the landscape is fragmented and LARCH can be used for an ecological assessment.

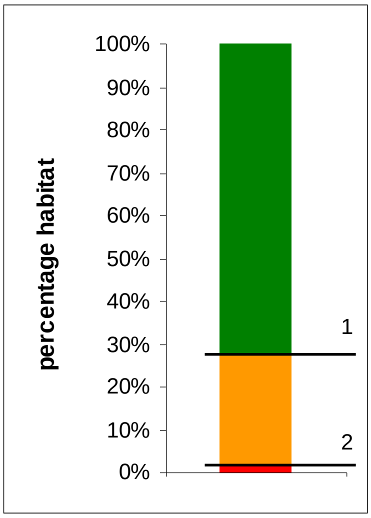

Figure 2. Thresholds of percentage of habitat within the landscape. Above threshold 1 there are no ecological networks within the landscape. Threshold 2 depends on the species and the size of the landscape. Below this threshold the landscape is so fragmented a population will never by viable.

Andrén (1994, 1996), Villard *et al.* (1996), Vos *et al.* (2001) and Foppen (2001) show a variation for the first threshold between 1 and 40%. Andrén (1994) gives a threshold of 20%; 10-30%. The threshold is species specific and difficult to determine. We use a threshold of 30%. When a landscape consists of a habitat type (like marshland or heather) over 30% we do not use LARCH for an ecological assessment. It can be that the total area of the landscape is too small for a viable population, but spatial configuration is not an issue. The threshold does not take into account barriers.

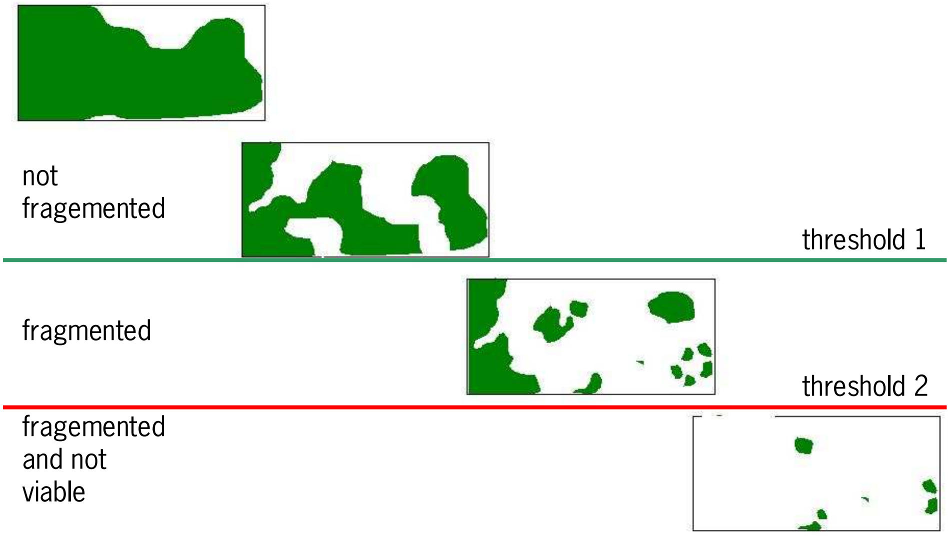

Figure 3. Domain of LARCH. The landscape will become more and more fragmented from the top-left to the bottom-right. Between the two thresholds the landscape is fragmented and spatial configuration is important for the viability of populations.

The second threshold is species specific too. In stead of the percentage habitat species specific area requirements can be used (Table 1). When the total amount of habitat in the landscape is below these area requirements the landscape will never be sustainable for this species. When the amount of habitat is above these area requirements the landscape might be sustainable for this species and the configuration is important.

Table 1. Area requirements for sustainable habitat networks some target species. Values are based on Pouwels et al. (2002a).

< 1.5 ha	**1.5 ha - 1.5 km^2**	**1.5 km^2 - 7.5 km^2**	**7.5 km^2 - 15 km^2**	**15 km^2 - 75 km^2**	**> 75 km^2**
Purple Hairstreak	Wall Brown	Viper	Bearded tit	Hen harrier	Wryneck
Silver-studded Blue	Nuthatch	Great Reed Warbler	Green Woodpecker	Pine marten	Otter
Common Blue	Wood Lark	Lesser Spotted Woodpecker	Large Tortoiseshell	Hobby	
Queen of Spain Fritilary	Brimstone	Roedeer	Middle Spotted Woodpecker	Red deer	
Ringlet	Red Squirrel	Sky Lark	Bittern	Goshawk	
Bank Vole	White Admiral	Golden oriole	Black Woodpecker	Raven	
	Root Vole	Pearl-Bordered Fritillary		Wheatear	
	Sedge Warbler			Honey Buzzard	
	Sand Lizard				

2.2.2 Defining and evaluating habitat networks

A landscape consists of different land use types. In maps patches of several ecosystem types are shown (Figure 4a). When habitat networks are defined and evaluated several steps have to be followed. We describe a procedure allowing the delimitation of the habitat network for a single species. First, a map of habitat patches is generated (Figure 4b). Basically, this is a habitat suitability modeling step. Any ecosystem patch is assessed for its size and quality whether it is good and large enough to contain at least one reproductive unit of a species. Patches so close that they fit the scale of individual home ranges are fused to a single habitat patch. Patches suitable as habitat but too small to contain a reproductive unit are not rated as habitat patches, but count as elements in the matrix. The sustainability of a habitat network is mainly based on the size of the largest patch. Based on the patch size and patch quality we classify each patch as a small local patch, key patch (Verboom *et al.* 2001) or minimum viable population (MVP) (Figure 4c).

Second, habitat networks are determined. Two habitat patches belong to the same network as long as the distance is less than most dispersal distances and no barriers are in between the patches. The Euclidean distance between the patches can ecologically be scaled with the permeability of the landscape matrix. To determine the maximum patch distance, we suggest neglecting rare long distance events, which will contribute little to the equilibrium dynamics of a metapopulation. For instance, we use a maximum distance which includes 90% of all dispersal events (Opdam *et al.* 2003). The result of the delimitation procedure is a map per species of the planning area with one or several habitat networks. Note that if a network extends beyond the borders of the planning area, the external part should be included in the delimitation procedure, because the sustainability assessment should of course be based on the whole network (Figure 4d). The thresholds for the assessment are based on field studies and model studies (Verboom *et al.* 2001, Verboom and Pouwels 2004). More details on defining and evaluating habitat networks can be found in Opdam *et al.* (2003), Verboom *et al.* (2001) and Verboom and Pouwels (2004). How these steps are implemented in LARCH is described in appendix 3 and chapter 4 (applications).

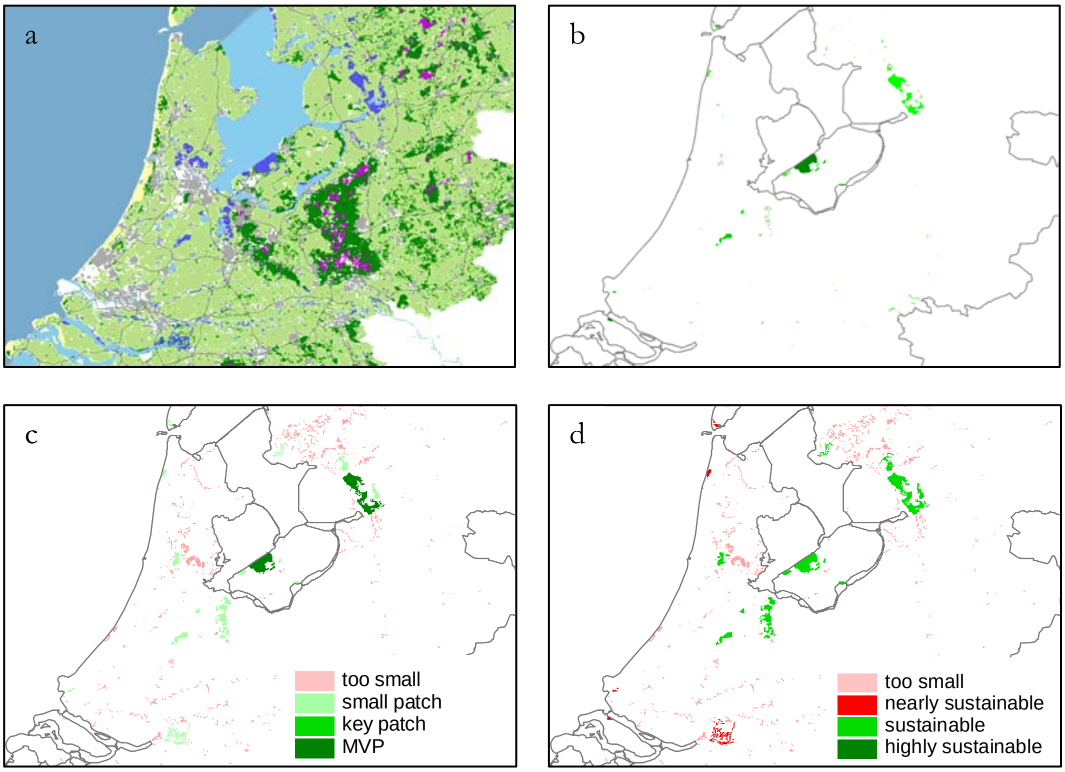

Figure 4a-d. Method of LARCH. Examples of Bittern in the study 'Natuurverkenningen 2' (RIVM 2002).

2.2.3 Choosing species

A landscape does not have a function for biodiversity, but for individual species. Therefore, we must scale down from landscape level to species level. The choice of species for landscape assessment appears critical. Can the results be manipulated by choosing certain species for conservation while disregarding others? Therefore choosing species or ecological profiles might be seen as part of the application and not targets themselves (Opdam *et al.* 2003, Verboom and Pouwels 2004). We propose to use a matrix of ecological profiles (Vos *et al.* 2001) along a gradient of relevant dispersal distances (e.g., 100 m, 1000 m, 10,000 m) and relevant individual area requirements (e.g., 1 ha, 10 ha, 100 ha) (Figure 5). Furthermore we choose species with different movement strategies (e.g., flying and nonflying, the latter perceive major roads and canals as barriers) and different ecosystem preferences that are relevant for the planning region (e.g., forest, marshland, grassland). A broad variety of species (true or profile) is recommended.

A restriction of using ecological profiles may result from the focus on ecosystem networks with discrete habitat patches. The method assumes that habitat requirements of species can properly be allocated in discrete units. However, the habitat of species might be a combination of such units, for example, when species use two ecosystem types in different phases of their life cycle.

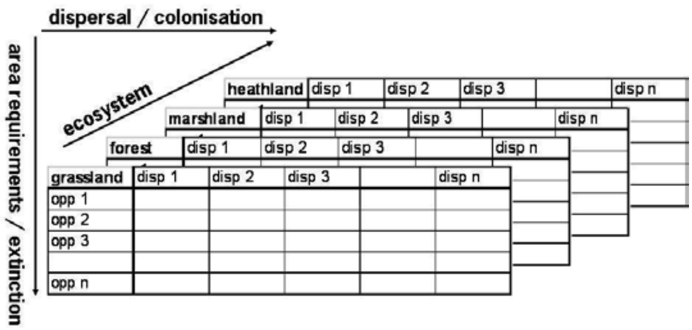

Figure 5. An ecological profile is a set of characteristics that represent a (set of) species. The characteristics are based on three components: ecosystem type, extinction and re-colonisation (see for example appendix 4).

2.2.4 Using models

Euler stated: "Give me five parameters and I will draw you an elephant; six, and I will have him wave his trunk". This quotation (in Mollison 1986) illustrates the pitfalls of model parameterization and calibration and is often used as a criticism of using models. However spatial models may be the only objective tools for scenario studies. Translating scenario studies into model parameters can simulate effects of, for example, changes in land-use. While the exact quantitative model outcomes sometimes have high levels of uncertainty, when used for comparing scenarios the results are more robust (Verboom and Wamelink 2005). For example, in applying the NTM model, Schouwenberg *et al.* (2000) illustrate that the model output had a large uncertainty for a single prediction, but when scenarios were compared the uncertainty was much smaller. The best alternative predicted by the model is likely to be the best one in real life (Verboom and Wamelink 2005). It is in the comparative evaluation of scenarios that integrated use of models such as LARCH may have its greatest utility. Managers faced with the task of accurately estimating outcomes of specific scenarios may find use of the models more problematic.

3 Technical description

3.1 Model structure

The LARCH system is built up from several smaller components. These components query a large database containing species specific data (Figure 6). By using these smaller components, the LARCH system becomes very flexible. A LARCH model is defined as a particular configuration of one or more components.

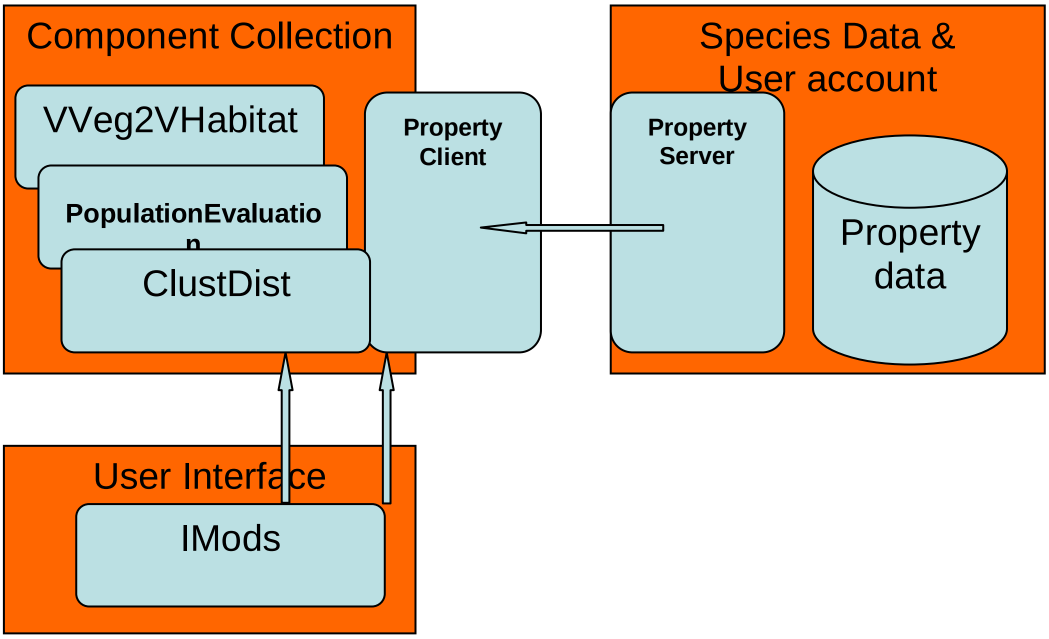

Figure 6. Model structure of LARCH.

Components are small software executables, containing an interface based on the COM technology. These components will be installed on the client side of the computer system. LARCH components do not have a graphical user interface (GUI) but appear as a tray icon in the tray bar (bottom right of the desktop). To initialize and run these components another application should be used that calls the COM interface. This can be done in either language that supports COM technology like Visual Basic or by using IMods (Chapter 3.9).

The property server provides access to the database that contains species specific data required for the COM components. The location of the database is: \\D0113365:D:\Databases\PropertyService\PROPERTYBASE8.FDB. The data stored in the database are described in Chapter3.3.

3.2 System and user requirements

Processor: Personal computer with Pentium 266-megahertz (MHz) or better.

Operating System: Microsoft Windows NT® Workstation operating system version 4.0 Service Pack 3 or later or Windows 2000 Professional.

RAM: For Windows NT Workstation 32 MB of RAM for the operating system, plus an additional 32 MB of RAM for each application running simultaneously. For Windows 2000 Professional * 64 MB of RAM for the operating system, plus an additional 32 MB of RAM for each application running simultaneously. In both cases 512 MB of RAM or more is preferred for the processes that require a lot of spatial calculations.

Available disk space: The hard-disk usage will vary depending on configuration. Choices made during custom installation may require more or less hard-disk space. A default installation will require 252 MB. For optimal performance, we recommend at least an additional 100 MB of free hard-disk space for caches. If model runs use large files the virtual memory can take up to 4 GB.

Additional Hardware: CD-ROM drive, VGA or higher resolution monitor (Super VGA recommended) and mouse (Microsoft Mouse, Microsoft IntelliMouse®) or compatible pointing device.

LARCH will need some additional software. The property service used by LARCH uses the *Firebird database*. Information and the freeware installation software for the database can be obtained at: firebird.sourceforge.net. To write and read dBase files LARCH uses the *Borland Database Engine* or BDE. LARCH is a GIS model without viewing and editing capabilities. When results need to be presented in a map a GIS package is needed. Most results are in the form of ESRI shapefiles or Import/Export formats for raster files. For vector files ArcView (3.0 or later) or compatible GIS software is needed. For raster files ArcView (3.0 or later) with Spatial Annalist (2.0 or later) or compatible GIS software is needed.

Users of LARCH need to be able to work with a GIS program and have experience with spatial models. Furthermore users need to have a basic knowledge of fragmentation, population dynamics, metapopulation dynamics and the species that are used in the assessment of the landscape. It is to be advised to use LARCH in collaborating with the developing team (see Chapter 6)

3.3 Database, parameters and property server

In a lot of projects data for species is gathered to parameterize LARCH. Sometimes these data is combined in a species profile. These species profiles contain backgrounds and discussion for parameters of one species. Although for birds a lot of data is available the species profiles have mainly been made for other species groups (Table 2). The reason might just be the availability of the data for birds which lead to an easier way to parameterize LARCH. Also one of the first applications of LARCH focused on birds and gathered a lot of background data for birds that was stored in the database (Reijnen *et al.* 2001).

Table 2 Number of species profiles for species from Habitat and Bird Directive.

	total in database	species profiles	percentage
birds	42	10	24%
mammals	14	6	43%
other species groups	34	18	53%

Data for each species are stored in a database under the combination of a unique species name (an abbreviation of the Latin name) and a unique project name. When LARCH is used and species name and project name are stated in the user interface (see also chapter 3.9) the user interface will connect the components to the database and the stored species parameters will be used by the component. The database is stored at \\D0113365:D:\Databases\PropertyService\PROPERTYBASE8.FDB.

The LARCH database contains the following parameters for each species:

Isolation parameters

1. Local population Distance (m): the distance between 2 habitat locations within which they will be clustered into 1 local population. The distance is usually calculated as 1.5 * the species' home range diameter. The resulting local populations are classified into the class of a small population, a key population or a minimum viable population, based on their number of RUs.
2. Network Distance (m): the distance between 2 local populations within which they will be clustered into 1 network population. This distance is the dispersion distance of 90% of the species' juveniles (e.g. Opdam *et al.* 2003). The viability of the resulting network populations is determined by the total number of RUs in the network cluster and the highest class of the supporting local populations.
3. Network Step Stone Size (-[2]): the minimum number of RUs for a habitat location to be considered a network cluster candidate. The default value is 1.

Viability parameters

1. Key Patch (RU)[3]: the species' minimum number of reproductive units needed to form a key population. The calculation #RU * (100/ Density) gives the minimum area in hectares needed to form a key population (e.g. Verboom et al. 2001 and Opdam *et al.* 2003).
2. MVP factor (-): the multiplication factor for the minimum area needed to form a network population when the strongest local population is a minimum viable population. A value of 1.5 indicates that at least 1.5 times the area calculated by #RU * (100/ Density) is needed to form a viable network.
3. NW+KP factor (-): the multiplication factor for the minimum area needed to form a network population when the strongest local population is a key population. A value of 2 indicates that at least twice the area calculated by #RU * (100/ Density) is needed to form a viable network.
4. NW-KP factor (-): the multiplication factor for the minimum area needed to form a network population when the strongest local population is a small population. A value of 6 indicates that at least 6 times the area calculated by #RU * (100/ Density) is needed to form a viable network.
5. NW+MVP factor (-): mostly not used. Default is per definition the same value as for MVP factor.
6. Local patch (RU): mostly not used. Value always > 1 to be more stringent; Ecological networks will only contain populations larger then this value.
7. Small population factor (-): not applicable in this project. Value always > 1 to be less stringent; Populations smaller then 1 RU will be multiplied with this value to imply the species is able to use part of the surroundings as feeding habitat too, but not as reproducing habitat.

Habitat parameters

1. Vector map: table with columns "key" and "value". The table contains a habitat quality (value) for every vegetation type (key). The habitat quality is represented by values between 0 and 1 (e.g. 0.1, 0.5, and 1.0). The vegetation type key has to correspond with the vegetation code used in the input shapefile (see also Table 10 as example).
2. Density Factor (RU/100ha): for population species only: the carrying capacity for a species in its optimal habitat is given, measured in number of RUs[4] per 100 ha (1 km^2).

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[2] - Means parameter has no unit
[3] It is also possible to use ha as a unit for key patch. Density factor should be set to 100 ha/ 100 ha.

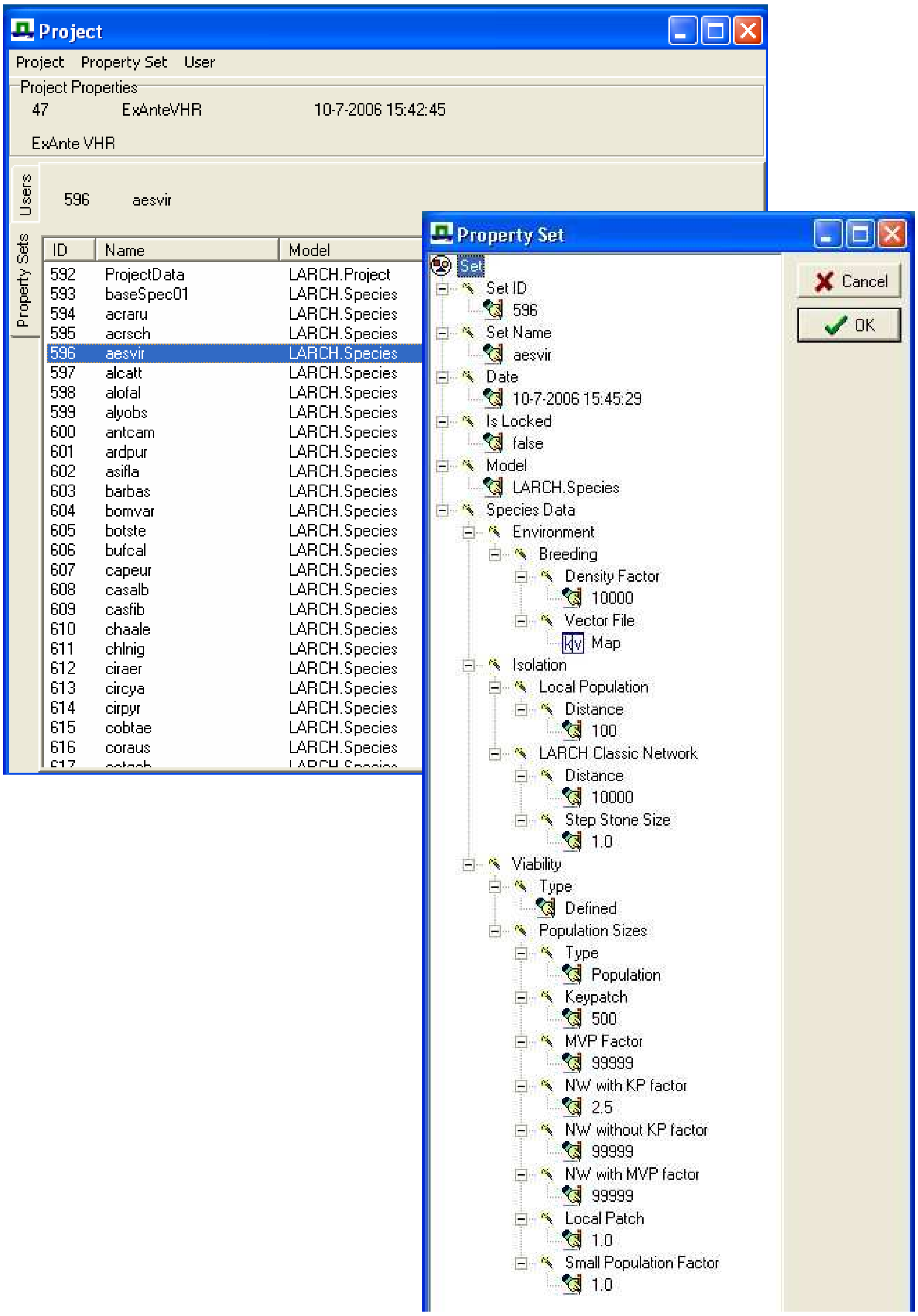

Figure 7. Property Set of a species in LARCH. Example for the Green Hawker (Aeshna viridis) in the application 'spatial conditions Habitat and Bird Directive species' (Pouwels et al. 2007). At the left back is the first property set containing project data and the species list. In front the property set for a species (Green Hawker) is given.

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[4] For birds the carrying capacity is usually expressed as number of territories (Reijnen *et al.* 2001, Schotman 2002). Each territory will contain one breeding pair (male and female) and the number of territories is related to the number of individuals as 1:2. For Red Deer a carrying capacity of 20 reproductive units is related to 60 individuals; 20 males and 20 females above the reproductive age and 20 old animals or not sexually mature animals (Groot Bruinderink *et al.* 2003).

All data stored in the database can be addressed by the property server. For each project a dataset is stored. The first property sets are general ones, containing (among others) project name, administrator, selected species and date. Data for each species are stored under the combination of a unique species name (an abbreviation of the Latin name) and a unique project name (Figure 7). When LARCH is used and species name and project name are stated in the user interface (see also chapter 3.9) the user interface will connect the components to the database and the stored species parameters will be used by the component.

3.4 Input

3.4.1 Landscape map

The basic input of LARCH is a landscape map containing vegetating types. It should be a shapefile (ArcView) containing single part polygons. The table of this file should contain several fields: Poly_ID, PolyArea, VegCode and if used PolyQual[5] (see also 3.5.1). The vegetation codes in the shape-file should correspond with the codes in the database. The units should be in meters.

3.4.2 Barrier compartment map

LARCH uses barrier compartment maps as input. These barrier compartment maps can be created by using GIS software, like ArcView and ArcInfo. Infrastructure can split up patches and habitat networks. Examples are highways, provincial roads, railroads, rivers and canals. Furthermore, build-up area and even landscape between patches can function as barriers.
Infrastructure that split up networks also split up patches. However, infrastructure that split up patches do not necessarily split up networks. Therefore barrier maps should be created for patches as well as for habitat networks.

Which type of infrastructure split up patches and networks should be indicated per species. For some species highways, provincial roads and railroads create barriers. For other species only highways create barriers (f.e. Chapter 3.1, Appendix 3 in Pouwels *et al.* 2007).

On certain locations road mitigation measures can be present, like wildlife bridges or badger tunnels. If a certain measure is suitable for a species, then roads with this measure no longer function as barrier for this species. For the barrier compartment maps this can be implemented by erasing part of the roads at the location of the mitigation measures (f.e. Appendix 4 in Pouwels *et al.* 2007).

All roads that create barriers for a certain species are merged into one file. These barriers are then converted into barrier compartments. Only patches that are situated in the same barrier compartment can be counted as one patch (local population) and only patches that are situated in the same network barrier compartment can be clustered to one network (network population). With this method it is necessary to merge the border of the study area into the file as infrastructure ends at the borders. This has caused some errors in earlier applications.

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[5] If the species selected is barrier sensitive the barrier compartment map is integrated in the input map or in between step 1 and step 2. This is done by using GIS-software like ArcView or ArcInfo (see also 4.3.2).

3.5 Components

3.5.1 VVeg2VHabitat

This model component converts a vector landscape map (vegetation or ecotope) into a habitat map containing number of reproductive units [RU]. Both files are in shape file format. For a species all polygon shapes with a vegetation type that is habitat for that species are extracted into a new shape file. Then based on the area and the quality of the habitat, the number of RUs is calculated.

Interface

Property	BSTR	Project	write
Property	BSTR	Species	write
Property	BSTR	Landscape	write
Property	BSTR	Habitat	write
Property	BSTR	VegCodeField	write
Property	Long	UseQuality	write
Property	BSTR	HabitatType	write
Property	Double	DimensionFactor	write
Function	HRESULT	Execute(void)	
Property	Long	ModelResult	read
Property	BSTR	ModelError	read
Property	BSTR	ModelVersion	read
Property	BSTR	ModelLogID	read

Project
Project name[6]
Species
Six letter code for species[6]
Landscape (inputfile)
In 'Landscape' the name of the input vector vegetation file is stated. If the file Vector Vegetation doesn't contain "POLY_ID" or "POLYAREA", this component will call the component "CalcPolyAttr.application" to add those fields. If the field "POLYQUAL" is added to the attributes and the property "UseQualty" is set to true, the number of reproductive units will take into account the quality in this field.
Habitat (outputfile)
In 'Habitat' the name of the new output vector file is stated. Only shapes with a value for "PolyRU" larger then 0 are added to the vector habitat file. All fields from the vector vegetation file are copied to the output file. The field "PolyRU" is added.
VegCodeField
Name of the field with vegetation codes that correspond with vegetation codes in the database. Default is VegCode.
UseQuality
If the value of the UseQuality property is 1 the POLYRU is multiplied by the POLYQUAL field. If the value is 0 (null) the POLYQUAL field is ignored.

[6] Data for each species are stored in a database under the combination of a unique species name (an abbreviation of the Latin name) and a unique project name.

HabitatType
Habitat type defines the use of the habitat. The habitat type is the name found in the LARCH database for the habitat type. The default name is "breeding". If the foraging habitat is needed "feeding" can be used, etc.
DimensionFactor
This factor converts the PolyArea field into square meters. The default value is 1. If the PolyArea field is not in square meters the default value should be changed. If for example the area value of PolyArea field has the dimension hectares, the DimensionFactor should be given a value of 10000.
ModelResult
This property will respond as the default ModelResult. However, if there is no habitat created the result value is 10.

Parameters

Vegetation codes	String(s)	List of one or more vegetation or ecotype codes
Densities	double(s)	The density value for each vegetation code in [RU/100ha]. For Spot species this should be <= 100.
Species Type[7]	SP_SPOT	Initializes the model for Spot species
	SP_AREA	Initializes the model for Area species
Density Factor	Double	Adjusts all vegetation type densities (calibration factor). Only for Area species
Minimal Area[7]	Double	Minimum area for one spot. Only for Spot species
Percentage Factor[7]	Double	Very large polygons can count for more than one spot (see: Algorithm for spot species). Only for Spot species

Algorithms
For every patch with vegetation type i the density is calculated.

polygon RU = Area * Quality * DimensionFactorArea * DensityFactor * Density[i]/1000000.0

Bugs and limitations
Limitation is found in the Attribute table. The memory size of the BDE and the use of that space can limit the number of polygons that can be handled. If the BDE is only used once, the number of polygons that can be processed is over 100.000.

Product Identification

Executable Name	VVeg2VHabitat.exe
Object Name	VVeg2VHabitat.application
Description	Vector Vegetation to Habitat
Version Number	4.5.0.0

3.5.2 ClustDist

This model component clusters polygons using distance, this means that when two polygons are within the range distance they belong to one cluster. As input there is a Vector Habitat shape file. For every polygon the compartment ID where the shape can be found can be set.

[7] The component is able to analyze two types of species. In the described application (Chapter 3) only the type 'area species' is used. For the technical documentation 'spot species' are mentioned too, but the method is not used in the applications. For more details on 'spot species' see Chapter 7.4 in Pouwels *et al.* (2002b).

Only polygons that belong to the same compartments can be clustered. In this way absolute barriers are implemented (see Chapter 3.4.2). Polygons with a compartment ID of 0 will not be clustered at all. After execution the cluster ID of every polygon can be retrieved.

Interface

Property	BSTR	Project	write
Property	BSTR	Species	write
Property	BSTR	ShapeFileName	write
Property	BSTR	CompartmentField	write
Property	BSTR	ClusterType	write
Property	double	Range	write
Property	BSTR	ClusterIDField	write
Property	BSTR	DistanceIndexField	write
Property	long	NumberOfClusters	read
Function	HRESULT	Execute(void)	
Property	long	ModelResult	read
Property	BSTR	ModelError	read
Property	BSTR	ModelVersion	read
Property	BSTR	ModelLogID	read

Project
Project name[8]
Species
Six letter code for species[8]
ShapeFileName (inputfile)
Name of the shape file to cluster. This filename is mostly the same as the outputfile (*habitat)* from the component VVeg2VHabitat. The file needs a numerical field, with the same name as the property CompartmentField value. If the value is "NONE" this field is not needed. A field is added to the attribute table if the value of the ClusterIDField is not "NONE". The field added will be a numerical field with the cluster IDs. It will have the same name as the value of the ClusterIDField property.
ClusterType
Select "LOCAL" or "NETWORK" to cluster polygons to local populations, respectively network populations. When "LOCAL" is stated the database will return the *Local population Distance* in "Range". When "Network" is stated the database will return the *Network Distance* in "Range".
Range
This is the maximum distance between two polygons to belong to the same cluster. This parameter will be set by the LARCH Data server if the values of "Species", "Project" and "ClusterType" are not equal to "NONE".
ClusterIDField
If the value of the "ClusterIDField" property is not equal to "NONE" the value will be used in the field name for a new field in the attribute table of the input shape. This field will contain the cluster IDs.

[8] Data for each species are stored in a database under the combination of a unique species name (an abbreviation of the Latin name) and a unique project name.

CompartmentField
If this property gets a value, this value will be used as the field name for the compartment ID. If the value of the CompartmentField property is "NONE" the CompertmentID that are set by the SetCompartmentID are used. The default value is "NONE".

SetCompartmentID(long PolyIndex [in] , long CompID [in])
This will set the Compartment ID for the polygon with index "PolyIndex". Indices are numbers from 0 to n-1. Where n is the number of shapes in the shapefile.
NumberOfClusters
The resulting number of clusters that are formed.
GetClusterID(long PolyIndex [in] , long ClusterID [out,retval])*
This will return the cluster ID for the polygon with index "PolyIndex". Indices are numbers from 0 to n-1. Where n is the number of shapes in the shapefile.

Parameters

Range	Double	This is the maximum distance between two polygons to belong to the same cluster. This parameter will be set by the LARCH Data server if "Species" and "Project" are given and the value of "ClusterType" are not equal to "NONE". When "LOCAL" is stated the database will return the *Local population Distance* in "Range". When "Network" is stated the database will return the *Network Distance* in "Range".

The only parameter used in the model component is "Range". If this component is called by LocNetEvaluation.application the first time the distance will be the *Local population Distance*. The second time the *Network Distance* is used.

Algorithms
Distances are calculated between two polygons. The distances are, if needed, calculated perpendicular on the line segments. Clusters are stored into a special container class. This class links all clusters. If two polygons belonging to two different clusters are joint all other polygons that belong to one of the clusters are joint into the same cluster.

Bugs and limitations
-
Product Identification

Executable Name	ClusDist.exe
Object Name	ClusDist.application
Description	Cluster Distance component
Version Number	4.5.0.1

3.5.3 PopulationEvaluation

This model component evaluates local populations and population networks using a species specific habitat map. The local populations are given a size class. There are three size classes; small populations (class 1), key populations (class 2) and minimum viable populations (MVP; class 3). Local populations can also be too small to hold a population (class 0). Next the network populations are evaluated for their viability. To create the polygon clusters of the local populations and population networks, "PopulationEvaluation" calls the component "ClustDist". The results are dbf-files that can be added to the output file (*habitat)* from the component "VVeg2VHabitat".

Interface

Property	BSTR	Project	write
Property	BSTR	Species	write
Property	BSTR	HabitatFile	write
Property	BSTR	Isolation	write
Property	BSTR	IsolationFile	write
Property	BSTR	PolyRUField	write
Property	BSTR	PolyAreaField	write
Property	BSTR	LocalIDField	write
Property	BSTR	DistIndexField	write
Property	BSTR	LocalCompField	write
Property	BSTR	NetworkCompField	write
Property	long	LocalOnly	write
Function	HRESULT	Execute(void)	
Property	Long	ModelResult	read
Property	BSTR	ModelError	read
Property	BSTR	ModelVersion	read
Property	BSTR	ModelLogID	read

Project
Project name[9]
Species
Six letter code for species[9]
HabitatFile (inputfile)
This filename is mostly the same as the outputfile (*habitat)* from the component VVeg2VHab. The vector habitat file is used to read the POLY_RU field. The field LOCAL_ID is added to this file. The shape file is also used by the isolation servers to create the relations.
Isolation[10]
The Isolation property defines which isolation model will be used. There are three models. They are "Distance", "Barrier" and "Isolation". The "Distance" model will call the component "ClustDist" to cluster the polygons to local populations and population networks.
IsolationFile
For the technical documentation this property is mentioned too, but it is only used in studies like MJPO (Van der Grift and Pouwels 2006). Default is NONE.
PolyRUField
Name of the field with RU's. Default is PolyRU.
PolyAreaField
Name of the field with the area. Default is PolyArea.
LocalIDField
For the technical documentation this property is mentioned too, but it is only used in pilotstudies like Pouwels *et al*. (in prep.). Default is NONE.

[9] Data for each species are stored in a database under the combination of a unique species name (an abbreviation of the Latin name) and a unique project name.
[10] The component is able to analyze three different isolation methods. In the described application (Chapter 3) only the component "ClusDist" is used and the setting for Isolation should be "Distance". For the technical documentation "Barrier" and "Isolation" are mentioned too, but these methods are not used in the applications. Both methods have been used for the application MJPO (Van der Grift and Pouwels 2006).

DistIndexField
For the technical documentation this property is mentioned too, but it is only used in pilotstudies like Pouwels *et al.* (in prep.). Default is NONE.
LocalCompField
Field name for the local barriers in the habitat file. If this is not used “LOCBAR” is the default name. If set to NONE the component will not take into account local barriers.

NetworkCompField
Field name for the network barriers in the habitat file. If this is not used “NETBAR” is the default name. If set to NONE the component will not take into account network barriers.
Local population file (outputfile)
This dbf-file is created to store the local population data. It can be joint to the *HabitatFile* in ArcView using the field LOCAL_ID. The filename is generated from the input file by adding ‘lp’ (……lp.dbf).

Network populations file (outputfile)
This dbf-file is created to store the network population data. It can be joint to the *HabitatFile* in ArcView using the field NETWORK_ID after the join with the *Local population File*. The filename is generated from the input file by adding ‘np’ (……np.dbf).

Parameters

Parameter name	**Type**	**Description**
SizeKey (Key Patch in Chapter 2.2)	double	Size for a key population [RU]
no_key_population (NW-KP factor in Chapter 2.2)	double	Factor multiplied with the size of a key population to obtain the size of a viable network population, for a network without a key population
key_plus_population (NW+KP factor in Chapter 2.2)	double	Factor multiplied with the size of a key population to obtain the size of a viable network population, for a network with a key population
mvp_population (MVP factor in Chapter 2.2)	double	Factor multiplied with the size of a key population to obtain the size of a minimum viable population
UnderOneRUFactor (Small population factor in Chapter 2.2)	double	Factor to set local populations that have less then one RU to local population that have one RU. If 1 then this function is not working
NetworkStepStoneSize	double	This value should be set to 1. No ecological implementation

Algorithms
The local populations are given a size class. There are three size classes; small populations (class 1), key populations (class 2) and minimum viable populations (MVP; class 3). Local populations can also be too small to hold a population (class 0). If *Small Population Factor* or *Small Patch* (chapter 3.3) is used local population are corrected for this.

The largest class of populations within the network is determined.

```
for every network population i
{
 if(i.GetClass() = 1)
i.SetViability(_no_key_population);
 if(i.GetClass() = 2 )
i.SetViability(_key_plus_population);
 if(i.GetClass() = 3 )
i.SetViability(_mvp_population);
  }
```

Where GetClass (previous routine) returns the maximum class of all local populations in the network the function SetViability sets the value for the viability. When evaluating the ecological networks viability standards are used that are based on the same field data and calibrated metapopulation models as the standard for key patches (Verboom *et al.*, 1997; Verboom *et al.*, 2001). These standards are species specific. Three types of ecological networks are distinguished: Networks with MVP, networks with key patch and networks without MVP and key patch. Any type of network must support sufficient RU's, before a species can have a viable population there. The total amount of RU's needed, increases with the degree of habitat fragmentation.

```
SetViability(double norm)
netwerk.viability = netwerk.RU/norm
```

If a network is viable or not is obtained by the following algorithm

```
NetworkIsViable = (netwerk.viability >= 1.0)
```

Bugs and limitations
Version Number: 3.0.0.2
There is a bug in the calculation of the number of RU for a MVP. This creates more MVP than there should be. This is resolved in version number: 3.0.0.4.

Product Identification

Executable Name	**PopulationEvaluation.exe**
Object Name	PopulationEvaluation.application
Description	Local & Network Population Evaluation
Version Number	4.5.0.2

3.6 Tests

3.6.1 VVeg2VHabitat

The component has been tested on a file containing more then 50000 polygons. The test resulted in a habitat map of more then 20000 polygons with for each polygon the number of RUs of the species selected in the test (Figure 8). A balance of the input file and the output file revealed a negligible small difference in numbers (Table 3).

Table 3. Balance of input file (land use) and output file (habitatfile). Calculation the number of RUs in Excel showed a slide difference in balance. The selected species had a 'density factor' (Chapter 3.3) of 0.08 RU per 100 ha. Quality refers to the parameter 'vector map' in Chapter 3.3.

	quality	sum area (ha)	sum RU Excel	sum RU model	difference
vegetation types quality 0.1	0.1	863017.2533	69.04138026	69.04139	100.00001%
vegetation types quality 0.5	0.5	871833.034	348.7332136	348.73341	100.00006%
vegetation types quality 1.0	1	2247211.578	1797.769262	1797.76954	100.00002%

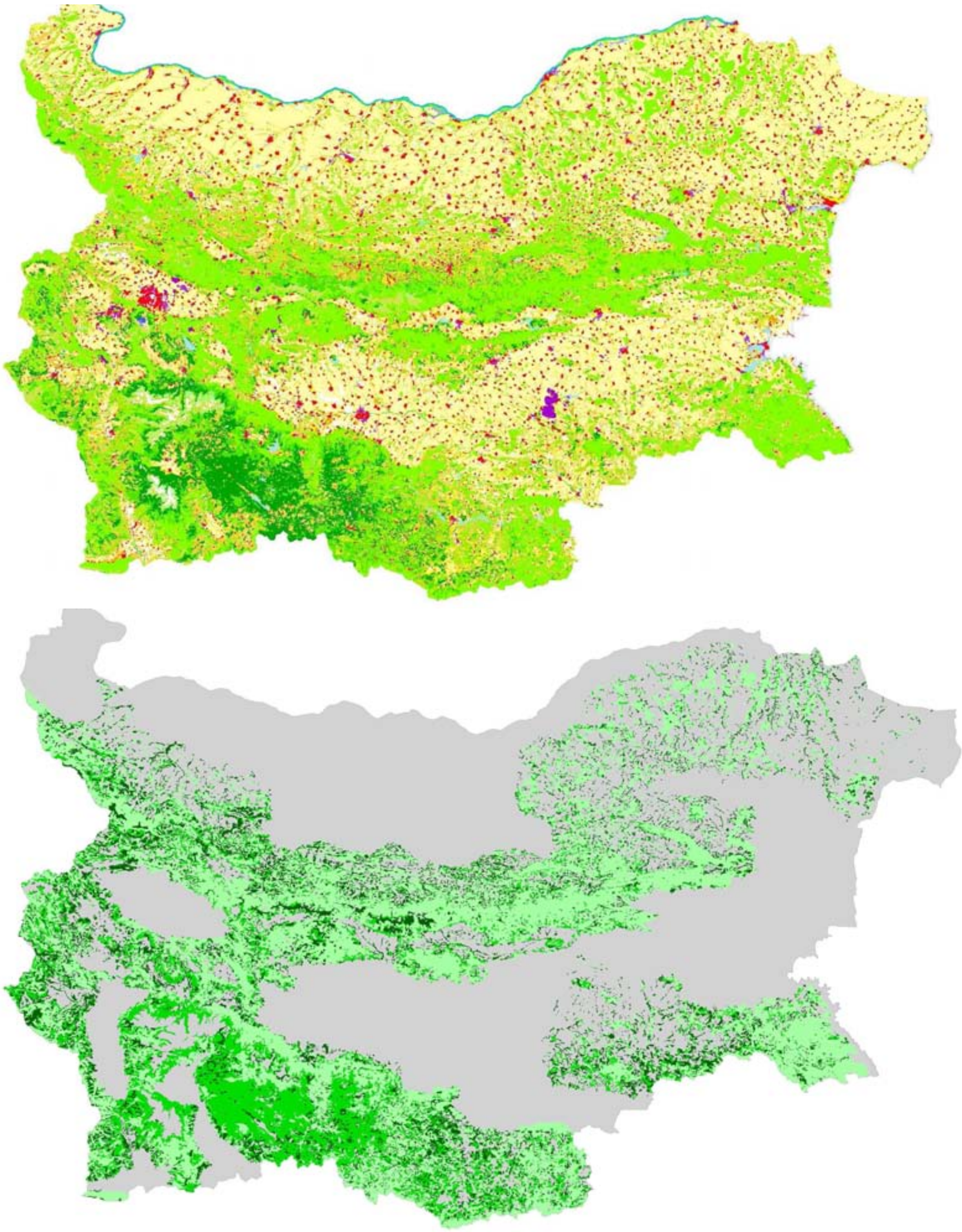


Figure 8. Result of the test of VVeg2VHabitat. Figure at top is input map and represent different land use types (f.e. red color represents build up area, yellow represents agricultural lands and green colors represent different forest types). Figure at bottom is output map and represent habitat of selected forest species. Grey is background, dark green represents optimal habitat and light green marginal habitat.

3.6.2 ClustDist

The component has been tested on a habitat map containing more than 10000 polygons in five different settings. A test with *Range* set to 100 meters (test 1) and a test with *Range* set to 1000 meters (test 2). A test with *Range* set to 100 meters using a barrier field (test 3). And finaly a test using the LARCH database with *Local population Distance* (test 4) and a test using the LARCH database with *Network Distance* (test 5). With ArcView the same habitat map has been buffered with half the distance (50 meters and 500 meters) so buffers would only be merged when polygons were 100 meters or 1000 meters apart. Figure 9-11 show the result of the component (different clusters have different colors) and the result of ArcView (buffered grey lines surrounding the polygons). Test 1 and test 4 resulted in 4048 clusters. Test 2 and test 5 resulted in 551 clusters. And test 3 resulted in 4315 clusters.

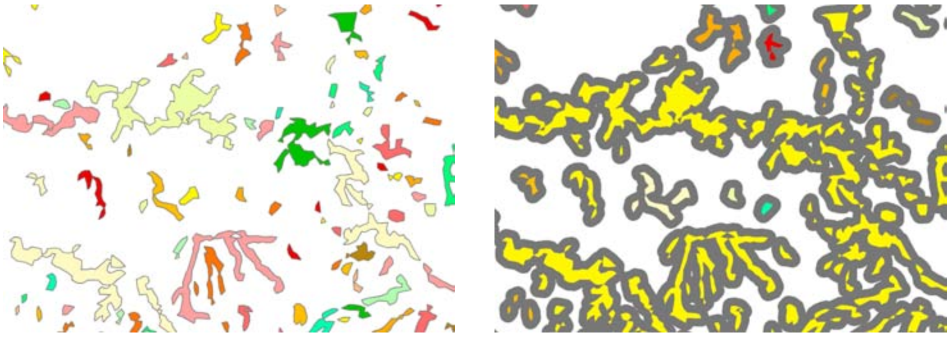


Figure 9. Result of test 1 (left) and test 2 (right) for the component "ClustDist". Lines are buffers made in ArcView and colors represent different clusters as a result of the component.

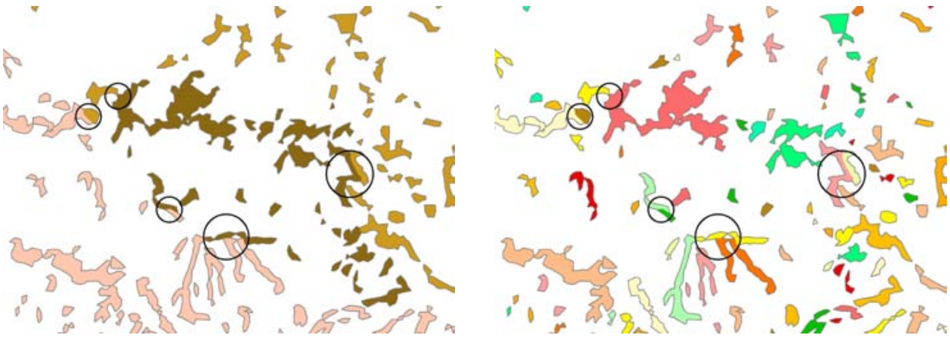


Figure 10. Result of test 3 for the component "ClustDist". The left figure represent different barrier compartments and the right figure represent different clusters as a result of the component. Lines are buffers made in ArcView. The circles indicate areas were the barrier compartment should result in different clusters (in the right figure).

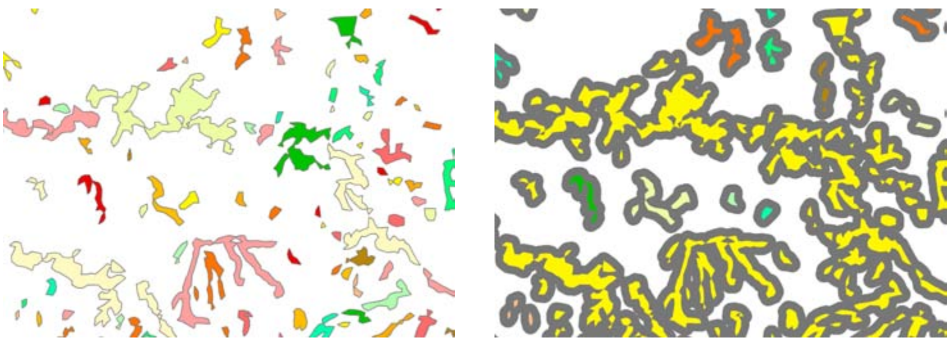


Figure 11. Result of test 4 (left) and test 5 (right) for the component "ClustDist". Lines are buffers made in ArcView and colors represent different clusters as a result of the component.

All clusters were compared with the clusters made in ArcView with X-tools. One difference was found for test 2. In one of the clusters from *ClustDist* the analyses of X-tools resulted in two clusters. A more detailed calculation of the distance between the clusters showed that the clusters were 997.83 meters apart and the result of X-Tools (ArcView) is wrong.

3.6.3 PopulationEvaluation

The component has been tested on a habitat map containing more than 10000 polygons in two different settings. In both tests the *ClustDist* component is triggered and parameters from the database are used. Test 1 resulted in 4048 local clusters and 551 network clusters. Test 2 resulted in 4315 local clusters and 559 network clusters. As expected, these numbers are comparable with the tests with *ClusDist*. Figure 12 and 13 show the result of the component.

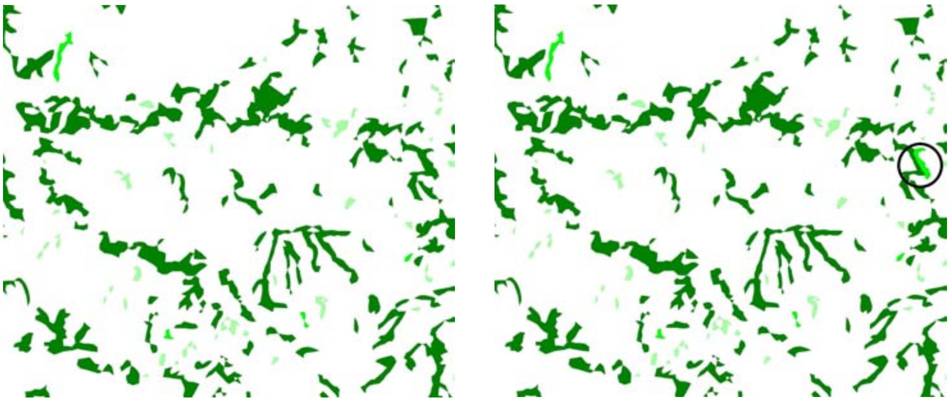


Figure 12. Populations for test 1 (left) and test 2 (right). Light green indicate populations in class 1 (small population), green indicate populations in class 2 (key population) and dark green indicate populations in class 3 (MVP). In circle (right figure) the effect of barriers can be seen as a shift of class of one of the populations.

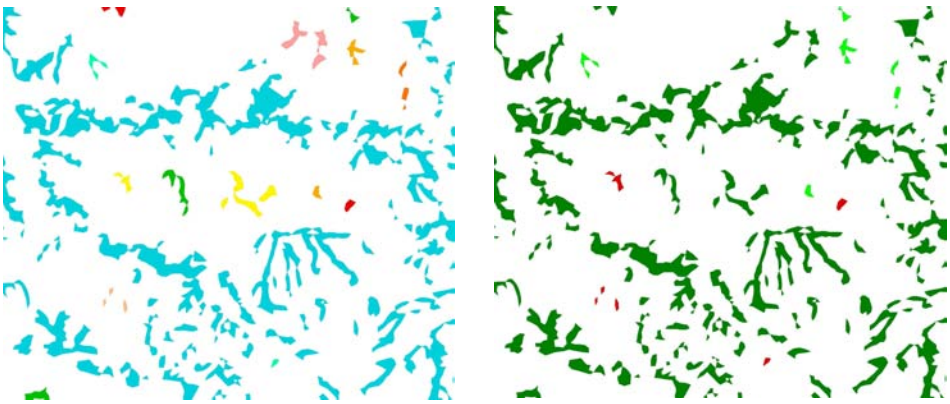


Figure 13. Networks (left) and viability (rigth) from test 1. Viability is given in three classes: not viable (red), viable (green) and strongly viable (dark green).

An extra check on the output files (….lp.dbf en ….np.dbf) with the results of the populations and viability (Figures 12 and 13) showed consistent results. A balance of the input file and two output files revealed a negligible small difference in numbers (Table 4)

Table 4. Balance of input file (habitat) and output files (….lp.dbf and ….np.dbf).

	PolyArea	% habitat	Poly_RU	% habitat
habitat	424998.80082	100%	1429482.67298	100%
lp-file	424998.80140	100.000000136%	1429482.67230	99.99999995%
np-file	424998.80040	99.999999901%	1429482.67250	99.99999997%

All components behaved as expected; habitat was assigned, patches within dispersal distance where clustered, densities were summed correctly and viability was evaluated. Only minor deviations in the balance of input and output files where found. It seems that the calculation of distances between patches is even more precise then the calculations within ArcView (3.6.2). This confirms the experiences over time, that until now unexpected results are always caused by mistakes in the input maps, mistakes in the database or wrong settings in the user interface (3.9).

3.7 Version management of LARCH components and source code

All LARCH code can be shared between the developers within the team 'Ecological Modeling and Monitoring'. To keep track of changes Subversion (SVN) (http://tortoisesvn.tigris.org/docs/) a version control system (VCS) is used. SVN was initiated in 2000 by CollabNet Inc. It allows users to keep track of changes made to any type of electronic data, typically source code, web pages or design documents. The software is released under an Apache/BSD-style open source license and can be found under http://subversion.tigris.org/.

LARCH is stored in four repositories (source databases). The location of the repository and the revisions used for the testing of the components in this report are:

Use	**Location**	**Revision**	**Components/Versions**
LARCH Components	\\D0113365:D\SVNRepo\LARCH	19	Vveg2Vhabitat 4.5.0.0 PopulationEvaluation 4.5.0.2 ClusDist 4.5.0.1
general GIS and modeling kernel	\\D0113365:D \SVNRepo\Resource	53	Libraries incorporated in components
database connectivity	\\D0113365:D \SVNRepo\PropertyService	18	IMods2006 4.5.0.0
IMODS Interface	\\D0113365:D \SVNRepo\Interfaces	56	PropertyServer 1.0.0.9

The Desktop PC "esg1258" is used as a server for SVN. Scheduled cross backups of the repository are made on \\d0106071\D0106071_Backup_SVN_repro four times a week:

Day of backup	Name of Backup
Monday/Wednesday	MWRene.bkf
Tuesday/Friday	TFRene.bkf

3.7.1 Procedure

Every time a developer starts developing components an update of the local copy of the source code should be made. When the development of a working component is finished the source should be committed to the repository. If two developers work on the same code SVN will indicate any conflicts which should be solved before the final commit takes place. Major releases, after an install application is created should be accompanied by the version numbers of the components into the SVN Repository message.

3.7.2 Component version numbers

Version numbers contain a Major, Minor, Release, and Build number, each specify an unsigned integer. The version number is Auto-incremented; the build number is incremented each time the component is rebuilt.

3.8 Results

The final result of a LARCH analyses is for each species a set of one habitat shape file and two joinable tables (….lp.dbf en ….np.dbf). The habitat shape file derived from *VVeg2VHab* is modified. The "Local_ID" field is added to the attribute table to provide a link with the other tables. The two tables provide local population data and network population data.

3.8.1 Local population table

The local population table (Table 5) contains the cluster data for the local populations. A local population contains 1 or more shapes.

Table 5. Local population table fields

Field Name	Comment
Local_ID	Local ID
Network_id	The network id this population belongs to
LocClass	Size class (see Table 6)
LocRU	Number of RU in local population
LocArea	Area in local population

Table 6. Local population classes, based on their size

Value	Classification of the local populations
0	Too small to contain a local population
1	Small local population
2	Local population is a key population
3	Local population is an MVP

In the shapefile the LocClass values (Table 6) are represented by the colors pink, light green, green and dark green respectively. Occasionally LocClass value 0 is represented by the color grey (see also Figure 4c).

3.8.2 Network population table

The network population table (Table 7) contains the cluster data for the network populations. A network population contains 1 or more local populations.

Table 7. Network population table fields

Field Name	Comment
Network_id	Network id
IsViable_b	Viability as a Boolean
Viab_RU_NW	Viability as a value (NetworkRU divided by viability standard)
MaxClass	Highest class of local populations
nLocalPop	Number of local populations
nLocP_c1	Number of local populations in local population class 1
nLocP_c2	Number of local populations in local population class 2
nLocP_c3	Number of local populations in local population class 3
NetworkRU	Total number of reproductive units
nRU_c1	Number of reproductive units in local population class 1
nRU_c2	Number of reproductive units in local population class 2
nRU_c3	Number of reproductive units in local population class 3
NetArea	Total area of the network

In the column Viab_RU_NV (Table 7) the viability of the networks is calculated by dividing the number of reproductive units by the viability standards. These values are then used to display the viability of the networks in three classes (Verboom and Pouwels 2004, Table 8). In the shape file the colors pink (occasionally grey), red, green and dark green respectively represent habitat networks that are too small, not viable, viable and strongly viable (see also Figure 4d).

Table 8 Degree of viability of habitat networks

Value in relation to standard	Degree of viability	Extinction chance in 100 years
0.001-1	Not viable	> 5%
1-5	Viable	>1% and ≤ 5%
>5	Strongly viable	≤ 1%

3.9 Running the model (IMods)

At this moment we provide our models with IMods. In this graphical user interface all models can be built and initialized. Although IMods is not part of LARCH 4.5 we will describe thE interface in more detail to get users started more easily. In short IMods is a scripting language in a cell format. These user interfaces can integrate both the required species data and the case data for the COM components. IMods requires detailed knowledge from the user.

3.9.1 Introduction

IMods is an application to build, initialize and run LARCH. To understand the concept of this program it is important to understand the concepts of the technical implementation of LARCH. The conceptual model of LARCH is flexible. This means that the implementation of the model should accommodate the same level of flexibility. Therefore the model is configured by the use of different components. These components can change according to the situation, species or application of the model.

Components are small applications that can be linked together to build a larger application. If you would start a LARCH component, for example “VVeg2VHabitat.exe”, very little will happen. The only appearance of the program will be in the form of a small WUR logo in the tray bar. The components do not have a visible Graphical User Interface (GUI). To extract results from the component the components’ properties should be initialized and a run command should be invoked. To achieve this, the component is created with a COM[11] interface. A COM interface is a standard way of communication between applications on a Windows platform. ArcGIS uses the same COM techniques. Those who have a brief introduction into ArcGIS also know that they can access these components through Python or Visual Basic. LARCH could also be accessed by using one of the many program languages in the same way. For those who are not interested in programming LARCH models we created IMods. IMods is a simple interface between the user and the COM interface of the LARCH components.

The aim of the program is to provide a quick interface for (new) models and model components that is adaptable to the needs of the user. It provides ways to create large numbers of simulations in a batch procedure and easy access to files, directories and value lists.

COM simplified

To use a component you always start with calling its name, the object name. Now the program knows who you are talking to. The next step is to initialize the component. The component needs to know which species or parameters and which files to use. These parameters are initialized through the "set" properties. After initializing the component the next step is invoking a method of the object. In the LARCH-components this is normally running the "execute" method. The last step in the process of using a component is to check if there where exceptions (errors) in the process. This is done by reading the "get" properties.

3.9.2 Getting started

After collecting the needed data and summarizing the conceptual LARCH model, it is time to do the actual model runs. This involves the following steps:

- Decide which of the components are needed
- Decide in which order these components should be run
- Describe the model in the IMods application
- Initialize the model with the needed properties
- A test run in this phase can be practical
- Apply the model to multiple species (creating multiple model files)
- Run the models in a batch process (optional)

The best way is to create one model file for each species. This can be done manually, however in IMods a model file can also be multiplied, initialized and ran for each required species by using batch procedures

3.9.3 The graphical user interface

The most apparent feature of the application is the worksheet. This is the white string grid. On the worksheet the model will be described and initialized. Above the worksheet different toolbars can be found. In Figure 14, on the top toolbar, from left to right we find the most commonly used menu items, the column visibility buttons (Type Rule File) and the find and replace toolbar. On the second toolbar in Figure 14 the automated filename generation toolbar is visible.

The worksheet contains a fixed number of columns. The columns 'property', 'name' and 'type' describe the interface of the component. In the third column 'value' the data to initialize the component is stored. The fifth column 'rule' contains the rules for the interface actions that can be chosen when the value column is double-clicked.

[11] Component Object Model

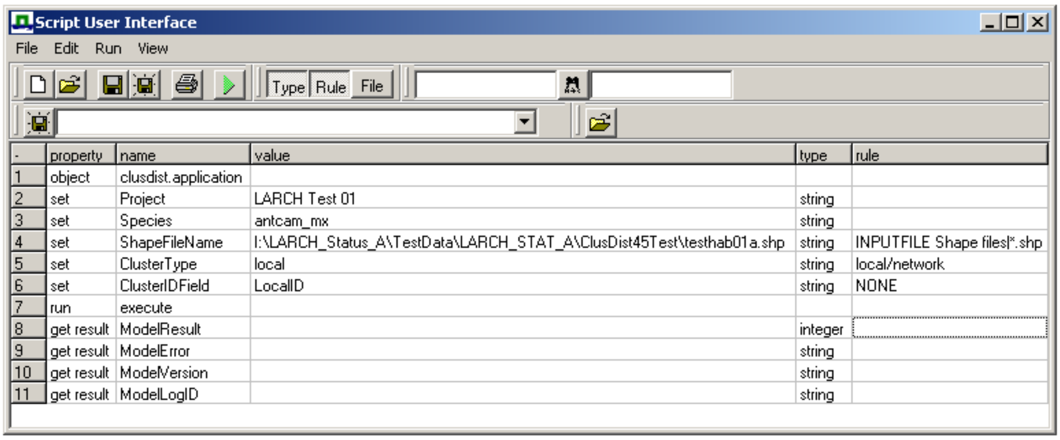


Figure 14 The IMODS GUI

Most of the items in the menu and toolbar are quite common. The most common ones are the buttons from left to right in Figure 13 'new', 'open', 'save', 'save as', 'print' and 'run' (green playing button).

3.9.4 MDS files

The information is saved in a *.mds file. The program registers this extension in the registry as a result of which the *.mds file is linked to the IMODS program. This implies that the file will be opened in IMods after double clicking it in Windows Explorer. It is also possible to run the file directly by clicking on it with the right mouse button.

The *.mds file is a comma-delimited text file (Figure 15). The first row contains the width of the columns. The following rows contain the interface data in the same order as the grid. The numbers in the first column are the row numbers. These are not always sorted ascending.
Thus it is possible to paste one interface below another. Such actions are very error sensitive and not supported.

Figure 15. Example of a MDS file in a text editor

```
25,50,137,263,62,386,0,0
"1","object","ClusDist.application"," ",~,~,~,~
"2","set","Range","100","real",~,~,~
"3","set","Shapefilename","D:\LARCH_STAT_A_base\ClusDist45Test\bulg_t001.shp","string","INPUTFILE Shape files|*.shp","Shape","files|*.shp"
"4","set","ClusterIDField","T001","string","SELECT:CLUS_ID/LOCAL_ID/NETWORK_ID",~,~
"5","run","Execute"," ",~,~,~,~
"6","get","ModelResult","0","integer",~,~,~
"7","get","ModelError","OK !","string",~,~,~
"8","get","ModelVersion","LARCH Cluster Distance version : 4.5.0.1","string"," ",~,~
```

3.9.5 Error message handling

LARCH will return a message in the IMods GUI if the application resulted in the expected output files. If the model runs into an error an error message will be stored. Default this directory is the same as the directory were the LARCH model is installed: C:\Program Files\ALTERRA\LARCH\errors\. It is possible to change the directory for error messages in the registry: [HKEY_LOCAL_MACHINE\SOFTWARE\ALTERRA\LARCH\Messages].

4 Applications

In this report we will describe the use of LARCH in two applications. Parameters and components used in the applications will be explained. Results of the applications can be found in the two reports (Reijnen *et al*. 2006 and Pouwels *et al.* 2007).

4.1 Application 'spatial conditions NEN[12]'

From : Reijnen *et al.*, 2006

For this study the input map was based on the spatial distribution of the planned 'natuurdoeltypen' (Ndt) in the Netherlands (Tweede Kamer, december 2003; (Bal *et al.* 2001). This input map was converted to the typology used by Bal *et al.* (1995). The method for this conversion is described in chapter 2 in Reijnen *et al.* (2006). The application used one components of LARCH; ClustDist 4.5.0.0. The assigning of habitat patches, the evaluation of key patches and the evaluation of the viability on a national scale have been done with an Access database. The queries used in this database are described in Reijnen *et al.* (2006).

4.1.1 Habitat parameters

For each species the suitability of the Ndt's is determined in 5 steps.

1. For each target species Bal *et al.* (2001) determined the importance of a specific Ndt as habitat for the species. They used two classes 'high importance' and 'low importance'. In this study we only used 406 (in the Netherlands reproducing) fauna target species and the Ndt's that had the classification 'high importance' were considered as optimal habitat (suitability = 1.0) and Ndt's that had the classification 'low importance' were considered as suboptimal habitat (suitability = 0.5).
2. In the map multifunctional-nature is distinguished from other nature types. The suitability of habitats in multifunctional-nature is multiplied by 0.5, so suitability is 0.5 or 0.25 depending on the importance of the Ndt. For a few species habitats in multifunctional grasslands or multifunctional forests are as suitable as habitats in other nature types. For these species the suitability will not be multiplied by 0.5 (Table 9).
3. Because the suitability of the Ndt's for a species is based on the typology from 2001 and the map uses the typology from 1995 a conversion table between both typologies has been made. This conversion table is based on information from Bal *et al.* (1995, 2005). The conversion table is described in Appendix 1 from Reijnen *et al.* (2006).
4. The typology from 1995 distinguishes Ndt's in several regions (FGR's). Because of the conversion some Ndt's might become suitable as habitat in one of the regions, while the species doesn't occur there. For most species this is corrected by species experts (Reijnen *et al.* 2006).
5. When the suitability of a Ndt for a species is less then 0.1, the suitability is set to 0.

In Table 10 the parameters for Common Buzzard, Grayling, Small Red Damselfly and Sand Lizard are given as an example of the habitat parameters.

[12] NEN without large water bodies

Table 9 Exceptions for which species and Ndt combination multifunctional nature is as suitable as other nature types.

species name	Ndt-code	importance	suitability
Ortolan Bunting	3.51	high	1
Ortolan Bunting	3.52	high	1
Ortolan Bunting	3.50	low	0.5
Ortolan Bunting	3.56	low	0.5
Ortolan Bunting	3.38	high	1
Ortolan Bunting	3.33	low	0.5
Pine Marten	3.65	high	1
Pine Marten	3.64	low	0.5
Pine Marten	3.67	low	0.5
Pine Marten	3.68	low	0.5
Pine Marten	3.69	low	0.5
Badger	3.52	high	1
Badger	3.53	high	1
Badger	3.56	high	1
Badger	3.65	high	1
Badger	3.58	low	0.5
Badger	3.60	low	0.5
Badger	3.64	low	0.5
Badger	3.68	low	0.5
Black-tailed Godwit	3.32	high	1
Black-tailed Godwit	3.38	high	1
Black-tailed Godwit	3.39	high	1
Black-tailed Godwit	3.30	low	0.5
Black-tailed Godwit	3.31	low	0.5
Goshawk	3.64	high	1
Goshawk	3.65	high	1
Goshawk	3.60	low	0.5
Goshawk	3.61	low	0.5
Goshawk	3.62	low	0.5
Goshawk	3.66	low	0.5
Goshawk	3.67	low	0.5
Goshawk	3.68	low	0.5
Goshawk	3.69	low	0.5

Table 10 Suitability of Ndt's for Common Buzzard, Grayling, Small Red Damselfly and Sand Lizard. Suitability of multifunctional Ndt's are always half of the suitability of the 'natural' Ndt for these species.

ndt	Common Buzzard	Grayling	Small Red Damselfly	Sand Lizard
az-3.7	1.00			
az-3.7 (multifunctional)	0.50			
az-3.8	0.75			
az-3.8 (multifunctional)	0.38			
du-3.10				0.50
du-3.10 (multifunctional)				0.25
du-3.11	0.33			
du-3.12	1.00			
du-3.12 (multifunctional)	0.50			
du-3.13	1.00			
du-3.13 (multifunctional)	0.50			
du-3.14	0.88			
du-3.14 (multifunctional)	0.44			
du-3.16	0.50			
du-3.7		0.73		0.95
du-3.8		0.50		1.00
hl-3.10	0.75			
hl-3.10 (multifunctional)	0.38			
hl-3.11	0.50			
hl-3.11 (multifunctional)	0.25			
hl-3.12	0.25			
hl-3.5		0.45		
hl-3.9	0.25			
hz-3.1			0.05	
hz-3.1 (multifunctional)			0.03	
hz-3.10		0.23	0.50	
hz-3.12	0.33			
hz-3.12 (multifunctional)	0.17			
hz-3.13	1.00			
hz-3.13 (multifunctional)	0.50			
hz-3.14	0.75			
hz-3.15	0.50			
hz-3.15 (multifunctional)	0.25			
hz-3.16	0.50			
hz-3.16 (multifunctional)	0.25			
hz-3.17	0.33			
hz-3.18	1.00			
hz-3.18 (multifunctional)	0.50			
hz-3.19	1.00			
hz-3.4			1.00	
hz-3.4 (multifunctional)			0.50	
hz-3.5		1.00		
hz-3.8		0.50		
hz-3.9		1.00		1.00
lv-3.10	1.00			
lv-3.10 (multifunctional)	0.50			
lv-3.8	0.25			
lv-3.8 (multifunctional)	0.13			
lv-3.9	1.00			
lv-3.9 (multifunctional)	0.50			
ri-3.10	0.83			
ri-3.10 (multifunctional)	0.42			
ri-3.11	0.40			
ri-3.12	0.50			
ri-3.12 (multifunctional)	0.25			
ri-3.8	0.25			
ri-3.8 (multifunctional)	0.13			
ri-3.9	0.75			
zk-3.10	0.75			
zk-3.11	1.00			
zk-3.11 (multifunctional)	0.50			
zk-3.12	0.50			
zk-3.13	0.50			
zk-3.13 (multifunctional)	0.25			
zk-3.9	0.25			
zk-3.9 (multifunctional)	0.13			

4.1.2 Spatial parameters

In the application two spatial parameters were used; *Local population Distance* (m) and *Key Patch* (ha) (Chapter 3.3). For 406 species both parameters were determined using the ecoprofile approach with available data. For *Key Patch*, species data was used from Bal *et al.* (2001). For 30 bird species and one mammal the values for *Key Patch* were changed during calibration (Table 11). For eleven species the area requirements increased and for 20 species the area requirements decreased.

Table 11 New values for Key Patch after calibration of LARCH.

Species name	Key Patch (ha) old	Key Patch (ha) new
Lesser Black-backed Gull (spp. Graellsii)	5	500
Lesser Black-backed Gull (spp. intermedius)	5	500
Common Tern	50	300
Mediterranean Gull	50	300
Little Tern	100	300
Blacknecked grebe	100	300
Sandwich Tern	100	5
Arctic tern	100	50
Sand martin	100	50
Common Buzzard	300	750
Curlew	300	750
Red-backed Shrike	300	750
Spoonbill	300	500
Bittern	750	300
Black Woodpecker	750	1500
Common hamster	750	300
Corncrake	750	300
Kwartelkoning	750	300
Night Heron	750	500
Purple Heron	750	500
Garganey	1500	750
Avocet	3000	300
Black Grouse	3000	750
Goldfinch	3000	750
Kingfisher	3000	1500
Little Egret	3000	500
Nightjar	3000	1500
Ortolan Bunting	3000	1500
Whinchat	3000	1500
Great Egret	10000	500
Hoopoe	25000	10000

For *Local population Distance* data was used if available. For butterflies data from Bink *et al.* (1992) was used. For birds data from SOVON was used (Van Dijk 2004). Based on research for the Nuthatch (Schotman 2001) data from SOVON was divided by 3. For colony birds and birds that forage outside their breeding habitats data from SOVON was multiplied by 5/6. For all other species the *Local population Distance* was determined based on species groups. For some mammals data was available to classify at the species level instead of the species group level. This resulted in the following classes (m):

0 all water bound species, slugs and ants
20 grasshoppers, crickets, amphibians
50 small mammals (mice and voles), reptiles, moths, small dragonflies
100 large dragonflies, large beetles, Squirrel
200 Common hamster
500 bats, Pine Marten, Beaver and Otter
1000 Badger

All 406 species were classified over 47 cells in a matrix (Figure 16).

Key Patch (ha) \ Local population Distance (m)	0	20	50	67	100	167	200	208	333	417	500	667	833	1000	1042	2083
5	177	20	35		20					1						
50	6	11	23	2	6					3						
300		1	2	5	13	6	1		5	6					1	
500										4			2			1
750				2	4	6			2	6	10				1	
1500				1	2		1					1				
3000						3		1	3	1		1				
10000						2			1	1	3		1	1		
25000										1						

Figure 16 Matrix of spatial parameters. 406 species were classified over 47 cells.

4.1.3 Viability thresholds on national scale

The standard output of LARCH is a map with the viability of the ecological networks in a landscape for a selected species. In this application the viability of a species was assessed at the national level by the number of key patches. From the point of view of spreading the risk of a extinction at the national level aiming at several key patches within the Dutch NEN is preferable (Foppen *et al.* 1998, Opdam 2002). Vertebrates (like birds, reptiles and fish) need less key patches then evertebrates (like dragonflies, butterflies and macro fauna) (Verboom *et al.* 1997) (Table 12). Because it is difficult to find a threshold between 'not viable' and 'viable' we use a third intermediate class 'possible viable'. For the evaluation of viability on a national scale LARCH is not used.

Table 12 Viability thresholds, number of key patches, on national scale for vertebrates and evertebrates.

	not viable	possible viable	viable
vertebrates	<5	5-19	≥20
evertebrates	<20	20-79	≥80

The number of key patches is calculated from the output files of LARCH. Some patches that are classified as key patch for a specific species exceed the thresholds for *Key Patch* for this species f.e. more then 10 times. Such patches should be considered as several key patches. However from the point of view of spreading risks one large patch is often less viable then the sum of several smaller ones. For species with small area requirements (≤ 500 ha) we are more stringent then for species with larger area requirements (> 500 ha) (Figure 17).

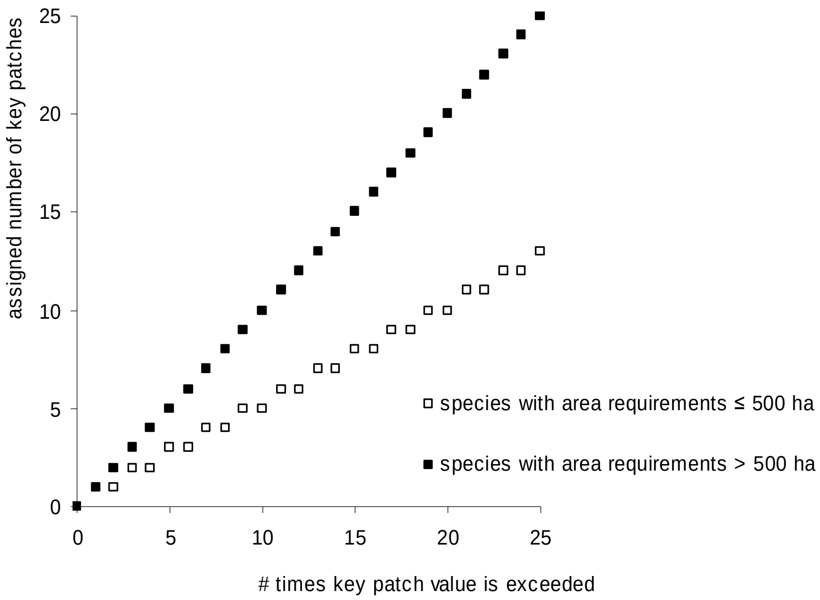


Figure 17 Large patches will account for several key patches based on the size and the area requirements of the species.

4.2 Application 'spatial conditions Habitat and Bird Directive species'

From Pouwels *et al.* 2007

For this study the same input map was used as in the application described in chapter 4.1.

4.2.1 Habitat parameters

For this application the same habitat parameters were used as in the application described in chapter 4.2. Only species from the Habitat and Bird Directive were taken into account (Table 13). In the analyses one habitat parameter was used; *Density Factor* (RU/100ha) (Chapter 3.3). In order to join up with the study from Reijnen *et al.* (2006) for each species the value of this parameter was calculated from *Key Patch* (Chapter 3.3; Reijnen *et al.* 2006) and values for the species from Verboom *et al.* (1997 and 2001). The last value, given in RU, is divided by the first value (divided by 100), given in ha[13]. For all species the results between both studies was compared and the end result (total number of key patches) was exactly the same. The only exceptions were 5 species that differed in spatial parameters (Little Tern, Blacknecked Grebe, Sandwich Tern, Arctic Tern, Sand Martin) or were barrier sensitive. For these 5 bird species old parameters for *Key Patch* (Table 11) were used.

[13] F.e.: When a species have a value for Key Patch of 750 ha in Reijnen *et al.* (2007) and of 20 RU in Verboom *et al.* (2001) we use a value of 20 RU and a Density Factor of (20/750*100 =) 2.67 RU per 100 ha.

Table 13. Species from Habitat and Bird Directive taken into account in study. Species names in Dutch.

Habitat Directive	Bird Directive	not evaluated (Habitat and Bird Directive)
Barbeel	Blauwborst	Brandts vleermuis
Bechstein vleermuis	Blauwe kiekendief	Brede geelrandwaterroofkever
Beekprik	Boomleeuwerik	Bruine kikker
Bever	Bruine kiekendief	Bruinvis
Bittervoorn	Dodaars	Bunzing
Boomkikker	Draaihals	Drijvende waterweegbree
Boommarter	Duinpieper	Dwergvleermuis
Bosvleermuis	Dwergstern	Elft
Donker pimpernelblauwtje	Eidereend	Geel schorpioenmos
Fint	Geoorde fuut	Gewone zeehond
Franjestaart	Grauwe kiekendief	Gewoon sneeuwklokje
Gaffellibel	Grauwe klauwier	Grijze grootoorvleermuis
Geelbuikvuurpad	Grote karekiet	Grijze zeehond
Gestreepte waterroofkever	Grote stern	Groenknolorchis
Gevlekte witsnuitlibel	Grote zilverreiger	Grote marene
Gewone baardvleermuis	IJsvogel	Houting
Gewone grootoorvleermuis	Kemphaan	Ingekorven vleermuis
Gladde slang	Kleine mantelmeeuw	Kruipend moerasscherm
Groene glazenmaker	Kluut	Kussentjesmos
Grote modderkruiper	Korhoen	Laatvlieger
Grote vuurvlinder	Kwartelkoning	Meerkikker
Hamster	Lepelaar	Meervleermuis
Hazelmuis	Nachtzwaluw	Middelste groene kikker
Heikikker	Noordse stern	Muurhagedis
Kamsalamander	Oeverzwaluw	Platte schijfhoorn
Kleine modderkruiper	Paapje	Rendiermos (5 soorten)
Knoflookpad	Porseleinhoen	Sphagna (alle soorten)
Medicinale bloedzuiger	Purperreiger	Steur
Nauwe korfslak	Rietzanger	Teunisbloempijlstaart
Noordse winterjuffer	Roerdomp	Tonghaarmuts
Noordse woelmuis	Roodborsttapuit	Tuimelaar
Oostelijke witsnuitlibel	Snor	Tweekleurige vleermuis
Otter	Strandplevier	Vale vleermuis
Pimpernelblauwtje	Tapuit	Valkruid
Poelkikker	Velduil	Wijngaardslak
Rivierdonderpad	Visdief	Witsnuitdolfijn
Rivierkreeft	Watersnip	Wolfsklauw (2 soorten)
Rivierprik	Wespendief	Zalm
Rivierrombout	Woudaap	Zeeprik
Rosse vleermuis	Zwarte specht	
Rugstreeppad	Zwarte stern	Aalscholver
Ruige dwergvleermuis	Zwartkopmeeuw	Bontbekplevier
Spaanse vlag		
Vliegend hert		
Vroedmeesterpad		
Watervleermuis		
Zandhagedis		
Zegge-korfslak		

4.2.2 Spatial parameters

In the application four spatial parameters were used; *Local population Distance* (m), *Network Distanc*e (m), *Key Patch* (RU) and *NW+KP factor* (-) (Chapter 3.3). All spatial parameters are described in Appendix 2 in Pouwels *et al.* 2007. Values for *Local Distance* were taken from Reijnen *et al.* (2006; see Chapter 4.1.2). *Key Patch* and *NW + KP* are taken from Verboom *et* *al.* (1997, 2001; see also Chapter 4.3 and Chapter 5.1.2 in Pouwels *et al.* 2002b). The unit of *Key Patch* used in this application is RU. Verboom *et al.* (1997 and 2001) determined the value for key patches on studies for mainly birds and some mammals. For other species groups the values for *Key Patch* and *NW + KP* are based on literature and expert judgement (Verboom *et al.* 1997). *Network Distance* for some species is based on literature, for some species on extrapolation from similar species and for some species on expert judgement. For network distance most research is available for birds, amphibian and mammals. All 90 species were classified over 18 cells in a matrix (Figure 18).

Key Patch (RU)	Network Distance (m)								
	5	500	2000	5000	10000	20000	30000	50000	200000
20							4	16	
40					1	2	5	6	
100			8	2	7	6	3	5	1
500	2	3	12	2	5				

Figure 18 Matrix of spatial parameters. All 90 species were classified over 18 cells.

4.2.3 Infrastructure

In the application the effect of infrastructure on a local scale and on ecological networks was taken into account for 28 species (6 mammals, 4 butterflies, 4 dragonflies, 8 amphibians, 2 reptiles, 2 bugs and 2 snails). Which infrastructure and which mitigation measure is used for the different species can be found in Chapter 3.1, Appendix 3 and Appendix 4 in Pouwels *et al.* (2007). The method of preparing the input maps is described in Chapter 4.3.2 and in Chapters 6.1, 6.2 and 6.3 in Pouwels *et al.* (2002b).

4.2.4 Viability on national scale

In this application the viability of a species was assessed at the national level by the number of key patches (Chapter 4.1.3). In this application only key patches that lie within a viable ecological network are taken into account. In the application 'spatial conditions NEN' all key patches are taken into account.

The number of key patches is gathered from the output files of LARCH. Some patches that are classified as key patch for a specific species exceed the thresholds for *Key Patch* for this species f.e. more then 10 times. Such patches should be considered as several key patches. However from the point of view of spreading risks one large patch is often less viable then the sum of several smaller ones. In this application we used the same rule for calculating the number of key patches (Figure 7; species with area requirements ≤ 500 ha). This rule was also used for species with area requirements > 500 ha.

4.2.5 Technical aspects of application

The application used three components of LARCH; VVeg2VHabitat 4.5.0.0, PopulationEvaluation 4.5.0.2. and ClustDist 4.5.0.1. The evaluation of key patches and the evaluation of the viability on a national scale have been done with an Access database.

4.2.6 Difference in results between applications

The application showed that for 96% of the 24 species, that might show an effect of infrastructure[14], had less key patches then when infrastructure would not have been taken into account. One species had as many key patches with and without infrastructure. On average the species had 10 percent less key patches. For 3 species (13%) the effect of infrastructure decreased the viability on a national scale.

The application showed that for 40% of all species, that might show an effect of ecological networks[15], had less viable key patches then when all key patches would have been taken into account. These species are mainly evertebrates, amphibians, fish, reptiles and small mammals. On average all species have 6% less (viable) key patches. This is mainly caused by barrier sensitive species. They have on average 18% less (viable) key patches as non barrier sensitive species have on average 1% less (viable) key patches. For 2 species (2%) there is a decrease in the viability on a national scale.

[14] Four species are left out because they have none key patches when the effect of infrastructure is not taken into account. For these species it is impossible to expect a difference in results.
[15] Nine species are left out because they have none key patches at all. For these species it is impossible to expect a difference in results.

5 Model development process

5.1 Calibration

For most species adequate knowledge on the habitat preferences are available. Often local knowledge is used to improve the parameter settings for specific applications of LARCH. During calibration the result of LARCH (f.e. Figure 4b) can be compared with distribution data for a species to check whether the spatial patterns are comparable. Also the total number of individuals LARCH predicts can be compared with estimations of the number of individuals in the study area. If wanted, LARCH can distinguish between individuals in viable ecological networks and non viable ecological networks.

When the numbers in the study area don't match carrying capacity (Density Factor; Chapter 3.3) can be corrected:

Carrying capacity vegetation cover type after calibration =
*A/B * carrying capacity per vegetation cover type before calibration*
A is numbers based on a preliminary LARCH run
B is numbers based on field data

See also chapter 5.2.2 and 5.3 in Pouwels *et al.* (2005) for calibration of a specific LARCH application.

In some cases parameters can be adjusted in consultation with local experts. An example is the Network Distance (Chapter 3.3) for the Dormouse for a study in Cheshire (Van Rooij *et al.* 2003). The network distance for this species was determined for the Dutch landscape. In Cheshire however, the landscape contained much more small landscape elements, which facilitates dispersion for the Dormouse. Therefore, in this study a larger network distance was used for this species.

For many species good data on spatial traits are not available. Therefore, most species are simplified by using the ecoprofile approach (Chapter 2.2.3). For area requirements species are classified in species groups based on their life history traits (long-lived versus short-lived and sensitive versus non-sensitive for environmental fluctuations). For these species groups Verboom *et al.* (2001) determined the area requirements for viable ecological networks. Species can only switch between these species groups. For dispersal distance often expert judgment is used. Often data from comparable species are used (f.e. the dispersal distance for Little Spotted Woodpecker is directly copied from available knowledge on Middle Spotted Woodpecker). In some cases these spatial traits are calibrated when the overall result of the landscape is underestimating or overestimating the viability of the species in the current situation. An example of such a calibration is the difference for area requirements described in chapter (Table 11; Chapter 4.1.2).

5.2 Sensitivity analysis

Sensitivity and uncertainty are important criteria for the credibility of a model. Three sensitivity analyses on the complete model have been carried out. One focused on the LARCH 2.0 (Houweling *et al.* 1999) and two focused on ecological model frameworks where LARCH 2.0

was included (Van der Lee *et al.* 2000 and Wamelink *et al.* 2005). All studies have resulted in Dutch reports. At this moment no uncertainty analysis has been carried out.

In the sensitivity analyses the species Beaver, Root Vole, Sedge Warbler and Little Tern were selected because of differences in parameters for dispersal capacity and area requirements (Houweling *et al.* 1999). In Table 14 the sensitivity of the parameters is given. The analysis showed that *Density Factor* and the value for K*ey Patch* are the most sensitive parameters.

Table 14. Main results from sensitivity analysis of LARCH 2.0 (Houweling et al. 1999). Mean is taken over all analysis and is the mean of the sum of the viability of all ecological networks. 'vc' is the variation coefficient in percentages.

	Total viability of all networks			
	Beaver	**Little tern**	**Root vole**	**Sedge warbler**
mean	2	1.9	51	.58
vc	92%	87%	66%	141%
Local population Distance	0%	0%	0%	0%
Network distance	0%	0%	0%	0%
Density Factor	58%	43%	43%	18%
Key Patch	2%	28%	25%	30%
NW - KP (factor)	0%	0%	0%	0%
NW + KP (factor)	0%	0%	0%	2%
MVP (factor)	4%	9%	11%	0%

The sensitivity analysis for the ecological model frameworks showed that aspects that affect habitat suitability and thus carrying capacity (Density Factor) are most sensitive (Duel *et al.* 2000, Van der Lee *et al.* 2000 and Wamelink *et al.* 2005). This can be due to changes in vegetation because of dynamics (Van der Lee *et al.* 2000) or succession (Wamelink *et al.* 2005).

Compared to the version of LARCH used for the sensitivity analyses no changes in methods have been implemented in current version of two components of LARCH; Weg2Vhabitat and ClustDist. Version numbers only have been changed because of some technical changes like new versions of C++ and changes in addressing the components. The only component that has been changed since LARCH 2.0 is PopulationEvaluation. The component has been adjusted for multiple barrier compartments (Pouwels *et al.* 2007) and for the pilot where quality in patches is used for determining ecological networks (Pouwels *et al.* in prep). The latter method will only be addressed in the pilot and not in other applications of LARCH. Because the new version of the component acts as expected in simple tests, it is to be expected that the results of the sensitivity analysis from 1999 are still valid for the current version of LARCH.

For the application 'spatial conditions NEN' (Reijnen *et al.* 2006) two simple sensitivity analyses were conducted. The ratio of the assigned number of key patches to a large patch and the relative area of that patch (steepness of the line in Figure 17) was changed (Figure 19) and thresholds for viability on a national scale (Table 12) were changed. These steps effect the viability by the number of key patches or the required number of key patches. Changing the ratio had an impact on 6% of the species when 0.5 of the standard value was used and 16% of the species when 1.5 of the standard value was used. When values were more stringent less species were viable, as expected. However these changes had a large effect on the size of the different viability classes (Table 15). However the overall results did not change much. Increasing or decreasing the values of key patches for all species at the same time would have resulted in the same viability.

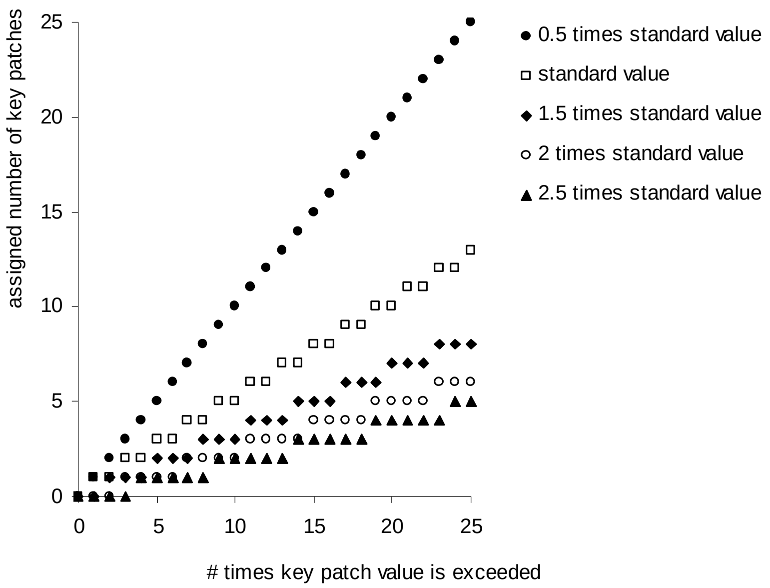


Figure 19 Changes in steepness of calculation of number of key patches for simple sensitivity analysis.

Table 15a Sensitivity (normalized; dS/S / dR/R) of the spread S of species over the classes not viable, possible viable and viable for the steepness R of the lines in Figure 19.

dS/S / dR/R	-50%	default value	+50%	+100%	+150%
not viable	0.05	-	0.16	0.24	0.18
possible viable	0.76	-	1.30	0.68	0.50
viable	-0.16	-	-0.28	-0.17	-0.12

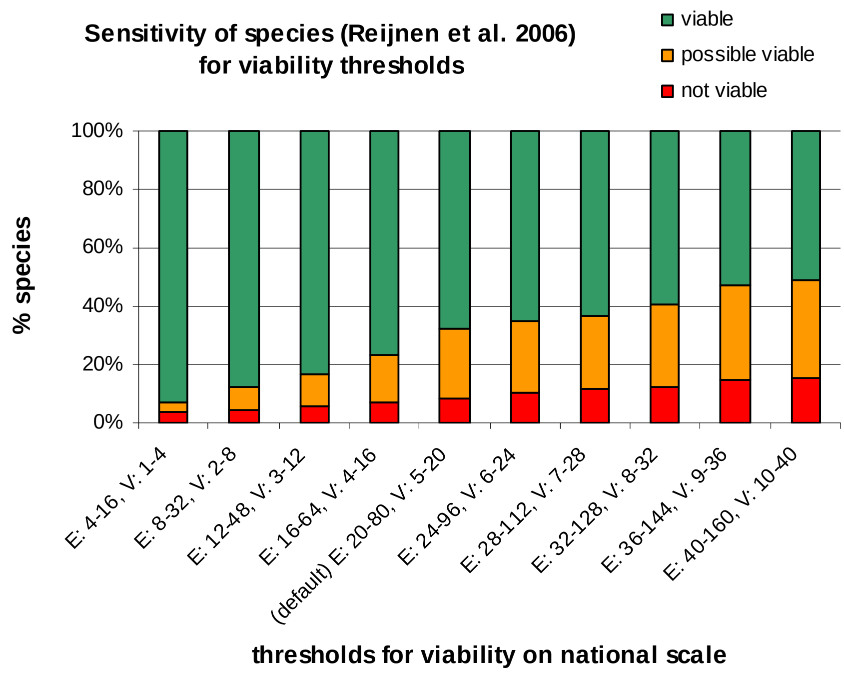
Table 15b Relative change (dS/S) of the spread S of species in the classes not viable, possible viable and viable for viability threshold T on national scale for species from Reijnen et al. (2006) and for species from Pouwels et al. (2007). '-80%' is 'E: 4-16, V: 1-4', '-60%' is 'E:8-32, V:2-8' in Figure 20 and so on.

		-80%	-60%	-40%	-20%	default	+20%	+40%	+60%	+80%	+100%
Reijnen et al. 2006	not viable	-0.53	-0.44	-0.29	-0.15	0.00	0.24	0.38	0.44	0.76	0.82
	possible viable	-0.87	-0.69	-0.54	-0.35	0.00	0.01	0.03	0.19	0.34	0.39
	viable	0.38	0.30	0.23	0.14	0.00	-0.03	-0.06	-0.12	-0.22	-0.24
Pouwels et al. 2007	not viable	-0.35	-0.29	-0.18	0.00	0.00	0.12	0.18	0.18	0.29	0.35
	possible viable	-0.75	-0.67	-0.54	-0.50	0.00	0.13	0.21	0.21	0.21	0.29
	viable	0.49	0.43	0.33	0.24	0.00	-0.10	-0.16	-0.16	-0.20	-0.27

Table 15c Sensitivity (normalized; dS/S / dT/T) of the spread S of species in the classes not viable, possible viable and viable for viability threshold T on national scale for species from Reijnen et al. (2006) and for species from Pouwels et al. (2007). '-80%' is 'E: 4-16, V: 1-4', '-60%' is 'E:8-32, V:2-8' in Figure 20 and so on.

		-80%	-60%	-40%	-20%	default	+20%	+40%	+60%	+80%	+100%
Reijnen et al. 2006	not viable	0.66	0.74	0.74	0.74	-	1.18	0.96	0.74	0.96	0.82
	possible viable	1.08	1.16	1.35	1.73	-	0.05	0.08	0.32	0.42	0.39
	viable	-0.47	-0.50	-0.57	-0.71	-	-0.16	-0.15	-0.21	-0.27	-0.24
Pouwels et al. 2007	not viable	0.44	0.49	0.44	0.00	-	0.59	0.44	0.29	0.37	0.35
	possible viable	0.94	1.11	1.35	2.50	-	0.63	0.52	0.35	0.26	0.29
	viable	-0.61	-0.71	-0.82	-1.22	-	-0.51	-0.41	-0.27	-0.26	-0.27

Changing the thresholds has also an a large effect on the percentage of species in the classes not viable, possible viable and viable compared to the standard values. The end results are more sensitive to lower thresholds then to higher thresholds (Figure 20).



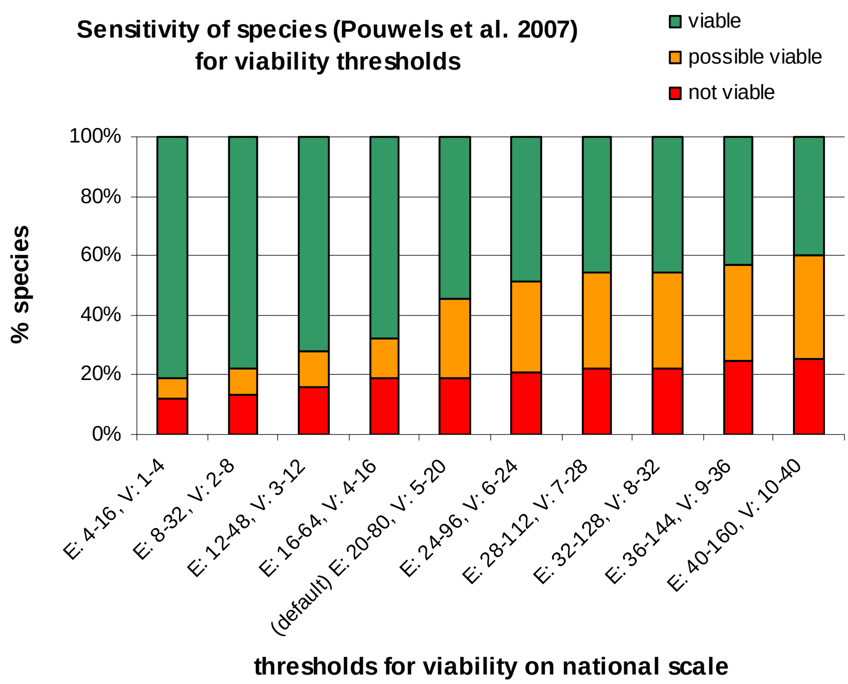


Figure 20. Sensitivity for viability threshold on national scale for Reijnen et al. (2006) and Pouwels et al. (2007). Threshold for evertabrates (E) and vertebrates (V) are given. Below the lowest value a species will not be viable, between the values a species will possible be viable and above the highest value a species will be viable.

Because it was expected that the end result (viability on a national scale) is sensitive to the used thresholds we use the third intermediate class of 'possible viable' (see also 4.1.3). According to Table 3 the end results are sensitive to the parameters density factor and key patch. For other parameters used in LARCH we expect that the sensitivity on the end result is not high. However, to be sure a complete sensitivity analysis should be conducted.

5.3 Validation

Validation of LARCH results is difficult. Testing a predicted viable ecological network (defined as the metapopulation with an extinction probability of 5% in 100 years) would mean waiting 100 years with, say, 100 independent replicas. Also time series on occurrence of species are not long enough and landscapes have changed too much to compare distribution patterns from the past with current distribution patterns. A regression study an ecosystem level was conducted. For species that are representative of the ecosystem the model results of LARCH were compared to the actual number of species present in the ecosystems. The study showed that the aggregated results of LARCH are an important predictor for the number of species that are actually present. For 11 out of 13 ecosystems an increase in the LARCH result resulted in an increase of species (Van der Hoek *et al.* in prep.).

All results of the application 'spatial conditions NEN' were validated by two experts by visually comparing LARCH results (see Figure 21 for example of Short-eared Owl) of each species with available distribution data and the species autoecology[16]. The validation was done on two criteria: habitat pattern and key patch pattern. The validation resulted in a good overview of the quality of each species model (Appendix 5). Of all 406 species 24 species could not be validated because no data was available (Table 16). This was mainly because the species is not present in the Netherlands. Half of the species were evaluated as 'good' or 'very good'. 20 Species were evaluated as 'bad'. Most species that were evaluated 'moderate' are species of aquatic ecosystems (Appendix 5). The input map doesn't differentiate a lot of aquatic ecosystems. Improving these species depend on better input maps.

Based on the validation an overview is made of the improvements that should be made for the next applications (Table 17) improvements that should be made after the input map have been improved for aquatic ecosystems (Table 18) and improvements that should be considered when new quality related projects are set up (Table 19). Of course the results of all species should be evaluated in projects that make changes in (habitat) parameters.

[16] Kleukers *et al.* 1997, Gittenberger *et al.* 2004, Nederlandse Vereniging voor Libellenstudies 2002, SOVON Vogelonderzoek Nederland 2002, Peters *et al.* 2004, Bos *et al.* 2006, RAVON 2006, Janssen & Schaminée 2004, La Haye *et al.* 2006, www.anemoon.org; www.naturalis.nl; www.vleermuis.net; www.waarneming.nl; www.vzz.nl; www.wikipedia.nl en www.milieuennatuurcompendium.nl

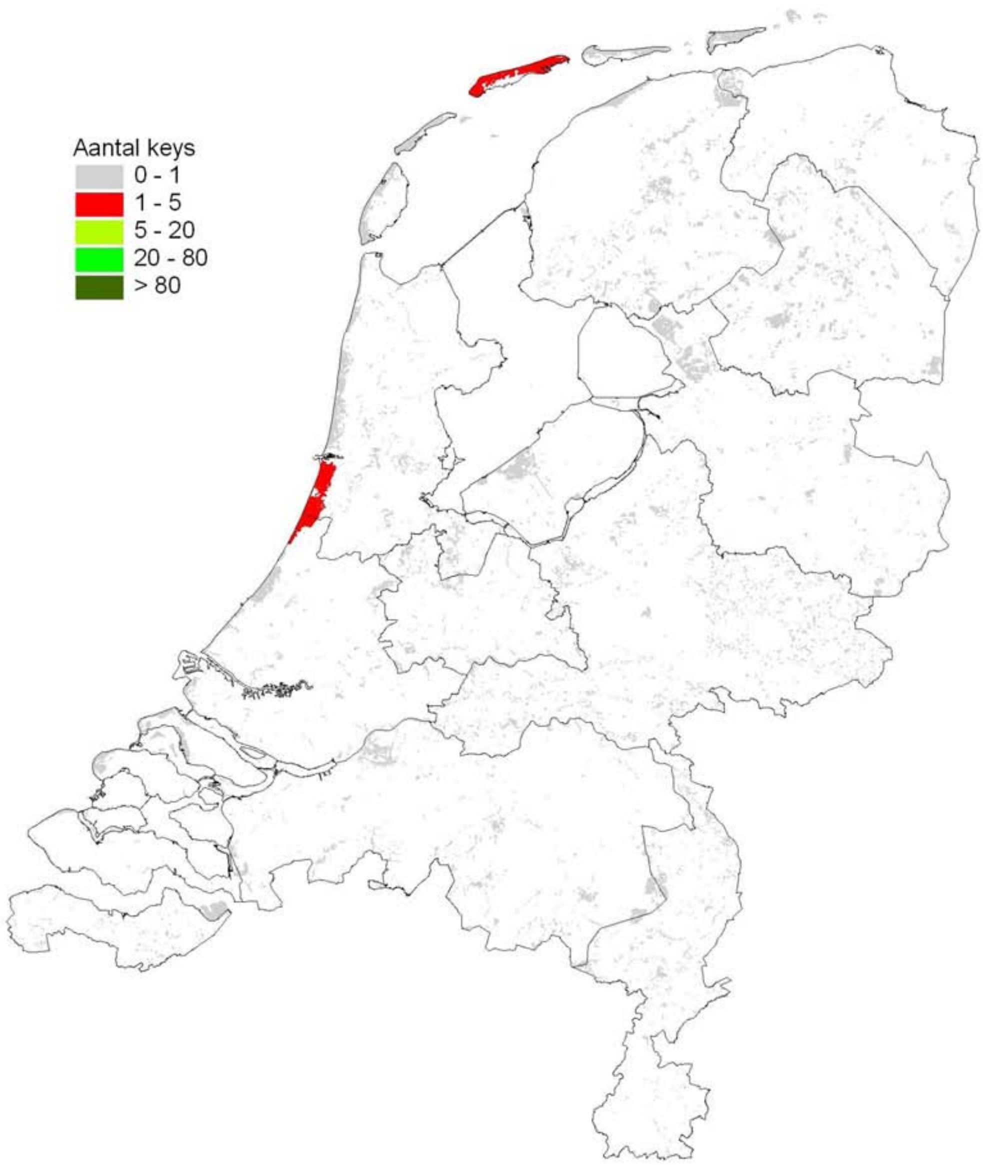


Figure 21. Result of LACRH for Short-eared Owl that was compared with actual distribution data from SOVON (2001). Black Grouse was one of the species that was evaluated as 'very good' for both criteria.

Table 16. Result of validation of species from Reijnen et al. (2006). A '-' means the experts were not able to judge the output of LARCH, mostly because of missing distribution data.

		key patch pattern				
		-	bad	moderate	good	very good
habitat pattern	-	24				
	bad		16			
	moderate		3	31		
	good	10	1	112	156	8
	very good				6	39

Table 17. Species that need adjustments before LARCH is used in new applications. The first column contain 24 species that were judged '-' (Table 16). Together with species experts the species should be removed or habitat parameters should be adjusted. The second column contain species that were judged 'bad' for habitat pattern and/or key patch pattern. Species in the third column contain species we the Key Patch parameter should be adjusted.

Remove species from model / Adjust habitat parameters	Adjust habitat parameters	Adjust Key Patch parameter
Bandheidelibel	Boomkikker	Glanzende gastmier
Britse putter	Bramesprinkhaan	Otter
Donker pimpernelblauwtje	Grasmus	Woekermier
Dwergjuffer	Grote stern	
Engelse kleine mantelmeeuw	Grutto	
Europese treksprinkhaan	Heikikker	
Grote koornaarvis	Klapekster	
Hulstblad	Kleine barmsijs	
Klappersprinkhaan	Kneu	
Koninginnenpage	Kwartelkoning	
Kroeskarper	Patrijs	
Kwabaal	Plasrombout	
Locomotiefje	Putter	
Pimpernelblauwtje	Ruige dwergvleermuis	
Purperstreepparelmoervlinder	Speerwaterjuffer	
Roodkopklauwier	Spiering	
Serpeling	Steenuil	
Sikkelsprinkhaan	Torenvalk	
Tijmblauwtje	Veenbesblauwtje	
Veldspitsmuis	Zwartkopmeeuw	
Vetje		
Weidesprinkhaan		
Zilverstreephooibeestje		
Zilvervlek		

Table 18. Species that need adjustments after input map has been improved for aquatic ecosystems. Species in left column should be modeled with aquatic models.

Species for aquatic models	Adjust after new input file (aquatic ecosystems)
bloedzuiger	Alpenwatersalamander
haft	Grote gele kwikstaart
kever	IJsvogel
kokerjuffer	Kleine mantelmeeuw
kokerjuffer	Oeverzwaluw
libel	Pijlstaart
platworm	Poelkikker
spin	Rietzanger
steenvlieg	Waterspitsmuis
tweekleppige	Zwarte stern
vis	Bruine winterjuffer
	Gestreepte waterroofkever

Table 19 Species were habitat parameters might be adjusted in future projects. Species in the first column are judges 'moderate' and 'moderate' in Table 16. Species in the second column are judges 'moderate' for Key Patch pattern only in Table 16.

Priority 1	Priority 2
Beekoeverlibel	Adder
Beekrombout	Bdellocephala punctata
Bever	Bont dikkopje
Bosdoorntje	Bruine winterjuffer
Dodaars	Damhert
Dwergstern	Elrits
Eider	Europese kanarie
Fint	Gentiaanblauwtje
Gevlekte glanslibel	Gestippelde alver
Grauwe gors	Gladde slang
Grauwe kiekendief	Glanzende gastmier
Grote gerande oeverspin	Grauwe klauwier
Hop	Groene specht
Knoflookpad	Grote gele kwikstaart
Kopvoorn	Grote karekiet
Moerassprinkhaan	Grote vos
Poelkikker	Iepenpage
Ringslang	Kluut
Rivierdonderpad	Krooneend
Rosse vleermuis	Kwak
Rugstreeppad	Lepelaar
Sleedoornpage	Medicinale bloedzuiger
Sneep	Oeverzwaluw
Strandplevier	Planaria torva
Veenmol	Rode wouw
Veldleeuwerik	Spiegeldikkopje
Veldparelmoervlinder	Woekermier
Visdief	Woudaap
Winde	Zilveren maan
Zwarte grondel	Zompsprinkhaan
Zwarte stern	

6 Management

LARCH has been developed by the Landscape Centre at Alterra. It's a joint product of the team 'Ecological Modeling and Monitoring', the team 'Ecological Networks' and the team 'Crossing Borders' (prof.dr. P.F.M. Opdam, dr. J. Verboom, dr. C.C. Vos, dr. M.J.S.M. Reijnen, drs. R. Pouwels, ing. R. Jochem, ir. I.M. Bouwma, dr. E.G. Steingröver and ir. E.A. van der Grift). At this moment Harold Kuipers and Jana Verboom are coordinating the use and the development of LARCH. Harold Kuipers mostly deals with technical aspects, data management and the use of LARCH by other organizations and institutes. Jana Verboom mostly coordinates the development and use of LARCH for research.

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6.1 Maintenance and management

Management and maintenance of LARCH is not structurally imbedded in projects. Every project that uses LARCH contributes to the maintenance. In 2006 and 2007 the following projects contributed to the maintenance of LARCH: 'LARCH status A' (5231675), 'kwaliteit Landschap' (5231074), 'aanpassing LARCH' (5231721), 'ex-ante VHR' (5230009.30.03), 'MJPO Bulgarije' (232309.01.01), 'condities EHS milieu fauna' (5233512), 'condities EHS' (5233033).

There should be a yearly reoccurring LARCH-project that takes care of the maintenance and support. An estimation of the required time is:

Jana Verboom: 5 days management
Harold Kuipers: 5 days maintenance input and output tools (connection to Arcview)
Rogier Pouwels: 3 days
René Jochem: 5 days technical maintenance
Marjolein van Adrichem: 10 days database maintenance and technical maintenance

In 2008 the Landscape Centre, Alterra, has set aside 10.0 k€ for maintenance and management of LARCH. This covers 2/3 of the estimated time. In this project a new business plan for LARCH will be written with specific attention for structural maintenance and management. Furthermore a meeting with Alterra users will be organized to clarify which applications of LARCH have granted Status A and implications for using LARCH. Finally an extra check on the parameters in the database will be carried out. First data from the projects 'condities EHS milieu fauna' (5233512), 'condities EHS' (5233033), 'ex-ante VHR' (5230009.30.03) and incorporating more environmental factors for plant species (5235087) will be gathered and the most recently used parameters for a species will be stored in the database. The extra check have to result in an up-to-date database for all species used for MNP.

6.2 Developments

A strategic plan for the use of LARCH by MNP and more detailed information on new methods are described in Verboom *et al.* (2006) and Pouwels *et al.* (in prep).

6.2.1 Current developments

At this moment development of LARCH is imbedded in specific projects. In 2005, 2006 and 2007 the main developments were incorporated in several projects: using quality in patches for determining ecological networks (5231721.01), using LARCH for the monitoring and ex-ante studies of the Dutch NEN (paragraph 4.1; 5232728.01), adding species of Habitat and Bird Directive to database (paragraph 4.2; 5230009.30.03), incorporating more environmental factors (5233512), adding plants species to LARCH (5232728.01).

6.2.2 Future developments

For the long term future of LARCH there are two major developments: the use by MNP and research programs on climate change. The following developments are planned in the short term and in the long term:

- shifting ecological networks (climate change) (several underpinning studies)
- incorporating more environmental factors for plant species (5235087)
- comparing actual key patches with potential key patches (5235024)
- writing business plan (2008; Landscape Centre)
- sensitivity and / or uncertainty analysis (planned for 2009)
- standardizing aggregation of species (not planned)

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Appendix 1 Checklist for Status A models [In Dutch]

Theorie
A 1 Is de theoretische onderbouwing van het model omschreven?
A 2 Is het doel waarvoor het model is ontworpen beschreven?
A 3 Is het toepassingsgebied van het model beschreven?
A 4 Zijn de vereenvoudigingen en aannamen over de gebruikte representatie van de werkelijkheid gemotiveerd en beschreven?

Technische documentatie
A 5 Is er een document met metainformatie van het model?
A 6 Is er een globale beschrijving van de werking van het computerprogramma?
A 7 Zijn alle modelparameters beschreven?
A 8 Is alle invoer beschreven?
A 9 Is alle uitvoer beschreven?

Gebruikersdocumentatie
A 10 Is het toepassingsgebied van het model beschreven en zijn er voorbeelden van uitgevoerde modelstudies gegeven?
A 11 Is het benodigde kennisniveau van de gebruiker van het model beschreven?
A 12ijn de beperkingen van het computerprogramma beschreven?
A 13 Is het user interface beschreven?
A 14 Is de invoer beschreven?
A 15 Is de uitvoer beschreven?
A 16 Is er een korte samenvatting van de validaties, de verificaties, het testen, de gevoeligheidsanalyses en de onzekerheidsanalyses van het computerprogramma?

Verificatie en testen software
A 17 Is er een set testgegevens waarmee de vertaling van de modelvergelijkingen naar de programmacode is geverifieerd?
A 18 Zijn de meest basale tests op het computerprogramma uitgevoerd?
A 19 Is het rekenhart geheel getest?
A 20 Zijn de testgegevens reproduceerbaar opgeslagen?
A 21 Zijn de uitgevoerde tests beschreven?

Kalibratie
A 22 Is het model voor een toepassing gekalibreerd?
A 23 Is de kalibratie beschreven?

Validatie
A 24 Zijn de uitgevoerde validaties beschreven?
A 25 Is in deze beschrijving opgenomen wat nog niet is gevalideerd?
A 26 Is er een kritische analyse van mogelijke tekortkomingen?

Gevoeligheidsanalyse
A 27 Zijn voor het toepassingsgebied van het model gevoeligheidsanalyses uitgevoerd?
A 28 Zijn deze gevoeligheidsanalyses beschreven?

Beheers- en exploitatieplan

A 29 Is er een beheersplan ?
A 30 Is het inhoudelijk beheer geregeld?
A 31 Is het technisch beheer geregeld?
A 32 Is de ondersteuning naar de gebruikers geregeld?
A 33 Zijn de uitgevoerde verbeteringen gerapporteerd?
A 34 Zijn de geplande verbeteringen voor het model beschreven?

Appendix 2 Landscape characteristics

From: Opdam *et al.* 2003

For a species to survive in a habitat network, two conditions have to be fulfilled: the dispersal stream across the landscape balances local extinction and recolonization rates, and the total network is large enough to minimize the chance that all local populations go extinct. The cohesion in the habitat network is the result of the dispersal stream across the landscape and the size of the local populations it links together. All local populations contribute to the dispersal stream, the larger ones more than the smaller ones. The dispersal stream augments with the density of (occupied) habitat in the landscape and the conductivity by landscape elements with relatively high survival chance in the matrix. The stronger the dispersal stream, the higher the proportion of occupied patches. Immigrants may prevent local populations to go extinct and larger and better habitat patches allow bigger and more persistent populations, causing a stronger and more continuous dispersal stream. Network cohesion encompasses the following four landscape components (figure A.1).

Habitat quality is directly related, through population density, to carrying capacity of the patches, to the growth rate of the local populations and consequently, to extinction rate and the intensity of the dispersal stream across the landscape. Below a certain quality level, the population in a patch will go through a process of deterministic extinction (mortality exceeds birth rate), unless it receives enough immigrants from other patches in the landscape.

Amount of habitat in the network. The amount of habitat area has two components: density of the network (amount of habitat per km^2) and the size of the network (km^2 landscape area over which the network extents). Habitat density is directly related to the size and density of local populations, and consequently to the local extinction rate and the dispersal stream across the landscape. Also, a higher patch density implies shorter average distances between patches, and generates a higher dispersal success.

Spatial distribution of habitat (combining patch size, shape and configuration). Patch perimeter/area ratio (and patch shape in general) may affect the extinction rate and the proportion of individuals leaving the habitat, whereas configuration affects dispersal success. Since larger patches have smaller extinction rates and a smaller proportion of edge area where habitat quality may be lower, their contribution to the dispersal stream is relatively great.

Matrix permeability affects the costs of dispersal, and hence dispersal success. Barriers and corridors, types of boundaries and their arrangement in space all influence dispersal success, and consequently the colonization rate of patches and the support of small local populations. These features all affect local population processes and dispersal, and thereby local extinction and recolonization (figure A.1).

Clearly, the components of habitat network cohesion are species specific. Species perceive landscapes at different scales, live in different ecosystem types and, while dispersing, have different preferences for or are differently affected by elements of the landscape matrix. So, a particular ecosystem network may be functionally totally different to species with diverging perceptions of scale, distance or barriers.

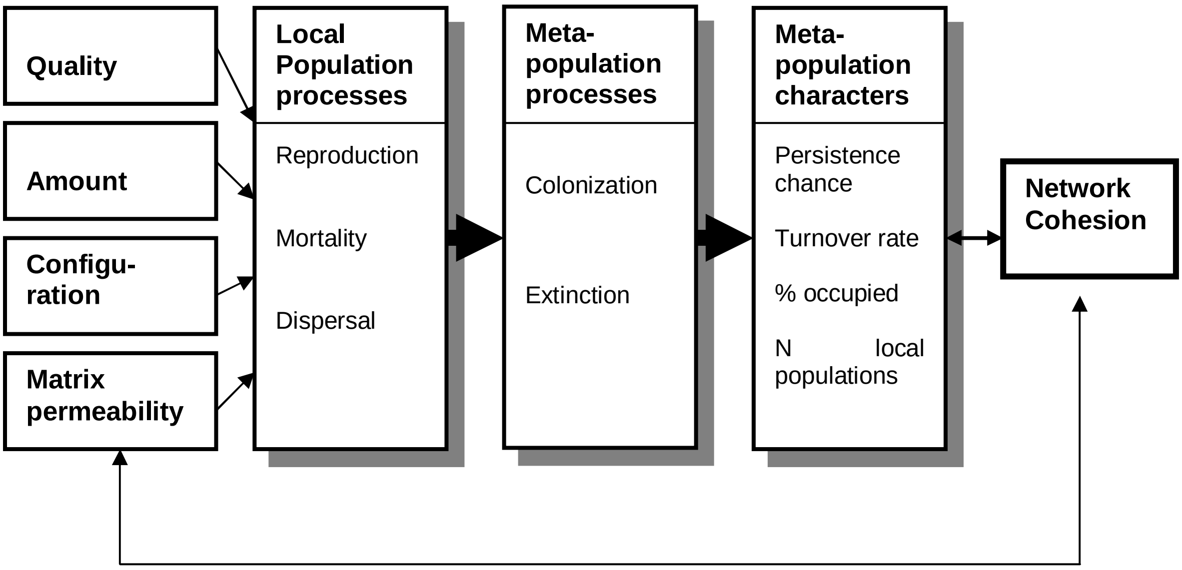

Figure A.1. The functional relationship between the four components of habitat networks (four blocks left) and the concept of network cohesion proceeds; via local population processes (left column), metapopulation processes (middle column) and metapopulation characteristics (right column). The aim of network cohesion assessment is to infer habitat network cohesion directly from the four network components.

Appendix 3 Mathematical model of LARCH

LARCH determines if a landscape is sustainable for a given species. Thereby it simplifies all population dynamical processes and metapopulation processes and only uses simple queries, simple algorithms like summing, multiplying, Booleans and simple statistics and a GIS-algorithm to determine distance between polygons.

The first step of LARCH is a query of the input map in which LARCH selects the landscape patches that are suitable as habitat for a chosen species. In this chapter each polygon in the shape-file is considered as a single patch. The input map should contain the fields Poly_ID, PolyArea, VegCode and if used PolyQual[17] (see also 3.5.1). All polygons containing vegetation types suitable for the species are selected. The vegetation codes in the shape-file should correspond with the codes in the database. Only the shapes there are suitable as habitat are saved as a new shape-file; the habitat map. Also the number of reproductive units for each polygon is calculated. This is done by a simple multiplication of the area and the potential density of the species in this specific vegetation type (see also formula in paragraph 3.5.1). This potential density is stored in the database. The value is added to the new habitat shape-file in the field PolyRU.

In the second step LARCH determines which patches are considered as one population. Therefore LARCH determines the shortest distance between all patches (even if they contain less then 1 reproductive unit) and compares this distance with the "Local population Distance" in the database. If the distance between patches is equal or smaller then the "Local population Distance" the patches are considered as one population and the ID in the field Local_ID will be given the same value. The field Local_ID is added to the shape-file.

In the third step LARCH generates a new dbf-file (…lp.dbf; see also 3.7.1) that can be linked to the habitat shape-file. The first field in this file is the field Local_ID. Based on the dbf file of the habitat shape-file LARCH makes some statistics. The reproductive units of all patches within the same local population are summed and this sum is added to the dbf-file in the field LocRU. Also the areas of all patches within the same local population are summed and added to the dbf-file in the field LocArea. The value in the field LocRU is compared with the "Key Patch" in the database. If the value in the field LocRU is equal or greater then the "Key Patch" the local population is considered to be a key patch. LARCH will return the value '2' in the field LocClass. If the value in the field is smaller then one LARCH will return the value '0' in the field LocClass. If the value is equal or greater then one but smaller then "Key Patch" LARCH will return the value '1' in the field LocClass. In the current applications the value for "MVP factor" is set to infinity so LARCH will not distinguish this type.

In the fourth step LARCH determines which patches are considered as one metapopulation (or ecological network). Therefore LARCH determines the shortest distance between all patches that contain more than 1 reproductive unit in the field LocRU (LocClass $\neq$ 0) and compares this distance with the "Network Distance" in the database. If the distance between patches is equal or smaller then the "Network Distance" the patches are considered as one ecological network and the ID in the field Network_ID of the shape-file will be given the same value. All

[17] If the species selected is barrier sensitive the barrier compartment map is integrated in the input map or in between step 1 and step 2. This is done by using GIS-software like ArcView or ArcInfo (see also 4.3.2).

patches with the same Local_ID of the two patches within the network distance are given the same value in the field Network_ID also.

In the fifth step LARCH generates a new dbf-file (…np.dbf; see also 3.7.2) that can be linked to the shape-file. The first field in this file is the field Network_ID. Based on the dbf-file (…lp.dbf) LARCH makes some statistics. The reproductive units of all patches within the same ecological network are summed and this sum is added to the dbf-file in the field NetworkRU. Also the areas of all patches within the same ecological network are summed and added to the dbf-file in the field NetArea. The total number of local populations is determined and added to the field nLocalPop. The number of local populations with LocClass 1, LocClass 2 and LocClass 3 is determined and added to the fields nLocP_c1, nLocP_c2 and nLocP_c3 respectively. Furthermore the maximum value of LocClass is determined for each ecological network and added to the field MaxClass. Also the reproductive units in local populations with LocClass 1, LocClass 2 and LocClass 3 is summed and added to the fields nRU_c1, nRU_c2 and nRU_c3 respectively.

In the sixth step LARCH determines if the ecological networks are viable. It uses the fields MaxClass and NetworkRU. Depending on the value in the field MaxClass LARCH compares the value in NetworkRU with the value of "NW-KP factor" (MaxClass =1), "NW+KP factor" (MaxClass =2) or "NW+MVP factor" (MaxClass =3). If the value in NetworkRU is equal or greater then this value the Boolean 'True' is returned in the field IsViable_b. If the value in NetworkRU is smaller the Boolean 'False' is returned in the field IsViable_b. The value in the field Viab_RU_NW is determined by dividing the value of NetworkRU by the value "NW-KP factor" (MaxClass =1), "NW+KP factor" (MaxClass =2) or the value "NW+MVP factor" (MaxClass =3). In the current applications the value for "NW+MVP factor" is set to infinity so LARCH will not distinguish this type of ecological network.

Some of the fields LARCH generates are not used in the current applications, but are useful for checking the results or generating other type of results. The fields that are not used are: LocArea, nLocalPop, nLocP_c1, nLocP_c2, nLocP_c3, nRU_c1, nRU_c2, nRU_c3, NetArea and IsViable. For the determination if an ecological network is viable the field Viab_RU_NW is used mostly (see Table 8 in 3.7.2).

Appendix 4 Example ecological profiles

Ecological profiles were used in a quick scan analysis of nature areas in the Netherlands. For each ecosystem 3 profiles (Figure A2) where selected and the spatial conditions where evaluated. Figure A3 give the results for forest on sandy soils and Figure A4 give the results for heathlands. Areas that are sustainable for small ecological profiles, might not by sustainable for larger ecological profiles and visa versa. When biodiversity indices are determined the landscape has to be evaluated at different scales of area requirements and dispersal capacity.

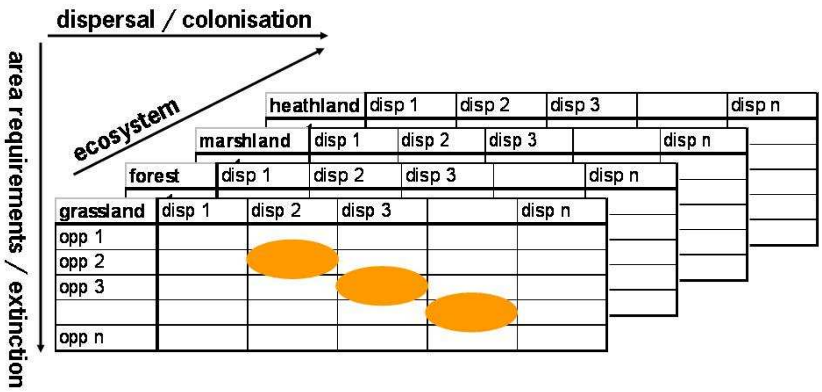

Figure A2 Selected ecological profiles.

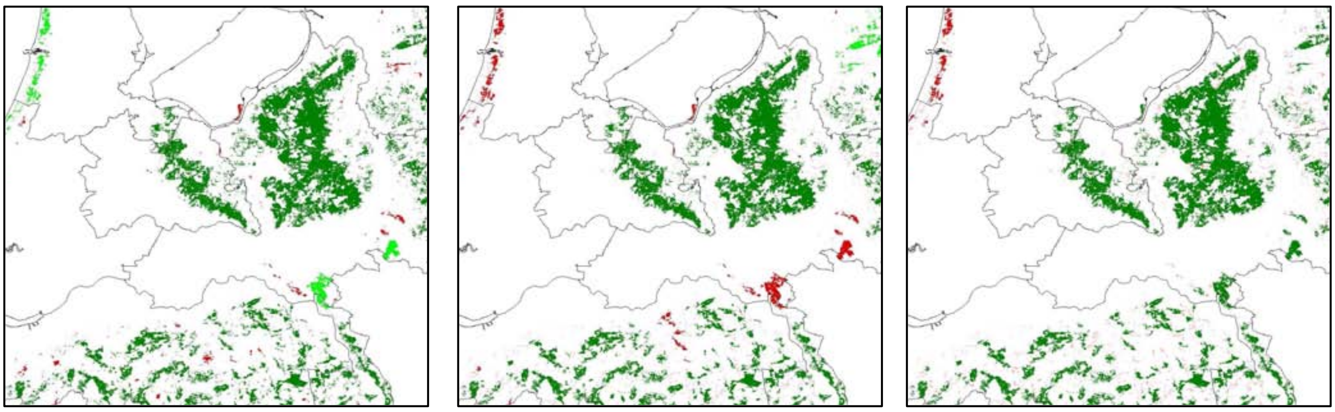

Figure A3 Spatial conditions for three ecological profiles in forests on sandy soils. Left figure is the result of the ecological profile with small area requirements and low dispersal capacity. Right figure is result of the ecological profile with large area requirements and high dispersal capacity. Dark green represents good spatial conditions, light green represents moderate spatial conditions and red represent bad spatial conditions.

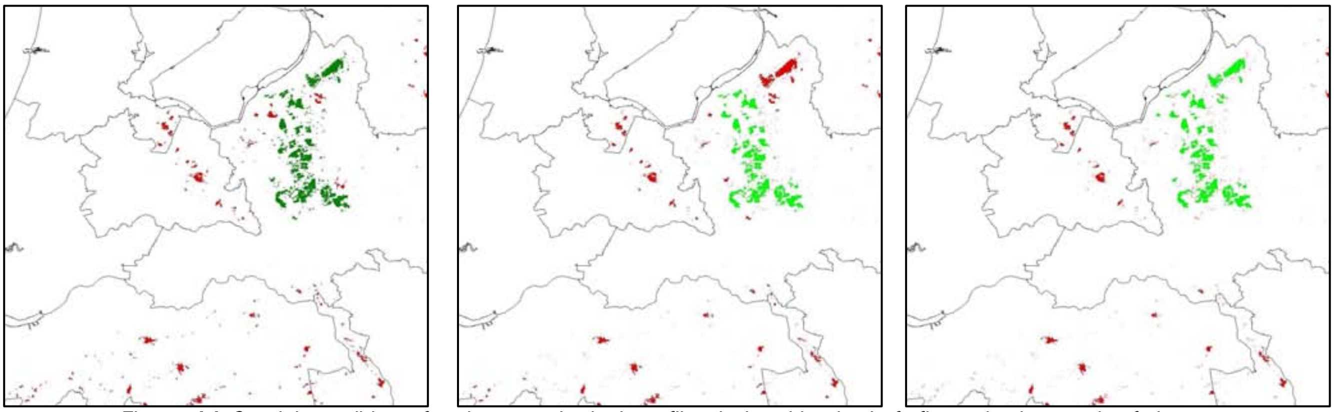

Figure A4 Spatial conditions for three ecological profiles in heathlands. Left figure is the result of the ecological profile with small area requirements and low dispersal capacity. Right figure is result of the ecological profile with large area requirements and high dispersal capacity. Dark green represents good spatial conditions, light green represents moderate spatial conditions and red represent bad spatial conditions.

Appendix 5 Overview validation species

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricited to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Alpenwatersalamander	amfibie	good	good					x								RAVON dec 2006
Boomkikker	amfibie	bad	bad						x							RAVON dec 2006 + Natuurcompendium
Geelbuikvuurpad	amfibie	very good	very good													RAVON dec 2006, Janssen
Heikikker	amfibie	bad	bad						x			x				RAVON dec 2006
Kamsalamander	amfibie	good	good		x											Janssen
Knoflookpad	amfibie	moderate	moderate				-									RAVON dec 2006
Poelkikker	amfibie	moderate	moderate					x								RAVON dec 2006
Rugstreeppad	amfibie	moderate	moderate						x							RAVON dec 2006
Vinpootsalamander	amfibie	good	good													RAVON dec 2006
Vroedmeesterpad	amfibie	good	good													RAVON dec 2006
Vuursalamander	amfibie	very good	very good													RAVON dec 2006
Medicinale bloedzuiger	bloedzuiger	good	moderate					x								internet (Naturalis)
Aardbeivlinder	dagvlinder	good	good													de dagvlinders van Nederland
Bont dikkopje	dagvlinder	good	moderate	x					x							de dagvlinders van Nederland
Bosparelmoervlinder	dagvlinder	good	good	x					x							de dagvlinders van Nederland
Bruin blauwtje	dagvlinder	good	good						x							de dagvlinders van Nederland
Bruin dikkopje	dagvlinder	good	good													de dagvlinders van Nederland
Bruine eikenpage	dagvlinder	very good	good						x							de dagvlinders van Nederland
Bruine vuurvlinder	dagvlinder	very good	very good	x												de dagvlinders van Nederland
Donker pimpernelblauwtje	dagvlinder	-	-	x			x									de dagvlinders van Nederland
Duinparelmoervlinder	dagvlinder	very good	very good						x							de dagvlinders van Nederland
Dwergblauwtje	dagvlinder	very good	very good													de dagvlinders van Nederland
Dwergdikkopje	dagvlinder	good	good													de dagvlinders van Nederland
Geelsprietdikkopje	dagvlinder	good	good													de dagvlinders van Nederland
Gentiaanblauwtje	dagvlinder	good	moderate						x							de dagvlinders van Nederland
Groot geaderd witje	dagvlinder	good	-													de dagvlinders van Nederland
Grote ijsvogelvlinder	dagvlinder	very good	very good													de dagvlinders van Nederland
Grote parelmoervlinder	dagvlinder	good	good													de dagvlinders van Nederland
Grote vos	dagvlinder	good	moderate						-							de dagvlinders van Nederland
Grote vuurvlinder	dagvlinder	very good	very good													de dagvlinders van Nederland
Grote weerschijnvlinder	dagvlinder	good	-													de dagvlinders van Nederland
Heideblauwtje	dagvlinder	very good	good						-							de dagvlinders van Nederland
Heivlinder	dagvlinder	very good	very good													de dagvlinders van Nederland
Iepenpage	dagvlinder	good	moderate				x									de dagvlinders van Nederland
Kalkgraslanddikkopje	dagvlinder	very good	very good	x												de dagvlinders van Nederland
Keizersmantel	dagvlinder	good	-													de dagvlinders van Nederland
Klaverblauwtje	dagvlinder	good	good													de dagvlinders van Nederland
Kleine heivlinder	dagvlinder	good	good													de dagvlinders van Nederland
Kleine ijsvogelvlinder	dagvlinder	good	good													de dagvlinders van Nederland
Kleine parelmoervlinder	dagvlinder	good	very good													de dagvlinders van Nederland
Kommavlinder	dagvlinder	very good	very good													de dagvlinders van Nederland
Koninginnenpage	dagvlinder	-	-													de dagvlinders van Nederland
Moerasparelmoervlinder	dagvlinder	good	good	x	x				x							de dagvlinders van Nederland
Pimpernelblauwtje	dagvlinder	-	-	x			x									de dagvlinders van Nederland
Purperstreepparelmoervlinder	dagvlinder	-	-	x			x									de dagvlinders van Nederland
Rode vuurvlinder	dagvlinder	good	-	x					x							de dagvlinders van Nederland
Rouwmantel	dagvlinder	good	good						x							de dagvlinders van Nederland
Sleedoornpage	dagvlinder	moderate	moderate				x									de dagvlinders van Nederland
Spiegeldikkopje	dagvlinder	good	moderate	x					x							de dagvlinders van Nederland
Tijmblauwtje	dagvlinder	-	-	x												de dagvlinders van Nederland
Tweekleurig hooibeestje	dagvlinder	good	good	x												de dagvlinders van Nederland
Vals heideblauwtje	dagvlinder	good	-	x												de dagvlinders van Nederland
Veenbesblauwtje	dagvlinder	bad	bad	x					x			x				de dagvlinders van Nederland
Veenbesparelmoervlinder	dagvlinder	very good	very good													de dagvlinders van Nederland
Veenhooibeestje	dagvlinder	very good	good	x												de dagvlinders van Nederland
Veldparelmoervlinder	dagvlinder	moderate	moderate	x					x			x				de dagvlinders van Nederland
Woudparelmoervlinder	dagvlinder	good	-	x												de dagvlinders van Nederland
Zilveren maan	dagvlinder	good	moderate						x							de dagvlinders van Nederland
Zilverstreephooibeestje	dagvlinder	-	-	x												de dagvlinders van Nederland
Zilvervlek	dagvlinder	-	-	x												de dagvlinders van Nederland

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricted to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Ametropus fragilis	haft	good	moderate				x	x	x							-
Baetis buceratus	haft	good	moderate				x	x	x							-
Baetis digitatus	haft	good	moderate				x	x	x							-
Baetis lutheri	haft	good	moderate				x	x	x							-
Baetis muticus	haft	good	good				x	x					x			-
Baetis niger	haft	good	moderate				x	x	x							-
Baetis tracheatus	haft	good	moderate				x	x	x							-
Brachycercus harrisella	haft	good	moderate				x	x	x							-
Caenis lactea	haft	good	moderate				x	x	x							-
Caenis rivulorum	haft	good	good				x	x					x			-
Centroptilum pennulatum	haft	good	moderate				x	x	x							-
Choroterpes picteti	haft	good	moderate				x	x	x							-
Ecdyonurus affinis	haft	good	moderate				x	x	x							-
Ecdyonurus dispar	haft	good	moderate				x	x	x							-
Ecdyonurus insignis	haft	good	moderate				x	x	x							-
Ecdyonurus lateralis	haft	good	good				x	x					x			-
Ecdyonurus torrentis	haft	good	good				x	x					x			-
Ecdyonurus venosus	haft	good	moderate				x	x	x							-
Ephemera glaucops	haft	good	moderate				x	x	x							-
Ephemera vulgata	haft	good	moderate				x	x	x							-
Habroleptoides modesta	haft	good	good				x	x					x			-
Habrophlebia lauta	haft	good	good				x	x					x			-
Heptagenia coerulans	haft	good	moderate				x	x	x							-
Heptagenia flava	haft	good	moderate				x	x	x							-
Heptagenia fuscogrisea	haft	good	moderate				x	x	x							-
Heptagenia longicauda	haft	good	moderate				x	x	x							-
Heptagenia sulphurea	haft	good	moderate				x	x	x							-
Isonychia ignota	haft	good	moderate				x	x	x							-
Leptophlebia marginata	haft	good	good				x	x					x			-
Metreletus balcanicus	haft	good	good				x	x					x			-
Oligoneuriella rhenana	haft	good	moderate				x	x	x							-
Palingenia longicauda	haft	good	moderate				x	x	x							-
Paraleptophlebia cincta	haft	good	good				x	x					x			-
Paraleptophlebia submarginata	haft	good	moderate				x	x	x							-
Potamanthus luteus	haft	good	moderate				x	x	x							-
Siphlonurus aestivalis	haft	good	moderate				x	x	x							-
Siphlonurus alternatus	haft	good	moderate				x	x	x							-
Siphlonurus armatus	haft	good	good				x	x					x			-
Siphlonurus lacustris	haft	good	moderate				x	x	x							-
Gestreepte waterroofkever	kever	good	good					x	x							Janssen, kansenkaarten
Vliegend hert	kever	good	good						-							Janssen + Natuurcompendium
Rivierkreeft	kreeftachtige	good	good					x					x			Natuurcompedium
Bandheidelibel	libel	-	-	x						?						de Nederlandse libellen
Beekoeverlibel	libel	moderate	moderate	?				x	x							de Nederlandse libellen
Beekrombout	libel	moderate	moderate		x				x							de Nederlandse libellen
Bosbeekjuffer	libel	good	good					x	-				x			de Nederlandse libellen
Bruine korenbout	libel	good	good					x								de Nederlandse libellen
Bruine winterjuffer	libel	good	moderate					x								de Nederlandse libellen
Donkere waterjuffer	libel	good	good	x			x	x								de Nederlandse libellen
Dwergjuffer	libel	-	-				x			x						de Nederlandse libellen
Gaffellibel	libel	good	good					x								de Nederlandse libellen
Gevlekte glanslibel	libel	moderate	moderate	x					x							de Nederlandse libellen
Gevlekte witsnuitlibel	libel	good	good						x							de Nederlandse libellen
Gewone bronlibel	libel	good	good					x					x			de Nederlandse libellen
Glassnijder	libel	good	good					x								de Nederlandse libellen
Groene glazenmaker	libel	good	good	x												de Nederlandse libellen
Hoogveenglanslibel	libel	good	good													de Nederlandse libellen
Kempense heidelibel	libel	good	-	x			x									de Nederlandse libellen
Koraaljuffer	libel	very good	very good													de Nederlandse libellen
Mercuurwaterjuffer	libel	good	good					x					x			de Nederlandse libellen
Noordse glazenmaker	libel	good	good	x												de Nederlandse libellen
Noordse winterjuffer	libel	good	good					x								de Nederlandse libellen
Oostelijke witsnuitlibel	libel	good	good	x												de Nederlandse libellen
Plasrombout	libel	bad	bad		x			x	x			x				de Nederlandse libellen
Rivierrombout	libel	good	good													de Nederlandse libellen
Sierlijke witsnuitlibel	libel	good	good	x												de Nederlandse libellen
Speerwaterjuffer	libel	bad	bad		?				x			x				de Nederlandse libellen
Tengere pantserjuffer	libel	good	good				x		x							de Nederlandse libellen
Venwitsnuitlibel	libel	good	good													de Nederlandse libellen
Vroege glazenmaker	libel	good	good													de Nederlandse libellen
Zuidelijke oeverlibel	libel	good	good	x												de Nederlandse libellen
Behaarde rode bosmier	mier	good	good						x							de wespen en mieren van Nederland
Glanzende gastmier	mier	good	moderate						x		?					de wespen en mieren van Nederland
Kale rode bosmier	mier	good	good						x							de wespen en mieren van Nederland
Woekermier	mier	good	moderate								x					de wespen en mieren van Nederland
Zwartrugbosmier	mier	very good	very good						x							de wespen en mieren van Nederland
Hulstblad	nachtvlinder	-	-				x									
Spaanse vlag	nachtvlinder	very good	very good													Janssen

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricited to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Adicella filicornis	kokerjuffer	good	good				x	x					x			-
Agapetus ochripes	kokerjuffer	good	good				x	x					x			-
Agrypnia obsoleta	kokerjuffer	good	moderate				x	x								-
Allogamus auricollis	kokerjuffer	good	good				x	x					x			-
Anabolia brevipennis	kokerjuffer	good	moderate				x	x								-
Annitella obscurata	kokerjuffer	good	good				x	x					x			-
Apatania fimbriata	kokerjuffer	good	good				x	x					x			-
Athripsodes albifrons	kokerjuffer	good	moderate				x	x								-
Brachycentrus subnubilus	kokerjuffer	good	moderate				x	x								-
Ceraclea alboguttata	kokerjuffer	good	moderate				x	x								-
Ceraclea dissimilis	kokerjuffer	good	moderate				x	x								-
Ceraclea nigronervosa	kokerjuffer	good	moderate				x	x								-
Drusus annulatus	kokerjuffer	good	good				x	x					x			-
Drusus trifidus	kokerjuffer	good	good				x	x					x			-
Ernodes articularis	kokerjuffer	good	good				x	x					x			-
Glossosoma conformis	kokerjuffer	good	good				x	x					x			-
Goera pilosa	kokerjuffer	good	good				x	x					x			-
Grammotaulius nigropunctatus	kokerjuffer	good	moderate				x	x								-
Grammotaulius nitidus	kokerjuffer	good	moderate				x	x								-
Grammotaulius submaculatus	kokerjuffer	good	good				x	x					x			-
Hagenella clathrata	kokerjuffer	good	moderate				x	x								-
Halesus tessellatus	kokerjuffer	good	good				x	x					x			-
Holocentropus insignis	kokerjuffer	good	moderate				x	x								-
Hydatophylax infumatus	kokerjuffer	good	good				x	x					x			-
Hydropsyche dinarica	kokerjuffer	good	good				x	x					x			-
Hydropsyche fulvipes	kokerjuffer	good	good				x	x					x			-
Hydropsyche instabilis	kokerjuffer	good	good				x	x					x			-
Hydropsyche modesta	kokerjuffer	good	moderate				x	x								-
Hydropsyche pellucidula	kokerjuffer	good	good				x	x					x			-
Hydroptila cornuta	kokerjuffer	good	moderate				x	x								-
Hydroptila dampfi	kokerjuffer	good	moderate				x	x								-
Hydroptila pulchricornis	kokerjuffer	good	moderate				x	x								-
Hydroptila sparsa	kokerjuffer	good	moderate				x	x								-
Hydroptila tineoides	kokerjuffer	good	moderate				x	x								-
Ithytrichia lamellaris	kokerjuffer	good	good				x	x					x			-
Lasiocephala basalis	kokerjuffer	good	good				x	x					x			-
Lepidostoma hirtum	kokerjuffer	good	good				x	x					x			-
Leptocerus interruptus	kokerjuffer	good	moderate				x	x								-
Leptocerus tineiformis	kokerjuffer	good	moderate				x	x								-
Limnephilus auricula	kokerjuffer	good	moderate				x	x								-
Limnephilus binotatus	kokerjuffer	good	moderate				x	x								-
Limnephilus bipunctatus	kokerjuffer	good	moderate				x	x								-
Limnephilus centralis	kokerjuffer	good	good				x	x					x			-
Limnephilus elegans	kokerjuffer	good	moderate				x	x								-
Limnephilus fuscicornis	kokerjuffer	good	moderate				x	x								-
Limnephilus griseus	kokerjuffer	good	moderate				x	x								-
Limnephilus ignavus	kokerjuffer	good	good				x	x					x			-
Limnephilus incisus	kokerjuffer	good	moderate				x	x								-
Limnephilus luridus	kokerjuffer	good	moderate				x	x								-
Limnephilus marmoratus	kokerjuffer	good	moderate				x	x								-
Limnephilus nigriceps	kokerjuffer	good	moderate				x	x								-
Limnephilus stigma	kokerjuffer	good	moderate				x	x								-
Limnephilus vittatus	kokerjuffer	good	moderate				x	x								-
Lithax obscurus	kokerjuffer	good	good				x	x					x			-
Lype phaeopa	kokerjuffer	good	moderate				x	x								-
Melampophylax mucoreus	kokerjuffer	good	good				x	x					x			-
Micrasemodes minimus	kokerjuffer	good	good				x	x					x			-
Molanna albicans	kokerjuffer	good	moderate				x	x								-
Neureclepsis bimaculata	kokerjuffer	good	moderate				x	x								-
Notidobia ciliaris	kokerjuffer	good	moderate				x	x								-
Odontocerum albicorne	kokerjuffer	good	good				x	x					x			-
Oecetis notata	kokerjuffer	good	moderate				x	x								-
Oligoplectrum maculatum	kokerjuffer	good	good				x	x					x			-
Oligostomis reticulata	kokerjuffer	good	good					?						x		-
Oxyethira falcata	kokerjuffer	good	good				x	x					x			-
Parachiona picicornis	kokerjuffer	good	good				x	x					x			-
Polycentropus flavomaculatus	kokerjuffer	good	moderate				x	x								-
Potamophylax luctuosus	kokerjuffer	good	good				x	x					x			-
Psychomyia pusilla	kokerjuffer	good	moderate				x	x								-
Ptilocolepus granulatus	kokerjuffer	good	good				x	x					x			-
Rhadicoleptus alpestris	kokerjuffer	good	good					?						x		-
Sericostoma flavicorne	kokerjuffer	good	good				x	x					x			-
Setodes argentipunctellus	kokerjuffer	good	good				x	x					x			-
Setodes punctatus	kokerjuffer	good	moderate				x	x								-
Setodes viridis	kokerjuffer	good	moderate				x	x								-
Silo piceus	kokerjuffer	good	good				x	x					x			-
Stenophylax permistus	kokerjuffer	good	good				x	x					x			-
Tinodes pallidulus	kokerjuffer	good	good				x	x					x			-
Tinodes unicolor	kokerjuffer	good	good				x	x					x			-
Triaenodes reuteri	kokerjuffer	good	good					?							x	-
Triaenodes simulans	kokerjuffer	good	moderate				x	x								-
Trichostegia minor	kokerjuffer	good	moderate				x	x								-
Wormaldia occipitalis	kokerjuffer	good	good				x	x					x			-
Wormaldia subnigra	kokerjuffer	good	good				x	x					x			-
Bdellocephala punctata	platworm	good	moderate				x	x								-
Crenobia alpina	platworm	good	good				x	x					x			-
Planaria torva	platworm	good	moderate				x	x								-
Polycelis felina	platworm	good	good				x	x					x			-

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricted to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Adder	reptiel	good	moderate				x									RAVON dec 2006
Gladde slang	reptiel	good	moderate						x							RAVON dec 2006
Hazelworm	reptiel	good	very good													RAVON dec 2006
Ringslang	reptiel	moderate	moderate													RAVON dec 2006
Zandhagedis	reptiel	very good	very good													RAVON dec 2006
Nauwe korfslak	slak	good	good						x							Janssen + Natuurcompendium
Zeggekorfslak	slak	good	good				?		x							Janssen + Natuurcompendium
Grote gerande oeverspin	spin	moderate	moderate					x								internet
Blauwvleugelsprinkhaan	sprinkhaan en krekel	very good	very good													de sprinkhanen en krekels van Nederland
Bosdoorntje	sprinkhaan en krekel	moderate	moderate	x					x							de sprinkhanen en krekels van Nederland
Boskrekel	sprinkhaan en krekel	good	good	x			x									de sprinkhanen en krekels van Nederland
Bramesprinkhaan	sprinkhaan en krekel	bad	bad						x			x				de sprinkhanen en krekels van Nederland
Duinsabelsprinkhaan	sprinkhaan en krekel	very good	very good													de sprinkhanen en krekels van Nederland
Europese treksprinkhaan	sprinkhaan en krekel	-	-				x			x						de sprinkhanen en krekels van Nederland
Gouden sprinkhaan	sprinkhaan en krekel	good	good						-							de sprinkhanen en krekels van Nederland
Klappersprinkhaan	sprinkhaan en krekel	-	-	x			x		x	?						de sprinkhanen en krekels van Nederland
Kleine wrattenbijter	sprinkhaan en krekel	good	good	x					x							de sprinkhanen en krekels van Nederland
Locomotiefje	sprinkhaan en krekel	-	-				x									de sprinkhanen en krekels van Nederland
Moerassprinkhaan	sprinkhaan en krekel	moderate	moderate													de sprinkhanen en krekels van Nederland
Rosse sprinkhaan	sprinkhaan en krekel	very good	very good													de sprinkhanen en krekels van Nederland
Sikkelsprinkhaan	sprinkhaan en krekel	-	-	x			x									de sprinkhanen en krekels van Nederland
Steppesprinkhaan	sprinkhaan en krekel	good	good	x					x							de sprinkhanen en krekels van Nederland
Veenmol	sprinkhaan en krekel	moderate	moderate				x									de sprinkhanen en krekels van Nederland
Veldkrekel	sprinkhaan en krekel	good	good	x												de sprinkhanen en krekels van Nederland
Weidesprinkhaan	sprinkhaan en krekel	-	-	x			x			?						de sprinkhanen en krekels van Nederland
Wrattenbijter	sprinkhaan en krekel	good	good	x												de sprinkhanen en krekels van Nederland
Zadelsprinkhaan	sprinkhaan en krekel	very good	very good													de sprinkhanen en krekels van Nederland
Zoemertje	sprinkhaan en krekel	good	good													de sprinkhanen en krekels van Nederland
Zompsprinkhaan	sprinkhaan en krekel	good	moderate						x							de sprinkhanen en krekels van Nederland
Amphinemura standfussi	steenvlieg	good	moderate				x	x								-
Amphinemura sulcicollis	steenvlieg	good	good				x	x					x			-
Euleuctra geniculata	steenvlieg	good	moderate				x	x								-
Isogenus nubecula	steenvlieg	good	moderate				x	x								-
Isoperla grammatica	steenvlieg	good	moderate				x	x								-
Isoptena serricornis	steenvlieg	good	moderate				x	x								-
Leuctra fusca	steenvlieg	good	moderate				x	x								-
Leuctra nigra	steenvlieg	good	good				x	x					x			-
Marthamea selysii	steenvlieg	good	moderate				x	x								-
Nemoura avicularis	steenvlieg	good	moderate				x	x								-
Nemoura cambrica	steenvlieg	good	good				x	x					x			-
Nemoura dubitans	steenvlieg	good	good				x	x					x			-
Nemoura marginata	steenvlieg	good	good				x	x					x			-
Nemurella pictetii	steenvlieg	good	good				x	x					x			-
Perlodes microcephala	steenvlieg	good	moderate				x	x								-
Protonemura meyeri	steenvlieg	good	good				x	x					x			-
Protonemura nitida	steenvlieg	good	good				x	x					x			-
Taeniopteryx nebulosa	steenvlieg	good	moderate				x	x								-
Xanthoperla apicalis	steenvlieg	good	moderate				x	x								-
Bataafse stroommossel	tweekleppige	good	good				-	x								de Nederlandse zoetwatermollusken
Platte zwanenmossel	tweekleppige	good	good					x								de Nederlandse zoetwatermollusken
Barbeel	vis	good	good					x								RAVON dec 2006
Beekforel	vis	good	good					x					x			internet (wikipedia.nl)
Beekprik	vis	good	good					x					x			RAVON dec 2006
Bermpje	vis	good	good					x								RAVON dec 2006
Bittervoorn	vis	good	good					x								RAVON dec 2006, Janssen
Elrits	vis	good	moderate					x					x			internet (wikipedia.nl)
Fint	vis	moderate	moderate					x								Janssen
Gestippelde alver	vis	good	moderate					x					x			internet (wikipedia.nl)
Grote koornaarvis	vis	-	-					x		?					x	internet (ANEMOON)
Grote modderkruiper	vis	good	good					x								Janssen
Kleine modderkruiper	vis	good	good					x								RAVON dec 2006, Janssen
Kopvoorn	vis	moderate	moderate					x								RAVON dec 2006
Kroeskarper	vis	-	-				x	x								RAVON dec 2006
Kwabaal	vis	-	-				x	x								RAVON dec 2006
Meerval	vis	good	-				x	x								RAVON dec 2006
Rivierdonderpad	vis	moderate	moderate		x			x								RAVON dec 2006, Janssen
Rivierprik	vis	good	good					x								RAVON dec 2006, Janssen
Serpeling	vis	-	-				x	x								RAVON dec 2006
Sneep	vis	moderate	moderate					x								RAVON dec 2006
Spiering	vis	bad	bad					x		x						internet
Vetje	vis	-	-				x	x								RAVON dec 2006
Vlagzalm	vis	good	good					x					x			internet (wikipedia.nl)
Winde	vis	moderate	moderate					x								RAVON dec 2006
Zwarte grondel	vis	moderate	moderate					x		?					x	internet (wikipedia.nl)

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricted to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Baardman	vogel	good	very good													De Nederlandse broedvogels
Blauwborst	vogel	very good	very good													De Nederlandse broedvogels
Blauwe kiekendief	vogel	very good	very good													De Nederlandse broedvogels
Bonte vliegenvanger	vogel	very good	very good													De Nederlandse broedvogels
Boomklever	vogel	very good	very good													De Nederlandse broedvogels
Boomleeuwerik	vogel	good	good						x			x				De Nederlandse broedvogels
Brandgans	vogel	good	good													De Nederlandse broedvogels
Britse putter	vogel	-	-													
Bruine kiekendief	vogel	good	very good													De Nederlandse broedvogels
Buizerd	vogel	very good	very good													De Nederlandse broedvogels
Dodaars	vogel	moderate	moderate						x							De Nederlandse broedvogels
Draaihals	vogel	very good	very good													De Nederlandse broedvogels
Duinpieper	vogel	good	-													De Nederlandse broedvogels
Dwergstern	vogel	moderate	moderate						x							De Nederlandse broedvogels
Eider	vogel	moderate	moderate													De Nederlandse broedvogels
Engelse kleine mantelmeeuw	vogel	-	-													
Europese kanarie	vogel	good	moderate													De Nederlandse broedvogels
Geelgors	vogel	good	good													De Nederlandse broedvogels
Geoorde fuut	vogel	good	good													De Nederlandse broedvogels
Glanskop	vogel	good	good													De Nederlandse broedvogels
Grasmus	vogel	bad	bad						x			x				De Nederlandse broedvogels
Grauwe gors	vogel	moderate	moderate						x			x				De Nederlandse broedvogels
Grauwe kiekendief	vogel	moderate	moderate													De Nederlandse broedvogels
Grauwe klauwier	vogel	good	moderate													De Nederlandse broedvogels
Griel	vogel	very good	very good													De Nederlandse broedvogels
Groene specht	vogel	good	moderate													De Nederlandse broedvogels
Grote gele kwikstaart	vogel	good	moderate		x			x								De Nederlandse broedvogels
Grote karekiet	vogel	good	moderate													De Nederlandse broedvogels
Grote stern	vogel	moderate	bad							?						De Nederlandse broedvogels
Grote zilverreiger	vogel	good	good													De Nederlandse broedvogels
Grutto	vogel	bad	bad						x	?						De Nederlandse broedvogels
Havik	vogel	very good	very good													De Nederlandse broedvogels
Hop	vogel	moderate	moderate						x							De Nederlandse broedvogels
IJsvogel	vogel	good	good					x								De Nederlandse broedvogels
Kemphaan	vogel	good	good						?							De Nederlandse broedvogels
Klapekster	vogel	bad	bad						x			x				De Nederlandse broedvogels
Kleine barmsijs	vogel	moderate	bad						x							De Nederlandse broedvogels
Kleine mantelmeeuw	vogel	good	good					x								De Nederlandse broedvogels
Kleine zilverreiger	vogel	good	good						x							De Nederlandse broedvogels
Kluut	vogel	good	moderate						x							De Nederlandse broedvogels
Kneu	vogel	bad	bad						x			x				De Nederlandse broedvogels
Korhoen	vogel	very good	very good													De Nederlandse broedvogels
Krooneend	vogel	good	moderate						?							De Nederlandse broedvogels
Kwak	vogel	good	moderate													De Nederlandse broedvogels
Kwartelkoning	vogel	good	bad						x							De Nederlandse broedvogels
Lepelaar	vogel	good	moderate						?							De Nederlandse broedvogels
Midden-Europese goudvink	vogel	good	good						x							De Nederlandse broedvogels
Nachtzwaluw	vogel	good	good													De Nederlandse broedvogels
Noordse stern	vogel	good	good													De Nederlandse broedvogels
Oeverzwaluw	vogel	good	moderate					x								De Nederlandse broedvogels
Ortolaan	vogel	good	good													De Nederlandse broedvogels
Paapje	vogel	good	good													De Nederlandse broedvogels
Patrijs	vogel	bad	bad						x							De Nederlandse broedvogels
Pijlstaart	vogel	good	good					x								De Nederlandse broedvogels
Porseleinhoen	vogel	very good	very good													De Nederlandse broedvogels
Purperreiger	vogel	very good	good						?							De Nederlandse broedvogels
Putter	vogel	bad	bad						x			x				De Nederlandse broedvogels
Raaf	vogel	very good	very good													De Nederlandse broedvogels
Rietzanger	vogel	good	very good					?								De Nederlandse broedvogels
Rode wouw	vogel	good	moderate						?							De Nederlandse broedvogels
Roerdomp	vogel	very good	good													De Nederlandse broedvogels
Roodborsttapuit	vogel	good	good													De Nederlandse broedvogels
Roodkopklauwier	vogel	-	-													De Nederlandse broedvogels
Scholekster	vogel	good	good													De Nederlandse broedvogels
Snor	vogel	very good	good						x							De Nederlandse broedvogels
Sprinkhaanzanger	vogel	good	very good						?							De Nederlandse broedvogels
Steenuil	vogel	bad	bad							x						De Nederlandse broedvogels
Strandplevier	vogel	moderate	moderate						?							De Nederlandse broedvogels
Tapuit	vogel	good	very good													De Nederlandse broedvogels
Torenvalk	vogel	bad	bad							x						De Nederlandse broedvogels
Tureluur	vogel	very good	very good													De Nederlandse broedvogels
Veldleeuwerik	vogel	moderate	moderate						x							De Nederlandse broedvogels
Velduil	vogel	very good	very good													De Nederlandse broedvogels
Visdief	vogel	moderate	moderate						x							De Nederlandse broedvogels
Vuurgoudhaan	vogel	good	good						x							De Nederlandse broedvogels
Watersnip	vogel	good	very good													De Nederlandse broedvogels
Wespendief	vogel	very good	very good													De Nederlandse broedvogels
Woudaap	vogel	good	moderate						?							De Nederlandse broedvogels
Wulp	vogel	good	good						?							De Nederlandse broedvogels
Zanglijster	vogel	good	good													De Nederlandse broedvogels
Zomertaling	vogel	very good	very good													De Nederlandse broedvogels
Zwarte specht	vogel	very good	very good						?							De Nederlandse broedvogels
Zwarte stern	vogel	moderate	moderate					x	x							De Nederlandse broedvogels
Zwartkopmeeuw	vogel	bad	bad						x			x				De Nederlandse broedvogels

species	species group	habitat pattern	key patch pattern	border distribution	Ndt's Overijssel?	decrease quality	species expert	improve map aquatic Ndt	adjust in future applications	remove?	adjust key patch	wrong	restricited to brooks	restricted to wet heathlands / bogs	restricted to brackish waters	used data
Bechsteins vleermuis	zoogdier	very good	very good	x												internet (waarneming.nl; vzz.nl)
Bever	zoogdier	moderate	moderate						x							Janssen
Boommarter	zoogdier	good	good						x							internet (waarneming.nl; vzz.nl)
Bosvleermuis	zoogdier	good	good	?			x									internet (vleermuis.net; waarneming.nl)
Damhert	zoogdier	good	moderate						x							internet (waarneming.nl; wikipedia.nl)
Das	zoogdier	good	good													internet (waarneming.nl; vzz.nl)
Dwergmuis	zoogdier	good	-				x									internet (waarneming.nl; wikipedia.nl)
Eekhoorn	zoogdier	very good	very good													internet (waarneming.nl; vzz.nl)
Eikelmuis	zoogdier	good	good													internet (vzz.nl)
Franjestaart	zoogdier	good	good													internet (vleermuis.net; waarneming.nl)
Gewone baardvleermuis	zoogdier	good	good				x									internet (vleermuis.net; waarneming.nl)
Gewone grootoorvleermuis	zoogdier	good	good						?							internet (vleermuis.net; waarneming.nl)
Grote bosmuis	zoogdier	very good	very good													internet (vzz.nl)
Hamster	zoogdier	good	good	x												internet (vzz.nl; Janssen; La Haye)
Hazelmuis	zoogdier	very good	very good	?												internet (vzz.nl)
Noordse woelmuis	zoogdier	good	good													Janssen, kansenkaarten
Otter	zoogdier	good	good								?					internet (vzz.nl)
Rosse vleermuis	zoogdier	moderate	moderate						x							internet (vleermuis.net; waarneming.nl)
Ruige dwergvleermuis	zoogdier	moderate	bad													internet (vleermuis.net; waarneming.nl)
Veldspitsmuis	zoogdier	-	-	x			?									
Waterspitsmuis	zoogdier	good	good					x								internet (waarneming.nl; vzz.nl)
Watervleermuis	zoogdier	good	good													internet (vleermuis.net; waarneming.nl)

WOt-onderzoek

Verschenen documenten in de reeks Werkdocumenten van de Wettelijke Onderzoekstaken Natuur & Milieu vanaf 2006

Werkdocumenten zijn verkrijgbaar bij het secretariaat van Unit Wettelijke Onderzoekstaken Natuur & Milieu, te Wageningen. T 0317 – 48 54 71; F 0317 – 41 90 00; E info.wnm@wur.nl

De werkdocumenten zijn ook te downloaden via de WOt-website www.wotnatuurenmilieu.wur.nl

2006

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24 *Jaarrapportage 2005.* WOT-04-002 – Onderbouwend Onderzoek Natuurplanbureaufunctie

25 *Jaarrapportage 2005.* WOT-04-385 - Milieuplanbureaufunctie

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28 *Verboom, J., R. Pouwels, J. Wiertz & M. Vonk.* Strategisch Plan LARCH. Van strategische visie naar plan van aanpak

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