State Forest Service, Latvia

Regional Forestry Board, Östra Götaland, Sweden

INVENTORY OF WOODLAND KEY HABITATS

METHODOLOGY

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RIGA 2002

PREFACE

This is the methodology for an inventory of Woodland Key Habitats (Methodology) which is suggested for a full-scale inventory of Latvia, within the framework of the project ”Inventory of Woodland Key Habitats” (Ek and Auzinš, 1998). The methodology used in the inventory is based on assessing whether or not a particular forest stand is a Woodland Key Habitat, by looking mainly at indicator species and habitat specialists, features important for habitat specialists (Key Elements) and the overall structure and history of the forest.

A Woodland Key Habitat is defined within the framework of the project as: *an area which contains habitat specialists, that cannot sustainably survive in stands managed for timber production. A well-founded expectation that a habitat specialist exists is a sufficient criterion for designating an area as a Woodland Key Habitat.*

On Nov. 9, 2001 the Ministry of Agriculture issued Instructions 7 “Methodology for Identifying Woodland Key Habitats to be in the Status of a Microreserve” (Instructions 7). It establishes the principal WKH types and the criteria for identifying them following a list of habitat specialist and indicator species. Following Instructions 7 the status of a microreserve can be applied to the WKHs identified following the Methodology.

The habitats referred to in Instructions 7 fully agree with the WKHs described in Methodology. After the status of a misroreserve is conferred to the respective WKH it is then named Forest Habitat.

We recommend using the Methodology as an **additional reference material** in identifying Forest Habitat following Instructions 7. Methodology describes in detail the WKH types, the criteria for their identification, explains the notions “habitat specialist and indicator species”, as well as the components of forest structure pointing to the presence of said species. Besides, it includes also the Field Sheet, the terminology and explanations. However, Methodology has no legal force.

Reflections and suggestions on the methodology are warmly welcome and should be sent to:

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From the Swedish party the scientific supervision over the WKH IM is done by Mr Tommy Ek (Ostergötaland County Board of Forestry), the administrative and organisational responsibility is with the State Forest Service of Latvia (SFS), the responsible executive Mr Rolands Auzinš.

Methodology was worked out during 1998. Since then a number of amendments are made in it (in 1999, in 2000 and 2001) to update the method in line with the new habitats discovered, make the Field Sheet and the species descriptions more precise. However, no substantial amendments are made and the Methodology basically remains as initially formulated. In working out Methodology a number of institutions and experts in different fields from several countries were involved. Below we describe the contribution of different parties, the assistance received and the organisations involved in working out the Methodology in 1998.

The terminology was written by Tommy Ek and Uvis Suško, and the work instruction by Tommy Ek. The field inventory sheet was developed by Rolands Auzinš together with Janis Vazdikis (State Forest Inventory Institute) and Tommy Ek. The descriptions of Woodland Key Habitats were developed by Uvis Suško and Tommy Ek.

A valuable contribution to the development of the methodology was provided by the expert on natural forests, Normunds Prieditis.

The lists of indicator species and habitat specialists were developed mainly by the following experts:

Kjell Antonsson (Provincial Government of Östergötland, Sweden)- beetles and other insects;
Bengt Ehnström (Swedish Threatened Species Unit)- beetles and other insects;
Tommy Ek (County Forestry Board, Östra Götaland, Sweden)- lichens;
Niklas Jansson (Provincial Government of Östergötland, Sweden)- beetles and other insects;
Ivars Kabucis (Latvian Fund for Nature)- vascular plants;
Brigita Laime (University of Latvia, Faculty of Biology)- vascular plants;
Diana Meiere (Nature Museum of Latvia)- polypores;
Sven G. Nilsson (University of Lund, Sweden)- beetles and other insects;
Digna Pilate (Nature Museum of Latvia)- molluscs;
Mudite Rudzite (University of Latvia, Zoological Museum)- molluscs;
Elga Strazdina (Latvian Fund for Nature)- vascular plants;
Uvis Suško (Latvia)- bryophytes, vascular plants.

Valuable suggestions and comments from many different persons have greatly influenced the methodology. We are very grateful to:

Kjell Antonsson (Provincial Government of Östergötland, Sweden);
Lasma Abolina (State Forest Service);
Imants Baumanis (Forestry Research Institute "Silava");
Osvalds Cinitis (State Environmental Inspectorate);
Ojars Demiters (State Forest Service);
Martinš Bicevskis (Forestry Research Institute "Silava");
Janis Birgelis (Ministry of Agriculture, Forest Department)
Ivars Bitenieks (State Forest Service);
Janis Donis (Forestry Research Institute "Silava");
Börje Drakenberg (Sweden);
Aigars Dudelis (State Forest Service);
Bengt Ehnström (Swedish Threatened Species Unit);
Niklas Jansson (Provincial Government of Östergötland, Sweden);
Gundega Jurane (State Forest Service);

Ivars Kabucis (Latvian Fund for Nature);
Uldis Kalnietis (Ministry of Environmental Protection and Regional Development of Latvia);
Vilmars Katkovskis (State Forest Service).
Sverker Kärrsgård (Provincial Government of Östergötland, Sweden);
Janis Kuze (University of Latvia, Faculty of Biology);
Brigita Laime (University of Latvia, Faculty of Biology);
Dzintars Laivenieks (State Forest Service);
Viesturs Larmanis (University of Latvia, Faculty of Biology);
Andis Liepa (Kemeri National Park);
Aldis Liepinš (Northern Vidzeme Biosphere Reserve);
Kaspars Liepinš (WWF- World Wildlife Fund, Latvian Office);
Ilona Lodzina (Ministry of Environmental Protection and Regional Development of Latvia);
Diana Meiere (Nature Museum of Latvia);
Arnis Melnis (State Forest Service);
Aigars Neimanis (Ministry of Agriculture, Forest Department);
Sven G. Nilsson (University of Lund, Sweden);
Mikael Norén (National Board of Forestry, Sweden);
Arvids Ozols (Ministry of Agriculture, Forest Department);
Velga Pakalnite (State Forest Inventory Institute);
Aivars Petrinš (University of Latvia, Zoological Museum);
Digna Pilate (Nature Museum of Latvia);
Valdis Pilats (Gauja National Park);
Guntars Platbardis (State Forest Service);
Normunds Prieditis (Latvia);
Janis Priednieks (Latvian Fund for Nature);
Ugis Rotbergs (WWF- World Wildlife Fund, Latvian Office);
Mudite Rudzite (University of Latvia, Zoological Museum);
Valdemars Spungis (University of Latvia);
Inga Straupe (Forest Faculty, Latvia University of Agriculture);
Antra Strautniece (State Forest Service);
Elga Strazdina (Latvian Fund for Nature);
Maris Strazds (Latvian Ornithological Society);
Roberts Stripnieks (State Forest Service);
Uvis Suško (Latvia);
Bo Thor (County Forestry Board, Östra Götaland, Sweden);
Janis Uzulis (State Forest Inventory Institute);
Aivars Vanags (State Forest Service);
Janis Vazdikis (State Forest Inventory Institute);
Peteris Zalitis (Forestry Research Institute "Silava");
Otto Žvaginš (State Forest Service).

The project “Woodland Key Habitat Inventory” was a co-opreation project between the Ostergötaland County Board of Forestry of Sweden and the State Forest Service (SFS) of Latvia. The Swedish Environment Protection Agency and the National Board of Forestry of

Sweden covered the costs of the Swedish party in the project. The costs of the Latvian party were covered by the SFS.

Finally, we would once again like to thank everyone involved in developing and testing this methodology. However, the authors take full responsibility for any weaknesses or mistakes in the methodology.

Riga, 27 August 1998

County Forestry Board,

Östra Götaland, Sweden,

Project Manager Tommy Ek

State Forest Service,

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CONTENT

1. TERMINOLOGY

This terminology is designed to help users of the Woodland Key Habitat Inventory to concur in their use of a number of more specialised words. It is also designed to be educational. However, it is not intended to be a set of formal scientific definitions.

Woodland Key Habitat (WKH)
An area which contains habitat specialists, that cannot sustainably survive in stands managed for timber production. A well-founded expectation that a habitat specialist exists within an area is a sufficient criterion for designating the area a Woodland Key Habitat.

There is an exception to the above-mentioned definition. An area with a habitat specialist is not a WKH:

-if the biodiversity values in an area have recently been severely damaged (for example by sanitary cutting) and a non-sustainable residual population of a habitat specialist still survives.

-if the habitat specialist clearly shows up merely by accident in an area which in no way resembles a WKH.

Potential Woodland Key Habitat (PWKH)
A habitat, that if it is managed in such a way as to promote its biodiversity values, may become a WKH during 20 years in stands of pine and spruce, during 30 years in stands of oak, ash, lime, elm, and during 10 years in stands of aspen, birch and alder.

These areas should not be looked for when the inventory is prepared but marked and described when encountered.

Stands managed for timber production
This expression in the definition of a WKH refers to management roughly in accordance with forestry legislation passed in 1997. It means that some old trees and woody debris are retained in connection with final felling, as well as areas surrounding large nests, etc.

Habitat
A rather homogenous area inhabited by specific animals and plants. Examples of different habitats are dry meadows or ravines.

Generalist
The opposite of a specialist. A species that can live under many different circumstances. One example is the crow *Corvus corone* which can adjust very well to the environment, for example eating different types of food, finding different places to nest etc. depending on the current situation.

Habitat specialist
A species that is specialised for a certain habitat. Within the framework of this project the definition is narrower. Here a habitat specialist is a threatened species that is dependent on a certain level of quality in specific (Woodland Key) habitats and will become extinct if these

habitats are subject to detrimental treatment. The largest number of habitat specialist species is found in the lower flora and fauna. One example is the moisture dependent lichen species *Ramalina thrausta*, whose dispersal ability is very low. It only lives on trees in spruce wetland forest that has been protected from fire for a very long time and where humidity is high. If the forest is felled, or subject to a forest fire, the species will disappear because the climate will become too dry. It will not be able to recolonize from another moist area with long continuity for an extremely long time. *Ramalina thrausta* is extinct in areas where spruce wetland forests have been subject to commercial forestry.

Threatened species
A threatened species is one that shows a certain risk of becoming extinct in Latvia. All habitat specialists are threatened species but other species may also be threatened. For example, species demanding a scattered forest quality rather than specific habitats, species that have a natural, climatic boundary of their distribution area in Latvia and species that are naturally rare, and thereby could become extinct just by coincidence.

Indicator species
A species that has rather high demands on its living conditions but not as high as those of a habitat specialist. It is a rather specialised species and shows a certain forest quality by its very existence. It is mostly found in Woodland Key Habitats, sometimes in large numbers, but may occasionally be found outside them, mostly in small numbers. The existence of an indicator species is one indication that an area is a WKH. The existence and quantities of different indicator species and Key Elements determine whether an area is a WKH. An indicator species is not a threatened species in Latvia. There is, of course, no clear-cut boundary between threatened habitat specialists and non-threatened indicator species. One example of a typical indicator species is *Lecanactis abietina* which is a lichen growing on spruce buttresses and which demands a rather long continuity of high humidity. The longer the continuity of a spruce wetland forest, for example, the greater the amount of *Lecanactis abietina* you will find. A small amount of *Lecanactis abietina* alone is not enough to make a forest a WKH, but in larger amounts and/or together with other indicator species and Key Elements it shows that a forest is a WKH. Thus it should be possible to find habitat specialists, such as *Ramalina thrausta* mentioned above. Indicator species are used because they are not as rare or difficult to find as habitat specialists.

Key Element
A feature of the forest that is important for habitat specialists. Examples are different kinds of woody debris and old trees of different species.

Coarse woody debris (CWD)
A collective name for all different kinds of coarse woody materials, for example lying logs, standing dead trees and snags of all different tree species, decomposition stages and expositions.

Continuity
Continuity, or more correctly, but often not mentioned, *long* continuity, means that a certain condition has existed for a long time. Different types of continuity could be defined; here the

most important are tree continuity and log continuity. Many habitat specialists have poor dispersal ability and therefore require long tree or log continuity.

Tree continuity
A stand with long tree continuity has been covered with trees for a long time; i.e. it has not been felled or severely affected by forest fire for a long time.

Log continuity
A stand with long log continuity has had a more or less continuous supply of dead standing wood and lying logs (diameter larger than 25 cm) for a long time. This usually means that for a long time the stand has been affected only by insignificant forestry activities.

Ecosystem and ecological continuity
Continuity does not always have to be a continuity in exactly the same place for a long time. The continuity must be judged by the demands of a certain species. Dispersal abilities set the limits for what is sufficient continuity for the survival of a specific species. If there are enough sites with adequate living conditions within the dispersal range of a specific species, sufficient continuity is provided. For species with poor dispersal abilities, the range over which sufficient living conditions must be supplied is small. But even these species will have some kind of ability to disperse. If you find one of these species it does not necessarily mean that the continuity of the exact site is long, but that there have been enough areas with adequate living conditions within a short enough distance so that the species has been able to move between them and survive. The ecological continuity is long even though the continuity on the exact site is not long. The important type of continuity to assess when you make the Woodland Key Habitat Inventory is the ecological continuity.

One striking example of ecological continuity on the ecosystem level is the movement of the large ecosystems northwards and southwards in Europe during the periods of glaciation. The movements of the ecosystems due to climatic changes were slow enough for the species with poor dispersal ability to follow. We can talk about a very long ecological continuity for spruce wetland forests, for example, even though they have sometimes been located in Central Europe and sometimes in Northern Europe. On a human time scale, though, continuity of a spruce wetland forest means continuity on exactly the same site. In practice, if you want to preserve the habitat specialists with poor dispersal ability, you must protect them where they are today, because habitats with suitable living conditions are few and far between. In the future, though, it may be possible to make dispersal corridors in which the species can spread.

Natural disturbance
A disturbance that occurs naturally in a virgin forest. Natural disturbances creating conditions important to many habitat specialists include forest fires, storms and floods. Because of the lack of natural disturbances in most forests today, for example, due to fire prevention and regulation of rivers, management methods could be used in order to try and imitate the natural disturbances and thus provide the conditions needed by habitat specialists dependent on these disturbances.

Gap disturbance

A disturbance that occurs naturally mostly in wetland forests and broad-leaved forests. When a large tree is blown down, or dies for other reasons, a small gap is created in the forest. In this gap, regeneration mostly of secondary tree species takes place. This is a small-scale disturbance, which creates a varied forest with different age classes in the forest. Stable conditions prevail and the habitat specialists that are adapted to forests with gap disturbances as the main disturbance factor generally have low dispersal ability.

Fire subject forest

Almost all boreal forests on dry or mesic ground naturally burn regularly and therefore the species connected with these ecosystems are adapted to forest fire. Many species connected with coarse, burned, woody debris; burned, old trees and burned soil are now threatened. Frequent, often large, fires favoured species that could move quickly and thus the species connected with these forests have very good dispersal ability.

Fire protected (=fire refugial) forest

An area which is not naturally influenced by forest fires. Examples are most wetland forests (not pine and birch wetland forest), ravine forests, forests on small islands, etc. Habitat specialists living in fire-protected forests generally have poor dispersal ability since this was not favoured by evolution; to stay in the same stable place was the best way to survive. Moving would only put the individual in a more hostile or dangerous environment, for example in a forest that might burn.

Dispersal ability

The ability of a species to disperse to new areas. If the dispersal ability is poor a species is only able to disperse short distances. Dispersal ability is generally poor for species adapted by evolution to fire-protected areas and good for species adapted to forests that, in a virgin forest landscape, frequently burn.

Succession

A gradual process by which the species composition of a community changes. A good example of community succession in boreal forests is the succession after a forest fire. On a burnt area, the pioneer tree species, pine, birch and aspen come first. Later, they will be thinned out by competition from secondary tree species, mostly spruce. In nemoral forests there is a similar succession but with other tree species. Species that come first in successions after disturbances are called pioneer species. Typical pioneer tree species are pine, birch, aspen, black alder, grey alder and oak. Typical secondary tree species are spruce, elm and lime. Late succession stages are vital to many habitat specialists. Other habitat specialists are connected with early stages of succession after natural disturbances.

Sustainable forestry

Forestry that, among other things, preserves the long-term productivity of the forests, and all the species of organisms living in the forests. The definition used in the Helsinki Ministerial Conference, 1993, is: the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and does not cause damage to other ecosystems.

Sustainable population
The size which is needed by a population of a species to survive in the long run. It must, for example, be large enough so that in-breeding is avoided and the risk of extinction by random factors is excluded.

Biodiversity
Biodiversity could be assessed on several levels; usually three or four levels are mentioned. The level which this project has focused on is: the richness and abundance of all species, including all flora, fauna and fungi. A lower level is the genetic diversity within species and populations, and a higher level is the diversity of ecosystems. A fourth level which sometimes is mentioned is the maintenance of ecological processes. All levels have to be looked at in order to assess the overall biodiversity.

Ecosystem
The organisms in a community and the non-living factors with which they interact.

Ecological niche
The ”job” of a species. A more varied forest, with more habitat opportunities for species, for example as different kinds of decomposers of woody debris, has more ”jobs” to offer to different species; more ecological niches exist.

Deciduous trees
All tree species that have leaves, including the selected broad-leaved trees.

Selected broad-leaved trees/broad-leaved trees
In Latvia and other Northern European countries the deciduous trees are divided into two parts: the more nutrient-demanding ”broad-leaved” trees and others. These selected ”broad-leaved” trees are: oak (*Quercus*), maple (*Acer*), lime (*Tilia*), elm (*Ulmus*) and common ash (*Fraxinus*). Within the framework of this project we follow this tradition. For practical reasons we call these selected trees: broad-leaved trees.

Stools
Hummocks around tree bases formed naturally rather than by drainage. A typical feature of black alder wetlands is a microrelief with uninundated hummocks (stools) around tree bases and seasonally or semi-permanently flooded spaces between them.

Virgin forest
A primaeval natural forest, never touched by man, characterised by undisturbed hydrology, regeneration dynamics, natural disturbances and specific structures. There are no virgin forests in Latvia today.

Natural forest

A forest with many virgin forest qualities where ecological continuity is largely preserved. The land may always, or nearly always, have been covered with forest, or located close enough, so that there is a high degree of ecological continuity. A natural forest is always a WKH.

Naturally regenerated forest

A naturally reproduced forest; spontaneously generated and consisting of naturally immigrant tree species. Naturally regenerated forests can be more or less influenced by forestry, for example logging and regeneration techniques, but the forest must not have been regenerated by sowing or planting. A naturally regenerated forest may have varying degrees of biodiversity ranging from very high to low.

Forest classification systems

At least four forest classification systems are used in Latvia for different purposes.

- *Forest land type classification*. This describes and organises forested areas in a practical way for forest management with particular attention to major soil types, water regime, stand and vegetation characteristics. The forests are divided into five landscape series: upland forests, swamps, bogs, drained swamps and drained bogs. each landscape series is divided into 4-6 forest land types, for example the upland forests are divided into Cladinoso callunoso (Sl), Vacciniosa (Mr), Myrtillosa (Ln), Hylocomiosa (Dm), Oxalidosa (Vr) and Aegopodiosa (Gr).
- *Phytosociological classification.* This classification is often used by biological science and treats the forest as a vegetation system. It is based on the investigation of the vegetation layers (tree, shrub, herb, moss) and quantitative evaluation of species as well as on the assumption that the vegetation structure in itself has stable and naturally distinct units, (groups of species) which are characteristic of each one of the vegetation types. The basic classification unit of the method is an association. Similar associations are united into alliances; alliances are united into orders; orders are united into classes. The forests of Latvia may be attributed to 3 vegetation classes: boreal coniferous forests, European broad-leaved forests and Eurosiberian alder swamps. The number of associations in the natural forests of Latvia is not yet completely known; about 20 associations are possible.
- *Forest biotope groups*. This system was used in the demonstration project for privatization and sustainable forestry in the Mežole area. The forest is divided into 6 forest biotope groups: recently disturbed biotope (NTRB), pioneer phase of deciduous trees (LKPF), pine forest (PM), spruce forest (EM), wet deciduous forest (SLKM) and broad-leaved forest (PLM).
- *Woodland Key Habitats.* This is to a large extent based on the three systems mentioned above but most of all it is a practical division of the forests designed to meet the purposes of the current project as well as being educational and constituting an aid in assessing whether an area is a Woodland Key Habitat.

2.WORK INSTRUCTION

The work associated with the inventory of Woodland Key Habitats can be divided into three parts:

- preparatory work
- field work
- compilation work.

Preparatory work

The aim of the preparatory work is to choose the areas that should be visited during field work. The field survey must be limited to areas chosen as a result of preparatory work and areas encountered at random during the field survey. Good preparatory work is essential to enable a high percentage of the WKH's to be found within a reasonable amount of time.

The list of the forest stands to be visited during the inventory following definite search criteria was drawn from the State Register of Forests. The search criteria are described in Section 6.

Topographical maps (preferably scale 1:10 000 and not exceeding 1:25 000) should always be used as a complementary source of information, when available. These show features like Ravines and Riparian Forests that have a high probability of being WKH's.

Information should be sought from the local ranger, other foresters and other local people who may be considered to have knowledge of where probable WKH's are located.

Other sources of information that may be used when available are: ecological inventories, ecological landscape planning, aerial photographs, orienteering maps, maps of soil type and bedrock, investigations made by universities, various projects, etc. These sources should be used only when the probability of finding additional WKH's is considered to be rather high.

Large areas without clear fellings, roads or drainage have a greater probability of hosting WKH´s, even if the search criteria are not fulfilled. They might be visited seldom and thereby are rather unmanaged areas. They could be found by studying the forestry management maps.

No special search should be made for Potential Woodland Key Habitats during preparatory work but they should be marked and described when they are encountered during field work, for example when an area thought to be a probable WKH turns out to be an PWKH.

Before field work starts it is a good idea to mark on the field map all the places found during preparatory work that should be visited. This will make the field work more efficient.

Field work

All places found during the preparatory work should be visited with maximum time efficiency. It may help to draw up a preliminary driving route every morning. This route could be changed during the day if more or less time than expected is needed at the different locations.

The first and major task when you enter an area is to assess whether or not it is a WKH; does the area contain habitat specialists? You do not need to find a habitat specialist to assess an area as a WKH. A well-founded expectation, based on earlier findings and experience of habitat specialists, will be enough. It should be noted that there are many more habitat specialists than those mentioned on the lists of indicator species and habitat specialists, especially when it comes to insects. Also a well-founded expectation that any of these exists is enough to make an area a WKH.

An area where a threatened species exists merely by chance, rather than because of the structure or history of the forest, is not a Woodland Key Habitat. For example, a rare plant may show up in an unexpected place without it being possible to say from the structure or history of the forest why it grows there. This type of occurrence seems to be more common with vascular plants than with other, lower plants. Threatened species that require a more scattered forest quality, not connected to continuous areas or habitats cannot be used in definition of a Woodland Key Habitat. Animals with large home ranges often fall into this category.

There is no size limit for a Woodland Key Habitat. A Woodland Key Habitat can range in size from a single, very large Oak to a forest area covering hundreds of hectares.

To help you in making your assessment you have the occurrence of indicator species or habitat specialists, the Key Elements, the structure, and possibly the history of the forest as well as your overall experience gained in training and calibration exercises. WKH's should be assessed according to the present-day situation.

When you enter an area you should start by walking around and making notes on indicator species and habitat specialists, Key Elements, etc. If it is neither a WKH nor an PWKH you should make a small note on the field map stating why it is not, for example ”too little woody debris” and then just leave the area.

If you assess the area to be a WKH or a PWKH you should mark the boundary on the map and start to fill in the field inventory sheet. A WKH should be marked on the map with a continuous red line and an PWKH with a broken green line.

Sometimes you will have to make a small collection of a probable indicator species or habitat specialist in order to have it determined by an expert. A specimen should only be taken when a species cannot be determined and when the population is large enough for a small collection to do only negligible damage. The collection should then be carefully marked with date, species name and a detailed description of the place of collection and stored in your own herbarium or in a herbarium at a university.

Filling in the field inventory sheet

Unless otherwise stated, the first two parts of the field inventory sheet should be filled in as you would when carrying out a technical forest inventory. If one Woodland Key Habitat consists of several sites, then a full inventory sheet should be filled in for only one of these sites. For the other sites, only the first two parts of the inventory sheet should be filled in, and the number of the first Woodland Key Habitat should be written at the point "Analogue with".

Number

Each WKH/PWKH should be given a unique number which is written on the map and on the field inventory sheet. Numbering should start with number one in every Forestry and numbers should be allocated in chronological order. If one WKH consists of several sub-sites the following numbering pattern should be used: 10-1, 10-2, 10-3.

Source of information

The number of the relevant source, according to the list below, should be written in the squares. A maximum of two sources may be given.

Sources of information and their codes

Source of information	***Code***
Database " State Register of Forests "	1
Topographical map	2
Local forester/person	3
Other maps	4
Other investigations	5
Found at random during field work	6
Other sources	7

WKH name

A Woodland Key Habitat is normally given one suitable name, but sometimes, when a WKH has features that would fit two WKH names almost equally well, it is justifiable to give two names on the field inventory sheet. The most suitable name is then given first. If there are several similar WKH's adjacent to each other, your aim should be to fill in only one inventory sheet completely, and then record the differences under *Description of the biodiversity values*.

A Bog-Forest Mosaic, or a Ravine, Slope or Riparian Forest, which includes more than one standard WKH type (found under A, B and C in the WKH descriptions) is given one WKH name, for example Ravine Forest, and described with analogues (see above under the heading ”Filling in the field inventory sheet”). The names of the standard WKH types should then be mentioned in the text *Description of the biodiversity values*. In cases where one of the WKH's described under D and E in WKH descriptions consists of one standard WKH type only, both the standard WKH name and, for example, the name Ravine Forest should be given on the field inventory sheet.

PWKH Name

The same names may be used as for WKH's.

Negative Disturbances

Disturbances negative to the biodiversity values should be recorded. The grade of the disturbance should be written with a number in the corresponding small square (1- small negative effects on the biodiversity values; 2- severe negative effects on the biodiversity values). A disturbance should be marked only if it have a negative impact on the biodiversity values.

A drainage system that is no longer working is recorded as *1*, while a drainage system that is still working is assessed as *2*.

A management is assessed as *recent* as long as it hasn't started to grow mosses on the stumps.

Other negative disturbances should be marked in the two following squares by using the following codes:

Criteria	***Code***
Clear felling in the vicinity	3
Ruts of forestry machines	4
Road	5
Railway	6
Power/telephone line	7
Dam	8
Deterioration/disturbance from visitors	9
Waste	10
Pollution	11
Other	12

A *clear felling in the vicinity* has a negative impact on those WKH´s that are dependent on a moist microclimate. The impact is larger if the clear felling is located south or west of the WKH. On the other hand, a WKH dependent on large sun exposure and heat will in many cases be favoured by a clear felling in its vicinity and such a clear felling should thereby not be recorded as a negative impact.

Deep *ruts of forestry machines* should be recorded as a negative disturbance.

A *road, railway* or *power/telephone line* should be recorded if it crosses or in some way is located inside a WKH. If it is located outside but in the vicinity, and the impact is negative and similar to that caused by a clear felling in the vicinity, it should be recorded only as such. A road or railway in many cases has also a drainage impact. Then this should also be recorded with a mark in the *drainage* square.

A manmade *dam*, located inside or outside a WKH, could have a negative impact and should then be recorded.

Deterioration/disturbance from visitors should be marked when a WKH is so frequently visited that it causes negative disturbance to the biodiversity values. In some cases the visitor pressure is so high that it causes deterioration of the vegetation. It should be noted though that such deterioration, though negative aesthetically, in many cases is unimportant or even positive to the biodiversity values. This is the case in many dry WKH´s naturally disturbed by fire.

Solid disposals are recorded as *waste*, while impact of air or water pollutants are marked as *pollution*. Only impact that is more severe than the background impact from for example, acid rain and nitrogen downfall should be recorded. This marking will mostly be used when a local pollution source affects the WKH. The type of impact should be described in the text *Description of the biodiversity values*.

If any other disturbance is present, *Other* should be marked and the disturbance should be described in the text *Description of the biodiversity values*.

Indicator Species and Habitat Specialists

The species should be recorded with their acronyms in the squares according to the lists of indicator species and habitat specialists. Please note that an empty square should be left in the middle of the acronym, for example AST FERR. In the right column the relative abundance of the species should be recorded on a scale of 1-3. If a living specimen (larvae, pupae or imago) of a certain beetle is found, entered is the abbreviated name of the species and the relative amount of it in given place, which is also recorded on a scale of 1-3. Normally are seen only the traces from beetles, for example gnawings and spillings. Here we write in the the abbreviated name of the species and the relative amount of it in given place, which is recorded on a scale of 7-9.

In the initial stage of the inventory attention should be focused on the list of species of Group A. Later, when experience is gained and skills acquired in species identification, the list of species of Group B must also be used. The species of Group B are more rare and the knowledge of them is less. These were the reasons why the indicator species and habitat specialist species were divided into Group A and B.

Degrees for assessing the relative abundance of the species

Abundance	***Degree***
Single specimen	1
Moderate abundance	2
Abundant	3

Degrees for assessing the relative abundance of the traces

Abundance	***Degree***
Some	7
Moderate abundance	8
Abundant	9

Key Elements

The Key Elements should be seen as a help, together with other aspects, in assessing an area as a WKH or not and a way of describing the WKH. It is important that the amount of marks made in the Key Element list should not be regarded as crucial.

The first 13 Key Elements should be marked if the criteria are met. Many of the criteria are difficult to assess in a perfectly objective way. Training and calibration exercises are needed to help different people make assessments in a similar way. Most of the Key Elements have the characteristic that the more of them the better. This means that the extent to which a criterion is met, or not quite met, should be kept in mind when you assess the overall biodiversity value of the stand.

A *stand with trees of varying age* consists of a mixture of younger and older trees. This mixture is positive in the evaluation of many WKH types; mainly Broad-leaved forest, most wetland forests (except pine and birch wetland forest) and those Coniferous forests where the biodiversity values mainly are connected to spruce. A mixture of younger and older trees helps to keep the microclimate moist, it helps to produce slowly grown trees, and shows, for example, that a Spruce and mixed spruce wetland forest is closer to its natural disturbance and regeneration regimes. It also tells that the forest is less managed. To be assessed as a stand with trees of varying age, it is not sufficient with single younger or older trees in an otherwise even aged stand. Different tree ages should be characteristic to the whole structure of the stand. A stand with two storeys of rather old and tall trees, for example 100 and 140 years, should not be assessed as a *stand with trees of varying age*, also smaller trees are then needed.

In many cases a younger generation of spruce is threatening the biodiversity values of a stand of, for example, old aspen. In these cases the square for *stand with trees of varying age* should not be marked.

Small *Open spaces* created by, for example, small windfalls are in most cases a positive feature. They are a part of a natural disturbance regime, gap-disturbance, which is very important in, for example, Broad-leaved forest, most wetland forests (except pine and birch wetland forest) and those Coniferous forests where the biodiversity values mainly are connected to spruce. Most of the regeneration takes place in these open spaces. Open spaces give the possibility for sunlight to reach into these often dark and moist forests, and the important and nowadays rare combination of high air-moisture and light conditions is created. Very small gaps, created after normal self-thinning, are not to be assessed as *Open spaces*.

Open spaces are also important in dry forests, for example pine forests, where the biodiversity values are dependent on sun exposure and heat.

To record *Open spaces* it is not sufficient with single open spaces in an otherwise evenly dense stand. Open spaces should be relatively characteristic to the whole structure of the stand. At least 3-5 open spaces/ha are probably needed, depending on how well developed and important they are in the actual forest.

Self-thinning is typical in dense, rather even aged stands. It is a positive feature in those rather even aged forest types naturally evolving after a large-scale disturbance, like forest fire. Nowadays such forest types mostly evolve after manmade large-scale disturbances. Self-thinning is especially important in Aspen and Other deciduous forests, where it produces a large amount of woody debris.

In forest types where a tree structure of varying age is important (see above), the occurrence of *self-thinning* could in one way, be seen as a negative sign, because it occurs in even aged stands. On the other hand it is a positive process which produces a lot of woody debris and in best case in the long term restores the varying tree age structure. When the self-thinning process has lasted long enough, so that large enough gaps to allow self-regeneration are created, the stand will slowly change into a stand of varying age.

Self-thinning should be recorded when the process is rather pronounced and currently ongoing. Self-thinning is the more important the more large sized woody debris it produces.

Flooding is important because it creates an increased amount of woody debris, a special tree species composition and other important features, like stools. It favours species like black alder and in many cases prevents spruce from taking over. Flooding creates an important micro-relief in the forest floor. It also produces higher air moisture, important for many moisture loving species.

Permanently flooded areas are those that are under water all the year round.

Temporarily flooded areas are those that are under water during some part of a normal year.

Different decomposition stages of woody debris host different flora and fauna of wood inhabiting insects, fungi, bryophytes etc. Most habitat specialists of fungi and bryophyte species are connected to late stages of decomposition while the insect habitat specialist species are more evenly distributed on all decomposition stages. The later decomposition stages are more rarely found in the forests and especially rare is an even composition of all decomposition stages of coarse woody debris. Many of the habitat specialists connected to the naturally fire refugial forest types are known to have bad dispersal ability. Thereby a continuous supply of their substrate, for example, a certain tree species in a certain decomposition stage, within their dispersal range is crucial for their existence. The decomposition stages of woody debris could be divided into; stage 1 – with bark, 2 – hard, without bark, 3 – slightly soft, a knife can be pushed one cm into the wood, 4 – soft, a knife can be pushed five cm into the wood, 5 – very soft, can easily be broken to pieces by hand.

The amount of woody debris is recorded further below. Here the amount of decomposition stages is recorded. If the woody debris is mainly of one or two decomposition stages, normally rather recently died trees and newly fallen logs, *Woody debris of some decomposition stages* should be recorded. If additionally single pieces of woody debris in another decomposition stage are found it still falls into this category.

If more than two decomposition stages are commonly found, *Woody debris of many decomposition stages* should be recorded. If four or five decomposition stages are found, it is enough to find slightly more than single pieces of the more rare decomposition stages, to make a record.

Wood inhabiting fungi are important for creating different living conditions (ecological niches) for other organisms. Many insects live in the fruiting bodies of the fungi itself or from the mycelia or the rot that it creates. The fungi also kill or weaken the trees so that they are more susceptible to an attack of other organisms. *Many wood inhabiting fungi/conks* should be recorded, if the richness of wood inhabiting fungi is an obvious and clear characteristic of the forest. The richness should be assessed in comparison with forests of similar type; an aspen forest should be assessed in comparison with what is typical for an aspen forest etc.

Many old hazel bushes should be recorded if, and only if, the hazel bushes are old. Both the size of the bush at the ground level, which to some extent tells the age of the bush specimen and the size/age of the single “branches”, should be considered. A help to evaluate the age of the bush specimen is the amount of the lichen species *Graphis scripta* found. Single old bushes are not sufficient to make a record, but the amount should be large enough to be characteristic of the whole stand.

Different species of broad-leaved trees creates additional ecological niches in a forest. The age of the trees, the amount of coarse woody debris, hollows etc. are crucial to most of the habitat specialist species, but these qualities are not needed for the marking of this criteria. It is sufficient to find single specimens, of any age, of *four different species of broad-leaved trees* to record it.

Spring influence gives the possibility for additional ecological niches and increases the air moisture in the forest. Some bryophytes and molluscs are specialised on living in undisturbed springs in the forest. To be recorded, a spring must have such a large waterflow that it makes it very difficult to pass by walking as you will easily sink deep. In many cases a spring rarely freezes in wintertime.

The beaver is a creator of important features. Single *signs of beaver activity*, either tree marks or a dam, is sufficient to fulfil this criterion.

The occurrence of a stream gives the possibility for additional ecological niches and increases the air moisture in the forest it run through. A *stream* could be of any size but should carry water all year round, to be recorded.

The next four Key Elements should, if they exist, be marked in different columns depending on their quantity. A rough estimation of the quantity should be made, rather than a count of every single Key Element.

Stools are created in flooded areas. A stool becomes larger with time and the size of the stools can, to some extent, tell the length of the continuity of a stand. Stools also provide additional ecological niches to, for example, habitat specialists of bryophytes. Stools, or stool like formations, can also be formed after drainage. They are not signs of continuity, but, instead, negative signs of severe drainage, and therefore not recorded as Key Elements.

For example spruce is very sensitive to forest fire and in most cases dies in a hot fire. An older pine tree, with thicker bark, is much more resistant to fire and will, if the fire is not too hot, only get wounded. The pine tree will heal the wound, and even get more persistent to a new fire. In many cases older wounds are not possible to recognise, since the wounds are completely healed and covered by bark. They will only be seen if the tree is cut. In some cases though, older more severe wounds, and younger wounds, are possible to identify. They are signs of a disturbance regime, which is very important to many habitat specialists. The most specialised species will leave the fire-scarred area already a few years after the fire. A forest fire also often creates more long-lived ecological niches, one example are so called silver logs, which are fallen pines, originally resinated and killed by fire. This hard substrate is important to many specialized beetles where they can live for many years. *Forest fire signs* should only be recorded, if it is clear that the recognised wounds are caused by fire, and not by for example forestry machines. In most cases forest fire signs are located in the same direction on all wounded trees.

Holes are important for many habitat specialist species, especially insects. Large holes in broad-leaved trees are maybe the single environment that is richest in habitat specialists. Also small holes are important. Holes with a depth of at least 5 cm are recorded as holes. All holes with a bird nest are included.

Woodpecker signs tell that there are insects in a tree. Woodpeckers also damage trees and creates more ecological niches. All kinds of signs made by woodpeckers are recorded, except holes deeper than 5 cm, which are recorded as *holes*.

Abbreviations of tree species and woody debris

Species	***Abbreviation***	***Species***	***Abbreviation***
Pinus sylvestris	P	*Acer platanoides*	K
Picea abies	E	*Fraxinus excelsior*	Os
Betula pendula, Betula pubescens	B	*Sorbus aucuparia*	Pl
Populus tremula	A	*Carpinus betulus*	Sk
Alnus glutinosa	M	*Padus avium*	Ie
Alnus incana	Ba	*Taxus baccata*	Iv
Salix caprea	Bl	*Corylus avellana*	Laz
Salix alba, Salix fragilis	Vi	Tree of other species	C
Quercus robur	Oz	Coniferous woody debris	SKK
Tilia cordata	L	Deciduous woody debris	LK
Ulmus glabra, Ulmus laevis	G	Woody debris of unknown species	NK

The last seven Key Elements should be quantified in the same way. Additionally the Key Elements should be specified by species, by writing the abbreviations of the tree species in the different columns. In this way all large, biologically old trees, for example, of different species and quantities should be marked. Only rough estimates of the quantities should be made. It is often difficult to see from which tree species different kinds of woody debris originate. In that case you may use coniferous woody debris (SKK), deciduous woody debris (LK) or unknown woody debris (NK).

Biologically old trees of different species in different sun exposure and growing conditions are hosts of many habitat specialist species of fungi, insects, lichens, bryophytes and molluscs. Generally it is so that the older the tree is the more valuable it is. Long continuity of a certain type of biologically old trees, for example, old, hollow oaks in large sun exposition, is crucial to the most specialised species.

The criteria for biologically old trees can be met in either of two ways:

- the tree is forestically mature and not perfectly healthy, for example it may be affected by polypores, insects, or have holes or a lot of dead branches;
- the tree looks perfectly healthy but is older than 140 years (Pinus, Picea, Quercus), 120 years (Fraxinus, Ulmus) or 100 years (Others).

The criteria for *normal size biologically old trees* and *small, slowly grown biologically old trees* merge into each other. A biologically old tree should be recorded as either category, not both. A slowly grown biologically old tree of normal size should be recorded as a normal size biologically old tree. Small, slowly grown trees have not to be forestically mature to qualify for being biologically old, but only needs to be relatively old.

Sun-exposure is crucial to many habitat specialist species, especially insects and lichens, connected to pine, aspen, birch and broad-leaved trees, especially oak. Sun-exposed trees of all these species are important for habitat specialists and should be considered when assessing if an area is a WKH. On the field sheet only broad-leaved trees should be recorded though, since there value is the highest.

Coarse woody debris of different tree species in different sun exposure, decomposition stage and position, fallen or standing, hosts many habitat specialist species of fungi, insects, lichens, bryophytes and molluscs. Long continuity of a certain type of CWD, for example large spruce logs in moist conditions, is crucial to the most specialised species.

A piece of woody debris that has a maximum diameter larger than 25 cm should always be recorded as either of the different types of woody debris but never as both. A fallen tree that has been broken into pieces should be counted only as one fallen tree.

If more than half of the bark is still left a *fallen tree* is assessed as *with bark*. If less than half of the bark is left, it is assessed as *without bark*.

A *dead tree* still has branches while a *natural snag* doesn't. A *natural snag* can be either short or tall, but should at least be 50 cm high.

Description of the biodiversity values

You should use your own words to describe the biodiversity values of the stand. The description should be thorough enough for someone who has not seen the stand to imagine how it looks. Try not to repeat the information given under part 6, Key Elements. Other traits indicative of the biodiversity in the given forest stand must also be mentioned, as the tree stems covered by moss and lichens. Species rare for the given region and highly valuable species other than habitat specialist or indicator species must also be mentioned (e.g. *Sphagnum vulfianum).*

Best Management for the biodiversity values

You should mark in the table what you think is the optimum management to preserve and develop the biodiversity values in the WKH. Some management can not be described only by a mark in the table. Then you should use your own words to describe what you think is the optimum management. Some guidance in your evaluation could be received under the heading *Best Management for the biodiversity values* in the descriptions of the different WKH types. No economic, recreational or other considerations should be taken into account if they conflict with optimum management from the biodiversity point of view.

No management is marked when no management at all is needed during the coming three decades.

Shelter zone is marked when some kind of shelter zone is needed outside the WKH. A shelter zone can be marked on the map, if the area of the WKH is not less than 0.3 ha. If a shelter zone is needed around a smaller area than 0.3 ha, for example a giant tree, this is shown on the field sheet point 8, *Notes about management*.

No removal of dying trees or woody debris should always be marked, except in some cases when grazing is suggested.

No drainage should be marked when drainage, inside or outside the WKH, is harming the biodiversity values. This should be marked in all wetland forests.

Solitary trees in need of clearing should be marked when a clearing of trees and bushes is needed around single large solitary trees. The tree species and number of trees in need of clearing should be marked. The number of meters around the tree that need to be cleared, should be written by you own words; normally at least 2 m outside the outermost branch-tip are needed.

The note *Tree species must be cut down* should be recorded when the biodiversity values are connected to other tree species and an expansion of the species to be cut down is threatening these values. The tree species to be cut is marked by using the symbols shown in point 6 of the field sheet. When showing the area to be cleared and the abbreviation of the tree species to be cut, show (in %) the standing volume to be removed. If there is a large risk for extensive storm felling after a cutting, or the climate will be to quickly changed, the cutting might be best done in two or three portions, which is marked in the last column.

	Cut _E_	% from understorey	% from II storey	% from I storey
100% of area	➔	100	100	50
> 50% of area	➔			
< 50% of area	➔			
Number of portions	➔	1	2	2

Follow this example when recording. You want all spruce to be removed from the understorey, all of the spruce removed from the second storey and half from the first storey, but you are afraid of to many windthrows. Therefore you think that half of the volume in the first and second storeys should be cut at once and the rest in ten years time. You want the cuttings to be made in the whole WKH.

If only part of the area needs this management, the size of the area and a description of its location should be given by your own words.

Cut bush layer should be recorded when then whole bush layer should be cleared, for example around an area rich in solitary trees in need of light.

If the suggested cutting activity is too complicated to fit into the table, or you need to complement the information in the table, you should write with your own words under *Notes about management*.

Additional features

Here some features of more general character are recorded. They should not be regarded as Key Elements since they are not so important in the evaluation of whether an area is a WKH or not, but are of more general interest for the overall biodiversity in the forests.

With *large bird nest* is meant those nests made by the larger predator birds, black stork etc. An *anthill* should be 50 cm high to be recorded. *Large animal burrows*, made, for example, by foxes, should be marked. *Wild boar marks* in the ground should be recorded. A *boulder* should be larger than 1 m in height or width, to be recorded. An *outcrop* could be of any size. If more than one anthill, for example, is found you should write the number of anthills in the square.

Equipment to be used in the field work

- Map (normally a stand map or subcompartment map of the scale 1: 10,000 or 15,000 are used.
- instruction
- field inventory sheets
- dictaphone
- magnifying glass (preferably 10 times enlargement)
- determination literature
- small paper bags for collecting unidentified species for later determination (remember to mark the location of the specimen on the paper bag)
- compass
- knife
- writing material

Compilation work

When the field work is completed, the boundaries of WKH's and PWKH's should be marked out on the subcompartment maps and the list of the sies visits is made. The WKH boundaries are marked by a continuous red line, those of PWKH by an interrupted green line, shelterzones should be marked when they are needed both with a cross on the field sheet (point 8) and with a continuous brown line on the map. 30 meter wide shelterzones should be used.

The data entered in the Field Sheets must be regularly fed into the data base VATSBIO.

3.FIELD INVENTORY SHEET

WOODLAND KEY HABITAT INVENTORY

Field inventory sheet

1. WKH address: VVM ______________________ VM __________________

User of land ___________________ ☐☐ ☐☐ ☐☐☐☐☐

KV ________ Site __________________

Sources of information _________ **Number ___________**

2. Forest stand description

	State Register of Forests	Real situation
Area		
Stand formula; age		
Type		

Analogues with _______________

3. WKH name ☐ ☐
____

____ ☐ ☐

PWKH name ☐ ☐
____

____ ☐ ☐

4. Negative disturbances (1; 2)

drainage		recent management		others ___		others ___		others ___		others ___	

5. Indicator species and habitat specialists (1; 2; 3), traces (7;8;9)

6. Key elements

Stand with trees of varying age	
Open spaces	
Self-thinning	
Permanently flooded	
Temporarily flooded	
Woody debris of some stages of decomposition	
Woody debris of many decomposition stages	
Many wood inhabiting fungi/conks	
Many old hazel bushes	
Four different species of broad-leaved trees	
Spring influence	
Signs of beaver activity	
Stream	

10. Notes:

	1-5	6-10	>10
Stools/ha			
Forest fire signs on trees/ha			
Trees with holes/ha			
Trees with woodpecker signs/ha			
Biologically old trees/ha (normal size)			
Small, slowly grown biologically old trees/ha			
Sun-exposed biologically old broad-leaved trees/ha			
Fallen trees with bark/ha (> 25 cm)			
Fallen trees without bark/ha (> 25 cm)			
Dead or dying standing trees/ha (> 25 cm)			
Natural snags/ha (> 25 cm)			

7. Description of the biodiversity values____
____
____
____
____
____
____
___

8. Best management for the biodiversity values

No management	Shelter zone	No removal of dying	No	Giant trees in need of clearing			Cut ____	% from understorey	% from II storey	% from I storey	Cut bush layer
				species	number	100% of area	➔				
						> 50% of area	➔				
						< 50% of area	➔				
						Number of portions	➔				

Notes about management:

9. Additional features

Large nests	Anthills	Animal burrows	Wild boar marks	Boulders	Outcrops
_____ (number)	_____ (number)	_____ (number)	__________ (number)	____ (number)	____ (number)

Others:

Date______________ Specialist name ____

4. DESCRIPTION OF WOODLAND KEY HABITATS

The descriptions should be regarded as a help in identifying and distinguishing Woodland Key Habitats. A Woodland Key Habitat type should be regarded as a group of several similar habitats of common origin and similar ecology, collected under one name. Every Woodland Key Habitat is, of course, unique and should be assessed individually in the field according to the definition of a Woodland Key Habitat.

The WKH's under the headings A, B and C are more ordinary forests. Under D and E there are WKH's with certain additional values connected to a specific feature, for example, a ravine formation or rich calcareous soil. Only the values additional to the ones under A, B and C are then described.

The following WKHs are identified:

A. CONIFEROUS FORESTS

1. CONIFEROUS FOREST (mainly the following land types - Sl, Mr, Ln, Dm, Vr, Mrs, Dms, Vrs, Am, Km) (SKUJ)

2. MIXED CONIFEROUS-DECIDUOUS FOREST (mainly the following land types - Sl, Mr, Ln, Dm, Vr, Gr, Mrs, Dms, Vrs, Am, Km, Ks) (MIS)

B. DECIDUOUS FORESTS

1. BROAD-LEAVED FOREST (mainly the following land types - Gr, Grs, Ap, Kp) (PLAT)

2. ASPEN FOREST (mainly the following land types - Dm, Vr, Gr, As, Ap, Ks, Kp) (*APS)*

3. OTHER DECIDUOUS FOREST (mainly the following land types - Dm, Vr, Gr, As, Ap, Ks, Kp) (*LAP*)

C. WETLAND FORESTS

1. BLACK ALDER WETLAND FOREST (mainly the following land types - Lk, Db, sometimes Nd) (MELN)

2. SPRUCE AND MIXED SPRUCE WETLAND FOREST (mainly the following land types - Mrs, Dms, Vrs, Db, Am, As, Km, Ks, sometimes Nd) (*SLAP-EGL*)

3. PINE AND BIRCH WETLAND FOREST (mainly the following land types - Pv, Nd, Gs, rarely Mrs) (*SLAP-PRIE*)

4. BROAD-LEAVED WETLAND FOREST (mainly the following land types - Grs, Lk, Db, rarely- Ap, As, Kp, Ks) (*SLAP-PLAT*)

D. GEOLOGICALLY SUPPORTED WOODLAND KEY HABITATS (all land types)

1. RAVINE FOREST (*GRAV*)

2. SLOPE FOREST (*NOGAZ*)
3. RIPARIAN FOREST (*KRAST*)
4. SPRING-INFLUENCED FOREST (*AVOT*)
5. CALCAREOUS CONIFEROUS FOREST (*KALK-SKUJ*)
6. OPEN CALCAREOUS FEN OR MEADOW (*ZAL-PURV*)
7. BOG-FOREST MOSAIC (*MOZA*)

E. OTHER WOODLAND KEY HABITATS (all land types)

1. FIRE-SCARRED FOREST (*DEDZIS*)
2. BEAVER ACTIVITY AREA (*BEBR*)
3. GIANT TREE (*KOKS*)
4. WIND-FALLEN FOREST (VEJG)

A. CONIFEROUS FORESTS

1. CONIFEROUS FOREST (SKUJ)

A usually naturally regenerated stand where at least 80% of the stand volume consists of coniferous trees. The WKH is a collective name for several different kinds of boreal coniferous forest including fire-dependent pine stands and moist, fire-protected spruce forests.

The forest may have been subjected to natural disturbances and processes under some period of time, primarily storms and forest fires on dry and mesic ground, and storms and gap-disturbances on moist and wet ground. Spruce regeneration normally takes place in gaps that occur after wind-throws, and pine regeneration originally, but rarely nowadays, took place after a forest fire.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present. A large amount of *Lecanactis abietina* and *Arthonia leucopellea* on the spruce stems may be used as an indication on long forest continuity. A large content of birch or pine is a sign of non-continuity.

The most important Key Elements are biologically old trees and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a very positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Heart rot and other fungal infections may be present, sometimes causing the stems to break in storms. Old wind-thrown trees sometimes with uprooted stems are an additional feature. Sometimes fire-scarred trees, soil and/or woody debris occur.

Fire-refuges are crucial for the survival of habitat specialists with poor dispersal ability. These habitat specialists are also often connected to moist conditions and sometimes also dependent on certain Key Elements, for example slowly-grown large diameter coniferous trees and logs, which have developed in stable microclimate and continuous shading.

Due to natural conditions, dry pine forests contain much fewer indicator species than moister spruce forests, but may still host many habitat specialists, mostly insects. Therefore, their biodiversity value cannot be assessed just by richness in indicator species. Crucial evaluation criteria for Woodland Key Habitats of pine forests are aged, large-diameter pine trees and sun-exposed natural snags and logs. In most cases the pine-dominated forests lack logs, snags and dead trees due to sanitary cutting. They may still be Woodland Key Habitats if the pines have rough “crocodile bark” and/or large dead or living branches. A relatively common habitat specialist in these occasions is *Nothorina punctata, which* grows in the crocodile bark.

In many cases, because of a successful repression of forest fires for a very long time, the coniferous forests on dry and mesic ground today have a rather large content of spruce. They might even have been protected from large-scale disturbances for such a long time that they have gained some of the biodiverity values connected to fire-protected spruce forests. The situation is, because of this, often rather complicated, and sometimes a mixture of biodiversity values connected to naturally fire-protected and fire-influenced forest can be found in the same stand.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Asterodon ferruginosus*, *Fomitopsis rosea*, *Gloeoporus taxicola*, *Leptoporus mollis*, *Oligoporus gutullatus*, *Oligoporus leucomalellus*, *Phaeolus schweinitzii*, *Phellinus ferrugineofuscus*, *Phellinus nigrolimitatus*, *Phlebia centrifuga*, *Skeletocutis lenis*, *Skeletocutis odora*, *Skeletocutis stellae*;

lichens: *Alectoria sarmentosa*, *Arthonia leucopellea*, *Cladonia parasitica*, *Evernia divaricata*, *Icmadophila ericetorum*, *Lecanactis abietina*, *Lecidea botryosa*, *Ramalina thrausta*;

bryophytes: *Anastrophyllum hellerianum*, *Bazzania trilobata*, *Calypogeia suecica*, *Hylocomium umbratum*, *Jamesoniella autumnalis*, *Leucobryum glaucum*, *Lophozia ascendens*, *Odontoschisma denudatum*, *Scapania apiculata*;

vascular plants: : *Diphasium tristachyum*, *Listera cordata*;

beetles and other insects: *Anthaxia similis*, *Buprestis novemmaculata*, *Buprestis octoguttata*, *Calitys scabra*, *Ceruchus chrysomelinus*, *Chalcophora mariana*, *Dicerca moesta*, *Monochamus urussovi*, *Nothorina punctata*, *Peltis grossa*, *Tragosoma depsarium*;

molluscs: *Clausilia cruciata.*

Best management for the biodiversity values:

In forests where most of the biodiversity values are connected to spruce the best management is no management at all. In forests where most of the biodiversity values are connected to pine and/or deciduous trees, and spruce is expanding to the extent that it is threatening the biodiversity values, some cutting of spruce in order to favour the pine/deciduous trees might be best. In that case the biodiversity values connected to spruce should not be high and it should be certain that this management is the most favourable for the overall biodiversity values in the future. In some cases controlled burning is needed in the management. No dying trees or woody debris should be removed from the stand.

2. MIXED CONIFEROUS-DECIDUOUS FOREST (MIS)

A usually naturally regenerated conifer dominated stand where the admixture of deciduous trees is 20 - 50% of the stand volume. The WKH is a collective name for several different kinds of boreal coniferous forests including fire-dependent pine dominated stands and moist, fire-protected mixed forests. It may also be represented by fundamentally different and more fertile forests from the European broad-leaved forest class which has, over a considerable period, been dominated by spruce.

The origin is often a major natural disturbance (wind-throw, fire) or human disturbance (clear-felling), which is followed by a natural succession favouring deciduous trees. Forest fires naturally, repeatedly, occurred in areas occupied by dry or mesic coniferous forest habitats. The natural succession after a forest fire, especially on mesic ground, often gives rise to a coniferous-deciduous forest. The forest may have been subjected to natural disturbances and processes under some period of time, primarily storms and forest fires. Spruce and broad-leaved tree regeneration usually takes place in gaps that occur after wind-throws while pine, birch, aspen and sallow normally, but rarely nowadays, regenerate after a forest fire. Large wind-throws may give rise to regeneration similar to that after a forest fire.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present.

Important Key Elements are biologically old trees and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a very positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Heart rot and other fungal infections may be present, sometimes causing the stems to break in storms. In stands disturbed by storms broken stems and wind-thrown trees with uprooted stems are additional valuable features. Sometimes fire-scarred trees, soil and/or woody debris occur. Aspen are usually infected by polypores and birds nest holes are frequent and valuable features in these trees. Self-thinning is common in dense stands.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Asterodon ferruginosus*, *Ceriporiopsis pannocincta*, *Clavicorona pyxidata*, *Climacocystis borealis*, *Dentipellis fragilis*, *Dichomitus campestris*, *Fomitopsis rosea*, *Hericium coralloides*, *Junghuhnia collabens*, *Junghuhnia nitida*, *Leptoporus mollis*, *Oligoporus placentus*, *Oxyporus corticola*, *Perenniporia subacida*, *Phellinus ferrugineofuscus*, *Phellinus nigrolimitatus*, *Phellinus populicola*, *Polyporus badius*, *Pycnoporellus fulgens*, *Rigidoporus crocatus*, *Skeletocutis nivea*, *Skeletocutis odora*, *Skeletocutis stellae*;

lichens*Alectoria sarmentosa*, *Arthonia leucopellea*, *Cladonia parasitica*, *Collema spp*., *Evernia mesomorpha*, *Hypogymnia farinacea*, *Icmadophila ericetorum*, *Lecanactis abietina*, *Lecidea botryosa*, *Leptogium lichenoides*, *Leptogium saturninum*, *Lobaria pulmonaria*, *Nephroma parile*, *Parmeliella triptophylla;*

bryophytes: *Anastrophyllum hellerianum*, *Anomodon longifolius*, *Antitrichia curtipendula*, *Bazzania trilobata*, *Buxbaumia viridis*, *Calypogeia suecica*, *Frullania tamarisci*, *Geocalyx graveolens*, *Homalia trichomanoides*, *Hylocomium umbratum*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Lejeunea cavifolia*, *Leucobryum glaucum*, *Lophozia ascendens*, *Lophozia incisa*, *Metzgeria furcata*, *Neckera complanata*, *Neckera pennata*, *Odontoschisma denudatum*, *Scapania apiculata*, *Scapania nemorea*, *Trichocolea tomentella*, *Ulota crispa*;

vascular plants *Allium ursinum*, *Cinna latifolia*, *Circaea lutetiana*, *Corallorhiza trifida*, *Festuca altissima*, *Galium triflorum*, *Galium schultesii*, *Glyceria lithuanica*, *Listera cordata*, *Polygonatum verticillatum*, *Poa remota*, *Sanicula europaea*;

beetles and other insects: *Ceruchus chrysomelinus*, *Dicerca moesta*, *Monochamus urussovi*, *Peltis grossa*, *Poecilonota variolosa*, *Saperda perforata*;

molluscs: *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Cochlodina orthostoma*, *Macrogastra latestriata*, *Macrogastra plicatula*, *Macrogastra ventricosa*, *Ruthenica filograna*.

Best management for the biodiversity values:

In forests where most of the biodiversity values are connected to spruce the best management is no management at all. In forests where most of the biodiversity values are connected to pine and/or deciduous trees, and spruce is expanding to the extent that it is threatening the biodiversity values, some cutting of spruce in order to favour the pine/deciduous trees might be best. In that case the biodiversity values connected to spruce should not be high and it should be certain that this management is the most favourable for the overall biodiversity values in the future. In some cases controlled burning is needed in the management. No dying trees or woody debris should be removed from the stand.

B. DECIDUOUS FORESTS

1. BROAD-LEAVED FOREST (PLAT)

Usually a naturally regenerated stand where at least 50% of the stand volume consists of broad-leaved trees. Spruce, birch, aspen as well as grey and black alder may be a natural admixture in the tree layer. It is common for hazel to be present or, in suitable habitats, to dominate the shrub-layer. The forest canopy is, in most cases, clearly uneven, with many storeys and pronounced gaps. The WKH is a collective name for several different kinds of European broad-leaved forests including stands on dry, mesic or slightly wet sites.

This WKH is characteristic of areas originally known as regions of broad-leaved tree distribution. The forest may have been subjected to natural disturbances and processes for some period of time, primarily storms and gap-disturbances. Regeneration mostly takes place in gaps that occur after wind-throws.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present.

Important Key Elements are biologically old trees, old hazel bushes and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a very positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Heart rot and other fungal infections may be present, sometimes causing the stems to break in storms. In stands disturbed by storms broken stems and wind-thrown trees with uprooted stems are additional valuable features. Open spaces give the possibility for the important and nowadays rather rare combination of high air-moisture and light conditions important for many tree-living habitat specialists of lichens. Sun-exposition and heat are important for many habitat specialists of beetles connected to broad-leaved trees, aspen and birch. Giant trees are additional very valuable features.

A relatively common situation in Latvia is that tree continuity is present but CWD is more or less lacking. Tree continuity is then shown by the occurrence of indicator species as for example *Neckera*. Stems of aged broad-leaved trees and aspen extensively covered with epiphytic mosses are a typical feature, which also indicates long continuity. The existence of tree continuity is enough to assess a relatively old broad-leaved stand as a WKH, irrespective of the lack of CWD.

WKH's of this type are crucial for many habitat specialists for example those that are dependent on rich bark of aged broad-leaved trees

<u>Examples of characteristic indicator species and habitat specialists (underlined)</u>:

polypores: <u>*Aurantiporus croceus*</u>, <u>*Ceriporiopsis pannocincta*</u>, *Clavicorona pyxidata*, <u>*Dentipellis fragilis*</u>, <u>*Dichomitus campestris*</u>, <u>*Fistulina hepatica*</u>, <u>*Phellinus ferruginosus*</u>, *Grifola frondosa*, <u>*Hericium coralloides*</u>, <u>*Inonotus dryophilus*</u>, *Junghuhnia nitida*, *Oxyporus corticola*, , *Phellinus ferruginosus*, *Polyporus badius*, *Pycnoporellus fulgens*, *Rigidoporus crocatus*, *Skeletocutis nivea*, *Xylobolus frustulatus*;

lichens: *Acrocordia gemmata*, *Arthonia byssacea*, *Arthonia cinereopruinosa*, *Arthonia cinnabarina*, *Arthonia vinosa*, *Bacidia rubella*, *Bacidia rosella*, *Bactrospora spp*., *Biatora sphaeroides*, *Buellia alboatra*, *Calicium adspersum*, *Cetrelia cetrarioides*, *Chaenotheca brachypoda*, *Chaenotheca chlorella*, *Cybebe gracilenta*, *Graphis scripta*, *Gyalecta ulmi*, *Lobaria pulmonaria*, *Nephroma spp*, *Opegrapha vermicellifera*, *Pertusaria flavida*, *Pertusaria hemisphaerica*, *Pertusaria pertusa*, *Phlyctis agelaea*, *Sclerophora spp*.;

bryophytes: *Anomodon attenuatus*, *Anomodon longifolius*, *Anomodon viticulosus*, *Antitrichia curtipendula*, *Frullania tamarisci*, *Geocalyx graveolens*, *Homalia trichomanoides*, *Isothecium alopecuroides*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Lejeunea cavifolia*, *Metzgeria furcata*, *Neckera complanata*, *Neckera pennata*, *Plagiothecium latebricola*;

vascular plants: *Allium ursinum*, *Bromopsis benekenii*, *Circaea lutetiana*, *Dentaria bulbifera*, *Festuca altissima*, *Galium schultesii*, *Hordelymus europaeus*, *Matteucia struthiopteris*, *Poa remota*, *Polygonatum verticilatum*, *Sanicula europaea*;

beetles and other insects: *Agrilus biguttatus*, *Anoplodera sexguttata*, *Ceruchus chrysomelinus*, *Dorcus parallellopipedis*, *Gnorimus nobilis*, *Gnorimus variabilis*, *Grynocharis oblonga*, *Lasius brunneus*, *Liocola marmorata*, *Lymexylon navale*, *Osmoderma eremita*, *Pseudocistela ceramboides*, *Velleius dilatatus*;

molluscs: *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Clausilia pumila*, *Cochlodina orthostoma*, *Ena montana*, *Ena obscura*, *Isognomostoma isognomostoma*, *Laciniaria plicata*, *Limax cinereoniger*, *Macrogastra latestriata*, *Macrogastra plicatula*, *Macrogastra ventricosa*, *Ruthenica filograna*.

Best management for the biodiversity values:

In most cases the best management is no management at all. In cases where spruce is expanding or previous management has favoured pioneer tree species like birch and aspen, and they are threatening the biodiversity values connected to the broad-leaved tree species, some cutting of spruce or pioneer tree species in order to favour the broad-leaved trees could be done. In this case the biodiversity values connected to spruce or the pioneer tree species should be low and it should be certain that this management is the most favourable for the overall biodiversity values in the future. Extensive grazing might be positive in some cases. No dying trees or woody debris should be removed from the stand.

2. ASPEN FOREST (APS)

Usually a naturally regenerated stand where at least 50% of the stand volume consists of aspen. It has often been exposed to a major natural disturbance (wind-throw, fire) or, more often, human disturbance (clear-felling) which is followed by a natural succession favouring deciduous trees. The WKH is a collective name for several different kinds of forests represented both by European broad-leaved forests and boreal coniferous forests.

The WKH is often a naturally regenerated left-over of previously broad-leaved or mixed coniferous-deciduous forests cut during the starting period of modern forestry. The forest may have been subjected to natural disturbances and processes under some period of time, primarily storms. Self-thinning is relatively common. Stands rich in aspen are highly prone to wind disturbance. Stands usually have a more or less pronounced difference in age structure with some gaps. Regeneration nowadays mostly takes place in gaps that occur after wind-throws. Aspen trees are usually infected with polypores and bird's nest holes are frequent in these trees.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present.

Important Key Elements are biologically old trees and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Biologically old aspen and CWD of aspen hosts different habitat specialists if they are sunexposed or located in a moist situation. They can be said to host two rather different, but equally important sets of specialised species.

A relatively common situation in Latvia is that tree continuity is present but CWD is more or less lacking. Tree continuity is then shown by the occurrence of indicator species as for example *Neckera*. Stems of aged broad-leaved trees and aspen extensively covered with epiphytic mosses are a typical feature, which also indicates long continuity. The existence of tree continuity is enough to assess a relatively old aspen stand as a WKH, irrespective of the lack of CWD.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Ceriporiopsis pannocincta*, *Clavicorona pyxidata*, *Inonotus rheades*, *Junghuhnia nitida*, *Oligoporus placentus*, *Oxyporus corticola*, *Phellinus populicola*, *Pycnoporellus fulgens*, *Rigidoporus crocatus*, *Skeletocutis nivea*;

lichens: *Acrocordia gemmata*, *Bacidia rubella*, *Biatora sphaeroides*, *Chaenotheca brachypoda*, *Collema spp*., *Graphis scripta*, *Leptogium lichenoides*, *Leptogium saturninum*, *Lobaria pulmonaria*, *Nephroma spp*, *Parmeliella triptophylla*, *Phlyctis agelaea*;

bryophytes: *Anomodon longifolius*, *Geocalyx graveolens*, *Homalia trichomanoides*, *Isothecium alopecuroides*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Lejeunea cavifolia*, *Metzgeria furcata*, *Neckera complanata*, *Neckera pennata*;

vascular plants: *Cinna latifolia*, *Cypripedium calceolus*, *Dentaria bulbifera*, *Epipogium aphyllum*, *Festuca altissima*, *Poa remota*, *Sanicula europaea*;

beetles and other insects: *Ceruchus chrysomelinus*, *Peltis grossa*, *Saperda perforata*;

molluscs: *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Clausilia pumila*, *Cochlodina orthostoma*, *Limax cinereoniger*, *Macrogastra latestriata*, *Macrogastra plicatula*, *Macrogastra ventricosa*, *Ruthenica filograna*;

Best management for the biodiversity values:

In most cases the best management is no management at all. In cases where spruce is expanding, and threatening the biodiversity values connected to the deciduous tree species, some cutting of spruce in order to favour the deciduous trees could be done. Likewise if there is a threat to the biodiversity values connected to the broad-leaved tree species, some cutting of spruce or pioneer tree species in order to favour the broad-leaved trees could be done. In these cases the biodiversity values connected to spruce (or pioneer tree species) should be low and it should be certain that this management is the most favourable for the overall biodiversity values in the future. No dying trees or woody debris should be removed from the stand.

3. OTHER DECIDUOUS FOREST (LAP)

This Woodland Key Habitat type is similar to the previous one with the exception that less than 50 % of the stand volume consists of aspen. More than 50 % consists of deciduous trees but less than 50 % of broad-leaved trees.

C. WETLAND FORESTS

1. BLACK ALDER WETLAND FOREST (MELN)

A naturally regenerated, fertile to slightly oligotrophic, periodically flooded, moderately to species-rich deciduous forest stand on excessively moist soil or peat-land. The tree layer is usually dominated by black alder, with silver or pubescent birch, common ash and spruce as admixture. Sometimes pubescent birch or silver birch predominates. These sites have usually been forested with black alder for several generations or originated in conjunction with black alder dominated sites. The WKH is a collective name for a kind of Eurosiberian alder wetland forest which usually occupies hollows and depressions often in the vicinity of bogs and mires as well as several different kinds of Eurosiberian alder wetland forests located on the flood plains of rivers and lakes, at places with ground water outflow and at temporarily flooded places with moving subsoil streams.

A typical feature of black alder wetlands is a microrelief with uninundated hummocks around tree bases (stools) and periodically flooded spaces between them. This microrelief determines the existence of a distinctly mosaic pattern vegetation with no monodominating species in herb and moss layers; the microgradient of humidity and light enables the mutual coexistence of ecologically different species. To a certain extent, the size of the stools also shows the tree continuity. An uneven tree canopy and a varying age structure is often present. An admixture of common ash in these habitats provides additional habitats for habitat specialists that depend on rich bark in moist conditions. The forest usually has been subject to natural disturbances and processes under a long period of time, primarily floods, storms and gap-disturbances. Regeneration mostly takes place in gaps that occur after wind-throws. Regeneration of new sprouts from a broken black alder, on a stool, is common.

Important Key Elements are biologically old trees, stools and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. Black alder logs are generally smaller than logs from other species. Relatively small logs of black alder can host habitat specialists though and should therefore be considered Key Elements even if they don't fulfil the general size criteria for logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Stems of aged black alders may be extensively covered with epiphytic mosses, which is a strong sign of an ecological continuity. A large content of birch is often a sign of non-continuity.

WKH's of this type are crucial for those threatened habitat specialists who have poor dispersal ability and require a wet environment with permanently high humidity and shade often in connection with a certain Key Element.

A relatively common situation in Latvia is that tree continuity is present but CWD is more or less lacking. Tree continuity is then shown by for example a rich occurrence of *Graphis scripta.* Stems of aged ashes extensively covered with epiphytic mosses also indicate long continuity. The existence of tree continuity is enough to assess a relatively old black alder stand as a WKH, irrespective of the lack of CWD.

A likewise relatively common situation in Latvia is that log continuity is present but tree continuity is lacking. This is the situation when no previous management has been done except a final felling. Log continuity is then shown by black alder logs from different decomposition stages and/or the occurrence of indicator species on the black alder logs. The existence of log continuity is enough to assess a black alder stand as a WKH, irrespective of the lack of tree continuity. If such a stand has become poor in black alder due to the final felling, it is though not a WKH since the log continuity of black alder can be said to be broken since no/few new black alder logs are produced. Also if the stand is strongly affected by drainage, the continuity of black alder logs with a suitable microclimate can be said to be broken, and consequently it is not a WKH if also the tree continuity is broken.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores *Junghuhnia nitida*, *Skeletocutis nivea*;

lichens: *Arthonia spadicea*, *Arthonia leucopellea*, *Arthonia vinosa*, *Chaenotheca brachypoda*, *Graphis scripta*, *Menegazzia terebrata*, *Phlyctia agelaea*, *Thelotrema lepadinum*;

bryophytes: *Bazzania trilobata*, *Geocalyx graveolens*, *Homalia trichomanoides*, *Isothecium alopecuroides*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Plagiothecium latebricola*, *Rhytidiadelpjus subpinnatus*, *Ulota crispa*;

vascular plants: *Carex disperma*, *Cinna latifolia*, *Epipogium aphyllum*, *Glyceria lithuanica*, *Poa remota*;

beetles and other insects *Ampedus erythrogonus*, *Ceruchus chrysomelinus*, *Dicerca alni*, *Dicerca furcata*, *Peltis grossa*;

molluscs: *Clausilia dubia*, *Clausilia pumila*, *Limax cinereoniger*, *Macrogastra plicatula*.

Best management for the biodiversity values:

In most cases the best management is no management at all. In order to preserve the moist microclimate in the WKH, a 20-40 m wide shelter zone outside the WKH probably needs to be left when clear-felling takes place in the vicinity. If spruce is expanding, due to earlier drainage, to the extent that it is threatening the biodiversity values, some cutting of spruce might be best. In this case the biodiversity values connected to spruce should be low and it should be certain that this management is the most favourable for the overall biodiversity values in the future. No dying trees or woody debris should be removed from the stand. Drainage is fatal to the biodiversity values.

2. SPRUCE AND MIXED SPRUCE WETLAND FOREST (SLAP-EGL)

A naturally regenerated spruce, spruce-pine or mixed coniferous-deciduous forest stand on excessively moist soil. The tree layer is dominated by spruce. The admixture is formed by pine and birch and in areas with nutrient rich soil, by black alder. In rare cases common ash may also be present. The WKH is a collective name for several different kinds of boreal coniferous forest including typical mesotrophic spruce wetland forests, species-rich eutrophic spruce wetland forests and mesotrophic mixed coniferous spruce wetland forests.

Spruce or mixed spruce wetland forests are most often to be found in northern and especially north-eastern Latvia although they are present in all regions of the country. A WKH is characterised by a permanently high ground water level, a fire-refuge, shady character with high humidity, and in some cases also occasional flooding. It is usually located in flat terrain, in rare cases also in slightly sloping terrain where moving ground water streams may be present and nutrient-rich conditions exist. Usually, the stand is non-ditched or the existing shallow drainage does not harm the natural value of the ecosystem. An uneven tree canopy and a varying age structure is mostly present. An additional, but rare, quality in some spruce or mixed spruce wetland forests is an occurrence of stools. The forest usually has been subject to natural disturbances and processes under some period of time, primarily storms, gap-disturbances and occasionally floods. Regeneration of spruce mostly takes place in gaps that occur after wind-throws.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present. A large amount of *Lecanactis abietina* and/or *Arthonia leucopellea* on the spruce stems may be used as an indication on long forest continuity. A large content of birch or pine is a sign of non-continuity.

The most important Key Elements are biologically old trees and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. An important feature is slowly grown spruce of different sizes. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a very positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Heart rot and other fungal infections may be present, sometimes causing the stems to break in storms. Old wind-thrown trees sometimes with uprooted stems are an additional feature.

Fire-refuges are crucial for the survival of habitat specialists with poor dispersal ability. These habitat specialists are also often connected to moist conditions and sometimes also dependent on certain Key Elements, for example slowly grown coniferous trees and logs, which have developed in stable microclimate and continuous shading. The existence of many sensitive distinctly boreal species in Latvia is restricted to this WKH.

A relatively common situation in Latvia is that tree continuity is present but CWD is more or less lacking. Tree continuity is then shown by for example a rich occurrence of *Lecanactis abietina* and/or *Arthonia leucopellea*. The existence of tree continuity is enough to assess a relatively old spruce wetland forest stand as a WKH, irrespective of the lack of CWD.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Asterodon ferruginosus*, *Ceriporiopsis pannocincta*, *Fomitopsis rosea*, *Junghuhnia collabens*, *Leptoporus mollis*, *Oligoporus gutullatus*, *Oligoporus leucomalellus*, *Oligoporus placentus*, *Phellinus ferrugineofuscus*, *Phellinus nigrolimitatus*, *Phellinus viticola*, *Phlebia centrifuga*, *Pycnoporellus fulgens*, *Skeletocutis odora*, *Skeletocutis stellae*;

lichens: *Alectoria sarmentosa*, *Arthonia leucopellea*, *Cladonia parasitica*, *Evernia divaricata*, *Evernia mesomorpha*, *Icmadophila ericetorum*, *Lecanactis abietina*, *Lecidea botryosa*, *Ramalina thrausta*;

bryophytes: *Anastrophyllum hellerianum*, *Bazzania trilobata*, *Calypogeia suecica*, *Geocalyx graveolens*, *Hylocomium umbratum*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Lophozia ascendens*, *Lophozia incisa*, *Odontoschisma denudatum*, *Rhytidiadelphus subpinnatus*, *Scapania apiculata*, *Trichocolea tomentella*, *Ulota crispa*;

vascular plants: *Cinna latifolia*, *Corallorhiza trifida*, *Galium triflorum*, *Glyceria lithuanica*, *Listera cordata*, *Poa remota*;

beetles and other insects: *Dicerca moesta*, *Monochamus urussovi*, *Peltis grossa;*

molluscs: , *Bulgarica cana*, *Clausilia bidentata*, *Clausilia dubia*, *Clausilia cruciata*, *Cochlodina orthostoma*, *Macrogastra latestriata*, *Macrogastra plicatula*.

Best management for the biodiversity values:

The best management is no management at all. In order to preserve the moist microclimate in the WKH a 20-40 m wide shelter zone outside the WKH is probably needed, when clear-felling takes place in the vicinity. No dying trees or woody debris should be removed from the WKH. Drainage is fatal to the biodiversity values.

3. PINE AND PINE-BIRCH WETLAND FOREST (SLAP-PRIE)

A naturally regenerated pine or birch forest stand on mostly nutrient-poor but sometimes medium-rich peat and wetland characterised by minor human interference. It is, in most cases, a naturally fire-prone forested bog or mire phase. Less than 50% of the stand volume consists of spruce. The WKH is a collective name for several different kinds of boreal coniferous forest including typical species-poor, oligotrophic pine and pine-birch forest bog and mire communities, species-poor, oligotrophic pine wetland forest communities in the coastal lowlands of Latvia and in rare cases species-rich birch wetland forests hydrologically influenced by moving carbonated ground water streams.

Pine, mixed pine-birch or birch wetland forests are characteristic of permanently wet sites; forested bogs, old bogged up areas affected by forest fires on wet mineral soil (typical of coastal lowlands) and transitional mires. They are usually located in relief depressions and on the margins of opened or dwarf-shrub covered raised bogs as well as in the lowlands near forest lakes (muskegs) which are slowly becoming bogs. The ground layer is dominated by *Sphagnum* mosses. It is characteristic that the highest occurring proportion of vascular plants consists of those typical of bogs. These forests are generally distributed throughout Latvia and may in suitable places occupy extensive stretches of land. A WKH of this type is non-ditched or the existing drainage does not harm the natural value of the ecosystem. A varying age structure is sometimes present. The tree layer is usually dominated by pine or both pine and birch, and under certain ecological conditions also by pubescent birch. The admixture usually consists of birch or spruce, and rarely, in the case of forested mires, also by scattered black alders. The microrelief is mainly even, habitats with stools are rare.

CWD and biologically old trees may be well represented or partially removed during previous forest utilisation. One important feature are slowly grown, old and sometimes twisted pines. Together with woody debris of pines, often slowly-grown, varying in degree of decomposition and moisture, they make up the most important Key Elements. All or just a few of the decomposition stages of the CWD may be present. There is usually a lack of richness in various wood-inhabiting fungus species (polypores in a broad sense). Some kind of log continuity may be present.

Few indicator species and habitat specialists can be found. Due to natural conditions, these fire-prone pine (and birch) forests contain much fewer indicator species than fire-refuge moist spruce forests, but can still host many habitat specialists, mostly insects. Therefore, their biodiversity value cannot be assessed merely by their richness in indicator species. Crucial evaluation criteria for Woodland Key Habitats in pine and pine-birch wetland forests are aged, large-diameter pine (and birch) trees and sun-exposed natural snags and logs.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Gloeoporus taxicola*;

lichens: *Cladonia parasitica*;

bryophytes: *Jamesoniella autumnalis, Odontoschisma denudatum*;

vascular plants: *Corallorhiza trifida*, *Listera cordata*;

beetles and other insects *Nothorina punctata*, *Tragosoma depsarium.*

Best management for the biodiversity values:

In most cases the best management is no management at all. In forests where spruce is expanding to the extent that it is threatening the biodiversity values, some cutting of spruce in order to favour the pine (and birch) might be best. In that case the biodiversity values connected to spruce should not be high and it should be certain that this type of management is the most favourable for the overall biodiversity values in the future. In some cases controlled burning is needed in the management. No dying trees or woody debris should be removed from the stand.

4. BROAD-LEAVED WETLAND FOREST (SLAP-PLAT)

A naturally regenerated, fertile, base-rich and very species-rich, regularly flooded and permanently wet, shady and fire-protected broad-leaved forest stand on shallow peat-land or wet mineral (gleyey) soil. It is in a late stage of succession, mostly with long forest continuity and characterised by moderate human interference. The WKH is a collective name for two kinds of European broad-leaved forests including temporarily flooded alder-ash wetlands in nutrient-rich soils with moving subsoil streams and common ash forests on wet alluvial soils. A typical feature of alder-ash wetlands is a hummocky microrelief with stools and mosaic pattern vegetation. In common ash forests on wet alluvial soils, silt deposited after flood-flushes is typical.

A WKH of this type occurs only in a stand located in one of the regions of broad-leaved tree distribution, which at the same time are subject to continuous ground water seepage. Sites usually occupy small areas and may be located on gentle slopes, in areas rich in cold springs or near brooks or riversides. The nutrient supply is good due to moving ground water and/or floods. The ground water normally seasonally exceeds or reaches just under the surface level of the soil. Usually, sites are non-ditched or the existing drainage does not harm the natural value of the ecosystem. The tree layer is usually dominated by common ash, often with a large admixture of black alder and/or silver birch, and with a small admixture of oak, lime, maple, elm, aspen and spruce. A typical feature of alder-ash wetlands is a microrelief with uninundated hummocks around tree bases (stools) and seasonally flooded spaces between them. This microrelief determines the existence of a distinctly mosaic pattern of vegetation with no monodominating species in the herb and moss layers; the microgradient of humidity and light enables the mutual coexistence of ecologically different species. The size of the stools also shows the tree continuity to a certain extent. An uneven tree canopy and a varying age structure are usually present. All vegetation layers are mostly well developed. The forest usually has been subject to natural disturbances and processes under some period of time, primarily storms, gap-disturbances and fluctuations in water level. Regeneration mostly takes place in gaps that occur after wind-throws or tree death. Regeneration of new sprouts from a broken black alder, on a stool, is common.

The amount of CWD and biologically old trees varies considerably depending on how affected the forest is by management. A certain amount of Key Elements are present though and/or long forest continuity is present.

Important Key Elements are biologically old trees, stools and different kinds of, often coarse, woody debris, both standing natural snags, dead trees and fallen logs. If the woody debris varies in degree of decomposition, moisture, age and diameter it is a very positive sign. Richness in various wood-inhabiting fungi species (polypores in a broad sense) is valuable. Heart rot and other fungal infections may be present, sometimes causing the stems to break in storms. Open spaces give the possibility for the important and nowadays rather rare combination of high air-moisture and light conditions important for many tree-living habitat specialists of lichens. Sun-exposition and heat are important for many habitat specialists of beetles connected to broad-leaved trees, aspen and birch. Giant trees are additional very valuable features.

WKH's of this type are crucial for many habitat specialists for example those that are dependent on rich bark of aged broad-leaved trees, and those that have a poor dispersal ability and which requires a wet environment with permanently high humidity and shade often in connection with a certain Key Element.

A relatively common situation in Latvia is that tree continuity is present but CWD is more or less lacking. Tree continuity is then shown by the occurrence of indicator species as for example *Neckera*. Stems of aged ashes and black alder trees extensively covered with epiphytic mosses are a typical feature, which also indicates long continuity. The existence of tree continuity is enough to assess a relatively old broad-leaved stand as a WKH, irrespective of the lack of CWD.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Junghuhnia nitida*, *Oxyporus corticola*, *Phellinus ferruginosus*, *Skeletocutis nivea*;

lichens: *Acrocordia gemmata*, *Arthonia byssacea*, *Arthonia cinereopruinosa*, *Arthonia cinnabarina*, *Arthonia spadicea*, *Arthonia vinosa*, *Bacidia rubella*, *Bacidia rosella*, *Bactrospora spp*., *Biatora sphaeroides*, *Buellia alboatra*, *Calicium adspersum*, *Cetrelia cetrarioides*, *Chaenotheca brachypoda*, *Chaenotheca chlorella*, *Cybebe gracilenta*, *Graphis scripta*, *Gyalecta ulmi*, *Leptogium lichenoides*, *Leptogium saturninum*, *Lobaria pulmonaria*, *Nephroma spp*, *Opegrapha vermicellifera*, *Pertusaria flavida*, *Pertusaria hemisphaerica*, *Pertusaria pertusa*, *Phlyctis agelaea*, *Sclerophora* spp., *Thelotrema lepadinum*;

bryophytes: *Bazzania trilobata*, *Frullania tamarisci*, *Geocalyx graveolens*, *Homalia trichomanoides*, *Isothecium alopecuroides*, *Jamesoniella autumnalis*, *Jungermannia leiantha*, *Lejeunea cavifolia*, *Metzgeria furcata*, *Neckera complanata*, *Neckera pennata*, *Plagiothecium latebricola*, *Ulota crispa*;

vascular plants *Allium ursinum*, *Circaea lutetiana*, *Dentaria bulbifera*, *Festuca altissima*, *Matteucia struthiopteris*, *Poa remota*;

beetles and other insects: *Agrilus biguttatus*, *Anoplodera sexguttata*, *Ceruchus chrysomelinus*, *Dorcus parallellopipedis*, *Gnorimus nobilis*, *Gnorimus variabilis*, *Grynocharis oblonga*, *Lasius brunneus*, *Liocola marmorata*, *Lymexylon navale*, *Osmoderma eremita*, *Pseudocistela ceramboides*, *Velleius dilatatus;*

molluscs: *Clausilia bidentata*, *Clausilia pumila*, *Limax cinereoniger*, *Macrogastra ventricosa*.

Best management for the biodiversity values:

In most cases the best management is no management at all. In order to preserve the moist microclimate in the WKH a 20-40 m wide shelter zone outside the WKH probably needs to be left, when clear-felling takes place in the vicinity. If spruce is expanding, due to earlier drainage, to the extent that it is threatening the biodiversity values, some cutting of spruce might be best. In this case the biodiversity values connected to spruce should be low and it should be certain that this management is the most favourable for the overall biodiversity values in the future. No dying trees or woody debris should be removed from the stand. Drainage is fatal to the biodiversity values.

D. GEOLOGICALLY SUPPORTED WOODLAND KEY HABITATS

1. RAVINE FOREST (GRAV)

A ravine, valley or brook gully formation, sometimes with a stream flowing in the ravine bottom. The width must exceed 10 m and the depth must be at least 5 m. The topography may be variously pronounced from a canyon-form ravine to a valley with more gentle slopes. The width of the stream, if there is a stream, does not exceed 15 metres. If it exceeds 15 m, there will be two WKH's with the name Slope Forest. A stream may be active all year round or only during some seasons. Ravine Forest is a collective name for the ordinary WKH types, which are described under A, B and C (as well as grey alder forest).

There are additional values connected to the ravine formation itself, which increases the probability that the forest in the valley is a WKH:

The valley sides give a stable microclimate with permanent shade and high humidity. The valley is usually protected from fire and wind, and accordingly, the level of moisture in the soil and humidity become higher. Ground water seepage (also in the form of springs), and the stream itself, also contribute to the maintenance of a stable and permanently moist microclimate. Inaccessibility and management problems have in many cases favoured the preservation of forest qualities. Because of its protected location in the landscape, some moisture-demanding species might have survived even after some kind of human interference.

In many cases there is valuable fauna in the stream which requires a shady riparian zone that is intact. Additional ecological niches may be provided if the bed of the watercourse is meandering or supplied with wind-throw debris. Distinct terrain variations may sometimes be present within a particular ravine. Soil erosion and the constant presence of bare soil are typical features, giving additional ecological niches. Sometimes even a pronounced landslide activity occurs. The soil may consist of different types of tills and silt deposits, which are found at stream banks after floods.

WKH's of this type are crucial for those threatened habitat specialists, which have a poor dispersal ability and require a damp environment with permanently high humidity and shade, often in connection with a certain Key Element. Ravine forests might serve as distribution corridors for these, or other, habitat specialists, or provide a refuge for them if ecological conditions necessary for their existence have been destroyed in other parts of the landscape.

Examples of characteristic indicator species and habitat specialists are found under the headings of the ordinary WKH types.

Best management for the biodiversity values:

In most cases the best management is no management at all. In order to preserve the moist microclimate in the WKH a 20-40 m wide shelter zone outside the WKH sometimes needs to be left, if the ravine is small, when clear felling takes place in the vicinity. No dying trees or woody debris should be removed from the stand.

2. SLOPE FOREST (NOGAZ)

A more or less steep slope, that may face in any direction, often sloping towards a water-course or lake, or located on the side of a moraine hill, or on a coastal or continental dune. The height must exceed 10 m. Slope Forest is a collective name for the ordinary WKH types which are described under A, B and C.

There are additional values connected to the slope formation itself, which increase the probability that the forest on the slope is a WKH:

Forest stands on north-facing slopes are often fire-refuges with permanently moist or water-saturated conditions. Ground water seepage (also in the form of springs) may be present in the slope, or a river might flow just below, and contribute to the maintenance of a stable and permanently moist microclimate. Because of its protected location in the landscape, some moisture-demanding species may have survived even after some kind of human interference.

South-facing slopes are often subjected to fire and are continuously exposed to the sun. Inaccessibility and management problems have in many cases favoured the preservation of forest qualities on slopes.

Distinct terrain variations may sometimes be present on one and the same slope. Soil erosion and the constant presence of bare soil are typical features, giving additional ecological niches. Sometimes pronounced landslide activity may also occur. The soil may consist of different types.

North-facing WKH's of this type are crucial for those threatened habitat specialists, which have poor dispersal ability and require a wet environment with permanently high humidity and shade, often in connection with a certain Key Element. Slope forests along rivers may serve as distribution corridors for these, or other, habitat specialists, or provide a refuge for them if ecological conditions necessary for their existence have been destroyed in other parts of the landscape. South-facing slopes may provide the necessary conditions for thermophilic species in particular.

Examples of characteristic indicator species and habitat specialists are found under the headings of the ordinary WKH types.

Best management for the biodiversity values:

In most cases the best management is no management at all. A 20-40 m wide shelter zone outside the WKH is generally needed in order to preserve the moist micro-climate on the north-facing slopes when clear-felling takes place below the WKH. No dying trees or woody debris should be removed from the stand.

3. RIPARIAN FOREST (KRAST)

A varyingly forested, often fertile, riparian zone at the water's edge of rivers, streams and lakes. It is characterised by exposure to wind, ice, sun and in many cases periodic flooding. The terrain may be either flat or slightly sloping, sometimes with running ground water. A seasonally high ground water level is often present. Riparian Forest is a collective name for several ordinary WKH types which are described under A, B and C (as well as grey alder forest).

There are additional values connected to location at the water's edge, which increase the probability that the forest is a WKH:

A Riparian Forest is a transition zone between two completely different ecosystems which provides living conditions for additional species depending on both ecosystems; additional ecological niches exist. Sun-exposed, old or dying trees and natural snags along the waterline are valuable features for threatened thermophilic insects.

The Riparian Forest is usually protected from fire and, if it is wide enough, also from wind. Accordingly humidity is high. Ground water seepage (also in the form of springs), a high ground water level, and the body of water itself, also contribute to the maintenance of a stable and permanently moist micro-climate. In some cases there is valuable fauna in a stream which requires a shady riparian zone that is intact. Additional ecological niches may be provided if the bed of the water-course is meandering or supplied with wind-throw debris. There may be soil erosion along rivers on the river bank in some places, and deposition of soil at other locations.

WKH's of this type are crucial for those threatened habitat specialists which have a poor dispersal ability and require a wet environment with permanently high humidity and either light conditions or shade often in connection with a certain Key Element. Riparian Forests may serve as distribution corridors for these, or other, habitat specialists, or provide a refuge for them if ecological conditions necessary for their existence have been destroyed in other parts of the landscape.

A special kind of Riparian Forest found close to meandering rivers, for example the Gauja, are the, sometimes dried out, oxbow lakes created when part of the river is cut off and isolated from the rest of it. These lakes may often be bordered by an interesting forest of aspen and other deciduous trees. A special characteristic are the old, partly sun-exposed oaks to which a large number of habitat specialists are connected.

Examples of characteristic indicator species and habitat specialists are found under the headings of the ordinary WKH types.

Best management for the biodiversity values:

In most cases the best management is no management at all. If spruce is expanding, due to regulation of the water regime, to the extent that it is threatening the biodiversity values, a cut of spruce might be best. In this case the biodiversity values connected to spruce should be low and it should be ascertained that this management is the most favourable for the overall biodiversity values in the future. No dying trees or woody debris should be removed from the stand. Drainage is fatal to the biodiversity values.

4. SPRING-INFLUENCED FOREST (AVOT)

A forest stand or patch that may have been preserved to varying degrees and which is under the permanent influence of (cold) springs or strong groundwater seepage. This may be located in any kind of forest type.

In this WKH, ground water seeps out and often creates a small wetland in the forest. The natural springs may seep out from one or more separate sources or affect a larger area through many small ground water streams. This WKH may occur in sloping terrain, in valleys or ravines as well as near lakes. It is often located at the foot of a slope. In the case of separate sources with strong flow, a naturally eroded stream-bed may be present. As a rule the stream has not been changed artificially. Individual springs may sometimes have a very strong flow and form a natural valley that is several kilometres long. Good nutrient transportation is a typical feature. The influence of carbonated ground water is an additional value, and in extreme cases lime deposits may be created.

It is the hydrology that provides the important conditions present in this WKH. A permanent ground water outflow keeps the area free of ice in the winter, and maintains a constantly low temperature, which are conditions necessary for certain habitat specialists. WKH's of this type are crucial for these habitat specialists.

Examples of characteristic indicator species and habitat specialists (underlined):

bryophytes: *Trichocolea tomentella*;

vascular plants: *Corallorhiza trifida*, *Festuca altissima*, *Glyceria lithuanica*, *Poa remota*;

Other indicator species and habitat specialists may also be found if the WKH also has biodiversity qualities connected to the tree layer or woody debris. Examples of them may be found under the headings of the ordinary WKH types.

Best management for the biodiversity values:

In most cases the best management is no management at all. A 20-40 m wide shelter zone outside the WKH is generally needed in order to preserve the moist micro-climate in the WKH when clear-felling takes place in the vicinity. No dying trees or woody debris should be removed from the stand. Drainage is fatal to the biodiversity values.

5. CALCAREOUS CONIFEROUS FOREST (KALK-SKUJ)

A naturally regenerated coniferous or mixed forest stand on lime-rich soil or bedrock. It is usually fertile and well-stocked. The soil may be dry to moist. Open fens and meadows or wetland forests are not included.

The WKH has been forested continually for several generations at some stage but it does not necessarily have to show long tree continuity. Older individual trees and some types of CWD may be present, but not necessarily. A stand on lime-rich soil may have many threatened species of vascular plants, bryophytes and fungi that are specialised on forests on lime-rich soil. This makes it a WKH regardless of the tree continuity of the stand. The field layer is usually rich in herbaceous plants. The number of rare species may be considerable.

Best management for the biodiversity values:

In most cases the best management is no management at all. No dying trees or woody debris should be removed from the WKH.

6. OPEN CALCAREOUS FEN OR MEADOW (ZAL-PURV)

Open calcareous fens or meadows located in a forest landscape are often rich in rare calciphilic species.

WKH's of this type are rare and usually occupy rather small areas. They have arisen in permanently wet places on calcimorphic till, freshwater lime or calcium-rich bedrock or are influenced by carbonate-rich ground water seepage. They are mostly not forested but may sometimes be over-grown with shrubs and trees to varying degrees. They might also have been used for grazing in earlier times. Many threatened species of vascular plants, bryophytes and fungi are specialised on open calcareous fens and meadows. Orchid species may be richly represented.

Examples of rare species:

bryophytes: *Drepanocladus revolvens, Hamatocaulis vernicosus, Helodium blandowii, Moerckia hybernica, Paludella squarrosa*;

vascular plants: *Cladium mariscus, Dactylorhiza cruenta, Hammarbya paludosa, Liparis loeselii, Malaxis monophyllos, Ophrys insectifera, Orchis mascula, Orchis militaris, Primula farinosa, Schoenus ferrugineus, Saussurea esthonica*.

Best management for the biodiversity values:

If trees or bushes are expanding, these need to be cleared. Calcareous meadows often need grazing to stay open and preserve their biodiversity values. Drainage is fatal to the biodiversity values.

7. BOG-FOREST MOSAIC (MOZA)

The WKH is a mosaic of ordinary WKH types and open or semi-open mire. It is in some cases difficult to distinguish the border between forest and mire and the borderline is often lobate. When an ordinary WKH type is rather large, and the mire has rather well-defined borders, the WKH should be described as usual and given its ordinary name. In this case, if the biodiversity values of the forest are dependent on the mire or vice versa, this should be mentioned on the field sheet. The WKH type ”Bog-forest mosaic” should be used for practical reasons when the forest and mire are difficult to separate and it is easier to see them as a totality.

Additional biodiversity values, to be added to the ones found in the ordinary WKH types are: well-preserved transition zones between forest and mire, well-preserved mire conditions (no or only insignificant drainage), the moist and stable microclimate often found in the vicinity of mires, occurrence of threatened mire species, and the occurrence of birds such as capercaillie (*Tetrao urogallus*), hazel hen (*Tetrastes bonasia*), and crane (*Grus grus*).

Examples of characteristic indicator species and habitat specialists are found under the headings of the ordinary WKH types.

Best management for the biodiversity values:

In most cases the best management is no management at all. No dying trees or woody debris should be removed from the WKH. Drainage is fatal to the biodiversity values.

E. OTHER WOODLAND KEY HABITATS

1. FIRE-SCARRED FOREST (DEDZIS)

An old or mature coniferous or mixed coniferous-deciduous forest that has burned recently (in the last decade) and where many trees have some sort of fire-scar and/or a lot of burned woody debris is found. The forest has been able to develop under conditions that have not been changed artificially, or only insignificantly, since the fire.

A WKH of this type usually occurs in mesic or dry pine or mixed pine forests which are most prone to forest fires. Fire-scarred trees and burned woody debris of different species and sizes, and burned soil are the most important components. Thick pines with "crocodile" bark and large diameter pine logs or natural snags may also be present. An additional ecological value in these stands may be pine wood, resinated after fire, which as a substrate can persist even for several centuries.

Due to natural conditions, there are very few indicator species to be found, but the WKH still hosts many habitat specialists, mostly insects. Therefore, its biodiversity value should be assessed only from the amount of old trees, fire-scarred trees and burned woody debris and soil. The WKH type is crucial for the existence of threatened forest habitat specialists, mostly insects, connected to these features.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores: *Gloeporus taxicola*, *Phaeolus schweinitzii*, *Skeletocutis lenis*;

vascular plants: *Diphasium tristachyum*, *Geranium bohemicum*;

beetles and other insects: *Agonum quadripunctatum*, *Denticollis borealis*, *Melanophila acuminata*, *Platyrrhinus resinosus*..

Best management for the biodiversity values:

The best management is no management at all. No dying trees or woody debris should be removed from the stand. The WKH may, in some cases, naturally disappear as such when the burned woody debris is completely decomposed.

2. BEAVER ACTIVITY AREA (BEBR)

A mature or near-mature aged, relatively varied, forest stand influenced by significant flooding initiated by beavers. Younger monocultures influenced by beaver are not considered as WKHs. The WKH is a significantly flooded forest stand with a large amount of CWD. The forest does not necessarily have long forest continuity.

The tree layer may consist of any tree species and the stand structure and ground flora may be of different kinds before the flooding. The typical features of these forests are their richness in woody debris of all kinds and the occurrence of standing water. After the beavers have used the flooded area they are likely to move to another place and the flood will eventually dissipate. The large amount of woody debris will, however, remain and tend to preserve the area as a WKH at least until the woody debris is completely decomposed.

Best management for the biodiversity values:

The best management is no management at all. No dying trees or woody debris should be removed from the stand.

3. GIANT TREE (KOKS)

A giant tree (in terms of this project) is a tree that is large enough by itself or together with a group of similar trees to contain a population of a habitat specialist species. This WKH-type can contain one or several trees and in more rare cases a whole stand can be marked as this WKH-type. In this case giant trees are scarcely spread out in the whole stand, but the stand in itself is not of WKH quality. If there are so many giant trees that they give character to the whole stand the stand should be marked as another type (normally A-C).

Very old and large, often giant-sized, solitary grown broad-leaved trees, mostly oaks, standing alone or in a group, may be expected to contain habitat specialists. Giant trees of other species may also sometimes, but less often, be expected to contain habitat specialists. Giant standing or lying dead trees or natural snags are also included.

A giant tree may have originated from agricultural land or from an original forest cover cleared a considerable time ago. It has spent most of its life on its own or in groups and thereby often acquired a very wide crown. Sometimes it has grown slowly and then will often have a gnarled appearance. The age and size of the tree, the occurrence of cavities, dead branches and indicator species, are important features to take into account when the tree is being evaluated as a WKH. Large broad-leaved solitaire trees in sunny positions are crucial habitats for a large number of threatened epiphytic lichens, wood-inhabiting insects and fungi.

Examples of characteristic indicator species and habitat specialists (underlined):

polypores *Aurantiporus croceus*, *Fistulina hepatica*, *Grifola frondosa*, *Inonotus dryophilus*, *Xylobolus frustulatus*;

lichens: : *Acrocordia gemmata*, *Arthonia byssacea*, *Arthonia cinereopruinosa*, *Arthonia vinosa*, *Bacidia rubella*, *Bactrospora spp*., *Biatora sphaeroides*, *Buellia alboatra*, *Buellia violaceofusca*, *Calicium adspersum*, *Caloplaca lucifuga*, *Chaenotheca chlorella*, *Chaenotheca phaeocephala*, *Cliostomum corrugatum*, *Gyalecta ulmi*, *Lobaria pulmonaria*, *Parmelia acetabulum*, *Parmelia tiliacea*, *Pertusaria flavida*, *Pertusaria hemisphaerica*, *Pertusaria pertusa*, *Sclerophora spp*;

beetles and other insects: *Agrilus biguttatus*, *Gnorimus nobilis*, *Gnorimus variabilis*, *Lasius brunneus*, *Liocola marmorata*, *Lucanus cervus*, *Lymexylon navale*, *Osmoderma eremita*, *Pseudocistela ceramboides*, *Velleius dilatatus*..

Best management for the biodiversity values:

Giant trees have their origin in an open position and both the tree itself and the tree-dwelling habitat specialists demand good sun exposure. In order to preserve the high biodiversity values, other trees and bushes must be cleared and cut away so that there will be a free space of at least 2 m from the outermost branch tip of, for example, the oak crown to the outermost branch tip of the closest standing tree. Experience shows that in some cases oaks dies if the change from darkness to sunexposure is to quick, for example if single oaks are retained on a clear-felling. In these cases the best might be to clear around the oak as described above but also leave a shelterzone outside the cleared area. If a giant tree has its origin in dense forest, its surroundings should in many cases be left untouched.

4. WIND-FALLEN FOREST (VEJG)

A mature or near-mature aged, relatively varied, forest stand influenced by significant windfall. Younger monocultures influenced by windfall are not considered WKHs. The tree layer may consist of any tree species and the stand structure and ground flora may be of different kinds before the windfall. The WKH contains a large amount of CWD. The forest does not necessarily have long forest continuity. The area will remain as WKH until the woody debris is completely decomposed, but might then loose its quality as a WKH.

Best management for the biodiversity values:

The best management is no management at all. No dying trees or woody debris should be removed from the stand.

5. HABITAT SPECIALISTS AND INDICATOR SPECIES

5.1. POLYPORES

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

Species	*Value*	*Acronym*	*Latvian name*
Asterodon ferruginosus	1	AST FERR	Rusassene, saraina
Aurantiporus croceus	1	AUR CROC	Zeltpore, koša
Fomitopsis rosea	1	FOM ROSE	Piepe, rožaina
Phellinus ferrugineofuscus	1	PHE FEFU	Cietpiepe, tumšbruna
Phellinus nigrolimitatus	1	PHE NIGR	Cietpiepe, melnsvitras
Phellinus viticola	1	PHE VITI	
Dentipellis fragilis	2	DEN FRAG	
Dichomitus campestris	2	DIC CAMP	
Fistulina hepatica	2	FIS HEPA	Aknene, parasta
Hericium coralloides	2	HER CORA	Dižadatene, zaraina
Leptoporus mollis	2	LEP MOLL	
Phellinus ferruginosus	2	PHE FERR	Cietpiepe, bruna
Polyporus badius	2	POL BADI	Katinpiepe, kastanbruna
Xylobolus frustulatus	2	XYL FRUS	Rutaine, plaisajoša

Indicator species

Latin name	*Acronym*	*Latvian name*
Clavicorona pyxidata	CLA PYXI	Svectursene, lapukoku
Gloeoporus taxicola	GLO TAXI	
Grifola frondosa	GRI FRON	Cemurene, daivaina
Inonotus rheades	INO RHEA	
Junghuhnia nitida	JUN NITI	
Oxyporus corticola	OXY CORT	
Phaeolus schweinitzii	PHA SCHW	
Phellinus populicola	PHE POPU	
Pycnoporellus fulgens	PYC FULG	Eglpiepe, liesmaina
Skeletocutis nivea	SKE NIVE	

Group *B*- good to learn while becoming more experienced

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	*Value*	*Acronym*	*Latvian name*
Climacocystis borealis	1	CLI BORE	
Junghuhnia collabens	1	JUN COLL	
Oligoporus guttulatus	1	OLI GUTT	
Oligoporus leucomalellus	1	OLI LEUC	
Oligoporus placentus	1	OLI PLAC	
Phlebia centrifuga	1	PHL CENT	
Rigidoporus crocatus	1	RIG CROC	Cietpore, melnejoša
Skeletocutis odora	1	SKE ODOR	
Skeletocutis stellae	1	SKE STEL	
Ceriporiopsis pannocincta	2	CER PANN	
Inonotus dryophilus	2	INO DRYO	
Perenniporia subacida	2	PER SUBA	
Skeletocutis lenis	2	SKE LENI	

5.2. LICHENS

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	*Value*	*Acronym*	*Latvian name*
Bactrospora spp.	1	BACTROS	
Alectoria sarmentosa	2	ALE SARM	Alektorija
Calicium adspersum	2	CAL ADSP	Kalicijs
Chaenotheca phaeocephala	2	CHA PHAE	Henoteka
Collema spp.	2	COLLEMA	Kolemas
Lobaria pulmonaria	2	LOB PULM	Plauškerpis, parastais
Menegazzia terebrata	2	MEN TERE	Menegacija, caurumota
Nephroma spp.	2	NEPHROM	Nefromas
Parmeliella triptophylla	2	PAR TRIP	Parmeliella, koralveida
Sclerophora spp.	2	SCLEROP	Skleroforas
Thelotrema lepadinum	2	THE LEPA	Telotrema, zvinaina

Indicator species

Latin name	*Acronym*	*Latvian name*
Acrocordia gemmata	ACR GEMM	
Arthonia leucopellea	ART LEUC	Artonija
Arthonia spadicea	ART SPAD	Artonija
Arthonia vinosa	ART VINO	Artonija
Bacidia rubella	BAC RUBE	Bacidija
Chaenotheca brachypoda	CHA BRAC	Henoteka
Graphis scripta	GRA SCRI	Kerpis, rakstu
Lecanactis abietina	LEC ABIE	Lekanaktis, diženglu
Leptogium saturninum	LEP SATU	Leptogija, piesatinata
Peltigera collina	PEL COLL	Peltigera
Pertusaria pertusa	PER PERT	Pertuzarija, rugta

Group *B*- good to learn while becoming more experienced

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	***Value***	***Acronym***	***Latvian name***
Arthonia byssacea	1	ART BYSS	Artonija, sikpunktaina
Arthonia cinereopruinosa	1	ART CINE	Artonija, pelnupeleka
Arthonia cinnabarina	1	ART CINN	Artonija, cinobrsarkana
Bacidia rosella	1	BAC ROSE	Bacidija, bala
Buellia violaceofusca	1	BUE VIOL	
Caloplaca lucifuga	1	CAL LUCI	
Cetrelia cetrarioides	1	CET CETR	
Cybebe gracilenta	1	CYB GRAC	
Evernia divaricata	1	EVE DIVA	Evernija, izplesta
Evernia mesomorpha	1	EVE MESO	Evernija, videja
Gyalecta ulmi	1	GYA ULMI	Gialekta, gobu
Hypogymnia vittata	1	HYP VITT	Hipogimnija, lentveida
Leptogium cyanescens	1	LEP CYAN	Leptogija, zilgana
Lobaria scrobiculata	1	LOB SCRO	Plaušķerpis, dobumainais
Opegrapha vermicellifera	1	OPE VERM	Opegrofa, izlocita
Ramalina thrausta	1	RAM TRAU	Ramalina, trausla
Usnea florida	1	USN FLOR	Usneja, dasna
Biatora sphaeroides	2	BIA SPHA	Biatora, lodveida
Chaenotheca chlorella	2	CHA CHLO	Henoteka, zalgana
Cladonia parasitica	2	CLA PARA	
Cliostomum corrugatum	2	CLI CORR	Kliostoma, dzelteniga
Cyphelium sessile	2	CYP SESS	Cifelija, sedoša
Leptogium lichenoides	2	LEP LICH	
Parmelia tiliacea	2	PAR TILI	Parmelina, liepu

Indicator species

Latin name	***Acronym***	***Latvian name***
Buellia alboatra	BUE ALBO	
Hypogymnia farinacea	HYP FARI	
Icmadophila ericetorum	ICM ERIC	
Lecidea botryosa	LEC BOTR	
Parmelia acetabulum	PAR ACET	
Pertusaria flavida	PER FLAV	Pertuzarija, dzelteniga
Pertusaria hemisphaerica	PER HEMI	Pertuzarija, puslodes
Phlyctis agelaea	PHL AGEL	

5.3. BRYOPHYTES

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	*Value*	*Acronym*	*Latvian name*
Frullania tamarisci	1	FRUL TAM	Frulanija, tamarisku
Lophozia ascendens	1	LOPH ASC	Smaillape, astišu
Scapania apiculata	1	SCAP API	Lapstite, smaillapu
Anastrophyllum hellerianum	2	ANAS HEL	Killape, hellera
Bazzania trilobata	2	BAZZ TRI	Bacanija, trejdaivu
Geocalyx graveolens	2	GEOC GRA	Zemessomenite, smaržiga
Hylocomium umbratum	2	HYLO UMB	Stavaine, enaja
Scapania nemorea	2	SCAP NEM	Lapstite, birztalu
Trichocolea tomentella	2	TRIC TOM	Barkstlape, tubaina

Indicator species

Latin name	*Acronym*	*Latvian name*
Anomodon spp.	ANOMOD	Kažocenes
Homalia trichomanoides	HOMA TRI	Gludlape, tieva
Jamesoniella autumnalis	JAME AUT	Džeimsonite, rudens
Jungermannia leiantha	JUNG LEI	Jungermannija, gludkausina
Lejeunea cavifolia	LEJE CAV	Leženeja, doblapu
Leucobryum glaucum	LEUC GLA	Baltsamtite, zilgana
Metzgeria furcata	METZ FUR	Mecgerija, dakšveida
Neckera complanata	NECK COM	Nekera, gluda
Neckera pennata	NECK PEN	Nekera, issetas
Odontoschisma denudatum	ODON DEN	Apallape, kaila

Group *B*- good to learn while becoming more experienced

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	***Value***	***Acronym***	***Latvian name***
Antitrichia curtipendula	1	ANTI CUR	Stardzislene, nokarena
Buxbaumia viridis	1	BUXB VIR	Buksbaumija, zala
Calypogeia suecica	1	CALY SUE	Somenite, zviedru
Neckera crispa	1	NECK CRI	Nekera, vilnaina
Plagiothecium latebricola	1	PLAG LAT	Škibvacelite, nemanama

Indicator species

Latin name	***Acronym***	***Latvian name***
Isothecium alopecuroides	ISOT ALO	Vienadvacelite, lapsastes
Lophozia incisa	LOPH INC	Smaillape, leveru
Rhytidiadelphus subpinnatus	RHYT SUB	Spuraine, pluksnaina
Ulota crispa	ULOT CRI	Sprogaine, parasta

5.4. VASCULAR PLANTS

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	*Value*	*Acronym*	*Latvian name*
Carex disperma	1	CARE DIS	Grislis, divseklu
Cinna latifolia	1	CINN LAT	Cinna, platlapu
Cypripedium calceolus	1	CYPR CAL	Dzegužkurpite, dzeltena
Epipogium aphyllum	1	EPIP APH	Epipogija, bezlapu
Galium triflorum	1	GALI TRI	Madara, trejziedu
Geranium bohemicum	1	GERA BOH	Gandrene, Bohemijas
Glyceria lithuanica	1	GLYC LIT	Udenszale, Lietuvas
Hordelymus europaeus	1	HORD EUR	Kapumiezis, Eiropas
Poa remota	1	POA REM	Skarene, skrajziedu
Bromopsis benekenii	2	BROM BEN	Zakauza, Benekena
Circaea lutetiana	2	CIRC LUT	Raganzalite, liela
Dentaria bulbifera	2	DENT BUL	Zobainite, sipolinu
Festuca altissima	2	FEST ALT	Auzene, meža
Galium schultesii	2	GALI SCH	Madara, meža
Ranunculus lanuginosus	2	RANU LAN	Gundega, villaina

Indicator species

Latin name	*Acronym*	*Latvian name*
Allium ursinum	ALLI URS	Mežloks
Corallorhiza trifida	CORA TRI	Korallsakne, trejdaivu
Diphasium tristachyum	DIPH TRI	Plakanstaipeknis, trejvarpu
Listera cordata	LIST COR	Divlape, sirdsveida
Lunaria rediviva	LUNA RED	Menesene, ziemas
Matteucia struthiopteris	MATT STR	Strauspaparde, parasta
Polygonatum verticillatum	POLY VER	Mugurene, mieturu
Sanicula europaea	SANI EUR	Dziedenite, Eiropas

5.5. BEETLES AND OTHER INSECTS

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

(!- possible to recognize by traces)

Latin name	***Value***	***Acronym***	***Latvian name***
Calitys scabra	1	CAL SCAB	
Ceruchus chrysomelinus	1	CER CHRY	Briežvabole, berzu
Chalcophora mariana !	1	CHA MARI	Krašnvabole, liela
Dicerca alni !	1	DIC ALNI	
Gnorimus nobilis	1	GNO NOBI	Praulgrauzis, spidigais
Gnorimus variabilis	1	GNO VARI	Praulgrauzis, blavais
Grynocharis oblonga	1	GRY OBLO	
Lasius brunneus	1	LAS BRUN	
Osmoderma eremita !	1	OSM EREM	Praulgrauzis, lapkoku
Agonum quadripunctatum	2	AGO QUAD	
Anthaxia similis !	2	ANT SIMI	
Buprestis novemmaculata	2	BUP NOVE	
Buprestis octoguttata	2	BUP OCTO	
Liocola marmorata !	2	LIO MARM	Rožvabole, marmora
Lucanus cervus	2	LUC CERV	Briežvabole, diža
Nothorhina punctata !	2	NOT PUNC	Svekotajkoksngrauzis, priežu
Oplocephala haemorrhoidalis	2	OPL HAEM	
Poecilonota variolosa !	2	POE VARI	
Saperda perforata !	2	SAP PERF	
Tragosoma depsarium !	2	TRA DEPS	Dižkoksngrauzis, skujkoku

Indicator species

(!- possible to recognize by traces)

Latin name	***Acronym***	***Latvian name***
Dendrophagus crenatus	DEN CREN	
Necydalis major!	NEC MAJO	Slaidkoksngrauzis, vitolu
Peltis grossa !	PEL GROS	Asmalis, lielais
Thymalus limbatus	THY LIMB	

Group B- good to learn while becoming more experienced

Habitat specialists

(1- very strong value, 2- strong value)

(!- possible to recognize by traces)

Latin name	***Value***	***Acronym***	***Latvian name***
Agrilus biguttatus !	1	AGR BIGU	
Anoplodera sexguttata	1	ANO SEXG	Celmgrauzis, sešplankumu
Anoplodera variicornis	1	ANO VARI	
Boros schneideri	1	BOR SCHN	
Dorcus parallelepipedus	1	DOR PARA	Briežvabole, blava
Ergates faber	1	ERG FABE	Dižkoksngrauzis, lielais
Leptura nigripes	1	LEP NIGR	
Leptura thoracica	1	LEP THOR	
Lymexylon navale	1	LYM NIVA	
Melanophila acuminata	1	MEL ACUM	
Agrilus mendax	2	AGR MEND	
Ampedus erythrogonus	2	AMP ERYT	
Corticeus unicolor	2	COR UNIC	
Denticollis borealis	2	DEN BORE	
Dicerca furcata	2	DIC FORC	
Dicerca moesta	2	DIC MOES	
Harminius undulatus	2	HAR UNDU	
Melandrya dubia	2	MEL DUBI	
Monochamus urussovi	2	MON URUS	
Opilo mollis	2	OPI MOLL	
Platydema violaceum	2	PLA VIOL	
Platyrrhinus resinosus	2	PLA RESI	
Prionus coriarius	2	PRI CORI	Dižkoksngrauzis, priežu
Prionychus ater	2	PRI ATER	
Pseucocistela ceramboides	2	PSE CERA	
Rhamnusium bicolor	2	RHA BICO	
Strangalia attenuata	2	STR ATTE	
Velleius dilatatus	2	VEL DILA	Issparnis, sirsenu

Indicator species

(!- possible to recognize by traces)

Latin name	***Acronym***	***Latvian name***
Mycetophagus quadripustulatus	MYC QUAD	
Platycerus spp.	PLATYCSP	

5.6. MOLLUSCS

Group *A*- very useful to know

Habitat specialists

(1- very strong value, 2- strong value)

Latin name	*Value*	*Acronym*	*Latvian name*
Ena montana	1	ENA MON	Torngliemezis, lielais
Isognomostoma isognomostoma	1	ISO ISO	Vingliemezis, liellupas

Indicator species

Latin name	*Acronym*	*Latvian name*
Limax cinereoniger	LIM CIN	Kailgliemezis, tumšais
Ena obscura	ENA OBS	Torngliemezis, mazais
*Clausiliidae**	CLAUS	Varpstingliemeži

*Clausilidae except Cochlodina laminata. Findings of only Cochlodina laminata should not be recorded under CLAUS.

Group *B*- good to learn while becoming more experienced

Indicator species

Latin name	*Acronym*	*Latvian name*
Bulgarica cana	BUL CAN	Varpstingliemezis, pelekais
Clausilia bidentata	CLA BID	Varpstingliemezis, divzobu
Clausilia cruciata	CLA CRU	Varpstingliemezis, asribu
Clausilia dubia	CLA DUB	Varpstingliemezis, margainais
Clausilia pumila	CLA PUM	Varpstingliemezis, vališveida
Cochlodina orthostoma	COC ORT	Varpstingliemezis, taisnmutes
Lacinaria plicata	LAC PLI	Varpstingliemezis, kroklupas
Macrogastra latestriata	MAC LAT	Varpstingliemezis, skrajribu
Macrogastra plicatula	MAC PLI	Varpstingliemezis, krokainais
Macrogastra ventricosa	MAC VEN	Varpstingliemezis, vederainais
Ruthenica filograna	RUT FIL	Varpstingliemezis, graciozais

6. SEARCH CRITERIA IN THE STATE REGISTER OF FOREST

List no. 1

Species	***Age from:***	***% on stand mixture (from)***
Pinus	121	30
Spruce	111	50
Quercus	101	10
Betula	91	50
Alnus glutinosa	71	30
Fraxinus	61	20
Tilia	61	5
Ulmus	71	5
Acer	61	5
Alnus incana	51	50
Salix caprea	51	10
Populus	61	20

List no. 2

Only in land types: Am; Ap; As; Km; Kp; Ks; Gr; Gs; Lk; Grs; Mrs; Dms; Vrs; Db

Species	***Age:***	***% on stand mixture (from)***
Pinus	101-120	30
Spruce	95-110	50
Quercus	81-100	10
Betula	81-90	50
Alnus glutinosa	55-70	30
Tilia	41-60	20
Ulmus	61-70	20
Acer	51-60	20

List no. 3

Species	***Age from:***	***% on stand mixture (up to)***
Pinus	151	30
Spruce	151	50
Quercus	151	10
Betula	100	50
Alnus glutinosa	100	30
Fraxinus	100	20
Alnus incana	70	50
Salix caprea	70	10
Populus	110	20

List no. 4

Only in land type: Nd

Species	***Age:***	***% on stand mixture (from)***
Spruce	95-110	50

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