Vegetation analysis and distribution maps for EUNIS habitats

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Report EEA/NSV/14/006

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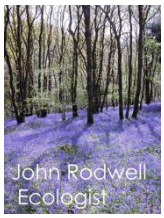

Date: 08 December 2014

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1 Introduction

The EU and global biodiversity targets for 2020 call for an enhanced capability of monitoring, reporting and assessing progress in the thematic area of biodiversity. A review of the available tools used to describe components of biodiversity at a European scale is a necessary preparatory action to meet the needs of the new biodiversity targets.

The EEA hosts and maintains the Biodiversity Data Centre, where European data sets and information on sites, species and habitats of Europe are coordinated and published. Together with data sets provided by other environmental data centres, these data sets support the assessment of progress in achieving biodiversity targets as shown in the Biodiversity Information System for Europe (BISE).

The EEA has developed the EUNIS habitat classification (Davies & Moss 1999; Davies et al. 2004; Moss 2008) and maintains it as part of the Biodiversity Data Centre. The aim of the EUNIS habitat classification is to provide a pan-European reference set of habitat units with a common unit description within a hierarchical classification aiming to fulfil specific objectives and support specific applications related to biodiversity monitoring and reporting at the European scale. Such applications include reporting for the implementation of the EU Habitats Directive and the Bern Convention, as well as providing information in the context of the Common Agricultural Policy and the Regional Development Funds. A European standard list of habitat types is also necessary for the implementation of the INSPIRE Directive, to which other national or regional classifications will have to make reference to be comparable.

Further to the above, the EEA is participating in MAES (Mapping and Assessment of Ecosystem and their Services), an activity within the framework of the EU Biodiversity Strategy. Relevant to this activity and in support of the ecosystem assessment of Europe, is the development of a baseline for documenting, monitoring and assessing the quality of habitats across Europe, by analysing existing *in situ* vegetation monitoring data in accordance with the EUNIS habitat classification.

Underpinning the EUNIS classification with well-documented information on the highly diverse European vegetation is a long-existing wish and, for this purpose, crosswalks have been developed between level 3 EUNIS terrestrial habitat types and vegetation syntaxa. The first crosswalks date from 1998 (Rodwell et al. 1998), which have been updated in 2002 (Rodwell et al. 2002) and more recently in 2012 (Schaminée et al. 2012). More work was considered necessary however, for strengthening the descriptions of species

compositions at level 3 by cross-referencing them with alliances derived from real in-situ vegetation data. To achieve this, a review of the EUNIS forest habitat types was carried out in 2013 (Schaminée et al. 2013) on the basis of in-situ vegetation measurements across Europe and the newly compiled overview of syntaxa (EuroVegChecklist, Mucina et al. 2014, version July 2012). Proposals were made for improvements in the relevant parts of the EUNIS classification (e.g. additional habitats, reorganisation of the existing units within the hierarchy), allowing the further development of the EUNIS classification on a robust scientific basis.

The present project treats heathlands, scrub and tundra. These habitat types are given priority as the existing classification and descriptions limit the usability of the EUNIS habitat classification, especially in the Mediterranean region. More specifically, the project will review the description and classification of level 3 of habitat group F of EUNIS (Heathland, scrub and tundra) as well as heathland and scrub included under habitat group B (B1.5: Coastal dune heaths; B1.6: Coastal dune scrub; B2.5: Shingle and gravel beaches with scrub). As with the 'EUNIS forest habitat review' (Schaminée et al. 2013), proposals are made for improvements of the EUNIS classification.

A second focus of the project is to provide maps and descriptions for each of the 38 forest habitat types in Appendix D of the 'EUNIS forest habitats review' report (Schaminée et al. 2013), in the standard EUNIS format, building on the results of the analysis presented in the report. Maps present the distribution of phytosociological relevés attributed to each EUNIS habitat type and the habitat suitability of each habitat type based on distribution models.

The objectives of this project were specified as tasks in the Annex I of the project specification (EEA/NSV/14/006) and elucidated in the Inception Report (June 2014, Service Contract No. 3417/B20134/EEA.55773):

- **Task 1** To determine and provide the floristic composition of heath and scrub vegetation syntaxa at the level of alliances of the EuroVegChecklist using the available vegetation databases and published sources.

- **Task 2** Based on the results of Task 1, to review and provide the descriptions of habitat at level 3 and propose improvements of the EUNIS heathland, scrub and tundra habitat classification as well as to provide for relevant updates to the EUNIS-EuroVegChecklist crosswalks. Also provide recommendations on how the work carried out would contribute to organising further a European-wide in situ data collection for assessment of heathland, scrub and tundra ecosystems, e.g. distribution maps for heathland, scrub and tundra habitats.

- **Task 3** To deliver maps of distribution of phytosociological relevés and probability of distribution based on distribution models for each of the 38 forest habitat types in Appendix D of the EEA 2013 report 'EUNIS forest habitats review'. To provide descriptions in the standard EUNIS format for each of the above EUNIS forest habitat types, and to provide

input for relevant updates in relation to forests for each alliance of the EuroVegChecklist to the EUNIS-EuroVegChecklist crosswalks of 2012 (in case changes have been introduced to the latter).

- **Task 4** To prepare and present an Inception Report on Tasks 1 and 2 as the basis for discussion in the Inception meeting and revise it if modifications are agreed in the Inception meeting.

- **Task 5** To participate in two meetings with the EEA (dates to be agreed bilaterally), the first being the Inception meeting and the second a Progress meeting.

2 Description and classification of EUNIS heathland, scrub and tundra habitats on the basis of in situ vegetation measurements throughout Europe – Task 1

2.1 Background

The present study is based on cross-walking two different European classification systems, which were developed more or less independently and for different purposes. On the one hand, there is the classification of vegetation types provided by phytosociology, the tradition which uses fine-scale vegetation-plot data on plant species composition and cover for 'bottom-up' fine-grained delimitation and characterisation of plant associations (Braun-Blanquet 1928; Tüxen 1937). On the other hand, there is the classification of habitat types, providing a pan-European reference system for policy making with a common unit description within a hierarchical classification, presently known as the EUNIS habitat classification (Davies & Moss 1999; Davies et al. 2004; Moss 2008).

The vegetation classification in particular is facing a new era, as a result of the availability nowadays of high-capacity computers and software packages for processing phytosociological data. During the last century, numerous studies have resulted in a large number of formally described associations, alliances, orders and classes throughout Europe, but their delimitation usually remained incomplete and contentious due to various theoretical constraints and methodological problems. In an attempt to achieve a respectable level of stability, the European Vegetation Survey (EVS) developed in the early years of the 21st century the first overview of European vegetation units at the levels of alliances, orders and classes, published as *The Diversity of European Vegetation* (Rodwell et al. 2002). From that moment onwards, the overview of European syntaxa has undergone substantial expert revision by a team under the leadership of Professor Ladislav Mucina. The new product, the EuroVegChecklist, is more comprehensive (covering all Europe as well as territories such as the Azores, Canary Islands, Cyprus, Caucasus and Greenland), scientifically robust, better grounded within current phytosociological understanding, and more meaningful for application within the user community. The 2013 version of this EuroVegChecklist was used for the EUNIS forest habitat revision (Schaminée et al. 2013) and, after further revision, was submitted for publication in 2013 and resubmitted after review in June 2014 (Mucina et al. 2014).

2.2 Vegetation-plot data as a scientific basis for habitat classification

As described in the project plan (*Research proposal EEA/NSV/14/006*), plot samples as collected by phytosociologists (Braun-Blanquet 1928, Mueller-Dombois & Ellenberg 1974) provide the most numerous and widely dispersed in-situ records of vegetation across Europe. Comprising at minimum a list of vascular plant species with an estimate of cover-abundance in plots ranging from less than 1 m^2 to a few hundreds m^2 (Chytrý & Otýpková 2003), such samples are dated and spatially located in a way that gives a record of the composition of vegetation at a particular time and place. In phytosociology, they have formed the basis of the classification of vegetation into associations organised into hierarchical systems, and have thus helped furnish inventories and maps of sites and accounts of the vegetation of countries and regions (e.g. Rodwell 1991 et seq.; Mucina et al. 1993; Schaminée et al. 1995 et seq.; Valachovič et al. 1995 et seq. Chytrý 2007 et seq.).

Various enquiries within and outside the EVS (Ewald 2001; Schaminée et al. 2009) have provided an insight into the patterns of accumulation of vegetation plots across Europe over the past 90 years. The latest estimates (based on data from 32 countries) suggest that more than 4.3 million vegetation descriptions have been recorded. Most of plots have been made in the countries of central and western Europe, particularly Germany, the Netherlands and France, but considerable numbers were also estimated for Poland, Spain, the Czech Republic, Italy, the United Kingdom and Austria (Schaminée et al. 2009).

The development of compatible software tools, one of the EVS core work objectives, has greatly encouraged the development of national and regional vegetation databases and fostered the creation of a network facilitating data exchange and research collaborations, and assisted the emergence of supra-national vegetation revisions and overviews over the last twenty years. The major software tool for database development has been TURBOVEG (Hennekens & Schaminée 2001), now accepted as an international standard for data input, storage, management and retrieval, and installed in over 30 countries in Europe and beyond. Complementary to TURBOVEG, the JUICE program (Tichý 2002) has added a wide range of analytical tools for data sets that can comprise thousands of relevés.

The most recent study designed to collect estimates of the total number of vegetation plots in Europe (Schaminée et al. 2009), revealed that more than 1.8 million relevés had been already computerised, 75% of which were found in centralised databases of countries or regions. Of all captured relevés, 59% were available in TURBOVEG format. Further key steps have now been taken by many EVS members to locate and capture additional plots, and to centralise data storage of such plots. In 2011, the Global Index of Vegetation-

Plot Databases platform (GIVD) was launched (Dengler et al. 2011) to provide a meta-resource of electronic databases whose hosts are willing in principle to share the captured data. At present (08-11-2014; http://www.givd.info/), 206 databases with 3,015,737 vegetation plots have been registered, a large part of them with records of European vegetation. The GIVD platform also assists in revealing gaps in the coverage and/or availability of the vegetation plot data.

Another young initiative – the European Vegetation Archive (EVA; announced at the Annual meeting of the European Vegetation Survey in Vienna in 2012) – yielded a centralised database of vegetation plots by storing copies of national and regional databases on a single software platform using a unified taxonomic reference database. Data storing in EVA does not affect the ongoing independent development of the source databases. EVA Data Property and Governance Rules (www.euroveg.org/eva-database), approved in 2012, guarantee that data property rights of the original contributors are respected. By November 2014, 41 databases from all European regions, including the largest ones, joined EVA. These databases contained in total 646 439 vegetation plots from most European regions, especially from western, central and southern Europe. However, there is a remarkable lack of data from Scandinavia and eastern European countries, i.e. European regions with less strong or interrupted phytosociological tradition. Vegetation-plot records are stored in EVA in three access regimes: free (available to anybody), semi-restricted (available in principle to the group of other data contributors) and restricted (available in principle to the group of other data contributors based on specific consent). These three access regimes are represented in turn by 6%, 82% and 12% of the total EVA database.

A prototype of the database management software TURBOVEG 3 was developed for joint management of multiple databases, that uses different species lists. This software also includes procedures for handling data requests, selections and provisions according to the approved EVA Rules. A specific challenge for EVA is combining multiple species lists based on different taxonomies used in national and regional databases. This is managed using the SynBioSys Taxon Database, which was initially established for the purposes of the *SynBioSys Europe* project and is now further developed and extended within the framework of EVA. Each relevé in this Archive has a unique Global Unified identifier (GUID) and version control will be used to keep track of date changes. Several specific projects devoted to detailed diversity assessment of selected vegetation types started within the EVA initiative in 2014. A prototype project for the EVA initiative is the Braun-Blanquet Project, aiming at the compilation and analysis of floristic and geographical information on European vegetation types. The project, led by Dr. Borja Jiménez-Alfaro, is dedicated to Josias Braun-Blanquet, whose legacy has been the inspiration for collecting the large datasets of vegetation-plot data (http://www.sci.muni.cz/botany/vegsci/braun_blanquet.php?lang=en) in Europe.

The vegetation-plot data used in the Braun-Blanquet Project form the basis for determining and providing the floristic composition of heathland, scrub and tundra vegetation data, in a similar fashion as in the EEA 2013 project on forest habitat types (Schaminée et al. 2013). As indicated before, the main input has come from computerized databases set up at many places throughout Europe. This refers to both 'single relevé databases' as well as to 'databases with constancy tables'; the second option is adequate for assessing the species composition of the heathland, scrub and tundra habitat types, but for the actual distribution of forest types (see Chapter 4) single, georeferenced vegetation plot data are needed.

The task to revise the EUNIS heathland, scrub and tundra habitat types is based on the current version of EUNIS level 3 and the 2013 version of the EuroVegChecklist, as presented at the Annual Symposium of the International Association for Vegetation Science (IAVS) in Perth earlier this year (1-5 September 2014) and submitted to the international journal *Applied Vegetation Science* for publication.

2.3 Update of crosswalks between EUNIS heathland, scrub and tundra habitats and EuroVegChecklist

The crosswalk between the EUNIS habitat types and phytosociological alliances, prepared for the 2012 report on the development of vegetation syntaxa crosswalks to EUNIS habitat classification (Schaminée et al. 2012),

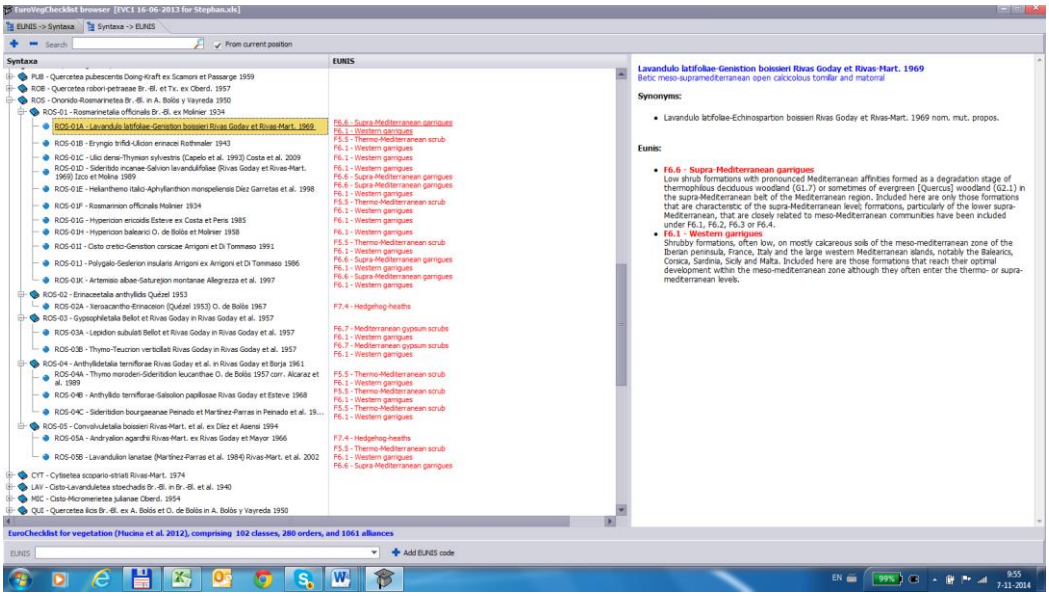

Figure 2.1. EuroVegChecklist browser with tab "Syntaxa -> EUNIS" open, based on the submitted version (2013) of the EuroVegChecklist.

was based on a version of the European Vegetation Checklist (EuroVegChecklist) from July 2012. However, the EuroVegChecklist was subjected to further modifications after July 2012 until it was ultimately submitted for publication on 30 March 2013. In the process of peer reviewing, the checklist has been further updated, based on the latest syntaxonomic discussions and insights. The submitted version of EuroVegChecklist recognizes 101 classes, 279 orders and 1,052 alliances. The document comprises 274 pages of text and several electronic appendices, including diagnostic species of classes, glossary of terms, bibliographic appendices, desktop browser and analytical tools. There are 32 authors from 16 countries. The overview also includes more than 4,000 scientific synonyms, that offer the connection with vegetation types published in the past (Mucina et al. 2014).

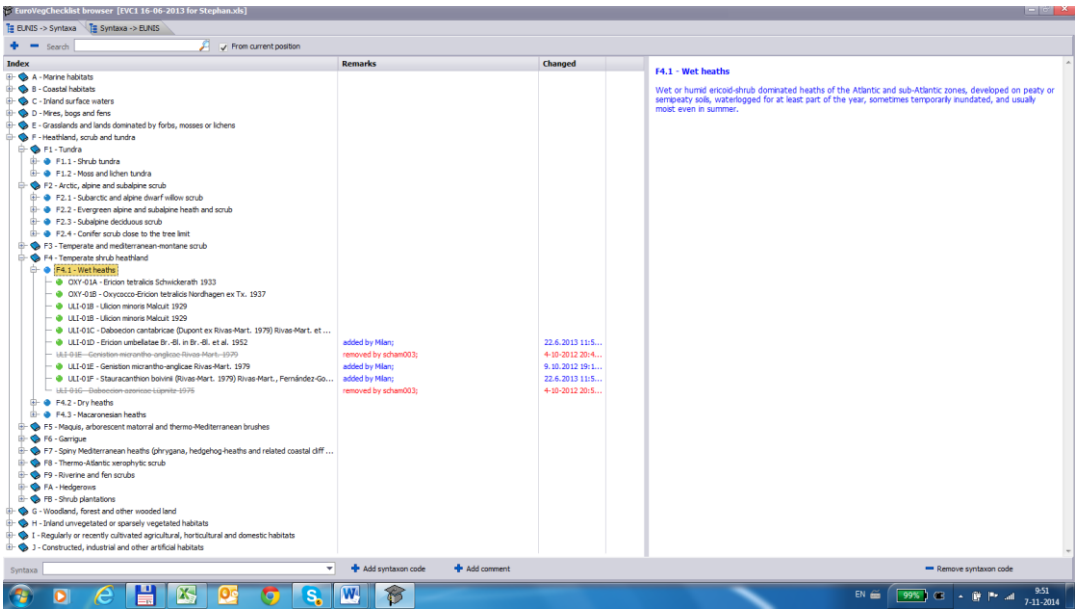

Figure 2.2. Screen shot of SynBioSys Europe, showing the crosswalks from EUNIS to syntaxa (left panel) and syntaxa to EUNIS (right panel).

In order to work with the updated version of European vegetation classification in the current project, we revised the EUNIS-syntaxa crosswalk to match the submitted version of EuroVegChecklist. Ladislav Mucina, the senior author of EuroVegChecklist, took part in this revision. This revision

reflected the merging of some alliances, the splitting of others, the introduction of new alliances and changes in the delimitation of some alliances that influenced established matches to the EUNIS habitat types.

To ease the workflow, a tool, called the EuroVegChecklist browser (see Figure 2.1 and Figure 2.2), has been developed for linking EUNIS habitats to alliances.

In relation to the definition of heathland, scrub and tundra, the following EUNIS types have been taken into account for the current task: B1.5 (Coastal dune heaths), B1.6 (Coastal dune scrub), B2.5 (Shingle and gravel beaches with scrub) and F (Heathland, scrub and tundra). The syntaxa of the EuroVegChecklist that have been considered were selected on the basis of the crosswalks. The EUNIS categories FA (Hedgerows) and FB (Shrub plantations) were not dealt with, as these types are based on a mixture of concepts. Some of these units correspond to physiognomic types that are unrelated to phytosociological types, whereas other units are complexes of different vegetation types.

2.4 The floristic composition of EUNIS heathland, scrub and tundra habitats at the level of alliances of the EuroVegChecklist

The floristic composition of the EUNIS heathland, scrub and tundra types has been determined on the basis of the floristic composition of the corresponding phytosociological alliances, according to the revised crosswalk EUNIS-syntaxa (Appendix A). As a basis for the analysis, a database of 930,000 relevés has been compiled, in TURBOVEG format (see Paragraph 2.2), of which 34,000 relevés could be assigned to heathland, scrub or tundra. This database contains datasets from a wide range of data providers throughout Europe (Appendix E).

The procedure consists of two steps. In a first step, the relevés of these – regional and national – datasets have been classified at the level of alliances of the 2013 EuroVegChecklist (submitted version). This was done by matching regional and national classification systems to which the relevés in the datasets of the data providers were assigned, with the European overview. At present, about 60% of the 930,000 relevés could be assigned to one of the alliances accepted in the 2013 EuroVegChecklist (565,000), 6% of which belong to heathlands, scrubs or tundra habitat. In a second step, the assignment to the EUNIS heathland, scrub and tundra habitat types was performed by merging the datasets of the alliances to the corresponding EUNIS type (according to the EUNIS-syntaxa crosswalk) and by averaging based on national constancy columns (not by simply adding up). Here we give

an example to illustrate this. Let us presume that we have data from two countries for a certain alliance, from the Czech Republic and Spain. If the occurrence of species A is 50% of Czech relevés from a total of 1,000 (=500) and 10% of Spanish relevés from a total of 100 (=10), then by simple taking the total number of relevés, a total frequency of 46% (510 relevés from a total of 1,100) would be the outcome, which is mainly determined by the larger dataset of the Czech Republic. If we apply average frequencies, the result would be a mean frequency of 30%, which probably is more representative across a broader region of Europe. For Russia, separate constancy columns were made for different regions before averaging, not for the whole country, because it is extremely large.

In the crosswalk, 215 heathland, scrub and tundra alliances of the EuroVegChecklist have been assigned to one of the 35 EUNIS heathland, scrub and tundra habitat types. At present, for 164 of these alliances in-situ vegetation data (relevés), i.e. 76%, were available. With regard to the EUNIS heathland, scrub and tundra habitat types, 32 out of 35 have been covered by real data (91%). As mentioned before (Paragraph 2.3), the categories FA and FB are not dealt with, as these EUNIS types are based on a mixture of concepts. The reasons for having no in-situ vegetation data for certain alliances are the following:

(1) Narrow alliance concepts in the EuroVegChecklist. For some heathland, scrub and tundra types, the EuroVegChecklist uses a narrow concept of alliances, which has not been used before. Relevés in the original databases are not classified to these alliances and correct assignment is difficult.

(2) Alliances described from Asia, occurrence in Europe not documented. They may occur in eastern or south-eastern Europe, but European data are scarce or non-existing.

(3) Alliances from regions with general lack of phytosociological data. Some areas are still not well covered in the vegetation databases available for the Braun-Blanquet project, like the Boreal zone of Scandinavia and Russia, Ukraine, Caucasus, parts of Balkan, and Cyprus.

(4) Macaronesian and Iberian alliances not recognized in the Spanish SIVIM database. In a few cases there are discrepancies between the concepts used in EuroVegChecklist and those recognized in SIVIM, making difficult to split original relevés into different EVC concepts.

3 Reviewing the EUNIS heathland, scrub and tundra habitats – Task 2

3.1 Background

The development of the EUNIS Habitat Classification (Davies & Moss 1999) afforded a fresh opportunity to provide a sound scientific cross-reference between widely accepted classification of European habitats and phytosociological definitions of vegetation types, as indicated in the *Introduction* (Chapter 1). Some 15 years ago, a team of the European Vegetation Survey (EVS) developed a crosswalk between phytosociological units to the level of the alliance and EUNIS habitats at level 3. *The Scientific Background to the EUNIS Habitat Classification* (Rodwell et al. 1998) provided the first overview of European vegetation types to the level of alliance, after which, in 2002, the booklet *The Diversity of European Vegetation* provided crosswalks from the EUNIS Level 3 habitats to the syntaxa and vice versa, accompanied by brief verbal descriptors of the vegetation units (Rodwell et al. 2002). In a recent EEA project, these crosswalks have been revised and updated (Schaminée et al. 2012).

Since the original crosswalk was developed, there have been only relatively modest changes to the terrestrial sections of the EUNIS Habitat Classification (Evans, personal communication). However, the overview of European syntaxa has undergone substantial expert revision, as discussed in Paragraph 2.1. In Paragraph 2.3, information has been provided on the update of the EuroVegChecklist and the crosswalks between the EUNIS classification and this checklist.

3.2 Review of the EUNIS heathland, scrub and tundra habitat classification

As mentioned above (Par. 2.3) the following EUNIS heathland, scrub and tundra habitat types were considered: F1-6 from the main category F, and three habitat types from category B: B1.5 (Coastal dune heaths), B1.6 (Coastal dune scrub) and B2.5 (Shingle and gravel beaches with scrub).

In line with the recommendations for improving the EUNIS forest habitat classification, similar conclusions can be drawn for the heath and scrub habitats. They will involve two types of recommendations, one concerning the classification itself, with recommendations for new units, splitting and merging

existing units and removing units considered unnecessary, and one dealing with their naming (see the EEA 2013 report fur further details; Schaminée et al. 2013).

Classification By comparing the existing EUNIS classification with the phytosociological content of the assigned syntaxa, we found strong grounds for revising the EUNIS types B1.5, B1.6, F2.2, F3.1, F3.2, F5.1, F5.2 and F1.7. We further propose to delete B2.5 (Shingle and gravel beaches with scrub) as a distinct habitat type, as the particular species composition of such habitats is similar to that of other shingle and gravel beaches (B1, B2, B3). The same applies to F6.5 Macaronesian garrigues, which can be deleted too as these low and open shrub communities of the Canary Islands, Azores and Madeira are coastal and covered by habitat types B1-3.

Proposal for improvement of the EUNIS types:

EUNIS B1.5 Coastal dune heaths. These stable dunes with a leached surface and vegetation dominated by various dwarf shrubs should be split into two types, according to the dominant species. The proposed separation in B1.5a *Atlantic and Baltic coastal Empetrum heaths* (with 1 alliance) and B1.5b *Atlantic coastal Calluna and Ulex heaths* (with 3 alliances) goes along well with the division in the equivalent Natura 2000 habitat types H2140 (Decalcified fixed dunes with *Empetrum nigrum*) and H2150 (Atlantic decalcified fixed dunes of the *Calluno-Ulicetea*), which is an extra advantage.

EUNIS B1.6 Coastal dune scrub. These stable dunes with scrub should be split in two geographically defined types, resulting in B1.6a Atlantic and Baltic coastal dune scrub (with 6 alliances), with *Hippophae rhamnoides* and *Salix repens* as dominant shrub species, and B1.6b Mediterranean and Black Sea coastal dune scrub (with 13 alliances), with *Juniperus* and other sclerophyllous shrubs as dominant species. A separate status could be given to the Macaronesian coastal dune scrub, but such communities are poorly developed. The proposed division reflects the classification scheme of most of the other coastal habitat types

EUNIS F2.2 Evergreen alpine and subalpine heath and scrub. These small, dwarf or prostrate shrub formations of the alpine and subalpine zones of mountains should be split into three types, on the basis of dominant growth form, resulting in F2.2a Alpine and subalpine ericoid heaths (11 alliances), F2.2b Alpine and subalpine *Juniperus* scrub (7 alliances) and F2.2c Alpine and subalpine genistoid scrub (2 alliances). The naming of the habitat types after dominant growth forms makes the indication 'evergreen' in the name superfluous.

We recommend combining the mostly deciduous *EUNIS F3.1 Temperate thickets and scrub* and *EUNIS F3.2 Submediterranean deciduous thickets and*

scrub and then splitting this combined group into six types on the basis of dominant growth forms (with a separate habitat type for forest clearings): F3.1a Lowland to montane temperate and submediterranean *Juniperus* scrub (3 alliances), F3.1b Temperate bramble scrub (2 alliances), F3.1c Lowland to montane temperate and submediterranean genistoid scrub (11 alliances), F3.1d Temperate forest clearing scrub (2 alliances), F.3.1e Temperate and submediterranean thorn scrub (17 alliances), and F3.1f Low steppic scrub (2 allianes).

We recommend combining the evergreen sclerophyllous and/or lauriphyllous mediterranean vegetation *EUNIS F5.1 Arborescent matorral* and *EUNIS F5.2 Maquis* into one habitat type, as these types are floristically difficult to distinguish. The resulting F5.1-2 Arborescent matorral and maquis (17 alliances) houses tall shrub communities that are dominated by phanerophytes.

EUNIS F6.1 Western garrigues. These mediterranean shrub formations should be split into two types on the basis of soil characteristics (basophilous versus acidic) in this part of the Mediterranean region, resulting in F6.1a Western basophilous garrigues (13 alliances) and F6.1b Western acidic garrigues (7 alliances). In the eastern part of the Mediterranean region this variation is less prominent, and a split here in the two habitat types of the Eastern garrigues (F6.2) is not recommended.

EUNIS F6.8 Xero-halophile scrub. These salt-tolerant shrub formations of the Mediterranean zone and Caspian Sea should be split into two types on the basis of geographic variation, resulting in F6.8a Mediterranean halo-nitrophilous scrub (12 alliances) and F6.8b Caspian Sea halo-nitrophilous scrub (3 alliances). Moreover, as these scrubs in these parts of Europe are more or less by definition xerophytic, it seems to be better to name them after their tolerance for salt and high amounts of nitrogen.

We recommend combining *EUNIS F7.1 West Mediterranean spiny heaths* and *EUNIS F7.2 Central Mediterranean spiny heaths* into one habitat type, as these types are floristically difficult to distinguish. Moreover, we propose renaming the resulting habitat type and restricting it to coastal areas, as these shrub formations tend to overlap with F6.1, resulting in F7.1 Western Mediterranean spiny scrubs on coastal cliffs.

EUNIS F7.4 Hedgehog-heaths. These, often spiny, cushion heaths of the Mediterranean mountains should be split into four types on the basis of geographic variation. Moreover, it seems to be appropriate to reflect their mountainous occurrence in the name, resulting in F7.4a West-Mediterranean mountain hedgehog heaths (9 alliances), F7.4b Central Mediterranean mountain hedgehog heaths (8 alliances), and F7.4c East-Mediterranean hedgehog heaths (7 alliances) and F7.4d Macaronesian mountain hedgehog heaths (3 alliances).

Naming: With regard to the names of the EUNIS forest habitat types we could derive a set of general recommedations, which we have applied to the existing classification. Where relevant, we have clarified our suggestions by one or more examples.

General recomendation 1: Adopt brief and clear names for the habitat types.

General recommendation 2: Names within a group of related habitat types should be mutually exclusive with regard to, for example, biogeographic zone. Example: F6.1 Western garrigues (to be split in acidic and basophilous), F6.2 Eastern, non-Illyrian garrigues, F6.3 Illyrian garrigues, F6.4 Black Sea garrigues. The addition 'non-Illyrian' is attached to the name of habitat type F6.3, because the Adriatic coast is part of the East Mediterranean region.

General recommendation 3: Do not use square brackets to indicate scientific names. If included, scientific taxon names should be in italics.

General recommendation 4: Use a standardized naming. Example: use only the name heaths instead of alternatively heaths or heath, like in F2.2 Evergreen alpine and subalpine heath and scrub. Another example is the use of the name 'fields' in F5.4 Spanish-broom (Spartium junceum) fields, which easily can be changed into F5.4 *Spartium junceum* scrub.

3.3 Proposed changes in the EUNIS heathland, scrub and tundra habitats

Applying these recommendation with regard to content and naming would result in the following updated list of EUNIS heathland, scrub and tundra habitat types (habitat types with changes in names are indicated with an *; in such case, the existing name is put within brackets behind the proposed new name):

► B1.5 Coastal dune heaths could be divided into two types, according to dominant species:

►► B1.5a Atlantic and Baltic coastal *Empetrum* heaths

►► B1.5b Atlantic coastal *Calluna* and *Ulex* heaths

► B1.6 Coastal dune scrub should be split into two types on the basis of geographical variation:

►► B1.6a Atlantic and Baltic coastal dune scrub

►► B1.6b Mediterranean and Black Sea coastal dune scrub

► B2.5 Shingle and gravel beaches with scrub should be merged with other habitat types on shingle and gravel beaches

► F1.1 Shrub tundra

► F1.2 Moss and lichen tundra

► F2.1 Subarctic and alpine dwarf willow scrub

► F2.2 Evergreen alpine and subalpine heath and scrub should be split into three types, on the basis of dominant growth form:

►► F2.2a Alpine and subalpine ericoid heaths

►► F2.2b Alpine and subalpine *Juniperus* scrub

►► F2.2c Alpine and subalpine genistoid scrub

► F2.3 Subalpine and subarctic deciduous scrub

► F2.4 Subalpine *Pinus mugo* scrub* [Conifer scrub close to the tree limit]

► F3.1 Temperate thickets and scrub and ► F3.2 Submediterranean deciduous thickets and scrub should be merged and than split into six types on the basis of dominant growth form:

►► F3.1-2a Lowland to montane temperate and submediterranean *Juniperus* scrub

►► F3.1-2b Temperate bramble scrub

►► F 3.1-2c Lowland to montane temperate and submediterranean genistoid scrub

►► F3.1-2d Temperate forest clearing scrub

►► F3.1-2e Temperate and submediterranean thorn scrub

►► F3.1-2f Low steppic scrub

► F4.1 Wet heaths* [Wet heath]

► F4.2 Dry heaths* [Dry heath]

► F4.3 Macaronesian heaths* [Macaronesian heath]

► F5.1 Arborescent matorral and ► F5.2 Maquis should be merged into one type as these types are difficult to distinguish:

►► F5.1-2 Arborescent matorral and maquis

► F5.3 Submediterranean pseudomaquis

► F5.4 *Spartium junceum* scrub* [Spanish-broom ([Spartium junceum]) fields]

► F5.5 Thermo-Mediterranean scrub

► F6.1 Western garrigues should be split into two types on the basis of soil characteristics:

►► F6.1a Western basophilous garrigues

►► F6.2b Western acidic garrigues

► F6.2 Eastern, non-Illyrian garrigues

► F6.3 Illyrian garrigues

► F6.4 Black Sea garrigues

► F6.5 Macaronesian garrigues should be merged with other habitat types on shingle and gravel beaches (B1-3).

► F6.6 Supra-Mediterranean garrigues

► F6.7 Mediterranean gypsum scrubs

► F6.8 Xero-halophile scrub should be split into two types on the basis of geographical variation:

►► F6.8a Mediterranean halo-nitrophilous scrub

►► F6.8b Caspian Sea halo-nitrophilous scrub

► F7.1 West Mediterranean spiny heaths and ► F7.2 Central Mediterranean spiny heaths should be merged and renamed:

► F7.1-2 Western Mediterranean spiny scrubs on coastal cliffs

► F7.3 Phrygana* [East Mediterranean phrygana]

► F7.4 Hedgehog-heaths should be renamed and split into two types on the basis of geographical variation:

► F7.4a West Mediterranean mountain hedgehog heaths

► F7.4b Central Mediterranean mountain hedgehog heaths

► F7.4c East Mediterranean hedgehog heaths

► F7.4d Macaronesian mountain hedgehog heaths

► F8.1 Canary Island xerophytic scrub

► F8.2 Madeiran xerophytic scrub

► F9.1 Temperate and boreal riparian scrub

► F9.2 Salix fen scrub

► F9.3 Mediterranean riparian scrub

4 Description and distribution of the revised EUNIS forest habitat types – Task 3

4.1 Background

4.1.1 Existing EUNIS habitat text descriptions

From the start, the aim of a European habitat classification has been to provide a comprehensive and definitive reference list that is scientific, unambiguous and easily understood (Moss & Roy 1998; Moss 2008). To this end, an integral feature of the EUNIS Habitat Classification is the habitat text descriptions which are incorporated into the underlying database, accessible as an interface via the EUNIS website portal and available in the hard-copy download of the Classification published as Davies et al. (2004).

Such text descriptions were not at first included for the CORINE Biotopes that were the forerunner of EUNIS, simply English language titles of the habitats (Internal Technical Handbook 1988, partially updated 1989; see Moss & Roy 1998). The later development of the CORINE Biotopes Manual (Devillers *et al*. 1991) included a descriptive text for each habitat, together with phytosociological and scientific references. When the classification was expanded to the whole Palaearctic, the published version of the classification (Devillers & Devillers Terschuren 1993) did not include text descriptions, simply habitat codes and titles, but in 1995 these were added to the underlying PHYSIS database that had first been released the previous year.

The development of the existing text descriptions in the EUNIS Habitat Classification from earlier versions is detailed in Hill *et al*. (2004a, 2004b): of the 31 forest habitats under consideration here, only 7 retain their original Palaearctic Habitats Classification description but changes in the rest appear to have been relatively minor. The text descriptions are variable in length, detail and content. For the Forest habitats, they all start with some kind of general statement about the character of the habitat though some habitats are termed 'woodland', some 'forest', on the basis, according to the glossary, of whether the tree canopy is open or closed. All descriptions mention one or more tree species which help define the type, in 31% there are some details about structure, often the pattern of dominance, in 2% mention of particular species-richness of the canopy, endemism or composition of the field layer. For 63% of the habitats there is a reference to the biogeographic or bioclimatic zone, in 16% to altitudinal level, in 37% to terrain and in 9% to soils. For 16% of the habitats, there are qualifiers to clarify what is excluded from the habitat.

4.1.2 The EUNIS glossary

There is a glossary appended to the EUNIS Habitats Classification (Davies et al. 2004, since been updated in 2006, version supplied by Doug Evans of the ETC-BD) and this has been derived from various sources: for terrestrial habitats, 28% of terms originate from the Institut Royal des Sciences naturelles de Belgique (presumably the Palaearctic Habitats Classification glossary that was also included in Moss & Roy (1998; Annex III), 16% from the General Multilingual Environmental Thesaurus of EIONET and the remainder from a variety of published dictionaries of the environment, ecology or science and technology in general. In fact, many of the terms in the Glossary, particularly more specific geographical and topographic terms, are redundant, never figuring in the text descriptions of the forests, though they might occur elsewhere.

4.1.3 EUNIS habitat parameters

Within and alongside the text descriptions, EUNIS also incorporates references to habitat attributes termed 'parameters'. So-called 'defining parameters', which refer to, for example, biogeographic zones, substrate type, hydrology and biotic impacts, have been used as criteria for the keys to the habitats for the upper 3 hierarchical levels of EUNIS (Davies et al. 2004). In fact, for the forests, second-level divisions are based not on the physical characteristics of the habitat, but on whether the tree canopy is broadleaved, deciduous, evergreen or mixed; and, at level 3, dominant tree species are often invoked to separate the forest types. Negotiating the fuzzy boundaries that often exist between habitats is aided in the keys by the use of extensive and detailed footnotes to the decision points.

On the EUNIS habitat fact sheets, the text description of each habitat is also accompanied by categorical information under the heading 'Descriptive or diagnostic parameters' on levels of wetness/dryness and chemical characteristics of the substrate, habitat usage but also dominant life-forms and % cover (Davies *et al.* 2004).

The 1995 Paris Workshop on the CORINE Biotopes Sites Database and Habitat Classification recognised that a more thoroughgoing parameterisation of the habitats would improve the utility of the classification (Moss & Roy 1998) and the task was scoped then in terms of a generalisation of the parameter framework that had already been developed for the Nordic Vegetation Classification (Påhlsson 1994). The parameters, categories and look-ups in EUNISHAB 2006 represent the current state of database architecture but they are not linked systematically to the 'Descriptive or diagnostic parameters' of the fact sheets in the EUNIS Habitat Classification itself.

4.1.4 Other considerations and sources for describing European habitats

The Habitats Directive provides 'a common framework for the conservation of wild animal and plant species and natural habitats of Community importance' (CEC 2003) and the definitions provided in Annex 1 include a text description derived from the CORINE Biotopes Manual (Devillers et al. 1991). For each priority habitat (and some non-priority habitats) in the EUR-12, this was later incorporated into more formalised descriptive sheet which established 'clear, operational, scientific definitions of habitat types using pragmatic descriptive elements and taking into account regional variation' and a 'minimal interpretation' was provided for the remaining non-priority habitats based on CORINE (CEC 1995). Text descriptions for new habitats and revisions of existing habitat definitions were produced for EUR15, EUR25, EUR27 and EUR28 with the accession of new countries in 1993, 1995, 2004, 2007 and 2013. The new and revised descriptions were based on a mix of information from the PHYSIS database which gives access to descriptions at EUNIS-4 and EUNIS-5, then subject to negotiation with the existing Member States and accession countries (Evans et al. 2013). Although there is a simple 1:1 correspondence between a EUNIS-3 Forest type and an Annex 1 habitat in only a minority of cases (33%), information at these lower levels allows the often complex relationships between the remainder to be explored. However, unlike the definitions of the EUNIS habitats, the interpretations of the Annex 1 habitats have acquired legislative force through the implementation of the Habitats Directive.

The Diversity of European Vegetation (Rodwell et al. 2002) established the idea of a simple English language descriptor for each alliance that included, as far as possible, standardised references to the vegetation type, the typical physiography and the geographical range, though these were not based on explicit standards nor were the terms used summarised in a glossary. The crosswalk to EUNIS-3 included in that overview enabled such tags to be used to interpret those EUNIS habitats. In the more ambitious EuroVegChecklist, such descriptors have been provided for the more comprehensive range of alliances using terminology summarised in a glossary appended to the typology. This has been compiled bottom-up from the definitions provided by contributors to the EuroVegChecklist, so no terms are redundant. It also incorporates many non-contentious definitions and some frameworks for describing geographical regions, altitudinal levels and bioclimatic zones that have found widespread, though not always universal, favour. Some of these are more applicable to certain parts of Europe than others, like the World Bioclimatic Classification (Rivas-Martínez et al. 2012). Only a minority of terms in this EuroVegChecklist glossary are common to the EUNIS Glossary mentioned above (Davies et al. 2004, revised 2006).

For all the ultimate mapping units of the *Map of the Natural Vegetation of Europe* (including 338 forest types), there is a modular descriptive text including the vegetation characters and environmental parameters shown in Figure 4.1 (Bohn et al. 2000-2004). There is also a comprehensive and standardised glossary of phytogeographical terms, vegetation and climate zones, ecological and geobotanical terms, geological, geomorphological and edaphic terms and details of the standard environmental classifications used like the Walter & Leith climate types and the FAO soil classification.

Geographical distribution (countries, area in km^2, number polygons)
Main syntaxa/plant communities
Structural features
Dominant & frequent species by layer
Diagnostic species
Ecological variants
Geographical variants
Natural accompanying vegetation
Adjacent climax communities
Land use
Site conditions (landscape, geomorphology, altitudinal belt, geology)
Soil conditions
Climate (Walter & Leith type, mean annual temperature, average annual precipitation, average temperature warmest month, average temperate coldest month, local peculiarities)
Importance for nature protection
Type sites
References
Author(s)
Images

Figure 4.1 The characteristics and parameters for the mapping units of the Map of the Natural Vegetation of Europe (Bohn et al. 2000-2004).

The current 'Red List of European Habitats' project funded by DG(Env) uses as its Habitats Typology a modified version of EUNIS (Rodwell et al. 2013) which incorporates, with some further very minor modifications, the changes for Forests recommended in Schaminée et al. (2013) and which can take advantage of the changes to the classification of Heaths and Scrub recommended in this report. Very relevant to the current task of providing revised descriptions of EUNIS habitats is the fact that much more detailed Red List Habitat Definitions are being prepared by experts for the territorial assessments of extent and quality. These Definitions include an audit trail from EUNIS, a detailed text description, crosswalk to the EuroVegChecklist and other relevant typologies, species lists and further details of the character and status of habitats across Europe and images. An example of a Habitat description is provided in Figure 4.2.

G1.8 Acidophilous *Quercus* woodland

Author and date
John Rodwell, September 2014
Relationship to EUNIS
= G1.8 Acidophilous [*Quercus*]-dominated woodland

Habitat description
These are oak-dominated woodlands typical of acidic, impoverished and free draining soils with mor humus on arenaceous sedimentaries, lime-poor metamorphic and igneous rocks and sandy and gravelly superficial deposits through the nemoral zone. Extending from the Atlantic fringe of northern Portugal and Spain, across north-west and central Europe into southern Scandinavia, the northern Balkans and on into Russia, the habitat is everywhere limited by the survival of suitable terrain, often very fragmentary and scattered now in the prevailingly agricultural semi-natural landscape. Variations in climate across this wide overall range, from extreme Atlantic on the western fringes of Ireland and the British Isles, Lusitanian in northern Iberia, through Continental to Boreal in the east and sub-Mediterranean in the south, have an effect on the associated flora, even though this is not in general very rich.

The characteristic oaks here are *Quercus robur* and *Q. petraea*, often occurring with a subordinate proportion of *Betula pendula* and/or *B. pubescens*, which can be pioneers in this habitat following fire or clear-felling, are relatively short-lived survivors in mature forest and which have been selected against in the coppice management or timber extraction often imposed on these woodlands. Through much of the range in central and north-western Europe, *Fagus sylvatica* is a potential competitor for canopy dominance on the better-quality soils and co-dominant Fagus-Quercus canopies are better classified under G1.6b *Fagus* woodland on acid soils. On highly acidic soils to the Boreal east of the range, *Pinus sylvestris* replaces the oaks as the dominant tree in woodlands with much the same field layer. Overall, other associated trees are typically very few in this habitat: *Sorbus aucuparia* and *Frangula alnus* occur through much of the range, *Castanea sativa, Sorbus torminalis* and *Pyrus cordata* in the Sub-Atlantic heartland and, to the west, *Ilex aquifolium* can be abundant.

The field layer is generally rather species-poor with calcifuge sub-shrubs, herbs and cryptogams most characteristic and lending a heathy appearance, especially under lighter shade and where grazing is absent. Constant through much of the range are *Vaccinium myrtillus, Calluna vulgaris (in more open places), Deschampsia flexuosa, Agrostis capillaris, Anthoxanthum odoratum, Holcus mollis, Carex pilulifera, Potentilla erecta, and Hieracium sabaudum*. The commonest bryophytes overall are *Polytrichum formosum, Hypnum cupressiforme, Pleurozium schreberi* and *Leucobryum glaucum*.

Regional variations in the flora in relation to climatic differences can be seen in each of the layers of the vegetation moving away from the Sub-Atlantic woodlands of central and western France, the lower Rhineland and north-east Italy/south-west Switzerland. In the more Atlantic climate of the north-west, there is a further contingent of herbs such as *Galium saxatile, Teucrium scorodonia, Hypericum pulchrum, Luzula sylvatica* and *Blechnum spicant* and to the western seaboard of Ireland and the British Isles an extraordinary additional richness in

On the Atlantic fringe of Portugal and Spain, with annual precipitation up to 2000mm but with warmer summers and milder winters, *Q. petraea* tends to be less prominent than further north but there is often some *Q. pyrenaica* along with *B. pubescens* spp. *celtiberica* and *Arbutus unedo. Cytisus scoparius, Ulex gallii* and *Erica arborea* enrich the sub-shrub layer, with the lianes *Rubia peregrina* and *Tamus communis.* Herbs such as *Pseudarrhenatherum longifolium, Potentilla montana, Daboecia cantabrica, Crepis lampsanoides, Luzula forsteri, Euphorbia dulcis, Melitis melissophyllum, Silene nutans, Polygonatum odoratum, Galium rotundifolium, Arenaria montana, Genista florida, Rumex papillaris* give a South Atlantic or more Mediterranean feel to the flora.

In northern Europe and southern Scandinavia, some Eurasian Temperate and Boreal species such as *Vaccinium vitis-idaea, Maianthemum bifolium* and *Luzula pilosa* begin to appear in these woodlands and examples on the Baltic-North Sea plain form the core of the Annex 1 9190 Old acidophilous oakwoods with *Quercus robur* on sandy plains.

Further east, through Germany, Poland, Belarus, Ukraine and into Russia, where *Pinus sylvestris* begins to challenge the dominance of *Quercus* spp. on impoverished acid soils, *Juniperus communis* and *Euonymus verrucosa* are additional woody species and, among the herbs, *Trientalis europaea, Rubus saxatilis, Pyrola rotundifolia, Orthilia secunda, Calamagrostis arundinacea*. At the extreme east of the range, where there is usually less than 800mm precipitation and winter temperatures down to -12°C, *Carex digitata, Galium schultesii* and *Chamaecystus ruthenicus* are characteristic. Among the bryophytes *Dicranum polysetum, Eurhynchium angustirete* and *Rhodobryum roseum* are distinctive here.

Further south, at the eastern sub-Mediterranean limit of this habitat in Czechia, Austria, the northern Balkans and Romania, the warmer climate is reflected in the appearance of *Quercus cerris, Q. delechampii* and *Q. polycarpa* in the canopy, *Pyrus communis* and *Euonymus verrucosa* among the shrubs and *Genista tinctoria, G. germanica, Cytisus nigricans, Rubus hirtus, Gentiana asclepiadea* and *Vincetoxicum hirundinaria* in the herb layer.

Countries list

AT, BA, BE, BG, CH, CZ, DE, DK, ES, FI?, FR, GR, HU, IE, IT, LT, LV, MK, NL, NO, PL, RO, RS, SE, SI, SK, UK (24 + 1?)

Figure 4.2 An example of a Red List Habitat description.

4.2 Description in a standard format of the revised EUNIS forest habitat types

Like the existing EUNIS habitat and Annex I habitat descriptions and the EuroVegChecklist descriptors, the Red List Habitat definitions sit rather lightly to the questions of explicit standardised parameter frames and terminology; and there are unresolved questions about the compatibility of terms in the various glossaries that are currently applied to the description of habitats. Furthermore, there is actually no accepted standard format for the description of a EUNIS habitat. Here we therefore provide only a provisional response to the challenge of what such descriptions should look like and in Chapter 5 recommend the next steps for developing what we believe to be the considerable potential of such descriptions and parameterisation.

What we would recommend is that the descriptions are regarded essentially as definitions: they should provide, as accurately, briefly and precisely as possible, the key distinguishing features of the habitat. They are not the place for small essays in ecology or status, particularly where the habitat is more readily recognisable. In general, any detail provided should reflect the variability in the habitat, not its species-richness or structural complexity.

The descriptions we provide have a roughly standardised shape:

► we have used the term 'woodland' throughout, irrespective of the degree of canopy closure which is the criterion used in the EUNIS Glossary for distinguishing 'woodland' from 'forest'. Canopy closure is is not always uniform within a type and these two terms have confusing resonances in different parts of Europe;

► we include a general reference to the character of the woodland, whether it is broadleaved or coniferous, deciduous evergreen but, with details of species composition now available through analysis of constituent relevés or data tables for the alliances of each habitat, we believe that there is no need to repeat this information in the description except where it has definitive value;

► we mention woodland structure or species-richness only when it is a diagnostic feature of the woodland type;

► we use non-technical terms as far as possible to describe terrain, soil types, altitudinal belts;

► though we recognise that local environmental conditions in one biogeographic zone may correspond to those prevailing more widely elsewhere, we use the ETC-BD terminology to refer to the biogeographic zone

generally typical of a habitat distribution and otherwise avoid any specialised terminology to describe climatic relationships or broad geographical distribution.

The new descriptions along with the original are attached as Appendix C.

4.3 Maps of distribution of phytosociological relevés and probability of occurrence based on distribution models for each of the revised EUNIS forest habitat types

4.3.1 Data selection

The locations of vegetation relevés available for the Braun-Blanquet project were used for the modelling of the EUNIS forest types. The selection of relevés belonging to the individual EUNIS forest types has been done on the basis of a supervised classification of more than 500,000 relevés in JUICE 7.0 (Tichý 2002). This supervised classification was performed using a computer expert system newly developed to identify relevés belonging to the individual EUNIS forest types. The procedure followed these steps:

(1) Relevés identified during the preparation of the 2013 report (Schaminée et al. 2013) as belonging to the particular EUNIS types based on their syntaxon assignment were marked and grouped in this dataset.

(2) The degree of concentration of occurrences of each species within each group of relevés (i.e. each EUNIS type) was calculated using the phi coefficient of association (Sokal & Rohlf 1995) standardized for the identical number of relevés across all groups, which was arbitrarily set to 1% of the total data set (Tichý & Chytrý 2006). The species with the highest values of phi were considered as diagnostic for each EUNIS type.

(3) Lists of European species of trees and shrubs occurring in this data set were compiled.

(4) The functional species groups were created using an expert judgement based on the lists of diagnostic species for EUNIS types and lists of trees and shrubs. These functional groups were defined in such a way that they could clearly separate the EUNIS forest habitat types based on their occurrence and total cover of their species. In general some functional groups included woody species and others included herb-layer species. Each group included species of similar ecology and distribution. The concept of functional species groups used here is described in Landucci et al. (submitted).

(5) Total covers of each functional species group were calculated assuming the random overlap of covers of their individual species based on the approach proposed by Chytrý et al. (2005) and newly formally described by Fischer (2015).

(6) Formal definitions of all EUNIS forest habitat types (Level 3, with modifications proposed by Schaminée et al. 2013) were prepared in a form of logical formulas. These formulas combined total covers of individual species or species groups using logical operators AND, OR and AND not, following the proposals of Bruelheide (1997). Details of the approach used here are described in Landucci et al. (submitted). For example, the logical formula for the habitat type G1.8 Acidophilous *Quercus* woodland is the following:

((<#TC Quercus petraea-robur GR15>AND<#TC Quercus petraea-robur GR #TC Trees EXCEPT #TC Quercus petraea-robur>)AND<#TC Quercion roboris GR15>)NOT<#TC Quercus-thermo-herbs GR05>

This means that the total cover (#TC) of the functional species group Quercus petraea-robur (includes deciduous temperate oak species *Quercus petreaea* and *Q. robur*) is greater than 15% (GR15) and at the same time the total cover of this group is greater than the total cover of any other tree species (#TC Trees EXCEPT #TC Quercus petraea-robur) and at the same time the total cover of the functional group Quercion roboris (includes herb species diagnostic of acidophilous *Quercus* woodlands) is greater than 15% and at the same time the functional group *Quercus*-thermo-herbs (includes herb species diagnostic of thermophilous *Quercus* woodlands) is not greater than 5%.

(7) Lists of species belonging to each functional species group, formal definitions of all EUNIS forest habitat types and instructions for handling taxonomic concepts and nomenclature of individal species were included in a single file with a computer code that can be read by JUICE 7.

(8) All relevés in the data set were assessed whether they meet conditions of each logical formula, using JUICE 7, and based on this, they were assigned to individual EUNIS forest habitat types.

In total more than 140,000 relevés were assigned to EUNIS forest habitat types in this way. The advantage of this procedure was that (i) relevés not assigned to syntaxa could be classified, (ii) new relevés obtained since the last year could be included and (iii) assignments of relevés to the types were based on uniform criteria applied consistently across the whole European data set. This data set was then used to create maps of known distributions and to serve as an input for the habitat suitability modelling. Where more than 5,000 relevés were available for a habitat type the data set was restricted to only one location per each grid cell of 5km x 5 km.

Excluded from the classification process were forest types located outside the geographic scope (Macaronesia), or floristically difficult to define according to the national classifications (B1.7, G1.D, G2.8, G2.9). However, B1.7 has been included by taking into account all forest relevés (selected by the expert system) that are located within the coastal dune area of the Map of the Natural Vegetation of Europe (Bohn et al. 2000-2004) with a buffer of 1 km.

4.3.2 Habitat suitability modelling

For the habitat suitability modelling, the widely used software Maxent for maximum entropy modelling of species' geographic distributions was used. Maxent is a general-purpose machine-learning method with a simple and precise mathematical formulation, and has a number of aspects that make it well-suited for species distribution modelling when only presence (occurrence) data but not absence data are available (Philips et al. 2006). Because EUNIS habitats have a particular species composition, they are assumed to respond to specific ecological requirements, allowing us to generate correlative estimates of geographic distributions. Modelling habitats that have been floristically defined is a well-known procedure for ecological modelling at local scales, and a promising technique to be applied also at the continental level.

The Maxent method considers presence data (known observations of a given entity) and the so-called background data. Background data comprise a set of points used to describe the environmental variation of the study area according to the available environmental layers. It is assumed that these layers represent well the most important ecological gradients on a European scale. These layers were selected from the most meaningful environmental predictors commonly used for modelling non-tropical plant and vegetation diversity, and are not mutually strongly correlated.

As environmental data (and their sources) the following layers have been used:

- PET = Potential Evapotranspiration
  http://www.cgiar-csi.org/data/global-aridity-and-pet-database
- Soil_pH = Topsoil pH
  www.isric.org
- Solar = Solar radiation
  http://www.worldgrids.org/doku.php?id=wiki:inmsre3
- BioClim 4 = Temperature Seasonality (standard deviation *100)
  http://www.worldclim.org/bioclim
- BioClim 8 = Mean Temperature of Wettest Quarter
  http://www.worldclim.org/bioclim

- BioClim 12 = Annual Precipitation
  http://www.worldclim.org/bioclim
- BioClim 15 = Precipitation Seasonality (Coefficient of Variation)
  http://www.worldclim.org/bioclim
  BioClim 18 = Precipitation of Warmest Quarter
  http://www.worldclim.org/bioclim
- NDVI peak = the Maximum NDVI
  (HANTS 2012)
- Water = Distance to water (rivers, lakes, sea)
  derived from the shapefile 'Inland_Waters.shp'

Maxent is expected to perform well for estimating the geographic distribution of EUNIS habitats in Europe. However, as with any other modelling technique this method is sensitive to sampling bias, i.e. when the spatial distribution of presence data is reflecting an unequal sampling effort in different geographic regions. In Maxent, it has been proposed that the best way to account for sampling bias (when bias is known or expected to occur) is to generate background data reflecting the same bias of the presence data. When a complete set of presence data is available, a general recommendation is to generate background points from the occurrences of other species/communities that were sampled in a similar way (Elith et al. 2011).

Two different approaches have been followed for the selection of a maximum of 10,000 locations for the background data, assuming biased and non-biased presence data. For the first approach, 10,000 locations were randomly selected from the forest plot database, assuming that they reflect the general geographic bias of forest sampling in Europe. The second approach concerns a random selection of 10,000 background points in the whole study area, assuming that the presence data describe a representative subset of the real distribution range of the target habitat.

In Appendix C the results of the analysis are presented. The two modelling approaches (assuming biased and non-biased data) were evaluated for each of the EUNIS habitat types in order to estimate which assumption is more likely. This evaluation was based on the expert knowledge of the team members in the distribution of European forest types by assessing (i) the distribution of the available presence data as an estimate of geographic bias, (ii) the realism of the habitat suitability maps to reflect known distribution of forests, and (iii) the environmental predictors that contribute most substantially to the models. The best performing model was then selected by consensus of the expert team for each habitat type. In the overview of forest types on the first page of the Appendix, the preference for one of the two outputs is indicated in the columns 'Forest' (assuming biased data) and 'Random' (assuming non-biased data).

For each EUNIS forest type the following data are presented:

- A habitat suitability map with colours varying from gray, over green to red, indicating increasingly favourable ecological conditions for the type (expressing the logistic output of the model between 0 and 1).
- A distribution map showing the location of the relevés that have been assigned to the EUNIS forest type concerned and therefore used as presence data.
- AUC, or the Area Under the Curve, as a general estimate of model performance. This is the probability that the classifier correctly orders two points (a random positive example and a random negative example). In general, AUC values in the range 0.5-0.7 were considered low, 0.7-0.9 were moderate and >0.9 were high, suggesting poor, good and very good model performances, respectively. We provide two estimates of the AUC as calculated by Maxent. 'AUC training' reflects the internal fit between observed and predicted occurrences in the computed model. 'AUC test' provides the mean AUC obtained from a 10-fold cross-validation procedure in which ten different models were computed with a random selection of 90% of data (calibration data set) and 10% for testing the model (validation data set).
- Contribution variables to the Maxent model (%). Indicates to what extent the environmental variables contribute to the model.

The habitat suitability maps will be further processed in the ETC/BD Task 1.7.5.C: 'Ecosystem mapping and assessment' in which the maps will be further downscaled to actual land cover situation based on remotely sensed information such as the JRC Forest Map (and 20 m spatial resolution GIO HR layer Forest) and phenological data as derived from RS data, e.g. MODIS time series (HANTS).

5 Recommendations and future prospects

5.1 Further steps to collect Europe-wide in-situ data to assess heathland, scrub and tundra habitats, e.g. for compiling distribution maps

Two major European groups of habitats have been reviewed in 2013 and 2014, the EUNIS G forest habitat types and EUNIS F the heathland, scrub and tundra habitat types, based on the crosswalks between the EUNIS habitat classification and the EuroVegChecklist syntaxa. Of these habitats, the floristic composition has been determined on the basis of in-situ vegetation measurements across Europe. An obvious next step would be to analyse further EUNIS habitat groups such as grasslands and wetlands.

Furthermore, mapping the distribution of phytosociological relevés and habitat suitability modelling as shown for the EUNIS forest habitat types in the present project could be extended to other habitats, for which the heathland, scrub and tundra types would be a logical next choice. At the same time, the development of formal definitions for supervised classificaiton and revision of EUNIS habitat descriptions presented here for forests could also be extended into heathland, scrub and tundra.

To illustrate the importance of linking the EUNIS habitat classification with the EuroVegChecklist syntaxa (and all the underlying data) and harmonising with other existing EU data platforms and research initiatives, three examples of further steps of integration are discussed here, dealing with (1) standardised parameterisation of habitats, (2) linkages between EUNIS and the Red List of European Habitats, and (3) developing relationships to MAES. Each of these raises wider questions about the future shape and potential of the EUNIS Habitat Classification.

5.2 Standardised parameterisation of habitats

We have here proposed only an interim and minimal solution to the question of standardisation of environmental references. Such standardisation also remains a key challenge for phytosociology, both in the recording of the point-source data which can help make the distribution of habitats spatially explicit and in the parameterisation of the syntaxa whose floristic composition is clearly becoming a key interpreter of the character and condition of habitats. Some such uniformity was trailed in an early attempt to encourage common

data standards in the recording of relevés (Mucina et al. 2000) and in an unpublished crosswalk between possible phytosociological parameters and those of EUNIS at that time (Rodwell et al. 2001).

Parallel to this contract, one author (JR) is conducting a questionnaire enquiry of members of the EVS and the European Dry Grassland Group using a set of parameters based on these two papers and EUNISHAB 2006, asking which parameters are recorded in field survey; which are accessed from other secondary sources like grid maps, map envelopes or by interpolations from contours or point sources away from relevés; and which standard frames, typologies or look-ups are used to define, for example, soil types, climatic regimes or degrees of hemeroby.

With such information to hand, we might be able to furnish the EEA and ETC-BD with a much more detailed scope of the capacity of phytosociology to deliver accurate, comprehensive and standardised information about the environmental dependencies of habitats and their possible response to shifts in, for example, climate change and human impacts to 2020 and beyond. This could be accompanied by some concerted attempt to integrate the parameters used in the text descriptions of EUNIS habitats with the parameter frame of EUNISHAB, so that more straightforward query routines could enable users to access and interrogate the EUNIS website.

5.3 Linkages between EUNIS and the Red List of European habitats

Over the next two years, the Red List of European Habitats project will deliver its own expert modifications of the EUNIS habitat classification and information for each habitat about current extent and quality, decline, threats and restorability. Since this typology has been developed by generally simple divisions, amalgamations or combinations of EUNIS habitats, it would be fairly simple to append such assessments to EUNIS habitats themselves as additional parameters. This will give added value to the existing EUNIS Classification within the frame of the 2020 Biodiversity targets for both habitat protection and restoration. We strongly recommend that further revision of EUNIS takes advantage of the legacy of the Red List project in both its revisions of the typology beyond Forests and Heath, Scrub & Tundra, in the expert habitat descriptions which are being provided for all habitats and in the various cross-walks to other classifications. Combination of results from these parallel initiatives would lay the foundations for a definitive manual of European habitats.

5.4 Developing relationships to MAES

Harmonisation of assessment activities among EU members states involves the EEA, DG(Env), the JRC and the MAES Working Group and, though flexibility is essential for the integration of different territorial circumstances, local descriptive and mapping typologies used for assessment need to be linked to a EU-wide frame (Ichter et al. 2014). Recently, the MAES ecosystem typology has been linked to EUNIS (Maes et al. 2013) and the refinement of the EUNIS classification and the provision of clearer standardised descriptions should assist coordination of assessment. Moreover, the provision of more precise maps of the distribution of European habitats will permit a higher thematic resolution of the spatially explicit frames available for ecosystem assessment. The prospect of defining more precisely the range of ecosystem services of particular habitats and treating these as additional parameters will bring a further level of precision and meaning to understanding of the value of the European landscape.

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Appendix A: An updated crosswalk EUNIS heathland, scrub and tundra habitat types (B1.5, B1.6, B2.5, F) to the 2013 EuroVegChecklist syntaxa

B - Coastal habitats
  B1 - Coastal dunes and sandy shores
    B1.5 - Coastal dune heaths
      * ULI-01A - Ericion cinereae Böcher 1940
      * ULI-01B - Ulicion minoris Malcuit 1929
      * ULI-01D - Ericion umbellatae Br.-Bl. in Br.-Bl. et al. 1952
      * ULI-02B - Genistion pilosae Bøcher 1943
      * ULI-02C - Empetrion nigri Schubert ex Westhoff et Den Held 1969
    B1.6 - Coastal dune scrub
      * LAV-01D - Quercion fruticosae Rothmaler 1954
      * MOQ-01A - Traganion moquinii Sunding 1972
      * QUI-01A - Oleo-Ceratonion siliquae Br.-Bl. ex Guinochet et Drouineau 1944
      * QUI-01C - Juniperion turbinatae Rivas-Mart. 1975 corr. 1987
      * QUI-01H - Rubo longifoliae-Coremation albi Rivas-Mart. in Rivas-Mart. et al. 1980
      * QUI-01J - Rhamno graeci-Juniperion lyciae Costa et al. 1984
      * RHA-02A - Berberidion vulgaris Br.-Bl. ex Tx. 1952 nom. conserv.
      * RHA-02C - Carpino-Prunion spinosae Weber 1974
      * RHA-02D - Pruno spinosae-Rubion radulae Weber 1974
      * RHA-03A - Salicion arenariae Tx. ex Passarge in Scamoni 1963
      * RHA-03B - Ligustro-Hippophaeion Géhu et Géhu-Franck 1983
      * RHA-03C - Holoschoeno australis-Salicion arenariae Neto et al. 2004
  B2 - Coastal shingle
    B2.5 - Shingle and gravel beaches with scrub
F - Heathland, scrub and tundra
  F1 – Tundra
    F1.1 - Shrub tundra
      * LOI-01A - Loiseleurio-Arctostaphylion Kalliola ex Nordhagen 1943
      * LOI-01B - Phyllodoco-Vaccinion myrtilli Nordhagen 1943
    F1.2 - Moss and lichen tundra
      * KOB-01B - Dryadion integrifoliae Ohba ex Daniëls 1982
      * LOI-01A - Loiseleurio-Arctostaphylion Kalliola ex Nordhagen 1943
  F2 - Arctic, alpine and subalpine scrub
    F2.1 - Subarctic and alpine dwarf willow scrub
      * HER-01A - Salicion herbaceae Br.-Bl. in Br.-Bl. et Jenny 1926
      * HER-01B - Salici herbaceae-Caricion lachenalii Béguin et Theurillat 1982
      * HER-01G - Cassiopo-Salicion herbaceae Nordhagen 1943
    F2.2 - Evergreen alpine and subalpine heath and scrub

* KOB-01A - Kobresio-Dryadion Nordhagen 1943
* KOB-01B - Dryadion integrifoliae Ohba ex Daniëls 1982
* LOI-01A - Loiseleurio-Arctostaphylion Kalliola ex Nordhagen 1943
* LOI-01B - Phyllodoco-Vaccinion myrtilli Nordhagen 1943
* LOI-01C - Loiseleurio-Vaccinion Br.-Bl. in Br.-Bl. et Jenny 1926
* LOI-01D - Rhododendro ferruginei-Vaccinion Br.-Bl. ex Schnyder 1930
* LOI-01E - Juniperion nanae Br.-Bl. in Br.-Bl. et al. 1939
* LOI-01F - Bruckenthalion spiculifoliae Horvat 1949
* LOI-01G - Rhododendrion caucasici Onipchenko 2002
* LOI-01H - Salici kazbekensis–Empetrion nigrae Onipchenko 2002
* LOI-01I - Aconito nasuti–Juniperion Onipchenko 2002
* RHO-01A - Ericion carneae Rübel ex Grabherr et al. 1993
* RHO-01B - Daphno oleoidis-Juniperion alpinae Stanisci 1997
* RHO-01C - Daphno-Genistion radiatae N. Randelovic et Rexhepi 1980
* SAB-03A - Cytision oromediterranei Tx. in Tx. et Oberd. 1958 corr. Rivas-Mart. 1987
* SAB-03B - Genisto versicoloris-Juniperion hemisphaericae Rivas-Mart. et J.A. Molina in Rivas-Mart., Fernández-González et Loidi 1999
* SAB-03C - Pruno prostratae-Juniperion sabinae Rivas-Mart. et J.A. Molina in Rivas-Mart., Fernández-González et Loidi 1999
* ULI-02A - Genisto-Vaccinion Br.-Bl. 1926

F2.3 - Subalpine deciduous scrub
* SAB-05A - Lonicero-Rhamnion falacis P. Fukarek 1969
* VIR-01A - Alnion viridis Schnyder 1930
* VIR-01B - Salicion pentandrae Br.-Bl. 1967
* VIR-01C - Salicion helveticae Rübel ex Theurillat in Theurillat et al. 1995
* VIR-01D - Salicion silesiacae Rejmánek et al. 1971

F2.4 - Conifer scrub close to the tree limit
* MUG-01A - Pinion mugo Pawlowski et al. 1928
* MUG-01B - Erico-Pinion mugo Leibundgut 1948 nom. invers. propos.
* MUG-01C - Epipactido atropurpureae-Pinion mugo Stanisci 1997
* MUG-01D - Lonicero borbasianae-Pinion mugo Carni et Mucina 2013

F3 - Temperate and mediterranean-montane scrub

F3.1 - Temperate thickets and scrub
* CYT-01A - Cytision oromediterraneo-scoparii Rivas-Mart. et al. 2002
* CYT-03A - Sarothamnion scoparii Oberd. 1957
* CYT-03B - Erico scopariae-Cytision scoparii Mucina in Mucina et al. 2013
* LON-01A - Lonicero-Rubion silvatici Tx. et Neumann ex Wittig 1977
* LON-02A - Frangulo-Rubion Rivas Goday 1964
* LON-03A - Vaccinio-Juniperion communis Passarge in Passarge et G. Hofmann 1968
* RHA-01A - Aegopodio podagrariae-Sambucion nigrae Chytrý in Mucina et al. 2013
* RHA-01E - Chelidonio-Acerion negundi L. Ishbirdin et A. Ishbirdin

1989
* RHA-02A - Berberidion vulgaris Br.-Bl. ex Tx. 1952 nom. conserv.
* RHA-02C - Carpino-Prunion spinosae Weber 1974
* RHA-02D - Pruno spinosae-Rubion radulae Weber 1974
* RHA-02E - Frangulo alni-Pyrion cordatae Herrera et al. 1991
* RHA-02F - Tamo communis-Viburnion lantanae (Géhu et al. 1983) Mucina in Mucina et al. 2013
* RHA-02G - Brachypodio pinnati-Juniperion communis Mucina in Mucina et al. 2013
* RHA-02Q - Prunion fruticosae Tx. 1952
* RHA-02R - Lamio purpureae-Acerion tatarici Fitsailo 2007
* RHA-03A - Salicion arenariae Tx. ex Passarge in Scamoni 1963
* RHA-03B - Ligustro-Hippophaeion Géhu et Géhu-Franck 1983
* RHA-03C - Holoschoeno australis-Salicion arenariae Neto et al. 2004
* RHA-04A - Sambuco racemosae-Salicion capreae Tx. et Neumann ex Oberd. 1957
* RHA-04C - Astrantio-Corylion avellanae Passarge 1978

F3.2 - Submediterranean deciduous thickets and brushes
* CYT-01B - Ulici europaei-Cytision striati Rivas-Mart. et al. 1991
* CYT-01C - Genistion floridae Rivas-Mart. 1974
* CYT-01D - Cytision multiflori Rivas-Mart. 1974
* CYT-01E - Retamion monospermae Rivas-Mart et al. 2002
* CYT-01F - Retamion sphaerocarpae Rivas-Mart. 1981
* CYT-01G - Adenocarpion decorticantis (Rivas-Mart. et F. Valle ex F. Valle 1985) Rivas-Mart. et al.1999
* CYT-01H - Violo messanensis-Adenocarpion intermedii Mucina in Mucina et al. 2013
* CYT-02A - Telinion monspessulano-linifoliae Rivas-Mart. et al. 2002
* CYT-02B - Genisto spartioidis-Phlomidion almeriensis Rivas Goday et Rivas-Mart. 1969
* CYT-02C - Genisto scorpii-Retamion sphaerocarpae Rivas-Mart. et Costa in Rivas-Mart. et al. 2011
* CYT-02D - Genistion specioso-equisetiformis Rivas-Mart. et F. Valle in Rivas-Mart. et al. 2011
* PUB-01A - Paliuro-Petterion P. Fukarek 1962
* PUB-01B - Eryngio campestris-Paliurion spinae-christi (Jovanovic 1985) Matevski et al. 2008
* PUB-01C - Junipero excelsae-Quercion pubescentis Jakucs 1960
* PUB-01D - Fraxino orni-Cotinion Soó 1960
* PUB-01E - Pruno tenellae-Syringion (B. Jovanovic 1979) Carni et al. 2009
* PUB-01F - Syringo-Carpinion orientalis Jakucs 1959
* RHA-02A - Berberidion vulgaris Br.-Bl. ex Tx. 1952 nom. conserv.
* RHA-02B - Amelanchiero-Buxion O. de Bolòs et Romo in Romo 1989
* RHA-02H - Rubio periclymeni-Rubion ulmifolii Oberd. ex Rivas-Mart. et al. 1993
* RHA-02I - Scrophulario glabratae-Rubion ulmifolii Vicente Orellana et al. 2012
* RHA-02J - Pruno spinosae-Rubion ulmifolii O. de Bolòs 1954

* RHA-02K - Lonicero arboreae-Berberidion hispanicae O. de Bolòs 1954
* RHA-02L - Cytision sessilifolii Biondi in Biondi et al. 1989
* RHA-02M - Berberido aetnensis-Crataegion laciniatae Gianguzzi et al. 2011
* RHA-02N - Pruno tenellae-Syringion Jovanovic ex Carni et Mucina 2013
* RHA-02O - Berberido creticae-Prunion cocomiliae Bergmeier 1990
* RHA-02P - Asparago verticillati-Crataegion tauricae Korzhenevsky et Klyukin 1990

F4 - Temperate shrub heathland

F4.1 - Wet heaths

* OXY-01A - Ericion tetralicis Schwickerath 1933
* OXY-01B - Oxycocco-Ericion tetralicis Nordhagen ex Tx. 1937
* ULI-01B - Ulicion minoris Malcuit 1929
* ULI-01C - Daboecion cantabricae (Dupont ex Rivas-Mart. 1979) Rivas-Mart. et al. in Loidi et al.1997
* ULI-01D - Ericion umbellatae Br.-Bl. in Br.-Bl. et al. 1952
* ULI-01E - Genistion micrantho-anglicae Rivas-Mart. 1979
* ULI-01F - Stauracanthion boivinii (Rivas-Mart. 1979) Rivas-Mart., Fernández-González et Loidi 1999

F4.2 - Dry heaths

* QUI-01B - Ericion arboreae (Rivas-Mart. ex Rivas-Mart. et al. 1986) Rivas-Mart. 1987
* ULI-01A - Ericion cinereae Böcher 1940
* ULI-01B - Ulicion minoris Malcuit 1929
* ULI-01C - Daboecion cantabricae (Dupont ex Rivas-Mart. 1979) Rivas-Mart. et al. in Loidi et al.1997
* ULI-01D - Ericion umbellatae Br.-Bl. in Br.-Bl. et al. 1952
* ULI-02A - Genisto-Vaccinion Br.-Bl. 1926
* ULI-02B - Genistion pilosae Bøcher 1943
* ULI-02C - Empetrion nigri Schubert ex Westhoff et Den Held 1969

F4.3 - Macaronesian heaths

* LAU-01A - Myrico fayae-Ericion arboreae Oberd. 1965
* ULI-01G - Daboecion azoricae Lüpnitz 1975

F5 - Maquis, arborescent matorral and thermo-Mediterranean brushes

F5.1 - Arborescent matorral

F5.2 – Maquis

* LAV-01D - Quercion fruticosae Rothmaler 1954
* QUI-01A - Oleo-Ceratonion siliquae Br.-Bl. ex Guinochet et Drouineau 1944
* QUI-01B - Ericion arboreae (Rivas-Mart. ex Rivas-Mart. et al. 1986) Rivas-Mart. 1987
* QUI-01D - Asparago albi-Rhamnion oleoidis Rivas Goday ex Rivas-Mart. 1975
* QUI-01E - Rhamno lycioidis-Quercion cocciferae Rivas Goday ex Rivas-Mart. 1975
* QUI-01F - Periplocion angustifoliae Rivas-Mart. 1975
* QUI-01H - Rubo longifoliae-Coremation albi Rivas-Mart. in Rivas-

Mart. et al. 1980
* QUI-01I - Asparago orientalis-Juniperenion macrocarpae (Díez-Garretas et Asensi 2013) Mucina stat. nov. hoc loco
* QUI-01J - Rhamno graeci-Juniperion lyciae Costa et al. 1984
* QUI-01K - Pistacio terebinthi-Rhamnion alaterni Barbero et Quézel ex Quézel et al. 1992
* QUI-02B - Ceratonio-Pistacion lentisci Zohary ex Zohary et Orshan 1959

F5.3 – Pseudomaquis
* PUB-01A - Paliuro-Petterion P. Fukarek 1962
* PUB-01B - Eryngio campestris-Paliurion spinae-christi (Jovanovic 1985) Matevski et al. 2008
* PUB-01C - Junipero excelsae-Quercion pubescentis Jakucs 1960
* PUB-01D - Fraxino orni-Cotinion Soó 1960
* PUB-01E - Pruno tenellae-Syringion (B. Jovanovic 1979) Carni et al. 2009
* PUB-01F - Syringo-Carpinion orientalis Jakucs 1959

F5.4 - [Spartium junceum] fields
* QUI-01A - Oleo-Ceratonion siliquae Br.-Bl. ex Guinochet et Drouineau 1944
* RHA-02L - Cytision sessilifolii Biondi in Biondi et al. 1989

F5.5 - Thermo-Mediterranean scrub
* CRI-02D - Euphorbion pithyusae Biondi et Géhu in Géhu et Biondi 1994
* CRI-02E - Anthyllidion barbae-jovis S. Brullo et De Marco 1989
* CYT-01E - Retamion monospermae Rivas-Mart et al. 2002
* CYT-01F - Retamion sphaerocarpae Rivas-Mart. 1981
* CYT-02A - Telinion monspessulano-linifoliae Rivas-Mart. et al. 2002
* CYT-02B - Genisto spartioidis-Phlomidion almeriensis Rivas Goday et Rivas-Mart. 1969
* CYT-02C - Genisto scorpii-Retamion sphaerocarpae Rivas-Mart. et Costa in Rivas-Mart. et al. 2011
* CYT-02D - Genistion specioso-equisetiformis Rivas-Mart. et F. Valle in Rivas-Mart. et al. 2011
* LAV-01B - Staehelino-Ulicion baetici Rivas Goday et Rivas-Mart. 1969
* LAV-01C - Ulici argentei-Cistion ladaniferi Br.-Bl. et al. 1965
* LAV-01D - Quercion fruticosae Rothmaler 1954
* LAV-01E - Cistion ladaniferi Br.-Bl. ex A. Bolós et O. Bolòs in A. Bolós 1950
* LAV-01F - Calicotomo villosae-Genistion tyrrhenae Biondi 2000
* LAV-01G - Teucrion mari (Gamisans et Muracciole 1984) Biondi et Mossa 1992
* LAV-02A - Coremation albi Rothmaler 1943
* MIC-01A - Cisto cretici-Ericion manipuliflorae Horvatic 1958
* MIC-01B - Cisto eriocephali-Ericion multiflorae Biondi 2000
* MIC-02A - Hyperico olympici-Cistion cretici (Oberd. 1954) R. Jahn et Bergmeier in Mucina et al. 2009
* MIC-02B - Helichryso barrelieri-Phagnalion graeci (Barbéro et

Quézel 1989) R. Jahn in Mucina et al. 2009
* MIC-02C - Hyperico empetrifolii-Micromerion graecae Barbero et Quézel 1989
* MIC-02D - Helichryso sanguinei-Origanion syriaci Barbero et Quézel 1989
* MIC-02E - Micromerion Oberd. 1954
* MIC-02F - Sarcopoterio spinosi-Genistion fasselatae Costa et al. 1984
* QUI-01A - Oleo-Ceratonion siliquae Br.-Bl. ex Guinochet et Drouineau 1944
* QUI-01C - Juniperion turbinatae Rivas-Mart. 1975 corr. 1987
* QUI-01D - Asparago albi-Rhamnion oleoidis Rivas Goday ex Rivas-Mart. 1975
* QUI-01F - Periplocion angustifoliae Rivas-Mart. 1975
* QUI-01G - Juniperon phoeniceae-Pinon acutisquamae A.V. Pérez et Cabezudo in A.V. Pérez et al. 1988 corr. Rivas-Mart. et al. 2002 nom. invers. propos.
* QUI-01H - Rubo longifoliae-Coremation albi Rivas-Mart. in Rivas-Mart. et al. 1980
* QUI-01J - Rhamno graeci-Juniperion lyciae Costa et al. 1984
* QUI-02B - Ceratonio-Pistacion lentisci Zohary ex Zohary et Orshan 1959
* ROS-01B - Eryngio trifidi-Ulicion erinacei Rothmaler 1943
* ROS-01F - Rosmarinion officinalis Molinier 1934
* ROS-01I - Cisto cretici-Genistion corsicae Arrigoni et Di Tommaso 1991
* ROS-04A - Thymo moroderi-Sideritidion leucanthae O. de Bolòs 1957 corr. Alcaraz et al. 1989
* ROS-04B - Anthyllido terniflorae-Salsolion papillosae Rivas Goday et Esteve 1968
* ROS-04C - Sideritidion bourgaeanae Peinado et Martínez-Parras in Peinado et al. 1992
* ROS-05B - Lavandulion lanatae (Martínez-Parras et al. 1984) Rivas-Mart. et al. 2002
* ULI-01D - Ericion umbellatae Br.-Bl. in Br.-Bl. et al. 1952
* ULI-01F - Stauracanthion boivinii (Rivas-Mart. 1979) Rivas-Mart., Fernández-González et Loidi 1999

F6 – Garrigue

F6.1 - Western garrigues

* CRI-02A - Dactylido hispanicae-Helichrysion stoechadis Géhu et Biondi in Géhu 1994
* CRI-02D - Euphorbion pithyusae Biondi et Géhu in Géhu et Biondi 1994
* CRI-02E - Anthyllidion barbae-jovis S. Brullo et De Marco 1989
* CRI-02F - Crucianellion rupestris S. Brullo et Furnari 1990
* LAV-01A - Cistion laurifolii Rivas Goday in Rivas Goday et al. 1956
* LAV-01B - Staehelino-Ulicion baetici Rivas Goday et Rivas-Mart. 1969
* LAV-01C - Ulici argentei-Cistion ladaniferi Br.-Bl. et al. 1965

* LAV-01E - Cistion ladaniferi Br.-Bl. ex A. Bolós et O. Bolòs in A. Bolós 1950
* LAV-01F - Calicotomo villosae-Genistion tyrrhenae Biondi 2000
* LAV-01G - Teucrion mari (Gamisans et Muracciole 1984) Biondi et Mossa 1992
* LAV-01H - Armerio sardoae-Genistion salzmannii Arrigoni 1986
* LAV-02A - Coremation albi Rothmaler 1943
* ROS-01A - Lavandulo latifoliae-Genistion boissieri Rivas Goday et Rivas-Mart. 1969
* ROS-01B - Eryngio trifidi-Ulicion erinacei Rothmaler 1943
* ROS-01C - Ulici densi-Thymion sylvestris (Capelo et al. 1993) Costa et al. 2009
* ROS-01D - Sideritido incanae-Salvion lavandulifoliae (Rivas Goday et Rivas-Mart. 1969) Izco et Molina 1989
* ROS-01E - Helianthemo italici-Aphyllanthion monspeliensis Díez Garretas et al. 1998
* ROS-01F - Rosmarinion officinalis Molinier 1934
* ROS-01G - Hypericion ericoidis Esteve ex Costa et Peris 1985
* ROS-01H - Hypericion balearici O. de Bolòs et Molinier 1958
* ROS-01I - Cisto cretici-Genistion corsicae Arrigoni et Di Tommaso 1991
* ROS-01J - Polygalo-Seslerion insularis Arrigoni ex Arrigoni et Di Tommaso 1986
* ROS-01K - Artemisio albae-Saturejion montanae Allegrezza et al. 1997
* ROS-03A - Lepidion subulati Bellot et Rivas Goday in Rivas Goday et al. 1957
* ROS-03B - Thymo-Teucrion verticillati Rivas Goday in Rivas Goday et al. 1957
* ROS-04A - Thymo moroderi-Sideritidion leucanthae O. de Bolòs 1957 corr. Alcaraz et al. 1989
* ROS-04B - Anthyllido terniflorae-Salsolion papillosae Rivas Goday et Esteve 1968
* ROS-04C - Sideritidion bourgaeanae Peinado et Martínez-Parras in Peinado et al. 1992
* ROS-05B - Lavandulion lanatae (Martínez-Parras et al. 1984) Rivas-Mart. et al. 2002

F6.2 - Eastern garrigues

* MIC-02A - Hyperico olympici-Cistion cretici (Oberd. 1954) R.Jahn et Bergmeier in Mucina et al. 2009
* MIC-02B - Helichryso barrelieri-Phagnalion graeci (Barbéro et Quézel 1989) R. Jahn in Mucina et al. 2009
* MIC-02C - Hyperico empetrifolii-Micromerion graecae Barbero et Quézel 1989
* MIC-02D - Helichryso sanguinei-Origanion syriaci Barbero et Quézel 1989
* MIC-02E - Micromerion Oberd. 1954
* MIC-02F - Sarcopoterio spinosi-Genistion fasselatae Costa et al. 1984

F6.3 - Illyrian garrigues

* MIC-01A - Cisto cretici-Ericion manipuliflorae Horvatic 1958
* MIC-01B - Cisto eriocephali-Ericion multiflorae Biondi 2000

F6.4 - Black Sea garrigues

F6.5 - Macaronesian garrigues

* CRI-04C - Helichrysion obconico-devium Rivas-Mart. et al. 2002

F6.6 - Supra-Mediterranean garrigues

* CYP-01A - Hyperico stenobotryos-Alyssion troodi S. Brullo et al. 2005
* LAV-01A - Cistion laurifolii Rivas Goday in Rivas Goday et al. 1956
* LAV-01B - Staehelino-Ulicion baetici Rivas Goday et Rivas-Mart. 1969
* LAV-01H - Armerio sardoae-Genistion salzmannii Arrigoni 1986
* ONO-01D - Genistion lobelii Molinier 1934
* ONO-01E - Echinospartion horridi Rivas-Mart. et al. 1991
* ONO-01F - Genistion occidentalis Rivas-Mart. in Rivas-Mart. et al. 1984
* ONO-01G - Lavandulo angustifoliae-Genistion cinereae Barbero et al. 1972
* ONO-02C - Plantagini discoloris-Thymion mastigophori Molina et Izco 1989
* ONO-02D - Seselio granatensis-Festucion hystricis Rivas-Mart. in Rivas-Mart. et al. 2011
* ROS-01A - Lavandulo latifoliae-Genistion boissieri Rivas Goday et Rivas-Mart. 1969
* ROS-01D - Sideritido incanae-Salvion lavandulifoliae (Rivas Goday et Rivas-Mart. 1969) Izco et Molina 1989
* ROS-01E - Helianthemo italici-Aphyllanthion monspeliensis Díez Garretas et al. 1998
* ROS-01J - Polygalo-Seslerion insularis Arrigoni ex Arrigoni et Di Tommaso 1986
* ROS-01K - Artemisio albae-Saturejion montanae Allegrezza et al. 1997
* ROS-05B - Lavandulion lanatae (Martínez-Parras et al. 1984) Rivas-Mart. et al. 2002

F6.7 - Mediterranean gypsum scrubs

* ROS-03A - Lepidion subulati Bellot et Rivas Goday in Rivas Goday et al. 1957
* ROS-03B - Thymo-Teucrion verticillati Rivas Goday in Rivas Goday et al. 1957

F6.8 - Xero-halophile scrubs

* CRI-02E - Anthyllidion barbae-jovis S. Brullo et De Marco 1989
* CRI-02F - Crucianellion rupestris S. Brullo et Furnari 1990
* CRI-04C - Helichrysion obconico-devium Rivas-Mart. et al. 2002
* LER-01A - Artemision lerchianae Golub 1994
* LER-02A - Euphorbion seguieranae Golub 1994
* PEG-01A - Salsolo vermiculatae-Peganion harmalae Br.-Bl. et O. de Bolòs 1954
* PEG-01B - Haloxylo tamariscifolii-Atriplicion glaucae Rivas Goday et Rivas-Mart. ex Rigual 1972

* PEG-01C - Salsolo oppositifoliae-Suaedion fruticosae Rigual 1972
* PEG-01D - Lycio europaei-Ipomoeion purpureae O. de Bolòs ex Mucina all. nov. hoc loco
* PEG-01E - Artemision arborescentis Géhu et Biondi 1986
* PEG-01F - Atriplici halimi-Suaedion verae Géhu et al. ex Bergmeier et Dimopoulos 2003
* PEG-01G - Medicagini citrinae-Lavaterion arboreae O. de Bolòs et Vigo in O. de Bolòs et al. 1984
* PEG-02A - Artemisio glutinosae-Santolinion rosmarinifoliae Costa 1975
* PEG-02B - Santolinion pectinato-canescentis Peinado et Martínez-Parras 1984
* PEG-03A - Chenoleion tomentosae Sunding 1972
* PEG-04A - Artemisio thusculae-Rumicion lunariae Rivas-Mart. et al. 1993
* PEG-04B - Launaeo arborescentis-Schizogynion sericeae Rivas-Mart. et al. 1993
* PEG-04C - Argyranthemo suculenti-Calendulion maderensis Capelo et al. 2000
* PEG-04D - Nicotiano glaucae-Ricinion communis Rivas-Mart., Fernández-González et Loidi 1999

F7 - Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)

F7.1 - West Mediterranean spiny heaths
* CRI-02B - Astragalion tragacanthae (Folch ex Rivas-Mart., Fernández-González et Loidi 1999) Rivas-Mart. et al. 2002
* CRI-02C - Launaeion cervicornis (O. de Bolòs et Vigo ex Gil et Llorens 1995) Rivas-Mart., Fernández-González et Loidi 1999

F7.2 - Central Mediterranean spiny heaths

F7.3 - East Mediterranean phrygana
* MIC-02E - Micromerion Oberd. 1954
* MIC-02F - Sarcopoterio spinosi-Genistion fasselatae Costa et al. 1984

F7.4 - Hedgehog-heaths
* CYP-01A - Hyperico stenobotryos-Alyssion troodi S. Brullo et al. 2005
* DAP-01A - Astragalo angustifolii-Seslerion coerulantis Quézel 1964
* DAP-01B - Eryngio multifidi-Bromion fibrosi Quézel 1964
* DAP-01C - Stipo pulcherrimae-Morinion persicae Quézel 1964
* DAP-02A - Astragalion cretici Bergmeier 2002
* DAP-02B - Verbascion spinosi Zaffran ex Bergmeier 2002
* DAP-02C - Colchico cretensis-Cirsion morinifolii Bergmeier 2002
* GEN-01A - Anthyllidion hermanniae Klein 1972
* ONO-01E - Echinospartion horridi Rivas-Mart. et al. 1991
* ROS-02A - Xeroacantho-Erinaceion (Quézel 1953) O. de Bolòs 1967
* ROS-05A - Andryalion agardhii Rivas-Mart. ex Rivas Goday et Mayor 1966

* RUM-01A - Rumici-Astragalion siculi Poli 1965
* RUM-02A - Cerastio-Astragalion nebrodensis Pignatti et Nimis ex S. Brullo 1984
* RUM-02B - Armerion nebrodensis S. Brullo 1984
* RUM-03A - Armerion aspomontanae S. Brullo et al. 2001
* RUM-03B - Koelerio brutiae-Astragalion calabrici Giacomini et Gentile ex S. Brullo in S. Brullo et al. 2005

F8 - Thermo-Atlantic xerophytic scrub

F8.1 - Canary Island xerophytic scrub

* AEO-01A - Soncho acaulis-Sempervivion Sunding 1972
* AEO-01B - Greenovion aureae Rivas-Mart. et al. 1993
* AEO-02A - Aichryso laxi-Monanthion laxiflorae Santos et Reyes Betancort 2009
* KLE-01A - Aeonio-Euphorbion canariensis Sunding 1972
* KLE-01B - Euphorbion regijsjubo-lamarckii Rivas-Mart., Wildpret, O. Rodríguez et Del Arco in Rivas-Mart. et al. 2011
* OLE-01A - Mayteno canariensis-Juniperion canariensis Santos et F. Galván ex Santos 1983 corr. Rivas-Mart. et al. 1993
* OLE-01B - Retamion rhodorhizoidis Del Arco et al. 2009
* OLE-02A - Cisto canariensis-Micromerion hyssopifoliae Pérez de Paz et al. 1990 corr. Rivas-Mart. in Rivas-Mart. 2011
* PEG-03A - Chenoleion tomentosae Sunding 1972
* PEG-04A - Artemisio thusculae-Rumicion lunariae Rivas-Mart. et al. 1993
* PEG-04B - Launaeo arborescentis-Schizogynion sericeae Rivas-Mart. et al. 1993
* PEG-04D - Nicotiano glaucae-Ricinion communis Rivas-Mart., Fernández-González et Loidi 1999
* SUP-01A - Spartocytision nubigeni Oberd. ex Esteve 1973
* SUP-01B - Plantaginion webbii Martín Osorio, Wildpret et Rivas-Mart. In Martín Osorio et al. 2007
* VIO-01A - Violion cheiranthifoliae Voggenreiter ex Martín Osorio, Wildpret et Rivas-Mart. in Martín Osorio et al. 2007

F8.2 - Madeiran xerophytic scrub

* AEO-01C - Sinapidendro angustifolii-Aeonion glutinosi Capelo et al. 2000
* KLE-01A - Aeonio-Euphorbion canariensis Sunding 1972
* OLE-01D - Oleo maderensis-Maytenion umbellatae Capelo et al. 2000
* OLE-02B - Soncho ustulati-Artemision argenteae Capelo et al. 2000
* PEG-04C - Argyranthemo suculenti-Calendulion maderensis Capelo et al. 2000

F9 - Riverine and fen scrubs

F9.1 - Riverine scrub

* PUR-01A - Salicion phylicifoliae Dierßen 1992
* PUR-01B - Salicion eleagno-daphnoidis (Moor 1958) Grass 1993
* PUR-01D - Salicion triandrae T. Müller et Görs 1958
* PUR-01E - Rubo caesii-Amorphion fruticosae Shevchyk et Solomakha in Shevchyk et al. 1996

* PUR-01F - Artemisio dniproicae-Salicion acutifoliae Shevchyk et Solomakha in Shevchyk et al. 1996
* PUR-01G - Salicion salvifoliae Rivas-Mart. et al. 1984
* PUR-01H - Salicion discolori-neotrichae Br.-Bl. et O. de Bolòs 1958 corr. Rivas-Mart. et al. 2002
* PUR-01I - Salicion pedicellatae Rivas-Mart. et al. 1984
* PUR-01J - Salicion cantabricae Rivas-Mart., T.E. Díaz et Penas in Rivas-Mart. et al. 2011

F9.2 - [Salix] carr and fen scrub

* CIN-01A - Salicion cinereae T. Müller et Görs ex Passarge 1961

F9.3 - Southern riparian galleries and thickets

* NER-01A - Tamaricion africanae Br.-Bl. et O. de Bolòs 1958
* NER-01B - Tamaricion boveano-canariensis Izco et al. 1984
* NER-01C - Rubo ulmifolii-Nerion oleandri O. de Bolòs 1958
* NER-01D - Securinegion buxifoliae Rivas Goday ex Lopez Saenz et Velasco 1995
* NER-01E - Tamaricion dalmaticae Jasprica in Mucina et al. 2013
* NER-01F - Rubo sancti-Nerion oleandri Brullo et al. 2004
* POP-03A - Salicion canariensis Rivas-Mart. et al. ex Rivas-Mart., Fernández González et Lodi 1999
* PUR-02A - Tamaricion parviflorae I. Kárpáti et V. Kárpáti 1961
* PUR-02B - Artemisio scopariae-Tamaricion ramosissimae Simon et Dihoru 1963
* TAM-01A - Agropyro fragilis-Tamaricion ramosissimae Golub in Barmin 2001

Appendix B: An updated crosswalk Syntaxa to EUNIS heathland, scrub and tundra habitat types (B1.5, B1.6, B2.5, F)

CRI-02A - Dactylido hispanicae-Helichrysion stoechadis Géhu et Biondi in Géhu 1994
  * F6.1 - Western garrigues
CRI-02D - Euphorbion pithyusae Biondi et Géhu in Géhu et Biondi 1994
  * F5.5 - Thermo-Mediterranean scrub
  * F6.1 - Western garrigues
HER-01B - Salici herbaceae-Caricion lachenalii Béguin et Theurillat 1982
  * F2.1 - Subarctic and alpine dwarf willow scrub
KOB-01B - Dryadion integrifoliae Ohba ex Daniëls 1982
  * F1.2 - Moss and lichen tundra
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01A - Loiseleurio-Arctostaphylion Kalliola ex Nordhagen 1943
  * F1.1 - Shrub tundra
  * F1.2 - Moss and lichen tundra
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01B - Phyllodoco-Vaccinion myrtilli Nordhagen 1943
  * F1.1 - Shrub tundra
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01C - Loiseleurio-Vaccinion Br.-Bl. in Br.-Bl. et Jenny 1926
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01D - Rhododendro ferruginei-Vaccinion Br.-Bl. ex Schnyder 1930
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01E - Juniperion nanae Br.-Bl. in Br.-Bl. et al. 1939
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01F - Bruckenthalion spiculifoliae Horvat 1949
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01G - Rhododendrion caucasici Onipchenko 2002
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01H - Salici kazbekensis–Empetrion nigrae Onipchenko 2002
  * F2.2 - Evergreen alpine and subalpine heath and scrub
LOI-01I - Aconito nasuti–Juniperion Onipchenko 2002
  * F2.2 - Evergreen alpine and subalpine heath and scrub
RHO-01A - Ericion carneae Rübel ex Grabherr et al. 1993
  * F2.2 - Evergreen alpine and subalpine heath and scrub
RHO-01B - Daphno oleoidis-Juniperion alpinae Stanisci 1997
  * F2.2 - Evergreen alpine and subalpine heath and scrub
RHO-01C - Daphno-Genistion radiatae N. Randelovic et Rexhepi 1980
  * F2.2 - Evergreen alpine and subalpine heath and scrub
SAB-03A - Cytision oromediterranei Tx. in Tx. et Oberd. 1958 corr. Rivas-Mart. 1987
  * F2.2 - Evergreen alpine and subalpine heath and scrub
SAB-03B - Genisto versicoloris-Juniperion hemisphaericae Rivas-Mart. et J.A.

Molina in Rivas-Mart., Fernández-González et Loidi 1999
* F2.2 - Evergreen alpine and subalpine heath and scrub

SAB-03C - Pruno prostratae-Juniperion sabinae Rivas-Mart. et J.A. Molina in Rivas-Mart., Fernández-González et Loidi 1999
* F2.2 - Evergreen alpine and subalpine heath and scrub

SAB-05A - Lonicero-Rhamnion falacis P. Fukarek 1969
* F2.3 - Subalpine deciduous scrub

MUG-01A - Pinion mugo Pawlowski et al. 1928
* F2.4 - Conifer scrub close to the tree limit

MUG-01B - Erico-Pinion mugo Leibundgut 1948 nom. invers. propos.
* F2.4 - Conifer scrub close to the tree limit

MUG-01C - Epipactido atropurpureae-Pinion mugo Stanisci 1997
* F2.4 - Conifer scrub close to the tree limit

MUG-01D - Lonicero borbasianae-Pinion mugo Carni et Mucina 2013
* F2.4 - Conifer scrub close to the tree limit

VIR-01A - Alnion viridis Schnyder 1930
* F2.3 - Subalpine deciduous scrub

VIR-01B - Salicion pentandrae Br.-Bl. 1967
* F2.3 - Subalpine deciduous scrub

VIR-01C - Salicion helveticae Rübel ex Theurillat in Theurillat et al. 1995
* F2.3 - Subalpine deciduous scrub

VIR-01D - Salicion silesiacae Rejmánek et al. 1971
* F2.3 - Subalpine deciduous scrub

ULI-01A - Ericion cinereae Böcher 1940
* B1.5 - Coastal dune heaths
* F4.2 - Dry heaths

ULI-01B - Ulicion minoris Malcuit 1929
* B1.5 - Coastal dune heaths
* F4.1 - Wet heaths
* F4.2 - Dry heaths

ULI-01C - Daboecion cantabricae (Dupont ex Rivas-Mart. 1979) Rivas-Mart. et al. in Loidi et al.1997
* F4.1 - Wet heaths
* F4.2 - Dry heaths

ULI-01D - Ericion umbellatae Br.-Bl. in Br.-Bl. et al. 1952
* B1.5 - Coastal dune heaths
* F4.1 - Wet heaths
* F4.2 - Dry heaths
* F5.5 - Thermo-Mediterranean scrub

ULI-01E - Genistion micrantho-anglicae Rivas-Mart. 1979
* F4.1 - Wet heaths

ULI-01F - Stauracanthion boivinii (Rivas-Mart. 1979) Rivas-Mart., Fernández-González et Loidi 1999
* F4.1 - Wet heaths
* F5.5 - Thermo-Mediterranean scrub

ULI-01G - Daboecion azoricae Lüpnitz 1975
* F4.3 - Macaronesian heaths

ULI-02A - Genisto-Vaccinion Br.-Bl. 1926

* F2.2 - Evergreen alpine and subalpine heath and scrub
* F4.2 - Dry heaths

ULI-02B - Genistion pilosae Bøcher 1943
* B1.5 - Coastal dune heaths
* F4.2 - Dry heaths

ULI-02C - Empetrion nigri Schubert ex Westhoff et Den Held 1969
* B1.5 - Coastal dune heaths
* F4.2 - Dry heaths

RHA-01A - Aegopodio podagrariae-Sambucion nigrae Chytrý in Mucina et al. 2013
* F3.1 - Temperate thickets and scrub

RHA-01E - Chelidonio-Acerion negundi L. Ishbirdin et A. Ishbirdin 1989
* F3.1 - Temperate thickets and scrub

RHA-02A - Berberidion vulgaris Br.-Bl. ex Tx. 1952 nom. conserv.
* B1.6 - Coastal dune scrub
* F3.1 - Temperate thickets and scrub
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02B - Amelanchiero-Buxion O. de Bolòs et Romo in Romo 1989
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02C - Carpino-Prunion spinosae Weber 1974
* B1.6 - Coastal dune scrub
* F3.1 - Temperate thickets and scrub

RHA-02D - Pruno spinosae-Rubion radulae Weber 1974
* B1.6 - Coastal dune scrub
* F3.1 - Temperate thickets and scrub

RHA-02E - Frangulo alni-Pyrion cordatae Herrera et al. 1991
* F3.1 - Temperate thickets and scrub

RHA-02F - Tamo communis-Viburnion lantanae (Géhu et al. 1983) Mucina in Mucina et al. 2013
* F3.1 - Temperate thickets and scrub

RHA-02G - Brachypodio pinnati-Juniperion communis Mucina in Mucina et al. 2013
* F3.1 - Temperate thickets and scrub

RHA-02H - Rubio periclymeni-Rubion ulmifolii Oberd. ex Rivas-Mart. et al. 1993
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02I - Scrophulario glabratae-Rubion ulmifolii Vicente Orellana et al. 2012
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02J - Pruno spinosae-Rubion ulmifolii O. de Bolòs 1954
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02K - Lonicero arboreae-Berberidion hispanicae O. de Bolòs 1954
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02L - Cytision sessilifolii Biondi in Biondi et al. 1989
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.4 - [Spartium junceum] fields

RHA-02M - Berberido aetnensis-Crataegion laciniatae Gianguzzi et al. 2011
* F3.2 - Submediterranean deciduous thickets and brushes

RHA-02N - Pruno tenellae-Syringion Jovanovic ex Carni et Mucina 2013
  * F3.2 - Submediterranean deciduous thickets and brushes
RHA-02O - Berberido creticae-Prunion cocomiliae Bergmeier 1990
  * F3.2 - Submediterranean deciduous thickets and brushes
RHA-02P - Asparago verticillati-Crataegion tauricae Korzhenevsky et Klyukin 1990
  * F3.2 - Submediterranean deciduous thickets and brushes
RHA-02Q - Prunion fruticosae Tx. 1952
  * F3.1 - Temperate thickets and scrub
RHA-02R - Lamio purpureae-Acerion tatarici Fitsailo 2007
  * F3.1 - Temperate thickets and scrub
RHA-03A - Salicion arenariae Tx. ex Passarge in Scamoni 1963
  * B1.6 - Coastal dune scrub
  * F3.1 - Temperate thickets and scrub
RHA-03B - Ligustro-Hippophaeion Géhu et Géhu-Franck 1983
  * B1.6 - Coastal dune scrub
  * F3.1 - Temperate thickets and scrub
RHA-03C - Holoschoeno australis-Salicion arenariae Neto et al. 2004
  * B1.6 - Coastal dune scrub
  * F3.1 - Temperate thickets and scrub
RHA-04A - Sambuco racemosae-Salicion capreae Tx. et Neumann ex Oberd. 1957
  * F3.1 - Temperate thickets and scrub
RHA-04C - Astrantio-Corylion avellanae Passarge 1978
  * F3.1 - Temperate thickets and scrub
LON-02A - Frangulo-Rubion Rivas Goday 1964
  * F3.1 - Temperate thickets and scrub
LON-03A - Vaccinio-Juniperion communis Passarge in Passarge et G. Hofmann 1968
  * F3.1 - Temperate thickets and scrub
PUB-01A - Paliuro-Petterion P. Fukarek 1962
  * F3.2 - Submediterranean deciduous thickets and brushes
  * F5.3 - Pseudomaquis
PUB-01B - Eryngio campestris-Paliurion spinae-christi (Jovanovic 1985) Matevski et al. 2008
  * F3.2 - Submediterranean deciduous thickets and brushes
  * F5.3 - Pseudomaquis
PUB-01C - Junipero excelsae-Quercion pubescentis Jakucs 1960
  * F3.2 - Submediterranean deciduous thickets and brushes
  * F5.3 - Pseudomaquis
PUB-01D - Fraxino orni-Cotinion Soó 1960
  * F3.2 - Submediterranean deciduous thickets and brushes
  * F5.3 - Pseudomaquis
PUB-01E - Pruno tenellae-Syringion (B. Jovanovic 1979) Carni et al. 2009
  * F3.2 - Submediterranean deciduous thickets and brushes
  * F5.3 - Pseudomaquis
PUB-01F - Syringo-Carpinion orientalis Jakucs 1959
  * F3.2 - Submediterranean deciduous thickets and brushes

* F5.3 - Pseudomaquis

ROS-01A - Lavandulo latifoliae-Genistion boissieri Rivas Goday et Rivas-Mart. 1969
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

ROS-01B - Eryngio trifidi-Ulicion erinacei Rothmaler 1943
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

ROS-01C - Ulici densi-Thymion sylvestris (Capelo et al. 1993) Costa et al. 2009
* F6.1 - Western garrigues

ROS-01D - Sideritido incanae-Salvion lavandulifoliae (Rivas Goday et Rivas-Mart. 1969) Izco et Molina 1989
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

ROS-01E - Helianthemo italici-Aphyllanthion monspeliensis Díez Garretas et al. 1998
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

ROS-01F - Rosmarinion officinalis Molinier 1934
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

ROS-01G - Hypericion ericoidis Esteve ex Costa et Peris 1985
* F6.1 - Western garrigues

ROS-01H - Hypericion balearici O. de Bolòs et Molinier 1958
* F6.1 - Western garrigues

ROS-01I - Cisto cretici-Genistion corsicae Arrigoni et Di Tommaso 1991
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

ROS-01J - Polygalo-Seslerion insularis Arrigoni ex Arrigoni et Di Tommaso 1986
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

ROS-01K - Artemisio albae-Saturejion montanae Allegrezza et al. 1997
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

ROS-02A - Xeroacantho-Erinaceion (Quézel 1953) O. de Bolòs 1967
* F7.4 - Hedgehog-heaths

ROS-03A - Lepidion subulati Bellot et Rivas Goday in Rivas Goday et al. 1957
* F6.1 - Western garrigues
* F6.7 - Mediterranean gypsum scrubs

ROS-03B - Thymo-Teucrion verticillati Rivas Goday in Rivas Goday et al. 1957
* F6.1 - Western garrigues
* F6.7 - Mediterranean gypsum scrubs

ROS-04A - Thymo moroderi-Sideritidion leucanthae O. de Bolòs 1957 corr. Alcaraz et al. 1989
* F5.5 - Thermo-Mediterranean scrub

* F6.1 - Western garrigues

ROS-04B - Anthyllido terniflorae-Salsolion papillosae Rivas Goday et Esteve 1968
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

ROS-04C - Sideritidion bourgaeanae Peinado et Martínez-Parras in Peinado et al. 1992
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

ROS-05A - Andryalion agardhii Rivas-Mart. ex Rivas Goday et Mayor 1966
* F7.4 - Hedgehog-heaths

ROS-05B - Lavandulion lanatae (Martínez-Parras et al. 1984) Rivas-Mart. et al. 2002
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

CYT-01A - Cytision oromediterraneo-scoparii Rivas-Mart. et al. 2002
* F3.1 - Temperate thickets and scrub

CYT-01B - Ulici europaei-Cytision striati Rivas-Mart. et al. 1991
* F3.2 - Submediterranean deciduous thickets and brushes

CYT-01C - Genistion floridae Rivas-Mart. 1974
* F3.2 - Submediterranean deciduous thickets and brushes

CYT-01D - Cytision multiflori Rivas-Mart. 1974
* F3.2 - Submediterranean deciduous thickets and brushes

CYT-01E - Retamion monospermae Rivas-Mart et al. 2002
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-01F - Retamion sphaerocarpae Rivas-Mart. 1981
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-01G - Adenocarpion decorticantis (Rivas-Mart. et F. Valle ex F. Valle 1985) Rivas-Mart. et al.1999
* F3.2 - Submediterranean deciduous thickets and brushes

CYT-01H - Violo messanensis-Adenocarpion intermedii Mucina in Mucina et al. 2013
* F3.2 - Submediterranean deciduous thickets and brushes

CYT-02A - Telinion monspessulano-linifoliae Rivas-Mart. et al. 2002
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-02B - Genisto spartioidis-Phlomidion almeriensis Rivas Goday et Rivas-Mart. 1969
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-02C - Genisto scorpii-Retamion sphaerocarpae Rivas-Mart. et Costa in Rivas-Mart. et al. 2011
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-02D - Genistion specioso-equisetiformis Rivas-Mart. et F. Valle in Rivas-

Mart. et al. 2011
* F3.2 - Submediterranean deciduous thickets and brushes
* F5.5 - Thermo-Mediterranean scrub

CYT-03A - Sarothamnion scoparii Oberd. 1957
* F3.1 - Temperate thickets and scrub

CYT-03B - Erico scopariae-Cytision scoparii Mucina in Mucina et al. 2013
* F3.1 - Temperate thickets and scrub

LAV-01A - Cistion laurifolii Rivas Goday in Rivas Goday et al. 1956
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

LAV-01B - Staehelino-Ulicion baetici Rivas Goday et Rivas-Mart. 1969
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

LAV-01C - Ulici argentei-Cistion ladaniferi Br.-Bl. et al. 1965
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

LAV-01D - Quercion fruticosae Rothmaler 1954
* B1.6 - Coastal dune scrub
* F5.2 - Maquis
* F5.5 - Thermo-Mediterranean scrub

LAV-01E - Cistion ladaniferi Br.-Bl. ex A. Bolós et O. Bolòs in A. Bolós 1950
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

LAV-01F - Calicotomo villosae-Genistion tyrrhenae Biondi 2000
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

LAV-01G - Teucrion mari (Gamisans et Muracciole 1984) Biondi et Mossa 1992
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

LAV-01H - Armerio sardoae-Genistion salzmannii Arrigoni 1986
* F6.1 - Western garrigues
* F6.6 - Supra-Mediterranean garrigues

LAV-02A - Coremation albi Rothmaler 1943
* F5.5 - Thermo-Mediterranean scrub
* F6.1 - Western garrigues

MIC-01A - Cisto cretici-Ericion manipuliflorae Horvatic 1958
* F5.5 - Thermo-Mediterranean scrub
* F6.3 - Illyrian garrigues

MIC-01B - Cisto eriocephali-Ericion multiflorae Biondi 2000
* F5.5 - Thermo-Mediterranean scrub
* F6.3 - Illyrian garrigues

MIC-02A - Hyperico olympici-Cistion cretici (Oberd. 1954) R.Jahn et Bergmeier in Mucina et al. 2009
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues

MIC-02B - Helichryso barrelieri-Phagnalion graeci (Barbéro et Quézel 1989)

R. Jahn in Mucina et al. 2009
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues

MIC-02C - Hyperico empetrifolii-Micromerion graecae Barbero et Quézel 1989
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues

MIC-02D - Helichryso sanguinei-Origanion syriaci Barbero et Quézel 1989
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues

MIC-02E - Micromerion Oberd. 1954
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues
* F7.3 - East Mediterranean phrygana

MIC-02F - Sarcopoterio spinosi-Genistion fasselatae Costa et al. 1984
* F5.5 - Thermo-Mediterranean scrub
* F6.2 - Eastern garrigues
* F7.3 - East Mediterranean phrygana

QUI-01A - Oleo-Ceratonion siliquae Br.-Bl. ex Guinochet et Drouineau 1944
* B1.6 - Coastal dune scrub
* F5.2 - Maquis
* F5.4 - [Spartium junceum] fields
* F5.5 - Thermo-Mediterranean scrub

QUI-01B - Ericion arboreae (Rivas-Mart. ex Rivas-Mart. et al. 1986) Rivas-Mart. 1987
* F4.2 - Dry heaths
* F5.2 - Maquis

QUI-01C - Juniperion turbinatae Rivas-Mart. 1975 corr. 1987
* B1.6 - Coastal dune scrub
* F5.5 - Thermo-Mediterranean scrub

QUI-01D - Asparago albi-Rhamnion oleoidis Rivas Goday ex Rivas-Mart. 1975
* F5.2 - Maquis
* F5.5 - Thermo-Mediterranean scrub

QUI-01E - Rhamno lycioidis-Quercion cocciferae Rivas Goday ex Rivas-Mart. 1975
* F5.2 - Maquis

QUI-01F - Periplocion angustifoliae Rivas-Mart. 1975
* F5.2 - Maquis
* F5.5 - Thermo-Mediterranean scrub

QUI-01G - Juniperon phoeniceae-Pinon acutisquamae A.V. Pérez et Cabezudo in A.V. Pérez et al. 1988 corr. Rivas-Mart. et al. 2002 nom. invers. propos.
* F5.5 - Thermo-Mediterranean scrub

QUI-01H - Rubo longifoliae-Coremation albi Rivas-Mart. in Rivas-Mart. et al. 1980
* B1.6 - Coastal dune scrub
* F5.2 - Maquis

* F5.5 - Thermo-Mediterranean scrub

QUI-01I - Asparago orientalis-Juniperenion macrocarpae (Díez-Garretas et Asensi 2013) Mucina stat. nov. hoc loco
* F5.2 - Maquis

QUI-01J - Rhamno graeci-Juniperion lyciae Costa et al. 1984
* B1.6 - Coastal dune scrub
* F5.2 - Maquis
* F5.5 - Thermo-Mediterranean scrub

QUI-01K - Pistacio terebinthi-Rhamnion alaterni Barbero et Quézel ex Quézel et al. 1992
* F5.2 - Maquis

QUI-02B - Ceratonio-Pistacion lentisci Zohary ex Zohary et Orshan 1959
* F5.2 - Maquis
* F5.5 - Thermo-Mediterranean scrub

PEG-01A - Salsolo vermiculatae-Peganion harmalae Br.-Bl. et O. de Bolòs 1954
* F6.8 - Xero-halophile scrubs

PEG-01B - Haloxylo tamariscifolii-Atriplicion glaucae Rivas Goday et Rivas-Mart. ex Rigual 1972
* F6.8 - Xero-halophile scrubs

PEG-01C - Salsolo oppositifoliae-Suaedion fruticosae Rigual 1972
* F6.8 - Xero-halophile scrubs

PEG-01D - Lycio europaei-Ipomoeion purpureae O. de Bolòs ex Mucina all. nov. hoc loco
* F6.8 - Xero-halophile scrubs

PEG-01E - Artemision arborescentis Géhu et Biondi 1986
* F6.8 - Xero-halophile scrubs

PEG-01F - Atriplici halimi-Suaedion verae Géhu et al. ex Bergmeier et Dimopoulos 2003
* F6.8 - Xero-halophile scrubs

PEG-01G - Medicagini citrinae-Lavaterion arboreae O. de Bolòs et Vigo in O. de Bolòs et al. 1984
* F6.8 - Xero-halophile scrubs

PEG-02A - Artemisio glutinosae-Santolinion rosmarinifoliae Costa 1975
* F6.8 - Xero-halophile scrubs

PEG-02B - Santolinion pectinato-canescentis Peinado et Martínez-Parras 1984
* F6.8 - Xero-halophile scrubs

PEG-03A - Chenoleion tomentosae Sunding 1972
* F6.8 - Xero-halophile scrubs
* F8.1 - Canary Island xerophytic scrub

PEG-04A - Artemisio thusculae-Rumicion lunariae Rivas-Mart. et al. 1993
* F6.8 - Xero-halophile scrubs
* F8.1 - Canary Island xerophytic scrub

PEG-04B - Launaeo arborescentis-Schizogynion sericeae Rivas-Mart. et al. 1993
* F6.8 - Xero-halophile scrubs
* F8.1 - Canary Island xerophytic scrub

PEG-04C - Argyranthemo suculenti-Calendulion maderensis Capelo et al.

2000
* F6.8 - Xero-halophile scrubs
* F8.2 - Madeiran xerophytic scrub

PEG-04D - Nicotiano glaucae-Ricinion communis Rivas-Mart., Fernández-González et Loidi 1999
* F6.8 - Xero-halophile scrubs
* F8.1 - Canary Island xerophytic scrub

ONO-01E - Echinospartion horridi Rivas-Mart. et al. 1991
* F6.6 - Supra-Mediterranean garrigues
* F7.4 - Hedgehog-heaths

ONO-01F - Genistion occidentalis Rivas-Mart. in Rivas-Mart. et al. 1984
* F6.6 - Supra-Mediterranean garrigues

ONO-01G - Lavandulo angustifoliae-Genistion cinereae Barbero et al. 1972
* F6.6 - Supra-Mediterranean garrigues

ONO-02D - Seselio granatensis-Festucion hystricis Rivas-Mart. in Rivas-Mart. et al. 2011
* F6.6 - Supra-Mediterranean garrigues

GEN-01A - Anthyllidion hermanniae Klein 1972
* F7.4 - Hedgehog-heaths

RUM-01A - Rumici-Astragalion siculi Poli 1965
* F7.4 - Hedgehog-heaths

RUM-02A - Cerastio-Astragalion nebrodensis Pignatti et Nimis ex S. Brullo 1984
* F7.4 - Hedgehog-heaths

RUM-02B - Armerion nebrodensis S. Brullo 1984
* F7.4 - Hedgehog-heaths

RUM-03A - Armerion aspomontanae S. Brullo et al. 2001
* F7.4 - Hedgehog-heaths

RUM-03B - Koelerio brutiae-Astragalion calabrici Giacomini et Gentile ex S. Brullo in S. Brullo et al. 2005
* F7.4 - Hedgehog-heaths

DAP-01A - Astragalo angustifolii-Seslerion coerulantis Quézel 1964
* F7.4 - Hedgehog-heaths

DAP-01B - Eryngio multifidi-Bromion fibrosi Quézel 1964
* F7.4 - Hedgehog-heaths

DAP-01C - Stipo pulcherrimae-Morinion persicae Quézel 1964
* F7.4 - Hedgehog-heaths

DAP-02A - Astragalion cretici Bergmeier 2002
* F7.4 - Hedgehog-heaths

DAP-02B - Verbascion spinosi Zaffran ex Bergmeier 2002
* F7.4 - Hedgehog-heaths

DAP-02C - Colchico cretensis-Cirsion morinifolii Bergmeier 2002
* F7.4 - Hedgehog-heaths

CYP-01A - Hyperico stenobotryos-Alyssion troodi S. Brullo et al. 2005
* F6.6 - Supra-Mediterranean garrigues
* F7.4 - Hedgehog-heaths

LER-01A - Artemision lerchianae Golub 1994
* F6.8 - Xero-halophile scrubs

LER-02A - Euphorbion seguieranae Golub 1994
  * F6.8 - Xero-halophile scrubs
PUR-01A - Salicion phylicifoliae Dierßen 1992
  * F9.1 - Riverine scrub
PUR-01B - Salicion eleagno-daphnoidis (Moor 1958) Grass 1993
  * F9.1 - Riverine scrub
PUR-01D - Salicion triandrae T. Müller et Görs 1958
  * F9.1 - Riverine scrub
PUR-01E - Rubo caesii-Amorphion fruticosae Shevchyk et Solomakha in Shevchyk et al. 1996
  * F9.1 - Riverine scrub
PUR-01F - Artemisio dniproicae-Salicion acutifoliae Shevchyk et Solomakha in Shevchyk et al. 1996
  * F9.1 - Riverine scrub
PUR-01G - Salicion salvifoliae Rivas-Mart. et al. 1984
  * F9.1 - Riverine scrub
PUR-01H - Salicion discolori-neotrichae Br.-Bl. et O. de Bolòs 1958 corr. Rivas-Mart. et al. 2002
  * F9.1 - Riverine scrub
PUR-01I - Salicion pedicellatae Rivas-Mart. et al. 1984
  * F9.1 - Riverine scrub
PUR-01J - Salicion cantabricae Rivas-Mart., T.E. Díaz et Penas in Rivas-Mart. et al. 2011
  * F9.1 - Riverine scrub
PUR-02A - Tamaricion parviflorae I. Kárpáti et V. Kárpáti 1961
  * F9.3 - Southern riparian galleries and thickets
PUR-02B - Artemisio scopariae-Tamaricion ramosissimae Simon et Dihoru 1963
  * F9.3 - Southern riparian galleries and thickets
CIN-01A - Salicion cinereae T. Müller et Görs ex Passarge 1961
  * F9.2 - [Salix] carr and fen scrub
NER-01A - Tamaricion africanae Br.-Bl. et O. de Bolòs 1958
  * F9.3 - Southern riparian galleries and thickets
NER-01B - Tamaricion boveano-canariensis Izco et al. 1984
  * F9.3 - Southern riparian galleries and thickets
NER-01C - Rubo ulmifolii-Nerion oleandri O. de Bolòs 1958
  * F9.3 - Southern riparian galleries and thickets
NER-01D - Securinegion buxifoliae Rivas Goday ex Lopez Saenz et Velasco 1995
  * F9.3 - Southern riparian galleries and thickets
NER-01E - Tamaricion dalmaticae Jasprica in Mucina et al. 2013
  * F9.3 - Southern riparian galleries and thickets
NER-01F - Rubo sancti-Nerion oleandri Brullo et al. 2004
  * F9.3 - Southern riparian galleries and thickets
TAM-01A - Agropyro fragilis-Tamaricion ramosissimae Golub in Barmin 2001
  * F9.3 - Southern riparian galleries and thickets
MOQ-01A - Traganion moquinii Sunding 1972
  * B1.6 - Coastal dune scrub

AEO-01A - Soncho acaulis-Sempervivion Sunding 1972
  * F8.1 - Canary Island xerophytic scrub
AEO-01B - Greenovion aureae Rivas-Mart. et al. 1993
  * F8.1 - Canary Island xerophytic scrub
AEO-01C - Sinapidendro angustifolii-Aeonion glutinosi Capelo et al. 2000
  * F8.2 - Madeiran xerophytic scrub
AEO-02A - Aichryso laxi-Monanthion laxiflorae Santos et Reyes Betancort 2009
  * F8.1 - Canary Island xerophytic scrub
KLE-01A - Aeonio-Euphorbion canariensis Sunding 1972
  * F8.1 - Canary Island xerophytic scrub
  * F8.2 - Madeiran xerophytic scrub
KLE-01B - Euphorbion regijsjubo-lamarckii Rivas-Mart., Wildpret, O. Rodríguez et Del Arco in Rivas-Mart. et al. 2011
  * F8.1 - Canary Island xerophytic scrub
OLE-01B - Retamion rhodorhizoidis Del Arco et al. 2009
  * F8.1 - Canary Island xerophytic scrub
OLE-01D - Oleo maderensis-Maytenion umbellatae Capelo et al. 2000
  * F8.2 - Madeiran xerophytic scrub
OLE-02A - Cisto canariensis-Micromerion hyssopifoliae Pérez de Paz et al. 1990 corr. Rivas-Mart. in Rivas-Mart. 2011
  * F8.1 - Canary Island xerophytic scrub
OLE-02B - Soncho ustulati-Artemision argenteae Capelo et al. 2000
  * F8.2 - Madeiran xerophytic scrub
LAU-01A - Myrico fayae-Ericion arboreae Oberd. 1965
  * F4.3 - Macaronesian heaths
SUP-01A - Spartocytision nubigeni Oberd. ex Esteve 1973
  * F8.1 - Canary Island xerophytic scrub
SUP-01B - Plantaginion webbii Martín Osorio, Wildpret et Rivas-Mart. In Martín Osorio et al. 2007
  * F8.1 - Canary Island xerophytic scrub
VIO-01A - Violion cheiranthifoliae Voggenreiter ex Martín Osorio, Wildpret et Rivas-Mart. in Martín Osorio et al. 2007
  * F8.1 - Canary Island xerophytic scrub

Appendix C Descriptions of EUNIS Forest habitat types

In the following, the EUNIS Forest habitats have been given their revised names, beneath which is given the original text description, then the draft revised description. Red text indicates those Forest habitats where Schaminée et al. (2013) recommended some revision, either splitting or fusion of adjacent units and then splitting. Where such changes have occurred, the original text description is repeated for each new unit. Green text indicates those habitats where further revision, either splitting or fusion of adjacent units, has been proposed for the Red List of European habitats project.

In the revised description, 'woodland' is used where the habitat has a large measure of uniformity, 'woodlands' where the habitat unites rather diverse woodland types. All biogeographic zones have been given lower-case initial letters (e.g. mediterranean) to avoid confusion with similarly named geographic regions.

B1.7 Coastal dune woodland

Original description: Coastal dunes colonised by woodland or riparian thickets.

Deciduous or evergreen woodlands variously dominated by durmast oak (Quercus robur), mixed broadleaves, evergreen oaks (Quercus spp.), Scot's Pine (Pinus sylvestris), thermophilous pines (Pinus spp.) or willows (Salix spp.) on stable dune sands along the Baltic, Atlantic, Mediterranean and Black Sea coasts, often indistinguishable from equivalent forests further inland.

G1.1 Temperate and boreal softwood riparian woodland

Original description: Riparian woods of the boreal, boreo-nemoral, nemoral and submediterranean and steppe zones, with one or few dominant species, typically Alnus, Betula, Populus or Salix. Includes woods dominated by narrow-leaved willows Salix alba, Salix eleagnos, Salix purpurea, Salix viminalis in all zones including the mediterranean. Excludes riverine scrub of broad-leaved willows, e.g. Salix aurita, Salix cinerea, Salix pentandra (F9.1).

Willow- and poplar- (Salix- and Populus-) dominated woodland of periodically-inundated terraces and shoals with deposition of nutrient-rich alluvium in the active floodplains of rivers through the lowlands of the boreal, nemoral, submediterranean and steppe zones.

G1.2 Temperate and boreal hardwood riparian woodland

Original description: Mixed riparian forests, sometimes structurally complex and species-rich, of floodplains and of galleries beside slow- and fast-flowing rivers of the nemoral, boreo-nemoral, steppe and submediterranean zones. Gallery woods with Acer, Fraxinus, Prunus or Ulmus, together with species listed for G1.1. Floodplain woodland characterized by mixtures of Alnus, Fraxinus, Populus, Quercus, Ulmus, Salix.

Ash-alder (Fraxinus excelsior-Alnus glutinosa/A. incana) and mixed deciduous broadleaved woodland of fresh mineral soils on less-frequently flooded river terraces and flushed valley sides in the lowlands and foothills of the nemoral and boreal zones and locally in the submediterranean.

G1.3 Mediterranean and Macaronesian riparian woodland

Original description: Alluvial forests and gallery woods of the mediterranean region. Dominance may be of a single species, of few species or mixed with many species including Fraxinus, Liquidambar, Platanus, Populus, Salix, Ulmus. Excludes mediterranean Salix woods (G1.1) and shrubby riparian vegetation (F9.3).

Deciduous broadleaved woodland, most commonly dominated by poplars (Populus), willows (Salix), oriental plane (Platanus orientalis) or Liquidambar, on periodically flooded alluvium or gravel terraces and streamsides in humid localities in the mediterranean zone and Macaronesia. Also includes streamside Rhododendron ponticum and birch (Betula pendula var. fontqueri) woodlands in Spain.

G1.4 Broadleaved swamp woodland on non-acid peat

Original description: Broadleaved swamp woodland not on acid peat. Includes Alnus, Populus, Quercus swamp woods. Excludes Salix carr, with shrubby willows, e.g. Salix aurita, Salix cinerea, Salix pentandra (F9.2).

Deciduous broadleaved woodland, commonly dominated by alder (Alnus glutinosa and A. incana), oak (Quercus robur) or aspen (Populus tremula) on non-acid peat with ground water at or seasonally above the surface in swamps through the lowlands of the nemoral and boreal zones.

G1.5 Broadleaved swamp woodland on acid peat

Original description: Broadleaved woodland on wet acid peat, dominated by Betula pubescens or rarely Alnus glutinosa, sometimes with an admixture of conifers or shrubby Salix species. Sphagnum spp. are normally prominent in the ground vegetation.

Deciduous broadleaved or mixed woodland on acid peat on or around active bogs and poor fens with nutrient-poor ground waters occurring through the atlantic and boreal zones and locally, where ground conditions permit, in the continental zone. Usually dominated by birch (Betula pubescens) but with increasing amounts of Scot's pine (Pinus sylvestris) towards the boreal zone.

G1.6a Fagus woodland on non-acid soils

Original description: Forests dominated by beech Fagus sylvatica in western and central Europe, and Fagus orientalis and other Fagus species in southeastern Europe and the Pontic region. Many montane formations are mixed beech-fir or beech-fir-spruce forests, which are listed under G4.6.

Beech- (Fagus sylvatica and F. orientalis) dominated woodland of base-rich to neutral, oligotrophic to mesotrophic, mineral soils occurring through the atlantic and continental zones, and reaching into the alpine and, at higher altitudes, the submediterranean region. Associated trees, including evergreen conifers like fir (Abies alba) and spruce (Picea abies) which figures at the altitudinal limit, are always subordinate in cover and usually in height, though broadleaved associates are more extensive and diverse on richer soils and, like the usually sparse shrub layer, show regional climate-related variation. The field layer can be species-rich.

G1.6b Fagus woodland on acid soils

Original description: Forests dominated by beech Fagus sylvatica in western and central Europe, and Fagus orientalis and other Fagus species in southeastern Europe and the Pontic region. Many montane formations are mixed beech-fir or beech-fir-spruce forests, which are listed under G4.6.

Beech- (Fagus sylvatica and F. orientalis) dominated woodland of oligotrophic, base-poor mineral soils through the atlantic and continental zones, into the alpine and, at higher altitudes, the submediterranean zone. Associated broadleaved trees are few and always subordinate in cover, though oaks may be co-dominant. Evergreen conifers like fir (Abies alba) and, at the altitudinal limit, spruce (Picea abies) can figure as minority canopy components. The field layer is generally species-poor.

G1.7 Thermophilous deciduous woodland

Original description: Forests or woods of submediterranean climate regions and supramediterranean altitudinal levels, and of western Eurasian steppe and substeppe zones, dominated by deciduous or semideciduous thermophilous Quercus species or by other southern trees such as Carpinus orientalis, Castanea sativa or Ostrya carpinifolia. Thermophilous deciduous trees may, under local microclimatic or edaphic conditions, replace the

evergreen oak forests in mesomediterranean or thermomediterranean areas, and occur locally to the north in central and western Europe.

Deciduous or evergreen woodland of thermophilous and drought-resistant trees, especially oaks (Quercus spp.), with a subordinate tier of regionally-varied associates, through the sub-mediterranean zones, drier and warmer situations further north, extending into more humid higher altitudes in the mediterranean zone.

G1.8 Acidophilous Quercus woodland

Original description: Forests of Quercus robur or Quercus petraea on acid soils with an herb layer mostly constituted by the ecological groups of Deschampsia flexuosa, Vaccinium myrtillus, Pteridium aquilinum, Lonicera periclymenum, Holcus mollis, and of Maianthemum bifolium, Convallaria majalis, Hieracium sabaudum, Hypericum pulchrum, Luzula pilosa, and the mosses Polytrichum formosum and Leucobryum glaucum.

Oak-dominated woodland (mainly Quercus robur and Q. petraea but also other regional species) of impoverished acid soils through the atlantic and continental zones, where beech (Fagus sylvatica) is a potential competitor and extending northwards into the boreal zone where Scot's pine (Pinus sylvestris) increasingly figures in the canopy. Associated floras are generally rather poor but show some regional distinctiveness and towards the very humid western Atlantic seaboard have extraordinary richness of ferns and cryptogams.

G1.9a Boreal and nemoral Betula woodlands on mineral soils

Original description: Forests or woods dominated by Betula, Populus tremula or Sorbus aucuparia. Excludes swamp woods (G1.4), woods on wet peat (G1.5) and riparian woods (G1.1).

Open, low canopy climax birch woodlands (Betula pubescens ssp. czerepanovii = B. tortuosa or ssp. carpatica) with a heathy or herb-rich field layer in the boreal region and nemoral mountains of Cantabria and the Sudeten.

G1.9b Mediterranean Betula and Populus tremula woodlands on mineral soils

Original description: Forests or woods dominated by Betula, Populus tremula or Sorbus aucuparia. Excludes swamp woods (G1.4), woods on wet peat (G1.5) and riparian woods (G1.1).

Diverse climax woodlands dominated by birch (Betula pubescens and its vicariants) or aspen (Populus tremula) on usually acidic mineral soils in humid ravines and gorges in the sub-alpine Pyrenees, Corsica, the Apennines and, Sicily, with associated floras characteristic of the local climatic conditions.

G1.A Mesotrophic and eutrophic deciduous woodland, not dominated by Fagus

Original description: Woods, typically with mixed canopy composition, on rich and moderately rich soils. Includes woods dominated by Acer, Carpinus, Fraxinus, Quercus (especially Quercus petraea and Quercus robur), Tilia and Ulmus. Excludes acid Quercus woodland (G1.8) and woodland with a large representation of southern species such as Fraxinus ornus or Quercus pubescens (G1.7).

Deciduous mixed broadleaved woodland on drought-free mineral soils, neutral to base-rich and of moderate to high nutrient status, through the lowlands and foothills of the nemoral zone extending locally into the boreal and submediterranean zones and pannonian region. The tree canopy is often diverse and structurally complex with a rich and extensive understorey and field layer showing striking regional variation and an often distinctive vernal aspect.

G1.B Non-riverine Alnus woodland on mineral soil

Original description: Nonriparian, nonmarshy woods dominated by Alnus spp.

G2.1 Mediterranean evergreen Quercus woodland

Original description: Woodland with dominant evergreen arborescent Quercus, e.g. Quercus alnifolia, Quercus coccifera, Quercus ilex, Quercus rotundifolia, Quercus suber

Woodland dominated by evergreen broadleaved oaks (most widely Quercus ilex) with associated sclerophyllous and lauriphyllous trees and shrubs in the summer-drought climate of the mediterranean lowlands and foothills. The tree canopy is often low and much modified, with widespread transitions to scrubby maquis/matorral and open dehesa/montado wood pasture.

G2.2 Mainland lauriphyllous woodland

Original description: Lauriphyllous and mixed lauriphyllous-xerophyllous evergreen forests of the Warm-Temperate Humid zones of the Eurasian continent and continental shelf islands and of humid enclaves within the Mediterranean zones. Lauriphyllous forests of the oceanic Macaronesian archipelagoes are listed separately under G2.3.

Evergreen lauriphyllous short-stature woodland, often dominant by bay (Laurus nobilis) or strawberry tree (Arbutus unedo) in warm temperate oceanic and hyper-humid situations, now surviving as small relics in sheltered situations like ravines along the Atlantic coast of Portugal and Spain and in Sardinia, southern Italy and Sicily. Typically species-poor with an associated flora similar to G2.1.

G2.3 Macaronesian lauriphyllous woodland

Original description: Humid to hyper-humid, mist-bound, luxuriant, evergreen, lauriphyllous forests of the cloud belt of the Macaronesian islands, extremely rich in floral and faunal species, among which many are restricted to these communities. Genera such as Picconia, Semele, Gesnouinia, Lactucosonchus, Ixanthus are entirely endemic to these communities, while others, such as Isoplexis, Visnea and Phyllis reach in them their maximum development; in addition, each of the formations of the various archipelagoes harbours distinctive endemic species. Laurel forests are the most complex and remarkable relict of the humid sub-tropical vegetation of the Mioceno-Pliocene late Tertiary of southern Europe. Areas of intact forests have been drastically reduced to a level below which the preservation of their elements could not be sustained.

Evergreen lauriphyllous woodland on deep soils in the hyper-humid, frost-free, fog belt of the Macaronesian hills. The tree and shrub canopy is very diverse and rich in endemics, with striking differences related to climatic conditions across the different island groups, local topography and long isolation of the floras.

G2.4 Olea europaea-Ceratonia siliqua woodland

Original description: Thermo-Mediterranean or thermo-Canarian woodland dominated by arborescent Olea europaea var. sylvestris, Ceratonia siliqua, Pistacia lentiscus, Myrtus communis or, in the Canary Islands, by Olea europaea ssp. cerasiformis and Pistacia atlantica. Most formations will be listed as arborescent matorral F5.1, but a few stands have a sufficiently tall, closed canopy to qualify for this unit.

Olive (Olea europea), carob (Ceratonia siliqua) and mastic (Pistacia lentiscus) woodland with a tall, closed tree canopy in the drought-prone lowlands and foothills of the Mediterranean and Macaronesia.

G2.5 Phoenix groves

Original description: Woods, often riparian, formed by palm trees of the Mediterranean and Macaronesian zones, Phoenix theophrasti of Crete and western Anatolia, and Phoenix canariensis of the Canary Islands.

Fragmentary woodlands of palms (Phoenix spp.) and dragon trees (Dracaena spp.), dependent on periodic torrents, often along temporary stream-sides, in the very dry to arid eastern Mediterranean and Macaronesian lowlands.

G2.6 Ilex aquifolium woodland

Original description: Woods dominated by tall arborescent Ilex aquifolium. They occur in the supra-Mediterranean level of Sardinia and Corsica and in Atlantic mountains of northwestern Spain, mostly as a facies of relict yew-holly forests G3.9. Other scattered occurrences exist in the nemoral zone of western Europe, as facies of beech forest G1.6 or acidophilous oak forest G1.8.

Holly- (Ilex aquifolium-) dominated woodland occurring in scattered localities across Europe and probably an arborescent survival of G3.9 *Taxus* woodland at middle altitudes in the Mediterranean zone and of G1.6 *Fagus* and G1.8 *Quercus* in the nemoral lowlands.

G2.7 Macaronesian heathy woodland

Original description: Very tall, forest-like, formations dominated by Erica arborea, Myrica faya, Arbutus canariensis or Visnea mocanera, occurring naturally in the most wind-exposed and the driest stations within the 'monte verde' of the Canary Island cloud belt; they also occur extensively as degradation stages of the Laurus woodland G2.3 or as secondary colonists.

Small-stature woodland variously dominated by arborescent ericoids, laurels (Laurus spp.), strawberry tree (Arbutus unedo) and Canarian holly (Ilex canariensis) in situations that range from cold and hyper-humid slopes and exposed fog-bound outcrops to sub-humid and dry foothills of Madeira and the Canaries.

G3.1a Temperate mountain Picea woodland

Original description of G3.1 Abies and Picea woodland: Woodland dominated by Abies or Picea.

Evergreen coniferous woodland dominated by spruce (Picea abies and, in the Dinaric mountains, relict P. omorika), often with some fir (Abies alba) on usually acidic, even very oligotrophic, wet, cold or rocky soils in the montane and sub-alpine belts of nemoral mountains.

G3.1b Temperate mountain Abies woodland

Original description of G3.1 Abies and Picea woodland: Woodland dominated by Abies or Picea.

Woodlands of fir (Abies alba) in nemoral mountains, often with beech (Fagus sylvatica) towards the sub-montane limit, spruce (Picea abies) where site conditions are harsher at higher altitudes. On generally acidic soils though extending on to more base-rich and mesotrophic soils where distinctive contingents of herbs augment or replace the usually heathy field layer.

G3.1c Mediterranean mountain Abies woodland

Original description of G3.1 Abies and Picea woodland: Woodland dominated by Abies or Picea.

Evergreen coniferous woodlands of more sunless or fog-bound slopes and gullies in the lower to mid altitudinal belts of mediterranean mountains where firs of very limited distribution dominate in highly distinctive relic stands: Spanish fir (A. pinsapo), Greek fir (A. cephalonica), King Boris's fir (A. borisii-regis), Apennine or Sicilian stands of silver fir (A. alba) and Sicilian fir (A. nebrodensis).

G3.2 Temperate subalpine Larix-Pinus woodland

Original description: Forests of the subalpine and sometimes montane levels of the Alps and the Carpathians, dominated by Larix decidua or Pinus cembra; the two species may form either pure or mixed stands, and may be associated with Picea abies or, in the western Alps, Pinus uncinata.

Coniferous, in part deciduous, woodland of larch (Larix decidua) or Arolla pine (Pinus cembra) in the mid sub-alpine belt of temperate mountains in the central Alps and Carpathians with long but shallow snow-lie and a short growing season. Dwarf mountain pine (P. mugo), spruce (Picea abies), fir (Abies alba), rhododendrons and other sub-shrubs are never more than subordinate but various whitebeams (Sorbus spp.) are characteristic associates.

G3.3 Pinus uncinata woodland

Original description: Mostly subalpine forests of the Alps, the Jura, the Pyrenees and the Iberian Range, dominated by Pinus uncinata, usually open and with a very developed shrubby understory.

Coniferous woodland dominated by Pinus uncinata with a shrubby Rhododendron-rich understorey at the sub-alpine level of the western Alps, Jura, Pyrenees and Iberian mountains.

G3.4/5a Temperate Continental Pinus sylvestris woodland

Original description of G3.4 Pinus sylvestris woodland south of the taiga: Forests of Pinus sylvestris ssp. sylvestris and Pinus sylvestris ssp. hamata of the Nemoral and Mediterranean zones and of their transitions to the Steppe zone. Included are, in particular, the forests of Scotland, of the Alpine system, of the Mediterranean peninsulas, of the lowlands of Central Europe, of the East European Nemoral zone and its adjacent wooded steppes, formed by Pinus sylvestris ssp. sylvestris, as well as those of Anatolia, of the Caucacus and of Crimea, formed by Pinus sylvestris ssp. hamata. Excluded are the formations situated within the range of natural lowland occurrence of Picea abies.

Original description of G3.5 Pinus nigra woodland: Forests dominated by pines of the Pinus nigra group.

Woodlands dominated by pine (Pinus sylvestris), often with some birch (Betula pendula and B. pubescens), aspen (Populus tremula), juniper (Juniperus communis) and various whitebeams (Sorbus spp.), on acidic to base-rich soils through the north nemoral zone and into the hemi-boreal.

G3.4/5b Temperate and submediterranean montane Pinus sylvestris-nigra woodland

Original description of G3.4 Pinus sylvestris woodland south of the taiga: Forests of Pinus sylvestris ssp. sylvestris and Pinus sylvestris ssp. hamata of the Nemoral and Mediterranean zones and of their transitions to the Steppe zone. Included are, in particular, the forests of Scotland, of the Alpine system, of the Mediterranean peninsulas, of the lowlands of Central Europe, of the East European Nemoral zone and its adjacent wooded steppes, formed by Pinus sylvestris ssp. sylvestris, as well as those of Anatolia, of the Caucacus and of Crimea, formed by Pinus sylvestris ssp. hamata. Excluded are the formations situated within the range of natural lowland occurrence of Picea abies.

Original description of G3.5 Pinus nigra woodland: Forests dominated by pines of the Pinus nigra group

Evergreen coniferous woodlands, generally dominated by either Scot's pine (Pinus sylvestris) or black pine (P. nigra and, towards the southern limit, various subspecies), less commonly with some spruce (Picea abies) and deciduous associates, often in isolated and small stands on base-rich soils through the mountains of the south temperate and sub-mediterranean zones.

G3.4/5c Mediterranean montane Pinus sylvestris-nigra woodland

Original description of G3.4 Pinus sylvestris woodland south of the taiga: Forests of Pinus sylvestris ssp. sylvestris and Pinus sylvestris ssp. hamata of the Nemoral and Mediterranean zones and of their transitions to the Steppe zone. Included are, in particular, the forests of Scotland, of the Alpine system,

of the Mediterranean peninsulas, of the lowlands of Central Europe, of the East European Nemoral zone and its adjacent wooded steppes, formed by Pinus sylvestris ssp. sylvestris, as well as those of Anatolia, of the Caucacus and of Crimea, formed by Pinus sylvestris ssp. hamata. Excluded are the formations situated within the range of natural lowland occurrence of Picea abies.

Original description of G3.5 Pinus nigra woodland: Forests dominated by pines of the Pinus nigra group

Evergreen coniferous woodland of more drought-prone situations at scattered localities through the mountains of the mediterranean zone, dominated by black pine (Pinus nigra) and, except on Mediterranean islands, sometimes with subordinate Scots pine (Pinus sylvestris), both trees often occurring as vicariant forms in different localities.

G3.6 Mediterranean and Balkan subalpine Pinus heldreichii-peuce woodland

Original description: Woods of Pinus heldreichii, Pinus leucodermis or Pinus peuce.

Evergreen coniferous woodland of timberlines in the mountains of the Balkans and southern Italy, dominated by Bosnian pine (Pinus heldreichii) on base-rich soils in more sunny and drought-prone situations or by Macedonian pine (P. peuce) on siliceous soils.

G3.7 Mediterranean lowland to submontane Pinus woodland

Original description: Mediterranean and thermo-Atlantic forests of thermophilous pines, mostly appearing as successional stages or plagioclimax replacements of Mediterranean evergreen broadleaved woodland G2.1 or G2.4. Long-established plantations of these pines, within their natural area of occurrence, and with an undergrowth basically similar to that of G2.1 and G2.4, are included.

Evergreen coniferous woodland dominated by various thermophilous pines: Maritime pine (Pinus pinaster in eastern mediterranean and warm atlantic zones), Aleppo pine (P. halepensis) and Stone pine (P. pinea all around the southern European coast) and Aegean pine (P. brutia in Greece and on Aegean islands), the first three often favouring unstable substrates or pre-climax situations.

G3.8 Pinus canariensis woodland

Original description: Forests of endemic Pinus canariensis, of the dry montane level at around 800 to 2000 m (locally down to 500 and up to 2500 m) in

Tenerife, La Palma, Gran Canaria and Hierro, with Chamaecytisus proliferus, Adenocarpus foliolosus, Cistus symphytifolius, Lotus campylocladus, Lotus hillebrandii, Lotus spartioides, Daphne gnidium, Juniperus cedrus, Micromeria spp.; these forests, of which well-preserved examples have become rare, are the only habitat of Fringilla teydea, Dendrocopos major canariensis and Dendrocopos major thanneri.

Woodland of endemic Canarian pine (Pinus canariensis) occurring mostly at high altitudes in dry sunny situations above the fog belt, locally on foothill rock outcrops and old lava flows, in the western Canary Islands.

G3.9a Taxus baccata woodland

Original description of Coniferous woodland dominated by Cupressaceae or Taxaceae: Woods dominated by Cupressus sempervirens, Juniperus spp. or Taxus baccata of the nemoral and Mediterranean mountains and hills.

Evergreen woodlands overwhelmingly dominated by yew (Taxus baccata), sometimes with holly (Ilex aquifolium), whitebeam (Sorbus aria) and box (Buxus sempervirens), maybe in halted successions or as senescent survivals, occurring very locally on base-rich soils in the mediterranean zone and in the British Isles.

G3.9b Mediterranean Cupressaceae woodland

Original description of Coniferous woodland dominated by Cupressaceae or Taxaceae: Woods dominated by Cupressus sempervirens, Juniperus spp. or Taxus baccata of the nemoral and Mediterranean mountains and hills.

Evergreen woodlands of cypress (Cupressus sempervirens), junipers (Juniperus excelsa, J. foetidissima, J. drupacea, J. thurifera) or alerce (Tetraclinis articulata) with a usually open canopy with scrubby understorey and grassy field layer, on shallow, usually base-rich soils, in dry rocky situations scattered through the mediterranean zone.

G3.9c Macaronesian Juniperus woodland

Original description of Coniferous woodland dominated by Cupressaceae or Taxaceae: Woods dominated by Cupressus sempervirens, Juniperus spp. or Taxus baccata of the nemoral and Mediterranean mountains and hills.

Evergreen woodlands of endemic macaronesian junipers (Juniperus turbinata ssp. canariensis, J. cedrus ssp. cedrus and ssp. maderensis, J. brevifolia) in diverse habitats as sometimes very small isolated populations, each with distinctive associated floras.

G3.A Picea taiga woodland of relatively rich and moist soils

Original description: Boreal spruce or spruce-pine forests of Fennoscandia, northeastern Poland, the Baltic States, Belarus and European Russia, with G3.B constituting the westernmost section of the continuous Eurasian northern taiga belt.

Woodland naturally dominated by spruce but frequently with an admixture of some Scot's pine (Pinus sylvestris) and birch (Betula pendula and B. pubescens) on more mesic soils through the north-eastern continental and boreal regions, often with a subordinate deciduous broadleaf component in the canopy and understorey and rich and varied field-layer, mosses and lichens.

G3.B Pinus sylvestris taiga woodland

Original description: Boreal pine forests of Fennoscandia, northeastern Poland, the Baltic States, Belarus and European Russia, with G3.A constituting the westernmost section of the continuous Eurasian northern taiga belt.

Woodland naturally dominated by Scot's pine (Pinus sylvestris) but often with some birch (Betula pendula and B. pubescens) and spruce (Picea abies and P. obovata) on lithomorphic and podsolized soils of dry and barren situations through the north-eastern continental and boreal regions with a generally heathy field layer but, when on eskers, a specialised herb flora.

G3.C Larix taiga woodland

Original description: Boreal larch, forests of Fennoscandia, the Baltic States, Belarus and European Russia, occuring in limited, edaphic pockets within the area dominated by G3.A and G3.B.

Deciduous coniferous woodland of Siberian larch (Larix sibirica) which extends west from its extensive realm in European Russia as small stands with an open, low-stature canopy on patches of moist, nutrient-poor sandy soils among spruce and pine taiga in the Boreal zone

G3.D Boreal bog conifer woodland

Original description: Woods of Pinus spp. or Picea spp., sometimes mixed with Betula pubescens, colonizing bogs and fens in the boreal and boreonemoral zones.

Evergreen coniferous woodland, often open and low-growing, dominated by spruce (Picea abies, especially to the north) or Scot's pine (Pinus sylvestris, more to the south) and sometimes forming extensive stands on peaty soils on or around bogs or in depressions kept moist by high ground water table, through the Boreal zone.

G3.E Temperate bog conifer woodland

Original description: Woods of Pinus spp. or Picea spp., sometimes mixed with Betula pubescens, colonizing bogs and fens in the nemoral zone. Conifer-dominated bog woodland occurs mainly in the boreal and boreonemoral zones, but extends into the nemoral, wooded steppe and steppe zones.

Evergreen coniferous woodland, often open and low-growing, dominated by Scot's pine (Pinus sylvestris) or spruce (Picea abies) on often drier but sometimes extensive peats, on bog margins or in depressions kept moist by high ground water table, through the nemoral zone.

Appendix D: Fact sheets EUNIS heathland, scrub and tundra habitat types

B1.5 Coastal dune heaths
B1.6 Coastal dune scrub
B2.5 Shingle and gravel beaches with scrub
F1.1 Shrub tundra
F1.2 Moss and lichen tundra
F2.1 Subarctic and alpine dwarf willow scrub
F2.2 Evergreen alpine and subalpine heath and scrub
F2.3 Subalpine deciduous scrub
F2.4 Conifer scrub close to the tree limit
F3.1 Temperate thickets and scrub
F3.2 Submediterranean deciduous thickets and brushes
F4.1 Wet heaths
F4.2 Dry heaths
F4.3 Macaronesian heaths
F5.1 Arborescent matorral
F5.2 Maquis
F5.3 Pseudomaquis
F5.4 [Spartium junceum] fields
F5.5 Thermo-Mediterranean scrub
F6.1 Western garrigues
F6.2 Eastern garrigues
F6.3 Illyrian garrigues
F6.4 Black Sea garrigues
F6.5 Macaronesian garrigues
F6.6 Supra-Mediterranean garrigues
F6.7 Mediterranean gypsum scrubs
F6.8 Xero-halophile scrubs
F7.1 West Mediterranean spiny heaths
F7.2 Central Mediterranean spiny heaths
F7.3 East Mediterranean phrygana
F7.4 Hedgehog-heaths
F8.1 Canary Island xerophytic scrub
F8.2 Madeiran xerophytic scrub
F9.1 Riverine scrub
F9.2 [Salix] carr and fen scrub
F9.3 Southern riparian galleries and thickets

Not covered by in situ vegetation data are B2.5 ‘Shingle and gravel beaches with scrub’, F1 ‘Arborescent matorral’, F6.4 Black Sea garrigues, F6.5 ‘Macaronesian garrigues’, and F7.2 ‘Central Mediterranean spiny heaths’.

In the tables of the floristic composition of the individual EUNIS types, all species with a frequency >= 10 % are mentioned. The full species lists will be provided electronically.

B1.5 - Coastal dune heaths

Origin of data (countries): DE, ES, FI, FR, NL, UK

List of alliances: ULI-01A - Ericion cinereae, ULI-01B - Ulicion minoris, ULI-01D - Ericion umbellatae, ULI-02B - Genistion pilosae, ULI-02C - Empetrion nigri

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: B1.5a Atlantic and Baltic coastal *Empetrum* heaths, B1.5b Atlantic coastal *Calluna* and *Ulex heaths*

Floristic composition:

Calluna vulgaris	64	Potentilla erecta	15
Dicranum scoparium	34	Cladonia portentosa	15
Carex arenaria	31	Calamagrostis epigejos	14
Empetrum nigrum	26	Molinia caerulea	12
Hypnum jutlandicum	24	Hypogymnia physodes	11
Salix repens	22	Agrostis curtisii	11
Erica australis	21	Cistus salvifolius	11
Erica tetralix	20	Festuca ovina	10
Erica cinerea	19	Carex trinervis	10
Erica umbellata	17	Lotus corniculatus	10
Chamaespartium tridentatum	16	Holcus lanatus	10
Pleurozium schreberi	15	Hieracium umbellatum	10
Deschampsia flexuosa	15		

B1.6 - Coastal dune scrub

Origin of data (countries): BE, DE, ES, FR, GR, HR, IT, ME, NL, PL, PT, SI, UK

List of alliances: LAV-01D - Quercion fruticosae, MOQ-01A - Traganion moquinii, QUI-01A - Oleo-Ceratonion siliquae, QUI-01C - Juniperion turbinatae, QUI-01H - Rubo longifoliae-Coremation albi, RHA-02A - Berberidion vulgaris, RHA-02C - Carpino-Prunion spinosae, RHA-02D - Pruno spinosae-Rubion radulae, RHA-03A - Salicion arenariae, RHA-03C - Holoschoeno australis-Salicion arenariae

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: B1.6a Atlantic and Baltic coastal dune scrub, B1.6b Mediterranean and Black Sea coastal dune scrub

Floristic composition:

Crataegus monogyna	43	Moehringia trinervia	16
Urtica dioica	34	Poa pratensis	16
Rubus ulmifolius	30	Galium aparine	16
Rubus caesius	30	Carex arenaria	15
Ligustrum vulgare	28	Smilax aspera	13
Rosa canina	24	Euonymus europaeus	13
Calamagrostis epigejos	22	Senecio jacobaea	13
Prunus spinosa	20	Quercus robur	12
Sambucus nigra	20	Holcus lanatus	11
Brachythecium rutabulum	19	Solanum dulcamara	11
Rubia peregrina	17	Clematis vitalba	11
Pistacia lentiscus	17	Asparagus acutifolius	11
Bryonia cretica subsp. dioica	17	Kindbergia praelonga	10
Lonicera periclymenum	17	Plagiomnium affine	10
Cynoglossum officinale	16	Glechoma hederacea	10
Hippophae rhamnoides	16	Cornus sanguinea	10

B2.5 - Shingle and gravel beaches with scrub

Origin of data (countries): n/a

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with other habitat types on shingle and gravel beaches

Floristic composition:
No data

F1.1 - Shrub tundra

Origin of data (countries): FI, NO, UK

List of alliances: LOI-01A - Loiseleurio-Arctostaphylion, LOI-01B - Phyllodoco-Vaccinion myrtilli

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Vaccinium myrtillus	81	Hypnum jutlandicum	22
Deschampsia flexuosa	77	Cladonia rangiferina	21
Empetrum nigrum	64	Alchemilla alpina	17
Pleurozium schreberi	57	Erica cinerea	17
Cladonia uncialis	53	Agrostis capillaris	17
Vaccinium vitis-idaea	53	Polytrichum commune	16
Dicranum scoparium	52	Arctostaphylos uva-ursi	16
Racomitrium lanuginosum	52	Agrostis canina	15
Cladonia arbuscula	52	Dicranum fuscescens	15
Calluna vulgaris	47	Cladonia coccifera	14
Carex bigelowii	46	Polytrichastrum alpinum	14
Galium saxatile	46	Trichophorum cespitosum	14
Hylocomium splendens	36	Sphaerophorus globosus	13
Cetraria islandica	36	Anthoxanthum odoratum	12
Rhytidiadelphus loreus	36	Blechnum spicant	12
Potentilla erecta	35	Diplophyllum albicans	12
Festuca ovina	34	Rhytidiadelphus squarrosus	11
Nardus stricta	28	Ochrolechia frigida	11
Ptilidium ciliare	28	Juncus squarrosus	11
Hypnum cupressiforme	27	Barbilophozia floerkei	11
Cladonia gracilis	26	Alectoria nigricans	11
Huperzia selago	25	Diphasiastrum alpinum	10
Carex pilulifera	24	Vaccinium uliginosum	10
Festuca vivipara	22	Cladonia pyxidata	10
Cetraria aculeata	22		

F1.2 - Moss and lichen tundra

Origin of data (countries): FI, NO, UK

List of alliances: LOI-01A - Loiseleurio-Arctostaphylion

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Deschampsia flexuosa	56	Cetraria aculeata	19
Cladonia uncialis	52	Festuca vivipara	19
Vaccinium myrtillus	51	Ptilidium ciliare	19
Racomitrium lanuginosum	50	Cladonia coccifera	18
Calluna vulgaris	50	Nardus stricta	18
Carex bigelowii	42	Ochrolechia frigida	17
Vaccinium vitis-idaea	42	Cassiope tetragona	17
Pleurozium schreberi	39	Cladonia rangiferina	15
Dicranum scoparium	38	Arctostaphylos alpinus	15
Cladonia arbuscula	37	Polytrichastrum alpinum	14
Empetrum nigrum	37	Agrostis canina	14
Cetraria islandica	34	Antennaria dioica	14
Potentilla erecta	32	Diplophyllum albicans	14
Huperzia selago	31	Salix herbacea	14
Hylocomium splendens	30	Polygonum viviparum	13
Festuca ovina	27	Vaccinium uliginosum	13
Arctostaphylos uva-ursi	26	Solidago virgaurea	12
Erica cinerea	26	Agrostis capillaris	12
Rhytidiadelphus loreus	25	Phyllodoce caerulea	12
Carex pilulifera	24	Alectoria nigricans	11
Cladonia gracilis	24	Hypogymnia physodes	11
Hypnum jutlandicum	23	Cladonia pyxidata	11
Hypnum cupressiforme	22	Diphasiastrum alpinum	11
Galium saxatile	21	Alchemilla alpina	11
Sphaerophorus globosus	20	Cladonia mitis	10
Trichophorum cespitosum	19		

F2.1 - Subarctic and alpine dwarf willow scrub

Origin of data (countries): AD, AT, CH, CZ, ES, FI, FR, IT, NO, PL, SI, SK, UK

List of alliances: HER-01A - Salicion herbaceae

Additional selection rules: Instead of the relevés belonging to the listed alliances, relevés with Salix herbacea, S. polaris, S. reticulata or S. retusa, with cover values higher than 25% have been selected

Implications for EUNIS classification: n/a

Floristic composition:

Salix herbacea	60	Carex nigra	14
Polygonum viviparum	54	Carex sempervirens	14
Poa alpina	43	Doronicum clusii	13
Salix retusa	39	Saxifraga androsacea	12
Gnaphalium supinum	32	Euphrasia minima	12
Luzula alpinopilosa	29	Polytrichastrum alpinum	12
Bartsia alpina	25	Campanula scheuchzeri	12
Leucanthemopsis alpina	23	Saxifraga exarata	12
Cetraria islandica	23	Sedum alpestre	12
Salix reticulata	22	Huperzia selago	11
Oreochloa disticha	21	Anthoxanthum odoratum	11
Juncus trifidus	20	Soldanella carpatica	11
Silene acaulis	20	Gentiana verna	11
Sibbaldia procumbens	19	Vaccinium vitis-idaea	11
Ligusticum mutellina	19	Hieracium alpinum	11
Veronica alpina	19	Cerastium cerastoides	10
Agrostis rupestris	19	Pritzelago alpina	10
Primula minima	18	Carex curvula	10
Campanula alpina	18	Dryas octopetala	10
Homogyne alpina	18	Festuca violacea	10
Myosotis alpestris	17	Leontodon pyrenaicus	10
Geum montanum	16	Plantago alpina	10
Minuartia sedoides	15	Pedicularis verticillata	10
Ranunculus alpestris	14	Saxifraga oppositifolia	10
Soldanella alpina	14	Selaginella selaginoides	10
Festuca airoides	14	Avenula versicolor	10

F2.2 - Evergreen alpine and subalpine heath and scrub

Origin of data (countries): AT, CZ, DE, ES, GR, HR, IT, PL, RU, SI, SK, UK

List of alliances: KOB-01A - Kobresio-Dryadion, LOI-01A - Loiseleurio-Arctostaphylion, LOI-01B - Phyllodoco-Vaccinion myrtilli, LOI-01C - Loiseleurio-Vaccinion, LOI-01D - Rhododendro ferrugineae-Vaccinion, LOI-01E - Juniperion nanae, LOI-01G - Rhododendrion caucasici, RHO-01A - Ericion carneae, RHO-01C - Daphno-Genistion radiatae, SAB-03A - Cytision oromediterranei, SAB-03B - Genisto versicoloris-Juniperion hemisphaericae, SAB-03C - Pruno prostratae-Juniperion sabinae, ULI-02A - Genisto-Vaccinion

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: F2.2a Alpine and subalpine ericoid heaths, F2.2b Alpine and subalpine *Juniperus* scrub, F2.2c Alpine and subalpine genistoid scrub

Floristic composition:

Vaccinium myrtillus	62	Juncus trifidus	18
Deschampsia flexuosa	57	Anthoxanthum odoratum	17
Calluna vulgaris	39	Potentilla erecta	16
Vaccinium vitis-idaea	39	Rhododendron ferrugineum	16
Cetraria islandica	32	Loiseleuria procumbens	16
Juniperus communis	27	Cladonia rangiferina	16
Empetrum nigrum	26	Cladonia uncialis	14
Pleurozium schreberi	25	Huperzia selago	14
Homogyne alpina	23	Solidago virgaurea	14
Dicranum scoparium	22	Racomitrium lanuginosum	13
Cladonia arbuscula	20	Avenula versicolor	11
Hylocomium splendens	19	Hieracium alpinum	11
Vaccinium uliginosum	19	Galium saxatile	10
Nardus stricta	19	Arctostaphylos uva-ursi	10

F2.3 - Subalpine deciduous scrub

Origin of data (countries): AT, CH, CZ, ES, FR, PL, SI, SK

List of alliances: VIR-01A - Alnion viridis, VIR-01B - Salicion pentandrae, VIR-01C - Salicion helveticae, VIR-01D - Salicion silesiacae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Alnus viridis	54	Primula elatior subsp. elatior	17
Viola biflora	54	Urtica dioica	17
Geranium sylvaticum	49	Thalictrum aquilegiifolium	17
Senecio nemorensis	47	Aconitum lycoctonum	16
Vaccinium myrtillus	46	Campanula scheuchzeri	16
Adenostyles alliariae	42	Daphne mezereum	15
Hypericum maculatum	41	Ranunculus serpens subsp. nemorosus	15
Saxifraga rotundifolia	40	Heracleum sphondylium	15
Solidago virgaurea	37	Rosa pendulina	15
Sorbus aucuparia	36	Calamagrostis arundinacea	15
Rumex alpestris	35	Gentiana asclepiadea	15
Rubus idaeus	35	Fragaria vesca	15
Luzula sylvatica	34	Rhododendron ferrugineum	14
Calamagrostis villosa	34	Polystichum lonchitis	14
Chaerophyllum hirsutum	33	Rhododendron hirsutum	14
Veratrum album	33	Crepis paludosa	14
Picea abies	32	Lilium martagon	13
Deschampsia cespitosa	32	Phyteuma spicatum	13
Stellaria nemorum subsp. nemorum	29	Carex ferruginea	13
Dryopteris dilatata	29	Tussilago farfara	13
Athyrium distentifolium	29	Soldanella alpina	13
Homogyne alpina	29	Rubus saxatilis	12
Oxalis acetosella	28	Epilobium alpestre	12
Peucedanum ostruthium	26	Veratrum lobelianum	12
Dryopteris filix-mas	25	Doronicum austriacum	12
Salix appendiculata	24	Achillea millefolium	12
Athyrium filix-femina	23	Potentilla erecta	12
Valeriana tripteris	22	Larix decidua	12
Salix silesiaca	22	Aster bellidiastrum	11
Alchemilla vulgaris	21	Aposeris foetida	11
Polygonatum verticillatum	20	Hylocomium splendens	11
Paris quadrifolia	20	Lamiastrum galeobdolon	11
Poa alpina	20	Astrantia major	11
Deschampsia flexuosa	20	Potentilla aurea	11

Geum rivale	20	Vaccinium vitis-idaea	10
Aconitum napellus	19	Cirsium erisithales	10
Epilobium montanum	18	Salix hastata	10
Silene vulgaris	18	Petasites albus	10
Poa nemoralis	18	Rhizomnium punctatum	10
Luzula luzuloides	18	Silene dioica	10
Myosotis sylvatica	18	Polytrichastrum formosum	10
Cicerbita alpina	17	Cardamine amara	10
Knautia maxima	17	Hieracium murorum	10
Acer pseudoplatanus	17		

F2.4 - Conifer scrub close to the tree limit

Origin of data (countries): AT, CZ, DE, HR, IT, PL, SK, UA

List of alliances: n/a

Additional selection rules: Only relevés with Pinus mugo cover >= 25% have been selected

Implications for EUNIS classification: proposed new name: F2.4 Subalpine *Pinus mugo* scrub

Floristic composition:

Pinus mugo	99	Rubus idaeus	17
Vaccinium myrtillus	88	Athyrium distentifolium	17
Vaccinium vitis-idaea	68	Polygonatum verticillatum	17
Homogyne alpina	61	Tortella tortuosa	16
Dicranum scoparium	56	Lycopodium annotinum	16
Deschampsia flexuosa	49	Daphne mezereum	16
Hylocomium splendens	45	Polytrichastrum formosum	16
Sorbus aucuparia	42	Carduus defloratus	16
Picea abies	42	Potentilla erecta	14
Calamagrostis villosa	41	Phyteuma orbiculare	14
Pleurozium schreberi	37	Huperzia selago	14
Rhododendron hirsutum	34	Rhododendron ferrugineum	13
Erica herbacea	33	Adenostyles alliariae	13
Oxalis acetosella	31	Carex ferruginea	13
Solidago virgaurea	26	Hypericum maculatum	13
Viola biflora	25	Salix appendiculata	13
Sorbus chamaemespilus	25	Soldanella alpina	12
Sesleria albicans	25	Ranunculus montanus	12
Luzula sylvatica	25	Larix decidua	12
Geranium sylvaticum	25	Veratrum album	12
Campanula scheuchzeri	24	Asplenium viride	12
Calamagrostis varia	24	Veratrum lobelianum	12
Rhytidiadelphus triquetrus	23	Gentiana asclepiadea	12
Dryopteris dilatata	23	Saxifraga rotundifolia	11
Rubus saxatilis	22	Carex sempervirens	11
Cetraria islandica	22	Dryopteris carthusiana	10
Valeriana tripteris	21	Ctenidium molluscum	10
Valeriana montana	21	Polygala chamaebuxus	10
Hieracium murorum	20	Luzula luzuloides	10
Rosa pendulina	20	Acer pseudoplatanus	10
Juniperus communis	19	Prenanthes purpurea	10
Aster bellidiastrum	18	Calluna vulgaris	10
Galium anisophyllon	18		

F3.1 - Temperate thickets and scrub

Origin of data (countries): AT, BE, CZ, DE, ES, FR, GR, HR, HU, IT, NL, PL, PT, RU, SI, SK, UA, UK

List of alliances: CYT-01A - Cytision oromediterraneo-scoparii, CYT-03A - Sarothamnion scoparii, LON-01A - Lonicero-Rubion silvatici, LON-03A - Vaccinio-Juniperion communis, RHA-01A - Aegopodio podagrariae-Sambucion nigrae, RHA-02A - Berberidion vulgaris, RHA-02C - Carpino-Prunion spinosae, RHA-02D - Pruno spinosae-Rubion radulae, RHA-02E - Frangulo alni-Pyrion cordatae, RHA-02F - Tamo communis-Viburnion lantanae, RHA-02Q - Prunion fruticosae, RHA-02R - Lamio purpureae-Acerion tatarici, RHA-03A - Salicion arenariae, RHA-03C - Holoschoeno australis-Salicion arenariae, RHA-04A - Sambuco racemosae-Salicion capreae, RHA-04C - Astrantio-Corylion avellanae

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with F3.2 (Submediterranean deciduous thickets and brushes) and then divided in: F3.1-2a Lowland to montane temperate and submediterranean *Juniperus* scrub, F3.1-2b Temperate bramble scrub, F 3.1-2c Lowland to montane temperate and submediterranean genistoid scrub, F3.1-2d Temperate forest clearing scrub, F3.1-2e Temperate and submediterranean thorn scrub, F3.1-2f Low steppic scrub

Floristic composition:

Crataegus monogyna	46	Corylus avellana	14
Urtica dioica	42	Moehringia trinervia	14
Rosa canina	32	Brachythecium rutabulum	14
Prunus spinosa	31	Clematis vitalba	13
Ligustrum vulgare	29	Lonicera periclymenum	13
Sambucus nigra	28	Bryonia cretica subsp. dioica	12
Rubus caesius	27	Rhamnus catharticus	12
Galium aparine	26	Geranium robertianum	11
Rubus ulmifolius	21	Agrostis capillaris	11
Cornus sanguinea	19	Fraxinus excelsior	11
Euonymus europaeus	17	Elymus repens	11
Calamagrostis epigejos	17	Carex arenaria	10
Quercus robur	16	Fragaria vesca	10
Geum urbanum	16	Hippophae rhamnoides	10
Dactylis glomerata	16	Holcus lanatus	10
Poa pratensis	15	Cynoglossum officinale	10
Glechoma hederacea	15		

F3.2 - Submediterranean deciduous thickets and brushes

Origin of data (countries): BA, ES, FR, GR, HR, IT, MK, RS, SI, SI

List of alliances: CYT-01B - Ulici europaei-Cytision striati, CYT-01C - Genistion floridae, CYT-01D - Cytision multiflori, CYT-01E - Retamion monospermae, CYT-01F - Retamion sphaerocarpae, CYT-01G - Adenocarpion decorticantis, CYT-02A - Telinion monspessulano-linifoliae, CYT-02B - Genisto spartioidis-Phlomidion almeriensis, CYT-02C - Genisto scorpii-Retamion sphaerocarpae, PUB-01A - Paliuro-Petterion, PUB-01B - Eryngio campestris-Paliurion spinae-christi, RHA-02A - Berberidion vulgaris, RHA-02B - Amelanchiero-Buxion, RHA-02H - Rubio periclymeni-Rubion ulmifolii, RHA-02K - Lonicero arboreae-Berberidion hispanicae, RHA-02L - Cytision sessilifolii, RHA-02O - Berberido creticae-Prunion cocomiliae

Additional selection rules: Data from countries PL, NL, BE, DE, UK have been excluded

Implications for EUNIS classification: should be merged with F3.1 (Temperate thickets and scrub) and then divided in: F3.1-2a Lowland to montane temperate and submediterranean *Juniperus* scrub, F3.1-2b Temperate bramble scrub, F 3.1-2c Lowland to montane temperate and submediterranean genistoid scrub, F3.1-2d Temperate forest clearing scrub, F3.1-2e Temperate and submediterranean thorn scrub, F3.1-2f Low steppic scrub

Floristic composition:

Pteridium aquilinum	24	Rubus ulmifolius	14
Erica arborea	24	Rosa canina	12
Cytisus scoparius	23	Lavandula stoechas	12
Crataegus monogyna	20	Prunus spinosa	11
Dactylis glomerata	15	Cytisus multiflorus	10

F4.1 - Wet heaths

Origin of data (countries): CZ, DE, ES, FR, IE, NL, PL, UK

List of alliances: OXY-01A - Ericion tetralicis, OXY-01B - Oxycocco-Ericion tetralicis, ULI-01B - Ulicion minoris, ULI-01C - Daboecion cantabricae, ULI-01D - Ericion umbellatae, ULI-01E - Genistion micrantho-anglicae, ULI-01F - Stauracanthion boivinii

Additional selection rules: n/a

Implications for EUNIS classification: proposed new name: Wet heaths

Floristic composition:

Calluna vulgaris	65	Narthecium ossifragum	13
Erica tetralix	48	Pteridium aquilinum	13
Molinia caerulea	40	Daboecia cantabrica	13
Potentilla erecta	32	Carex panicea	12
Eriophorum angustifolium	26	Juncus squarrosus	12
Erica cinerea	23	Vaccinium myrtillus	12
Drosera rotundifolia	19	Ulex gallii	12
Trichophorum cespitosum	19	Drosera intermedia	11
Agrostis curtisii	15	Rhynchospora alba	10
Erica vagans	15	Sphagnum papillosum	10
Eriophorum vaginatum	13		

F4.2 - Dry heaths

Origin of data (countries): AT, BE, CZ, DE, ES, FI, FR, HU, IT, NL, PL, SK, UK

List of alliances: QUI-01B - Ericion arboreae, ULI-01A - Ericion cinereae, ULI-01B - Ulicion minoris, ULI-01C - Daboecion cantabricae, ULI-01D - Ericion umbellatae, ULI-02A - Genisto-Vaccinion, ULI-02B - Genistion pilosae, ULI-02C - Empetrion nigri

Additional selection rules: n/a

Implications for EUNIS classification: proposed new name: Dry heaths

Floristic composition:

Calluna vulgaris	74	Empetrum nigrum	13
Dicranum scoparium	35	Pteridium aquilinum	13
Deschampsia flexuosa	33	Agrostis curtisii	12
Hypnum jutlandicum	26	Festuca ovina	12
Erica tetralix	24	Cladonia portentosa	12
Potentilla erecta	23	Pinus sylvestris	12
Molinia caerulea	22	Carex arenaria	12
Erica cinerea	22	Erica vagans	11
Pleurozium schreberi	18	Ulex gallii	11
Vaccinium myrtillus	16	Danthonia decumbens	11
Carex pilulifera	16	Daboecia cantabrica	11
Agrostis capillaris	13	Genista pilosa	10

F4.3 - Macaronesian heaths

Origin of data (countries): ES

List of alliances: LAU-01A - Myrico fayae-Ericion arboreae

Additional selection rules: n/a

Implications for EUNIS classification: proposed new name: Macaronesian heaths

Floristic composition:

Erica arborea	91	Rubus ulmifolius	28
Myrica faya	80	Picconia excelsa	21
Ilex canariensis	71	Davallia canariensis	20
Laurus azorica	63	Cedronella canariensis	18
Asplenium onopteris	52	Myosotis latifolia	18
Brachypodium sylvaticum	39	Phyllis nobla	16
Dryopteris oligodonta	38	Hypericum grandifolium	12
Pteridium aquilinum	38	Teline canariensis	12
Galium scabrum	36	Polystichum setiferum	11
Viburnum tinus	33	Pinus canariensis	10

F5.1 - Arborescent matorral

Origin of data (countries): n/a

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with F5.2 (Maquis)

Floristic composition:
No data

F5.2 - Maquis

Origin of data (countries): ES, FR, GR, HR, IT, ME, PT

List of alliances: LAV-01D - Quercion fruticosae, QUI-01A - Oleo-Ceratonion siliquae, QUI-01B - Ericion arboreae, QUI-01D - Asparago albi-Rhamnion oleoidis, QUI-01E - Rhamno lycioidis-Quercion cocciferae, QUI-01F - Periplocion angustifoliae, QUI-01H - Rubo longifoliae-Coremation albi, QUI-01K - Pistacio terebinthi-Rhamnion alaterni, QUI-02B - Ceratonio-Pistacion lentisci

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with F5.1 (Arborescent matorral)

Floristic composition:

Pistacia lentiscus	58	Phillyrea latifolia	15
Brachypodium retusum	43	Myrtus communis	15
Quercus coccifera	42	Arisarum vulgare	15
Rubia peregrina	37	Chamaerops humilis	14
Smilax aspera	29	Rhamnus lycioides	14
Asparagus acutifolius	29	Daphne mauritanica	14
Olea europaea	26	Erica arborea	14
Rosmarinus officinalis	24	Carex hallerana	12
Phillyrea angustifolia	20	Genista scorpius	12
Arbutus unedo	20	Dactylis glomerata	11
Pinus halepensis	19	Cistus albidus	11
Rhamnus alaternus	19	Urginea maritima	10
Lonicera implexa	19	Clematis flammula	10
Quercus ilex	17	Cistus monspeliensis	10
Cistus salvifolius	17	Thymus vulgaris	10

F5.3 - Pseudomaquis

Origin of data (countries): HR, HU, RO

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Quercus pubescens	62	Campanula sibirica	14
Fraxinus ornus	53	Geranium sanguineum	14
Carpinus orientalis	53	Festuca valesiaca	14
Dactylis glomerata	44	Orchis purpurea	14
Cotinus coggygria	44	Brachypodium pinnatum	14
Crataegus monogyna	41	Erysimum odoratum	14
Cornus mas	37	Berberis vulgaris	13
Euonymus verrucosus	36	Coronilla varia	13
Viburnum lantana	34	Galium glaucum	13
Acer campestre	33	Smilax aspera	13
Teucrium chamaedrys	30	Arabis hirsuta	13
Ligustrum vulgare	28	Melica ciliata	13
Paliurus spina-christi	28	Tamus communis	13
Buglossoides purpurocaerulea	26	Helichrysum italicum	13
Prunus mahaleb	24	Inula ensifolia	13
Juniperus oxycedrus	24	Sanguisorba minor	12
Dictamnus albus	23	Physospermum cornubiense	11
Brachypodium sylvaticum	23	Phillyrea latifolia	11
Asparagus acutifolius	23	Prunus spinosa	11
Polygonatum odoratum	21	Bromus pannonicus	11
Clematis flammula	21	Potentilla cinerea	11
Tanacetum corymbosum	21	Muscari neglectum	11
Rhamnus intermedius	20	Festuca rupicola	11
Euphorbia cyparissias	20	Thalictrum minus	11
Carex hallerana	20	Arum orientale	11
Asparagus verticillatus	18	Epipactis helleborine	11
Paeonia peregrina	18	Mercurialis ovata	11
Polygonatum latifolium	18	Vinca herbacea	10
Geum urbanum	18	Carex michelii	10
Stachys recta	18	Spartium junceum	10
Galanthus elwesii	17	Sedum sexangulare	10
Brachypodium retusum	17	Lembotropis nigricans	10
Galium mollugo	15	Pistacia lentiscus	10
Hypericum perforatum	15	Galium odoratum	10
Pistacia terebinthus	15	Fraxinus excelsior	10

Salvia pratensis	15	Viola hirta	10
Carex humilis	15	Coronilla coronata	10
Vincetoxicum hirundinaria	15	Pyrus pyraster	10
Rosa canina	14		

F5.4 - [Spartium junceum] fields

Origin of data (countries): ES, FR, GR, HR, IT, SI, SM

List of alliances: n/a

Additional selection rules: Instead of the relevés belonging to the listed alliances, relevés with Spartium junceum cover >= 50% have been selected

Implications for EUNIS classification: proposed new name: F5.4 *Spartium junceum* scrub

Floristic composition:

Spartium junceum	100	Quercus ilex	14
Rubus ulmifolius	66	Eryngium campestre	14
Asparagus acutifolius	47	Bromus erectus	14
Rubia peregrina	40	Cistus incanus	13
Crataegus monogyna	35	Cornus sanguinea	13
Brachypodium pinnatum	33	Dittrichia viscosa	12
Dactylis glomerata	32	Foeniculum vulgare	12
Quercus pubescens	28	Lonicera implexa	12
Rosa canina	27	Pyrus amygdaliformis	12
Clematis vitalba	27	Phillyrea angustifolia	12
Rosa sempervirens	24	Psoralea bituminosa	11
Fraxinus ornus	23	Erica arborea	11
Clematis flammula	22	Carlina corymbosa	11
Prunus spinosa	19	Galium album	10
Teucrium chamaedrys	19	Geranium purpureum	10
Hedera helix	17	Phillyrea latifolia	10
Pistacia lentiscus	16	Osyris alba	10
Ulmus minor	15	Juniperus communis	10
Dorycnium hirsutum	14	Carex flacca	10
Smilax aspera	14	Pistacia terebinthus	10
Brachypodium phoenicoides	14	Hypericum perforatum	10

F5.5 - Thermo-Mediterranean scrub

Origin of data (countries): CY, ES, FR, GR, HR, IT, MC, ME, PT, TR

List of alliances: CRI-02D - Euphorbion pithyusae, CRI-02E - Anthyllidion barbae-jovis, CYT-01E - Retamion monospermae, CYT-01F - Retamion sphaerocarpae, CYT-02A - Telinion monspessulano-linifoliae, CYT-02B - Genisto spartioidis-Phlomidion almeriensis, CYT-02C - Genisto scorpii-Retamion sphaerocarpae, LAV-01B - Staehelino-Ulicion baetici, LAV-01C - Ulici argentei-Cistion ladaniferi, LAV-01D - Quercion fruticosae, LAV-01E - Cistion ladaniferi, LAV-01G - Teucrion mari, LAV-02A - Coremation albi, MIC-01A - Cisto cretici-Ericion manipuliflorae, MIC-01B - Cisto eriocephali-Ericion multiflorae, MIC-02A - Hyperico olympici-Cistion cretici, MIC-02D - Helichryso sanguinei-Origanion syriaci, MIC-02E - Micromerion, MIC-02F - Sarcopoterio spinosi-Genistion fasselatae, QUI-01A - Oleo-Ceratonion siliquae, QUI-01C - Juniperion turbinatae, QUI-01D - Asparago albi-Rhamnion oleoidis, QUI-01F - Periplocion angustifoliae, QUI-01G - Juniperon phoeniceae-Pinon acutisquamae, QUI-01H - Rubo longifoliae-Coremation albi, QUI-02B - Ceratonio-Pistacion lentisci, ROS-01B - Eryngio trifidi-Ulicion erinacei, ROS-01F - Rosmarinion officinalis, ROS-04A - Thymo moroderi-Sideritidion leucanthae, ROS-04B - Anthyllido terniflorae-Salsolion papillosae, ROS-04C - Sideritidion bourgaeanae, ROS-05B - Lavandulion lanatae, ULI-01D - Ericion umbellatae, ULI-01F - Stauracanthion boivinii

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Pistacia lentiscus	47	Quercus ilex	13
Brachypodium retusum	34	Rhamnus alaternus	13
Rosmarinus officinalis	28	Cistus albidus	13
Rubia peregrina	24	Lonicera implexa	13
Asparagus acutifolius	24	Juniperus phoenicea	13
Smilax aspera	22	Juniperus oxycedrus	12
Olea europaea	21	Erica multiflora	12
Cistus salvifolius	20	Thymus vulgaris	12
Pinus halepensis	16	Chamaerops humilis	12
Quercus coccifera	16	Myrtus communis	11
Dactylis glomerata	15	Ulex parviflorus	11
Arisarum vulgare	14	Sedum sediforme	10
Phillyrea angustifolia	14	Phillyrea latifolia	10
Cistus monspeliensis	14	Rhamnus lycioides	10

F6.1 - Western garrigues

Origin of data (countries): ES, FR, IT

List of alliances: CRI-02A - Dactylido hispanicae-Helichrysion stoechadis, CRI-02D - Euphorbion pithyusae, CRI-02E - Anthyllidion barbae-jovis, LAV-01A - Cistion laurifolii, LAV-01B - Staehelino-Ulicion baetici, LAV-01C - Ulici argentei-Cistion ladaniferi, LAV-01E - Cistion ladaniferi, LAV-01G - Teucrion mari, LAV-02A - Coremation albi, ROS-01A - Lavandulo latifoliae-Genistion boissieri, ROS-01B - Eryngio trifidi-Ulicion erinacei, ROS-01D - Sideritido incanae-Salvion lavandulifoliae, ROS-01E - Helianthemo italici-Aphyllanthion monspeliensis, ROS-01F - Rosmarinion officinalis, ROS-01G - Hypericion ericoidis, ROS-01H - Hypericion balearici, ROS-03A - Lepidion subulati, ROS-03B - Thymo-Teucrion verticillati, ROS-04A - Thymo moroderi-Sideritidion leucanthae, ROS-04B - Anthyllido terniflorae-Salsolion papillosae, ROS-04C - Sideritidion bourgaeanae, ROS-05B - Lavandulion lanatae

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: F6.1a Western basiphilous garrigues, F6.1b Western acidic garrigues

Floristic composition:

Rosmarinus officinalis	40	Helianthemum syriacum	12
Brachypodium retusum	39	Leuzea conifera	12
Thymus vulgaris	35	Carex hallerana	12
Genista scorpius	29	Lithodora fruticosa	12
Fumana ericoides	21	Stipa offneri	12
Lavandula latifolia	18	Teucrium polium	12
Atractylis humilis	17	Ulex parviflorus	12
Avenula bromoides	17	Cistus albidus	11
Fumana thymifolia	17	Quercus coccifera	11
Dorycnium pentaphyllum	17	Erica multiflora	11
Koeleria vallesiana	16	Coronilla minima	11
Helichrysum stoechas	16	Argyrolobium zanonii	11
Aphyllanthes monspeliensis	16	Helianthemum cinereum	11
Eryngium campestre	15	Linum suffruticosum	11
Sedum sediforme	15	Quercus ilex	11
Bupleurum fruticescens	15	Cistus salvifolius	10
Fumana procumbens	14	Lavandula stoechas	10
Coris monspeliensis	13	Juniperus oxycedrus	10
Dactylis glomerata	12	Cistus clusii	10

F6.2 - Eastern garrigues

Origin of data (countries): CY, GR

List of alliances: MIC-02A - Hyperico olympici-Cistion cretici, MIC-02D - Helichryso sanguinei-Origanion syriaci, MIC-02E - Micromerion, MIC-02F - Sarcopoterio spinosi-Genistion fasselatae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Sarcopoterium spinosum	56	Salvia triloba	18
Calicotome villosa	35	Anthyllis hermanniae	16
Erica manipuliflora	33	Quercus ilex	16
Arbutus unedo	32	Cistus monspeliensis	16
Stipa bromoides	28	Cistus parviflorus	16
Thymus capitatus	28	Fumana arabica	16
Asparagus acutifolius	26	Desmazeria rigida	15
Pinus halepensis	26	Pterocephalus brevis	15
Cistus incanus	26	Ballota acetabulosa	15
Cistus salvifolius	26	Osyris alba	15
Smilax aspera	24	Cynodon dactylon	15
Erica arborea	24	Fumana thymifolia	13
Lithodora hispidula	22	Helichrysum italicum	13
Phillyrea latifolia	22	Trifolium campestre	13
Helichrysum stoechas	20	Fagonia cretica	13
Lonicera implexa	20	Melica minuta	13
Dactylis glomerata	20	Ruscus aculeatus	11
Asphodelus ramosus	20	Capsella bursa-pastoris	11
Quercus coccifera	18	Genista tinctoria	11
Teucrium divaricatum	18	Hordeum murinum	11
Micromeria nervosa	18	Cerastium brachypetalum	11

F6.3 - Illyrian garrigues

Origin of data (countries): HR, IT

List of alliances: MIC-01A - Cisto cretici-Ericion manipuliflorae, MIC-01B - Cisto eriocephali-Ericion multiflorae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Pistacia lentiscus	68	Coronilla emerus	19
Cistus incanus	59	Salvia officinalis	18
Rosmarinus officinalis	45	Dorycnium hirsutum	18
Brachypodium retusum	44	Juniperus phoenicea	17
Teucrium fruticans	41	Euphorbia dendroides	16
Erica multiflora	39	Tanacetum cinerariifolium	16
Cistus monspeliensis	37	Satureja montana	14
Myrtus communis	36	Rhamnus alaternus	14
Juniperus oxycedrus	35	Teucrium flavum	14
Asparagus acutifolius	34	Pistacia terebinthus	13
Smilax aspera	31	Pinus halepensis	13
Quercus ilex	30	Arbutus unedo	13
Arisarum vulgare	29	Asperula aristata	13
Fumana ericoides	27	Frangula rupestris	13
Cistus salvifolius	24	Micromeria juliana	11
Rubia peregrina	24	Daphne gnidium	11
Lonicera implexa	22	Galium corrudifolium	11
Helichrysum italicum	22	Fumana thymifolia	11
Clematis flammula	22	Teucrium polium	11
Dactylis glomerata	20	Helichrysum stoechas	11

F6.4 - Black Sea garrigues

Origin of data (countries): n/a

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:
No data

F6.5 - Macaronesian garrigues

Origin of data (countries): n/a

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with other habitat types on shingle and gravel beaches (B1-3)

Floristic composition:
No data

F6.6 - Supra-Mediterranean garrigues

Origin of data (countries): ES, FR, IT

List of alliances: LAV-01A - Cistion laurifolii, LAV-01B - Staehelino-Ulicion baetici, ONO-01D - Genistion lobelii, ONO-01E - Echinospartion horridi, ONO-01F - Genistion occidentalis, ONO-01G - Lavandulo angustifoliae-Genistion cinereae, ONO-02C - Plantagini discoloris-Thymion mastigophori, ROS-01A - Lavandulo latifoliae-Genistion boissieri, ROS-01D - Sideritido incanae-Salvion lavandulifoliae, ROS-01E - Helianthemo italici-Aphyllanthion monspeliensis, ROS-05B - Lavandulion lanatae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Genista scorpius	37	Argyrolobium zanonii	13
Thymus vulgaris	30	Asperula cynanchica	12
Koeleria vallesiana	27	Carex hallerana	12
Aphyllanthes monspeliensis	26	Helianthemum apenninum	12
Lavandula latifolia	24	Fumana ericoides	12
Brachypodium retusum	23	Sedum sediforme	12
Carex humilis	22	Avenula pratensis	11
Fumana procumbens	20	Coris monspeliensis	11
Genista hispanica	20	Buxus sempervirens	11
Dorycnium pentaphyllum	19	Helianthemum nummularium	11
Eryngium campestre	19	Festuca hystrix	11
Bromus erectus	17	Teucrium pyrenaicum	11
Rosmarinus officinalis	17	Dactylis glomerata	10
Coronilla minima	17	Arctostaphylos uva-ursi	10
Avenula bromoides	16	Helianthemum cinereum	10
Brachypodium pinnatum	16	Linum narbonense	10
Teucrium chamaedrys	16	Bupleurum fruticescens	10
Erica vagans	15	Carduncellus monspelliensium	10
Potentilla tabernaemontani	15	Lithodora fruticosa	10
Helichrysum stoechas	14	Helianthemum oelandicum subsp. italicum	10
Leuzea conifera	13	Koeleria dasyphylla	10
Globularia bisnagarica	13		

F6.7 - Mediterranean gypsum scrubs

Origin of data (countries): ES

List of alliances: ROS-03A - Lepidion subulati, ROS-03B - Thymo-Teucrion verticillati

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Herniaria fruticosa	62	Gypsophila struthium subsp. struthium	20
Helianthemum squamatum	62	Sedum sediforme	20
Rosmarinus officinalis	46	Lithodora fruticosa	18
Ononis tridentata	45	Stipa parviflora	18
Helianthemum syriacum	45	Lygeum spartum	17
Brachypodium retusum	44	Helichrysum stoechas	16
Thymus vulgaris	41	Centaurea hyssopifolia	14
Plantago albicans	37	Fumana thymifolia	14
Atractylis humilis	33	Koeleria dasyphylla	14
Genista scorpius	32	Coris monspeliensis	13
Koeleria vallesiana	30	Artemisia herba-alba	12
Lepidium subulatum	30	Brachypodium distachyon	11
Teucrium polium	30	Helianthemum salicifolium	11
Gypsophila struthium subsp. hispanica	26	Launaea fragilis	11
Fumana ericoides	26	Astragalus incanus	11
Linum suffruticosum	25	Matthiola fruticulosa	11
Reseda stricta	21	Teucrium libanitis	11
Thymus zygis	21	Thymus aranjuezii	10
Launaea pumila	21	Stipa tenacissima	10

F6.8 - Xero-halophile scrubs

Origin of data (countries): ES, IT, KZ, RU

List of alliances: CRI-02E - Anthyllidion barbae-jovis, CRI-04C - Helichrysion obconico-devium, LER-01A - Artemision lerchianae, LER-02A - Euphorbion seguieranae, PEG-01A - Salsolo vermiculatae-Peganion harmalae, PEG-01B - Haloxylo tamariscifolii-Atriplicion glaucae, PEG-01C - Salsolo oppositifoliae-Suaedion fruticosae, PEG-01D - Lycio europaei-Ipomoeion purpureae, PEG-01E - Artemision arborescentis, PEG-01G - Medicagini citrinae-Lavaterion arboreae, PEG-02A - Artemisio glutinosae-Santolinion rosmarinifoliae, PEG-02B - Santolinion pectinato-canescentis, PEG-03A - Chenoleion tomentosae, PEG-04A - Artemisio thusculae-Rumicion lunariae, PEG-04B - Launaeo arborescentis-Schizogynion sericeae, PEG-04C - Argyranthemo suculenti-Calendulion maderensis, PEG-04D - Nicotiano glaucae-Ricinion communis

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: F6.8a Mediterranean halo-nitrophilous scrub, F6.8b Caspian Sea halo-nitrophilous scrub

Floristic composition:

Salsola vermiculata	21	Atriplex halimus	15
Eryngium campestre	20	Dactylis glomerata	14
Artemisia herba-alba	18	Plantago albicans	10
Artemisia campestris	15	Helichrysum italicum	10

F7.1 - West Mediterranean spiny heaths

Origin of data (countries): ES

List of alliances: CRI-02B - Astragalion tragacanthae

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with F7.2 (Central Mediterranean spiny heaths): Western Mediterranean spiny scrubs on coastal cliffs

Floristic composition:

Dactylis glomerata	65	Echinops ritro	15
Astragalus massiliensis	54	Euphorbia canariensis	15
Helichrysum stoechas	50	Aeonium volkerii	15
Cistus salvifolius	47	Senecio bicolor	15
Brachypodium retusum	40	Urginea maritima	15
Sedum sediforme	38	Opuntia maxima	15
Polycarpon polycarpoides subsp. polycarpoides	31	Ononis spinosa	15
Sonchus tenerrimus	29	Crithmum maritimum	15
Festuca ovina	25	Daucus halophilus	13
Reichardia picroides	25	Pallenis maritima	13
Centaurea spinabadia	25	Rubia peregrina	13
Aetheorhiza bulbosa	25	Juniperus oxycedrus	13
Pistacia lentiscus	18	Scilla haemorrhoidalis	13
Plantago subulata	18	Asphodelus gracilis	13
Aeonium lindleyi	18	Armeria pungens	13
Urospermum dalechampii	18	Andryala integrifolia	13
Carlina hispanica	18	Cenchrus ciliaris	13
Festuca arundinacea	18	Carpobrotus edulis	13
Kleinia neriifolia	18	Frankenia laevis	13
Hyparrhenia hirta	15		

F7.2 - Central Mediterranean spiny heaths

Origin of data (countries): n/a

List of alliances: n/a

Additional selection rules: n/a

Implications for EUNIS classification: should be merged with F7.1 (West Mediterranean spiny heaths): Western Mediterranean spiny scrubs on coastal cliffs

Floristic composition:
No data

F7.3 - East Mediterranean phrygana

Origin of data (countries): CY, GR, IT, TR

List of alliances: MIC-02E - Micromerion, MIC-02F - Sarcopoterio spinosi-Genistion fasselatae

Additional selection rules: Instead of the relevés belonging to the listed alliances, relevés with Sarcopoterium spinosum, Thymus capitatus or Euphorbia acanthothamnos, with a cover >= 25% have been selected

Implications for EUNIS classification: proposed new name: Phrygana

Floristic composition:

Thymus capitatus	50	Cistus parviflorus	12
Sarcopoterium spinosum	43	Hedypnois cretica	12
Euphorbia acanthothamnos	35	Gagea graeca	12
Pistacia lentiscus	29	Quercus coccifera	12
Asphodelus ramosus	27	Calicotome villosa	12
Lagurus ovatus	22	Cistus salvifolius	11
Olea europaea	20	Thymbra capitata	11
Brachypodium retusum	18	Sherardia arvensis	11
Ballota acetabulosa	18	Bromus intermedius	11
Asparagus acutifolius	16	Salvia triloba	11
Desmazeria rigida	14	Linum strictum	11
Hypochaeris achyrophorus	14	Urginea maritima	11
Fumana thymifolia	14	Phagnalon graecum	11
Trifolium campestre	14	Poa bulbosa	11
Dactylis glomerata	14	Genista acanthoclada	11
Rostraria cristata	12	Convolvulus althaeoides	10
Reichardia picroides	12		

F7.4 - Hedgehog-heaths

Origin of data (countries): ES, GR, IT

List of alliances: DAP-01B - Eryngio multifidi-Bromion fibrosi, DAP-01C - Stipo pulcherrimae-Morinion persicae, ONO-01E - Echinospartion horridi, ROS-02A - Xeroacantho-Erinaceion, ROS-05A - Andryalion agardhii, RUM-01A - Rumici-Astragalion siculi

Additional selection rules: n/a

Implications for EUNIS classification: proposed division: F7.4a West Mediterranean mountain hedgehog heaths, F7.4b Central Mediterranean mountain hedgehog heaths, F7.4c East Mediterranean hedgehog heaths, F7.4d Macaronesion mountain hedgehog heaths

Floristic composition:

Erinacea anthyllis	37	Poa ligulata	15
Koeleria vallesiana	28	Arenaria armerina	15
Echinospartum horridum	26	Pterocephalus spathulatus	14
Carex humilis	24	Echinospartum boissieri	14
Jurinea humilis	21	Alyssum spinosum	14
Thymus vulgaris	21	Thymus granatensis	14
Buxus sempervirens	21	Dianthus subacaulis subsp. brachyanthus	14
Vella spinosa	19	Fumana ericoides	13
Anthyllis vulneraria	19	Helianthemum oelandicum subsp. italicum	13
Convolvulus boissieri	18	Aphyllanthes monspeliensis	13
Fumana procumbens	17	Hippocrepis squamata subsp. eriocarpa	12
Helianthemum cinereum	17	Genista scorpius	12
Centaurea granatensis	16	Brachypodium retusum	12
Sideritis incana	16	Teucrium polium	11
Asperula aristata	16	Carex hallerana	11
Teucrium chamaedrys	15	Festuca hystrix	11
Avenula pratensis	15	Potentilla tabernaemontani	10
Bupleurum spinosum	15		

F8.1 - Canary Island xerophytic scrub

Origin of data (countries): ES

List of alliances: AEO-01A - Soncho acaulis-Sempervivion, AEO-01B - Greenovion aureae, KLE-01A - Aeonio-Euphorbion canariensis, OLE-01A - Mayteno canariensis-Juniperion canariensis, OLE-02A - Cisto canariensis-Micromerion hyssopifoliae, PEG-03A - Chenoleion tomentosae, PEG-04A - Artemisio thusculae-Rumicion lunariae, PEG-04B - Launaeo arborescentis-Schizogynion sericeae, PEG-04D - Nicotiano glaucae-Ricinion communis, SUP-01A - Spartocytision nubigeni

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Kleinia neriifolia	23	Euphorbia canariensis	11
Launaea arborescens	19	Bituminaria bituminosa	10
Euphorbia regis-jubae	17	Periploca laevigata subsp. angustifolia	10
Plocama pendula	15	Euphorbia balsamifera	10
Rubia fruticosa	14	Erysimum scoparium	10
Spartocytisus supranubius	14	Pterocephalus lasiospermus	10
Lycium intricatum	12		

F8.2 - Madeiran xerophytic scrub

Origin of data (countries): ES

List of alliances: AEO-01C - Sinapidendro angustifolii-Aeonion glutinosi, KLE-01A - Aeonio-Euphorbion canariensis, OLE-01D - Oleo maderensis-Maytenion umbellatae, OLE-02B - Soncho ustulati-Artemision argenteae, PEG-04C - Argyranthemo suculenti-Calendulion maderensis

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Kleinia neriifolia	43	Scilla haemorrhoidalis	20
Plocama pendula	41	Ceropegia fusca	20
Launaea arborescens	40	Lavandula canariensis	16
Euphorbia canariensis	32	Neochamaelea pulverulenta	14
Euphorbia regis-jubae	31	Opuntia dillenii	13
Rubia fruticosa	30	Aristida adscensionis	12
Lycium intricatum	29	Argyranthemum frutescens	12
Euphorbia balsamifera	26	Helianthemum canariense	11
Schizogyne sericea	26	Suaeda vera	10
Cenchrus ciliaris	24	Campylanthus salsoloides	10
Periploca laevigata subsp. angustifolia	23	Limonium pectinatum	10
Hyparrhenia sinaica	23	Frankenia laevis	10

F9.1 - Riverine scrub

Origin of data (countries): AT, CZ, DE, ES, FR, GL, HR, HU, IT, SI, SK, SM, UA

List of alliances: PUR-01A - Salicion phylicifoliae, PUR-01B - Salicion eleagno-daphnoidis, PUR-01D - Salicion triandrae, PUR-01E - Rubo caesii-Amorphion fruticosae, PUR-01F - Artemisio dniproicae-Salicion acutifoliae, PUR-01G - Salicion salvifoliae, PUR-01H - Salicion discolori-neotrichae, PUR-01I - Salicion pedicellatae, PUR-01J - Salicion cantabricae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Salix purpurea	44	Equisetum arvense	14
Salix elaeagnos	29	Poa trivialis	13
Urtica dioica	28	Salix fragilis	13
Phalaris arundinacea	27	Clematis vitalba	12
Salix triandra	26	Deschampsia cespitosa	12
Rubus caesius	22	Salix atrocinerea	12
Rubus ulmifolius	21	Angelica sylvestris	12
Salix alba	21	Cornus sanguinea	11
Populus nigra	18	Crataegus monogyna	11
Lythrum salicaria	18	Fraxinus angustifolia	11
Solanum dulcamara	18	Lycopus europaeus	11
Ranunculus repens	16	Alnus incana	10
Galium aparine	16	Humulus lupulus	10
Calystegia sepium	15	Rumex obtusifolius	10
Mentha longifolia	15	Eupatorium cannabinum	10
Agrostis stolonifera	15	Aegopodium podagraria	10
Brachypodium sylvaticum	14		

F9.2 - [Salix] carr and fen scrub

Origin of data (countries): AT, BE, CZ, DE, HU, IT, NL, SI, SK, UK

List of alliances: CIN-01A - Salicion cinereae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Salix cinerea	81	Holcus lanatus	17
Lysimachia vulgaris	51	Agrostis stolonifera	16
Phragmites australis	48	Filipendula ulmaria	16
Solanum dulcamara	47	Quercus robur	15
Galium palustre	42	Eupatorium cannabinum	15
Calamagrostis canescens	41	Carex elata	14
Lycopus europaeus	38	Scutellaria galericulata	14
Urtica dioica	34	Cardamine pratensis	13
Iris pseudacorus	33	Hydrocotyle vulgaris	13
Alnus glutinosa	33	Potentilla palustris	13
Juncus effusus	32	Dryopteris dilatata	12
Lythrum salicaria	26	Angelica sylvestris	12
Dryopteris carthusiana	23	Sorbus aucuparia	11
Betula pubescens	22	Agrostis canina	11
Cirsium palustre	21	Ranunculus repens	11
Salix aurita	21	Calamagrostis epigejos	11
Mentha aquatica	21	Calliergonella cuspidata	11
Frangula alnus	21	Glyceria maxima	10
Peucedanum palustre	20	Salix repens	10
Poa trivialis	20	Betula pendula	10
Rubus sect. Rubus	18	Carex pseudocyperus	10
Molinia caerulea	17		

F9.3 - Southern riparian galleries and thickets

Origin of data (countries): ES, GR, IT, RO, RU

List of alliances: NER-01A - Tamaricion africanae, NER-01B - Tamaricion boveano-canariensis, NER-01C - Rubo ulmifolii-Nerion oleandri, NER-01D - Securinegion buxifoliae, NER-01F - Rubo sancti-Nerion oleandri, POP-03A - Salicion canariensis, PUR-02A - Tamaricion parviflorae, PUR-02B - Artemisio scopariae-Tamaricion ramosissimae, TAM-01A - Agropyro fragilis-Tamaricion ramosissimae

Additional selection rules: n/a

Implications for EUNIS classification: n/a

Floristic composition:

Rubus ulmifolius	32	Tamarix africana	16
Nerium oleander	31	Piptatherum miliaceum	15
Tamarix canariensis	27	Dittrichia viscosa	15
Scirpoides holoschoenus	25	Tamarix gallica	14
Phragmites australis	18	Arundo donax	11

Appendix E: List of Data Contributors

Country/region	*Data sources*	*Contact*
Austria	Austrian Vegetation database (VINCA)	Wolfgang Willner
Balkan region	Balkan Vegetation Database	Kiril Vassilev
	Slovenian Academy of Sciences and Arts	Andraž Čarni
Belgium	Institute for Nature and Forest Database	Els de Bie
Croatia	Vegetation Databases University of Zagreb	Daniel Krstonošić
		Zvjezdana Stančić
		Željko Škvorc
Cyprus	Literature review	Erwin Bergmeier
Czech Republic	Czech National Phytosociological Database	Milan Chytrý, Dana Michalcová
European coastal areas	European Coastal Vegetation Database	John Janssen
France	SOPHY database	Henry Brisse
Germany	VegMV (Mecklenburg-Vorpommern)	Florian Jansen, Christian Berg
	VegetWeb	Jörg Ewald
	GVRD Halle	Ute Jandt
Greece	Hellenic Natura 2000 Database	Panayotis Dimopoulos
	Hellenic woodland database	Ioannis Tsiripidis
	Literature review	Erwin Bergmeier
Hungary	CoenoDat Hungarian Phytosociological Database	János Csiky
Ireland	Irish Vegetation Database	Úna Fitzpatrick
Italy	Database of La Sapienza University	Emiliano Agrillo, Nicola Alessi, Fabio Attorre
	BVN/ISPRA Vegetation Database	Laura Casella
	VegItaly	Roberto Venanzoni, Flavia Landucci
	Literature review	Alessandro Properzi
The Netherlands	Dutch National Vegetation Database	Joop Schaminée, Stephan Hennekens
Poland	Polish Vegetation Database	Zygmunt Kącki
Romania	Vegetation DB of forests of Romania	Adrian Indreica, Pavel Dan Turtureanu

Russia	Literature review	Pavel Dřevojan, Marcela Řezníčková
	Russian regional vegetation databases	Sergey Yamalov
		Tatyana Lysenko
		Valentin Golub
Scandinavia	Nordic database Consortium	Jonathan Lenoir, Jörg Brunet
Slovakia	Slovak Vegetation Database	Milan Valachovič, Jozef Šibík
Slovenia	Vegetation Database of Slovenia	Urban Šilc
Spain	Vegetation database of the Basque Country	Idoia Biurrun
	SIVIM Database	Xavier Font
	Literature review	Borja Jiménez-Alfaro
Switzerland	WSL databases of Switzerland	Thomas Wohlgemuth
Turkey	Forest Vegetation Database of Turkey	Ali Kavgacı
UK	British NVC Database	John Rodwell
Ukraine	Database Academy of Sciences of Ukraine, Kiyv	Viktor Onyshchenko, Yakov Didukh

Appendix F: Distribution and suitability maps of revised EUNIS forest habitat types

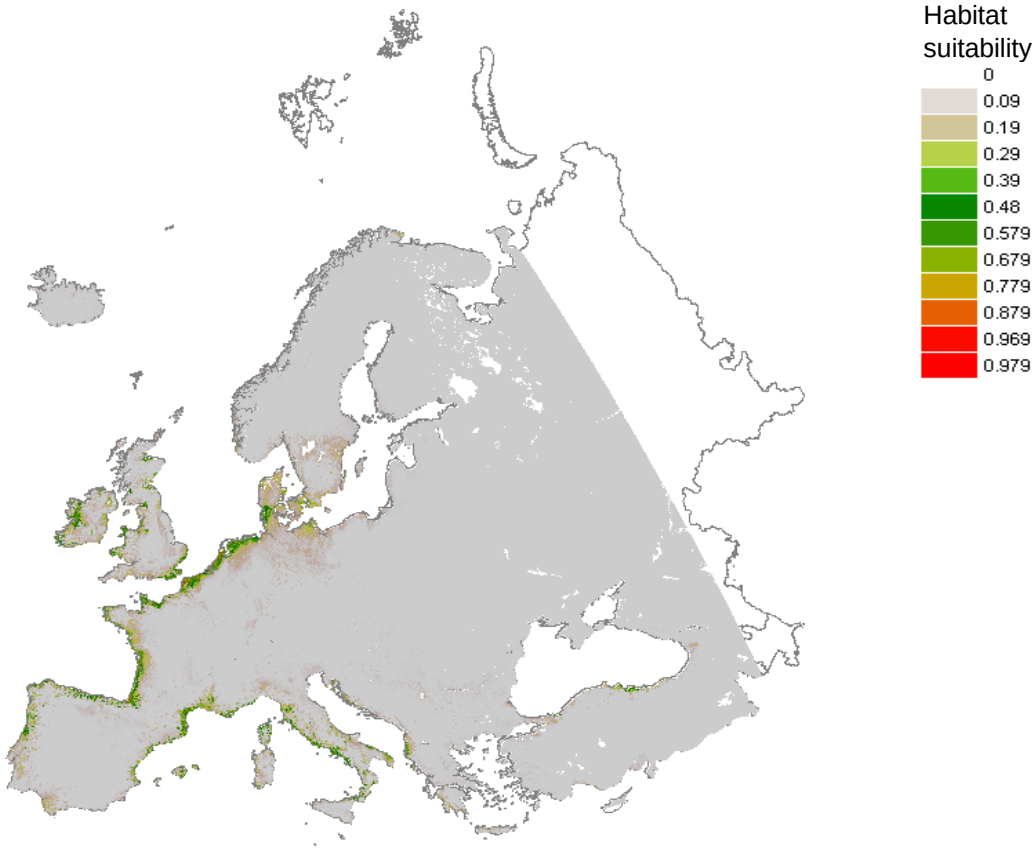
EUNIS classes and number of representing relevés

Type	Subtype	Name	Number of locations	Backgound: Forest	Backgound: Random
B1.7		Coastal dune woodland* [Coastal dune woods]	550		1
G1.1		Temperate and boreal softwood riparian woodland* [Riparian and gallery woodland, with dominant [Alnus], [Betula], [Populus] or [Salix]]	3219	1	
G1.2		Temperate and boreal hardwood riparian woodland* [Mixed riparian floodplain and gallery woodland]	5393	1	
G1.3		Mediterranean and Macaronesian riparian woodland* [Mediterranean riparian woodland]	1377	1	
G1.4		Broadleaved swamp woodland on non-acid peat* [Broadleaved swamp woodland not on acid peat]	3828	1	
G1.5		Broadleaved swamp woodland on acid peat* [Broadleaved swamp woodland on acid peat]	1956	1	
G1.6		[Fagus] woodland could be divided into two types, because of the high variation within the overall type and the possibility to make a clear division:			
	G1.6a	Fagus woodland on non-acid soils	21695		1
	G1.6b	Fagus woodland on acid soils	12981		1
G1.7		Thermophilous deciduous woodland	15196	1	
G1.8		Acidophilous Quercus woodland* [Acidophilous [Quercus]-dominated woodland]	9410		1
G1.9		Non-riverine woodland with [Betula], [Populus tremula] or [Sorbus aucuparia] has to be divided into two types:			
	G1.9a	Mountain Betula and Populus tremula woodlands on mineral soils	162	1	
	G1.9b	Lowland continental Betula and Populus tremula woodlands on mineral soil	No data		
G1.A		Mesotrophic and eutrophic deciduous woodland, not dominated by Fagus* [Meso- and eutrophic [Quercus], [Carpinus], [Fraxinus], [Acer], [Tilia], [Ulmus] and related woodland]	19668	1	
G1.B		Non-riverine Alnus woodland on mineral soil* [Non-riverine [Alnus] woodland]	No data		
G1.C		Broadleaved deciduous plantations of non site-native trees* [Highly artificial broadleaved deciduous forestry plantations]	No data		
G1.D		*Fruit and nut tree orchards is not a woodland and should be removed (it could go into EUNIS group I)*	No data		
G2.1		Mediterranean evergreen Quercus woodland* [Mediterranean evergreen [Quercus] woodland]	6493	1	
G2.2		Mainland lauriphyllous woodland* [Eurasian continental sclerophyllous woodland]	39		0
G2.3		Macaronesian lauriphyllous woodland* [Macaronesian [Laurus] woodland]	No data		
G2.4		Olea oleaster-Ceratonia siliqua woodland* [Olea europaea] - [Ceratonia siliqua] woodland]	856		1
G2.5		Phoenix groves* [[Phoenix] groves]	10		0
G2.6		Ilex aquifolium woodland* [[Ilex aquifolium] woods]	313		1
G2.7		*Macaronesian heathy woodland* [Canary Island heath woodland]*	No data		

G2.8		*Broadleaved evergreen plantations of non site-native trees* [Highly artificial broadleaved evergreen forestry plantations]*	No data		
G2.9		*Evergreen orchards and groves*	No data		
G3.1		[Abies] and [Picea] woodland has to be divided into three types (according to dominant species and geographic distribution):			
	G3.1a	Temperate mountain Picea woodland	12596		1
	G3.1b	Temperate mountain Abies woodland	6994		1
	G3.1c	Mediterranean mountain Abies woodland	64		0
G3.2		Temperate subalpine Larix-Pinus woodland* [Alpine [Larix] - [Pinus cembra] woodland]	2487		1
G3.3		[Pinus uncinata] woodland should be merged into G3.2 [Alpine [Larix] - [Pinus cembra] woodland] (this category corresponds to the same phytosociological units, with Pinus species as the usual dominant)]	No data		
G3.4		[Pinus sylvestris] woodland south of the taiga has to be divided into three types:			
	G3.4a	Temperate continental Pinus sylvestris woodland	9387	1	
	G3.4b	Temperate and submediterranean montane Pinus sylvestris-nigra woodland	3530		1
	G3.4c	Mediterranean montane Pinus sylvestris-nigra woodland	24		0
G3.5		[Pinus nigra] woodland should to be merged into the G3.4a and G3.4c types	No data		
G3.6		Mediterranean and Balkan subalpine Pinus heldreichii-peucis woodland* [balpine mediterranean [Pinus] woodland]	211		0
G3.7		Mediterranean lowland to submontane Pinus woodland* [Lowland to montane mediterranean [Pinus] woodland (excluding [Pinus nigra])]	2065		1
G3.8		*Pinus canariensis woodland* [Canary Island [Pinus canariensis] woodland]*	No data		
G3.9		Coniferous woodland dominated by [Cupressaceae] or [Taxaceae] should be divided into two types: Taxus baccata woodland and Juniperus-Cupressus woodland and further into mainland and Macaronesia.			
	G3.9a	Taxus baccata woodland	317		1
	G3.9b	Mediterranean Cupressaceae woodland	1621	1	
	G3.9c	Macaronesian Juniperus woodland	No data		
G3.A		Picea taiga woodland* [{Picea] taiga woodland]	164	0	
G3.B		Pinus sylvestris taiga woodland* [[Pinus] taiga woodland]	2		0
G3.C		Larix taiga woodland* [[Larix] taiga woodland]	No data		
G3.D		Boreal bog conifer woodland* [Boreal bog conifer woodland]	No data		
G3.E		Temperate bog conifer woodland* [Nemoral bog conifer woodland]	1047		1
G3.F		Conifer plantations of non site-native trees* [Highly artificial coniferous plantations]	No data		

B1.7 - Coastal dune woodland* [Coastal dune woods]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

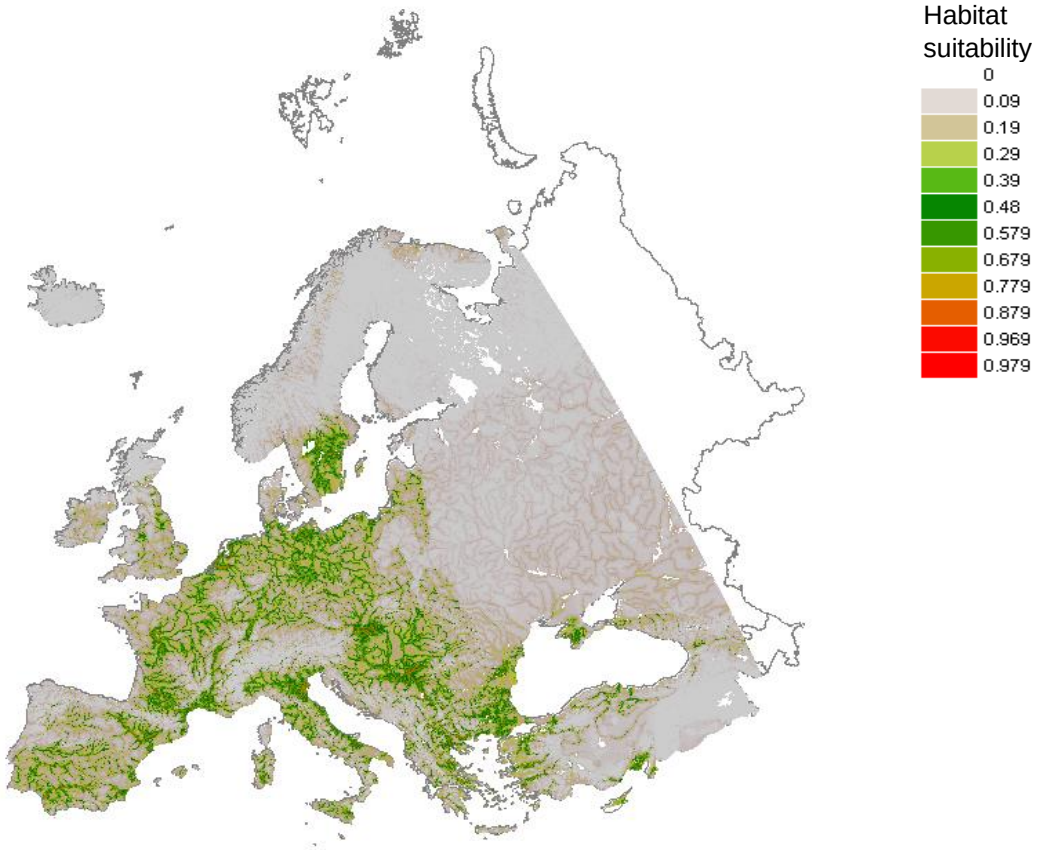
AUC training (0-1)	0.987
AUC test (0-1)	0.9904
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	39.5222
Solar radiation	31.5583
Mean Temperature of Wettest Quarter	15.8472
Precipitation Seasonality (coef. of var.)	8.5057
Precipitation of Warmest Quarter	1.2786
Annual Precipitation	1.018
Potential Evapotranspiration	0.9996
Distance to water	0.947
Soil pH	0.3234

Comment

Suitable areas in the coastline of temperate and mediterranean climates. Inland predictions reflect climatic similarity but they must be masked to coastal habitats.

G1.1 - Temperate and boreal softwood riparian woodland* [Riparian and gallery woodland, with dominant [Alnus], [Betula], [Populus] or [Salix]]

Distribution based on vegetation relevés



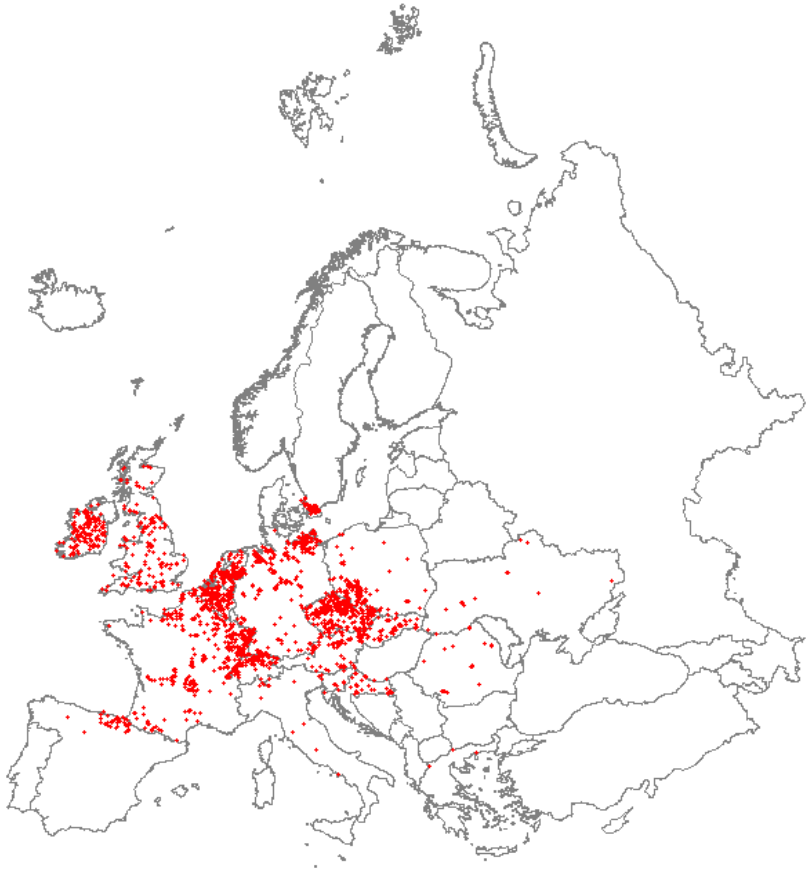
Model prediction. Background data randomly selected from the complete forest data set

AUC training (0-1)	0.8625
AUC test (0-1)	0.8529
Contribution variables to the Maxent model (%)	
Distance to water	40.9207
Solar radiation	26.2171
Annual Precipitation	11.4437
Soil pH	10.1855
Temperature Seasonality (stdev * 100)	4.7345
Precipitation of Warmest Quarter	2.8407
Potential Evapotranspiration	1.6611
Precipitation Seasonality (coef. of var.)	1.3648
Mean Temperature of Wettest Quarter	0.6319

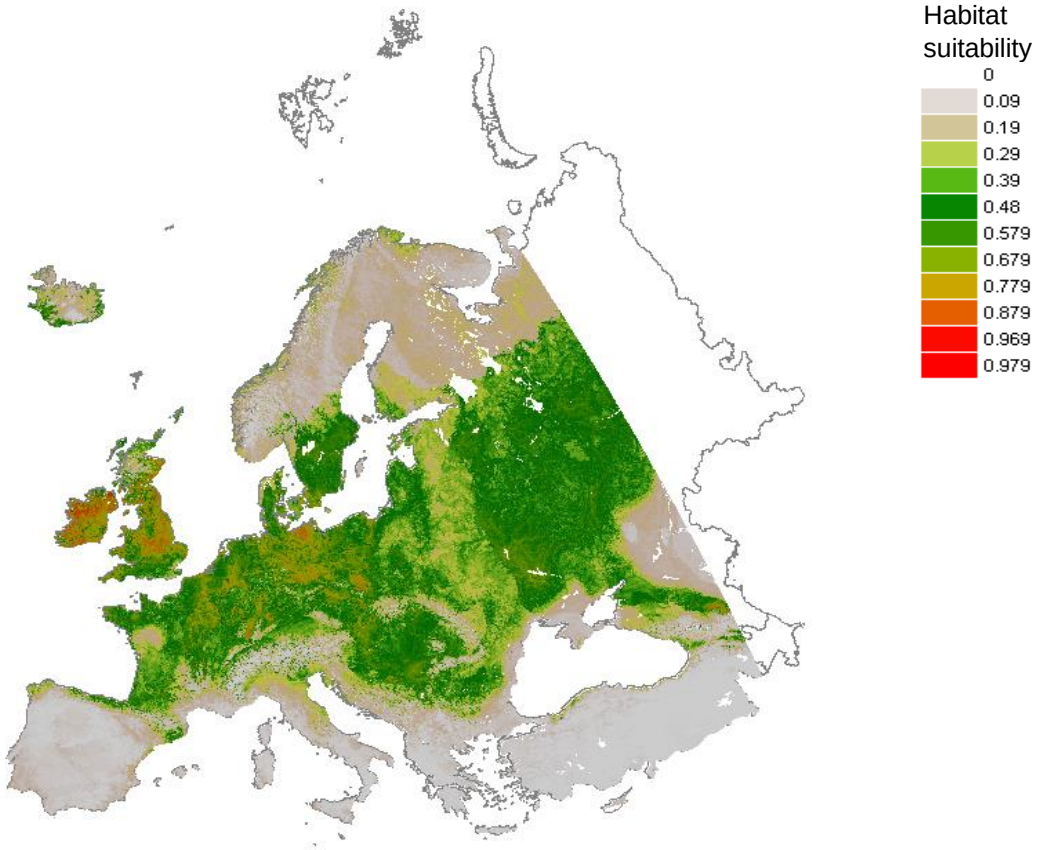
Comment

Suitable areas mainly distributed along the river basins. Potential underprediction for Eastern Europe and the Boreal zone because of the lack of data for these regions.

G1.2 - Temperate and boreal hardwood riparian woodland* [Mixed riparian floodplain and gallery woodland]



Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

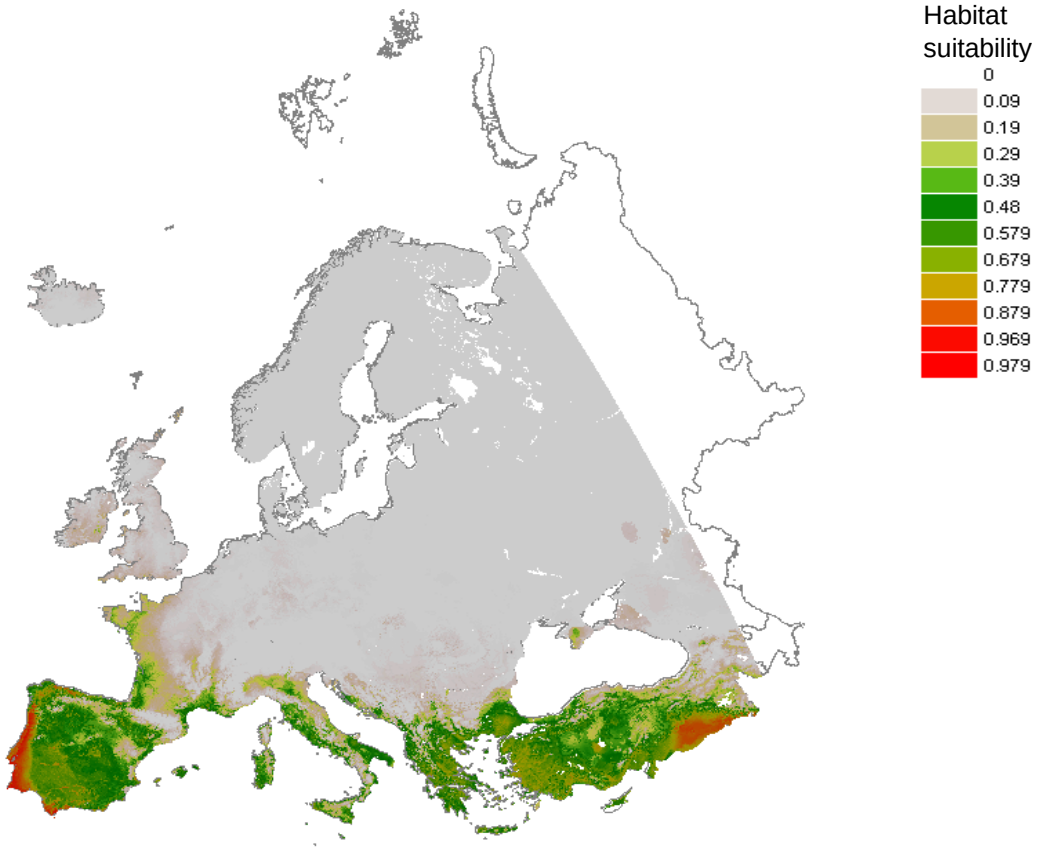
AUC training (0-1)	0.7676
AUC test (0-1)	0.7524
Contribution variables to the Maxent model (%)	
Solar radiation	44.5248
Precipitation of Warmest Quarter	31.0573
Temperature Seasonality (stdev * 100)	5.8461
Mean Temperature of Wettest Quarter	5.4082
Potential Evapotranspiration	5.0005
Annual Precipitation	4.4875
Soil pH	1.7308
Precipitation Seasonality (coef. of var.)	1.0157
Distance to water	0.929

Comment

Suitable areas mainly confined to the Temperate biome, with a possible underprediction in the Boreal zone. The lack of soil moisture variables expands the predictions to non-riparian habitats.

G1.3 - Mediterranean and Macaronesian riparian woodland* [Mediterranean riparian woodland]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

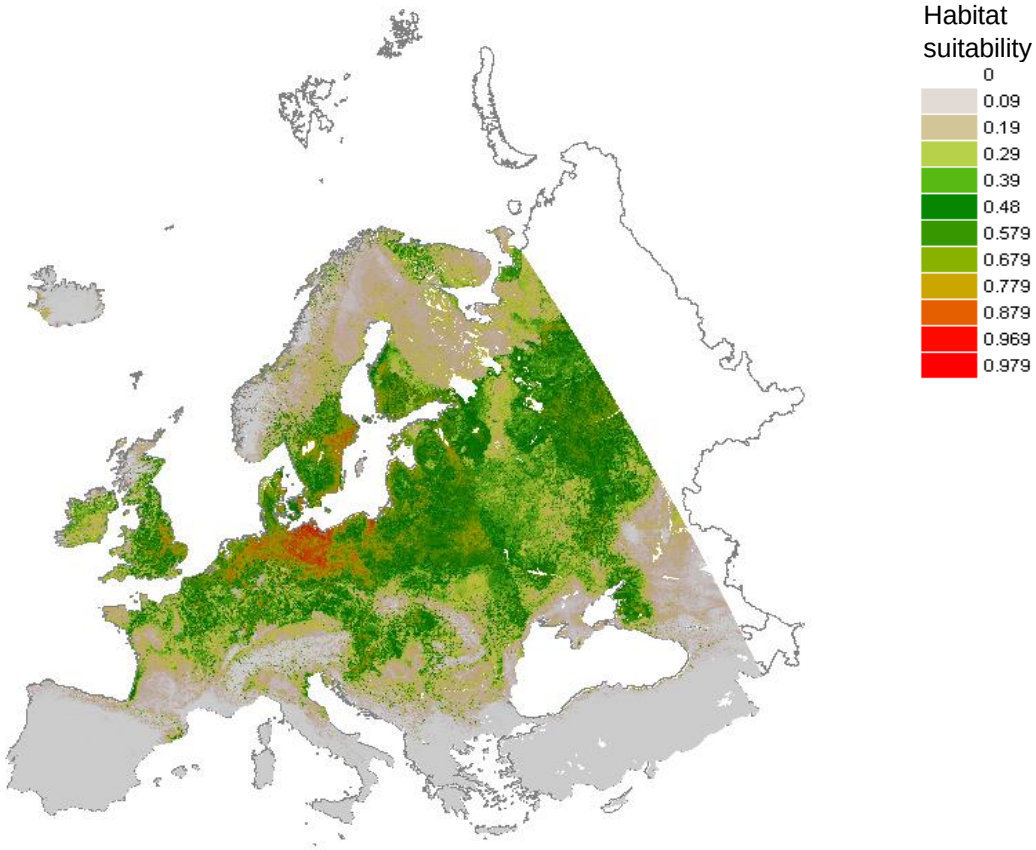
AUC training (0-1)	0.9318
AUC test (0-1)	0.9149
Contribution variables to the Maxent model (%)	
Potential Evapotranspiration	53.4946
Precipitation of Warmest Quarter	28.0611
Temperature Seasonality (stdev * 100)	9.4465
Mean Temperature of Wettest Quarter	3.8968
Precipitation Seasonality (coef. of var.)	2.2413
Solar radiation	1.5617
Soil pH	0.4755
Distance to water	0.4626
Annual Precipitation	0.3599

Comment

Suitable areas mainly confined to the Mediterranean biome. The lack of soil moisture variables expands the predictions to non-riparian habitats.

G1.4 - Broadleaved swamp woodland on non-acid peat* [Broadleaved swamp woodland not on acid peat]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

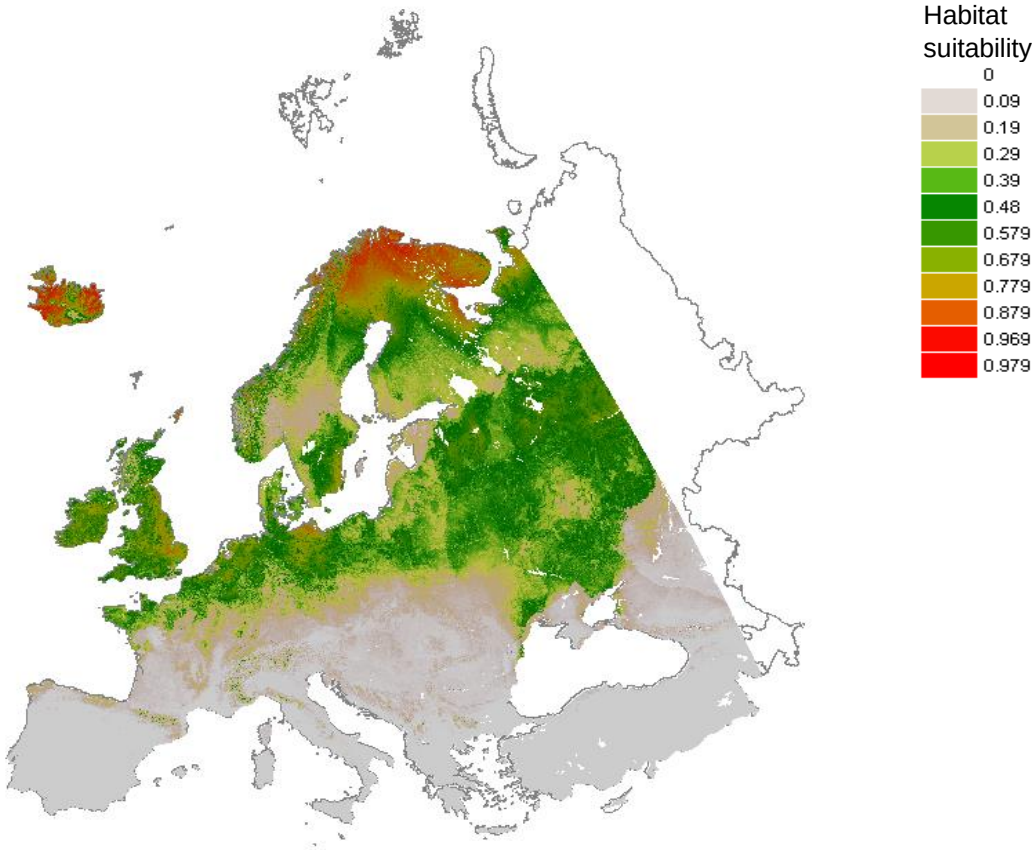
AUC training (0-1)	0.8424
AUC test (0-1)	0.8173
Contribution variables to the Maxent model (%)	
Solar radiation	35.2926
Precipitation of Warmest Quarter	18.6273
Mean Temperature of Wettest Quarter	16.2205
Annual Precipitation	12.3519
Potential Evapotranspiration	9.4265
Soil pH	4.6459
Temperature Seasonality (stdev * 100)	2.535
Precipitation Seasonality (coef. of var.)	0.8557
Distance to water	0.0447

Comment

Suitable areas in the Temperate and Boreal zones, reflecting low solar radiation and high precipitation. The lack of soil moisture variables expands the predictions to non-swamp habitats.

G1.5 - Broadleaved swamp woodland on acid peat* [Broadleaved swamp woodland on acid peat]

Distribution based on vegetation relevés



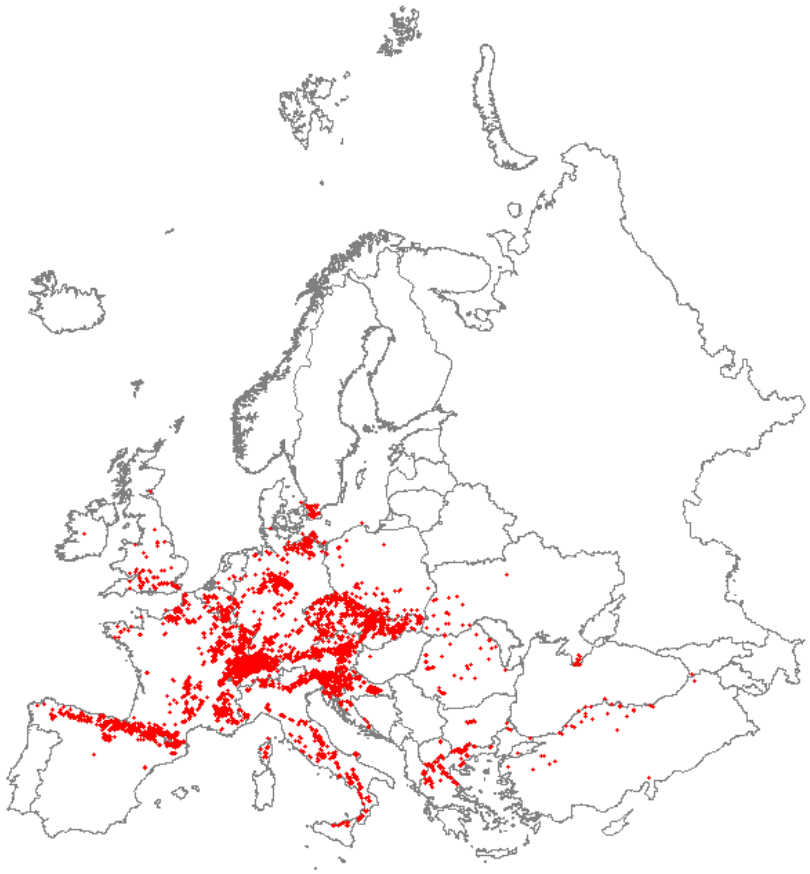
Model prediction. Background data randomly selected from the complete forest data set

AUC training (0-1)	0.8759
AUC test (0-1)	0.855
Contribution variables to the Maxent model (%)	
Potential Evapotranspiration	48.1552
Solar radiation	20.9292
Precipitation of Warmest Quarter	11.3991
Precipitation Seasonality (coef. of var.)	5.7861
Soil pH	4.7057
Temperature Seasonality (stdev * 100)	4.0095
Annual Precipitation	2.9986
Mean Temperature of Wettest Quarter	1.4044
Distance to water	0.6122

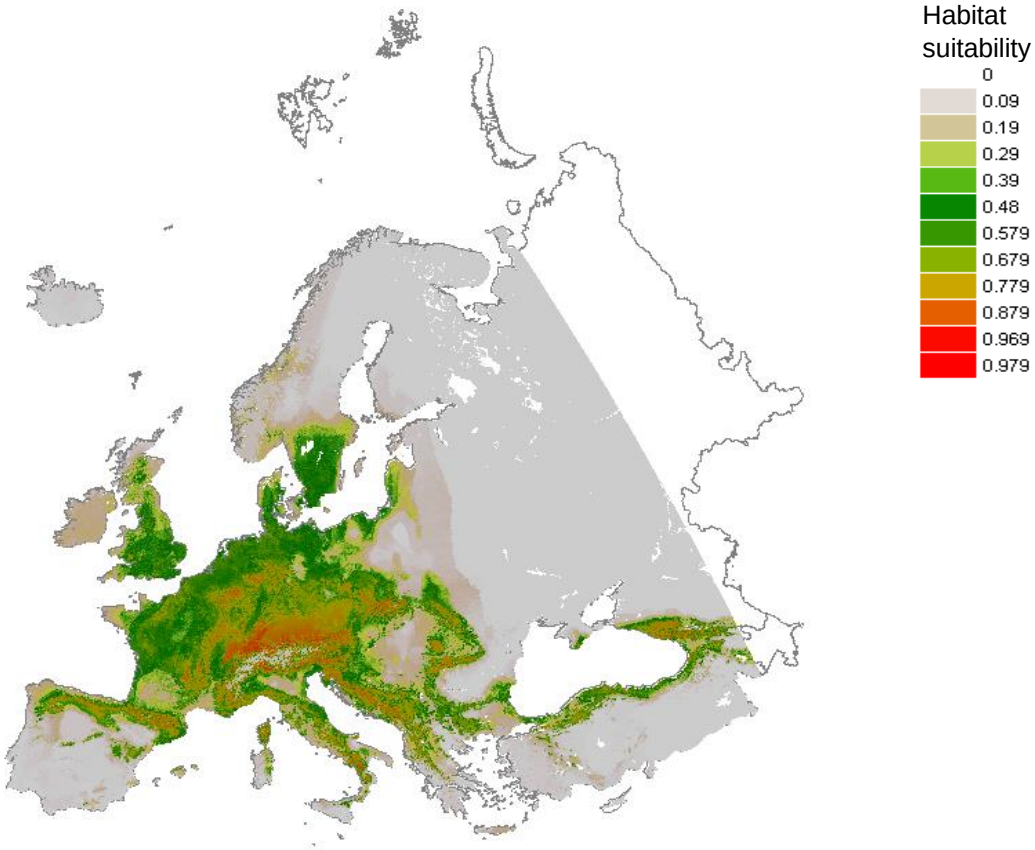
Comment

Suitable areas in the Boreal and North-Temperate zones, reflecting low potential evapotranspiration and low solar radiation. The lack of soil moisture variables expands the predictions to non-swamp habitats.

G1.6a - Fagus woodland on non-acid soils



Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

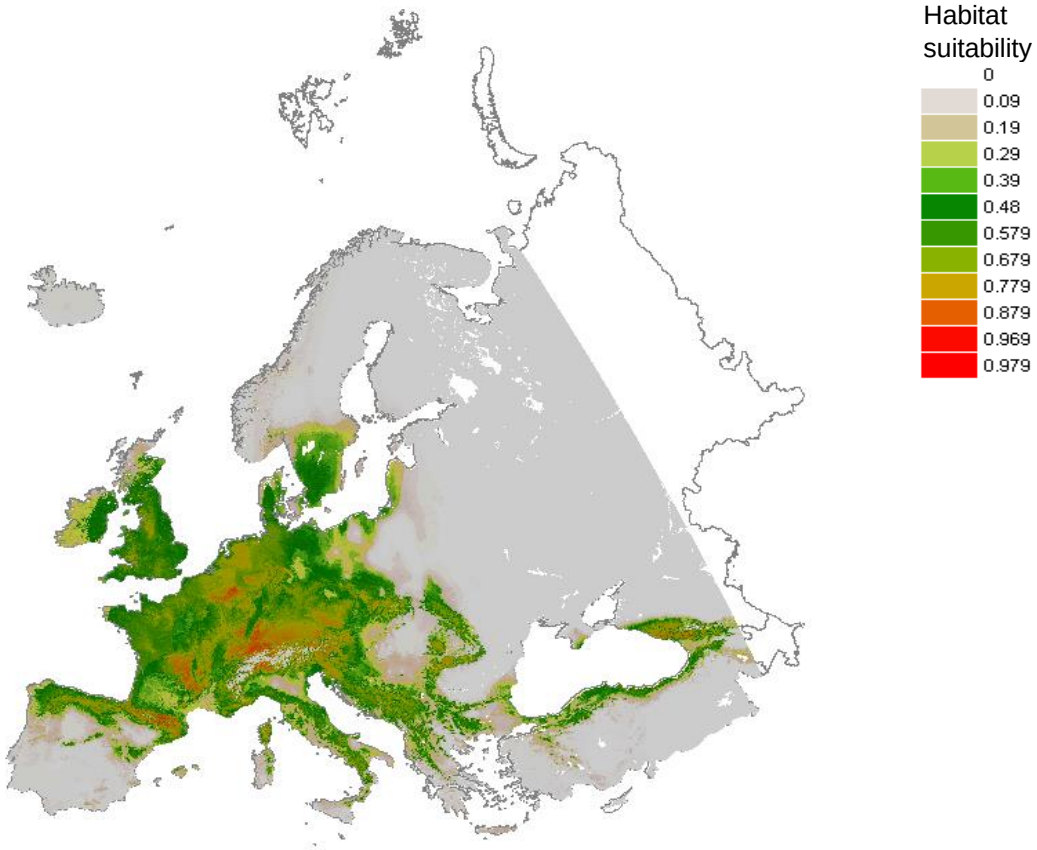
AUC training (0-1)	0.8144
AUC test (0-1)	0.8091
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	57.2887
Potential Evapotranspiration	25.3307
Annual Precipitation	7.2249
Precipitation of Warmest Quarter	5.0275
Solar radiation	3.3526
Precipitation Seasonality (coef. of var.)	1.3313
Soil pH	0.2365
Mean Temperature of Wettest Quarter	0.1087
Distance to water	0.099

Comment

Suitable areas match the current distribution of Fagus forests in Europe. More accurate predictions for different soil conditions are limited by the lack of fine-resolution explanatory variables

G1.6b - Fagus woodland on acid soils

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

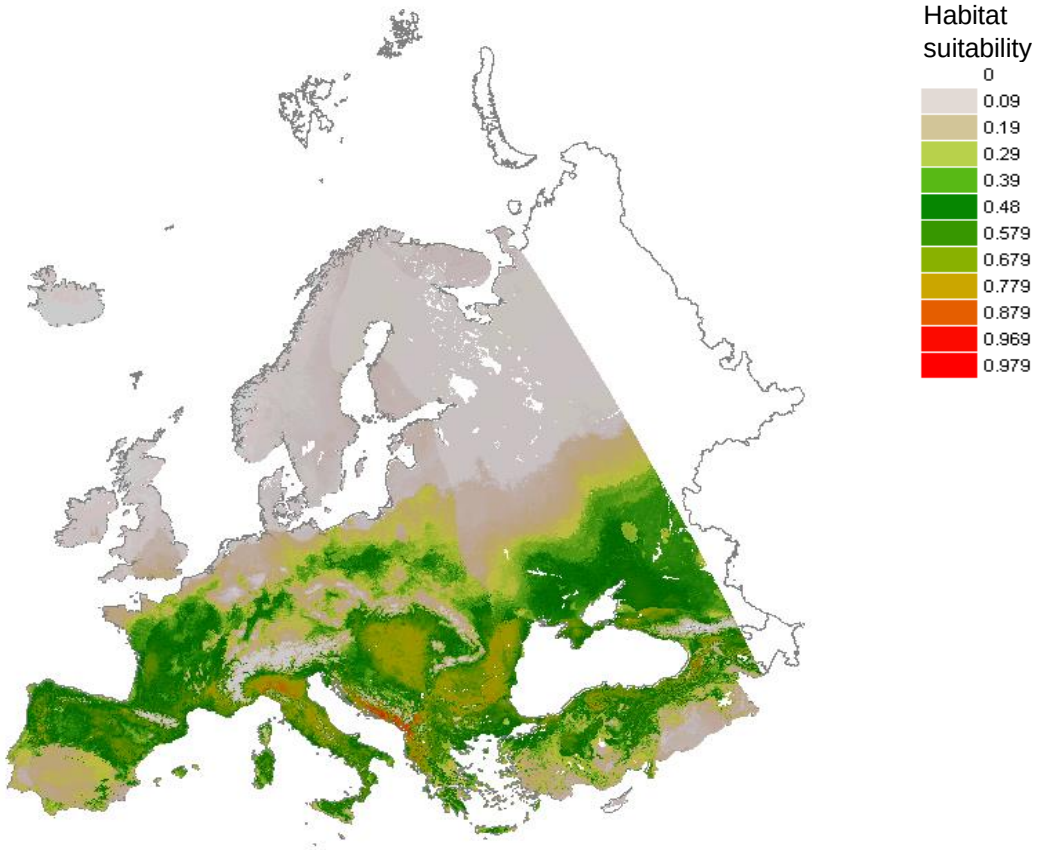
AUC training (0-1)	0.8336
AUC test (0-1)	0.8312
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	58.7703
Potential Evapotranspiration	22.2968
Annual Precipitation	8.8968
Precipitation of Warmest Quarter	7.0438
Solar radiation	1.4606
Precipitation Seasonality (coef. of var.)	1.1614
Soil pH	0.224
Mean Temperature of Wettest Quarter	0.0876
Distance to water	0.0586

Comment

Suitable areas match the current distribution of Fagus forests in Europe.More accurate predictions for different soil conditions are limited by the lack of fine-resolution explanatory variables

G1.7 - Thermophilous deciduous woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

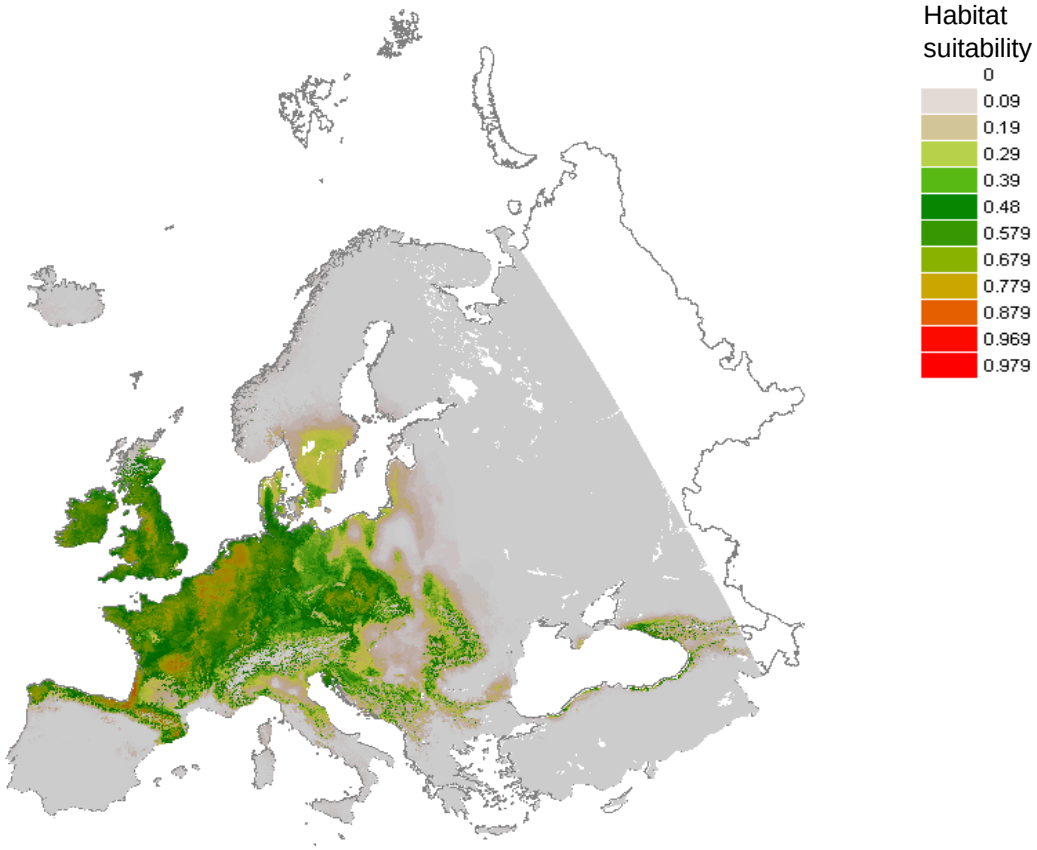
AUC training (0-1)	0.7726
AUC test (0-1)	0.768
Contribution variables to the Maxent model (%)	
Potential Evapotranspiration	75.8512
Precipitation of Warmest Quarter	10.3186
Temperature Seasonality (stdev * 100)	3.8745
Mean Temperature of Wettest Quarter	3.3564
Precipitation Seasonality (coef. of var.)	2.2401
Soil pH	1.5313
Annual Precipitation	1.5267
Solar radiation	0.8308
Distance to water	0.4704

Comment

Suitable areas represented in the southern-Temperate zone, reflecting relatively warm conditions and excluding mountain regions.

G1.8 - Acidophilous Quercus woodland* [Acidophilous [Quercus]-dominated woodland]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

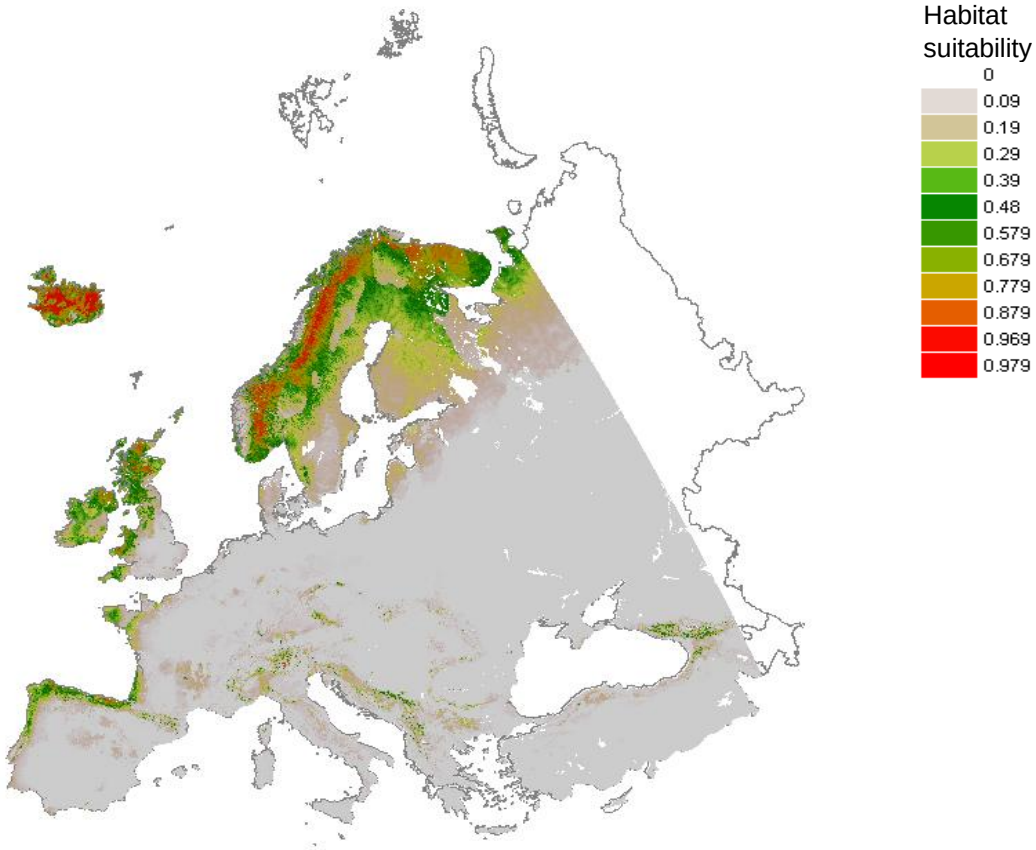
AUC training (0-1)	0.8628
AUC test (0-1)	0.863
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	58.255
Precipitation of Warmest Quarter	21.5749
Potential Evapotranspiration	14.6326
Solar radiation	2.9419
Precipitation Seasonality (coef. of var.)	1.4857
Soil pH	0.7197
Mean Temperature of Wettest Quarter	0.2729
Annual Precipitation	0.1128
Distance to water	0.0045

Comment

Suitable areas in warm Temperate regions of Western and Central Europe. Possible underprediction for Eastern Europe because of the lack of occurrence data.

G1.9a - Mountain Betula and Populus tremula woodlands on mineral soils

Distribution based on vegetation relevés



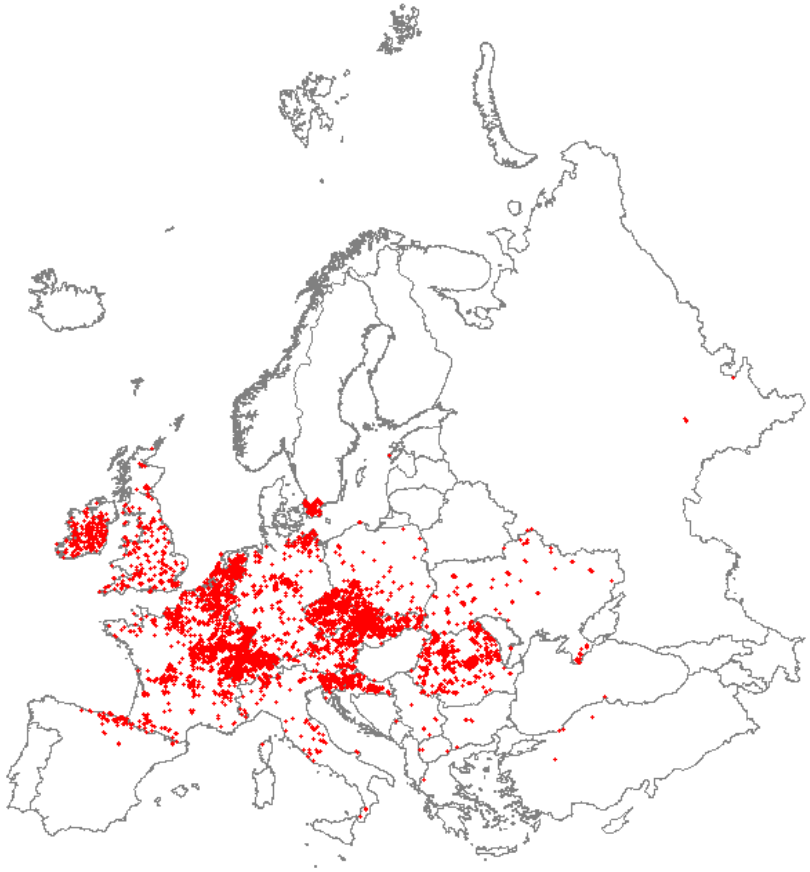
Model prediction. Background data randomly selected from the complete forest data set

AUC training (0-1)	0.9694
AUC test (0-1)	0.9146
Contribution variables to the Maxent model (%)	
Potential Evapotranspiration	25.3501
Temperature Seasonality (stdev * 100)	21.1121
Mean Temperature of Wettest Quarter	15.3974
Precipitation Seasonality (coef. of var.)	9.189
Soil pH	8.7273
Annual Precipitation	8.5167
Precipitation of Warmest Quarter	7.8623
Solar radiation	3.1554
Distance to water	0.6898

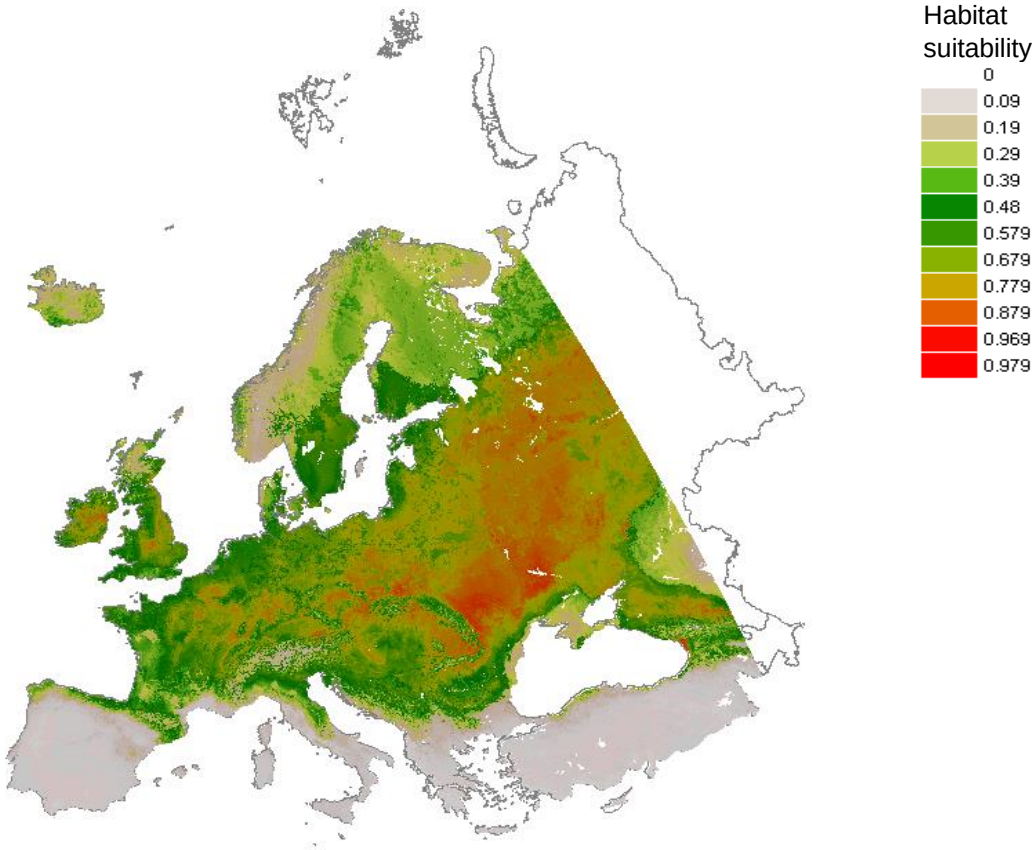
Comment

Suitable areas mainly distributed in Noth-Atlantic regions with low Potential Evapotranspiration and also with low seasonality. Although predictions seem realistic, the low number of occurrences makes necessary to interpret this model with caution.

G1.A - Mesotrophic and eutrophic deciduous woodland, not dominated by Fagus* [Meso- and eutrophic [Quercus], [Carpinus], [Fraxinus], [Acer], [Tilia], [Ulmus] and related



Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

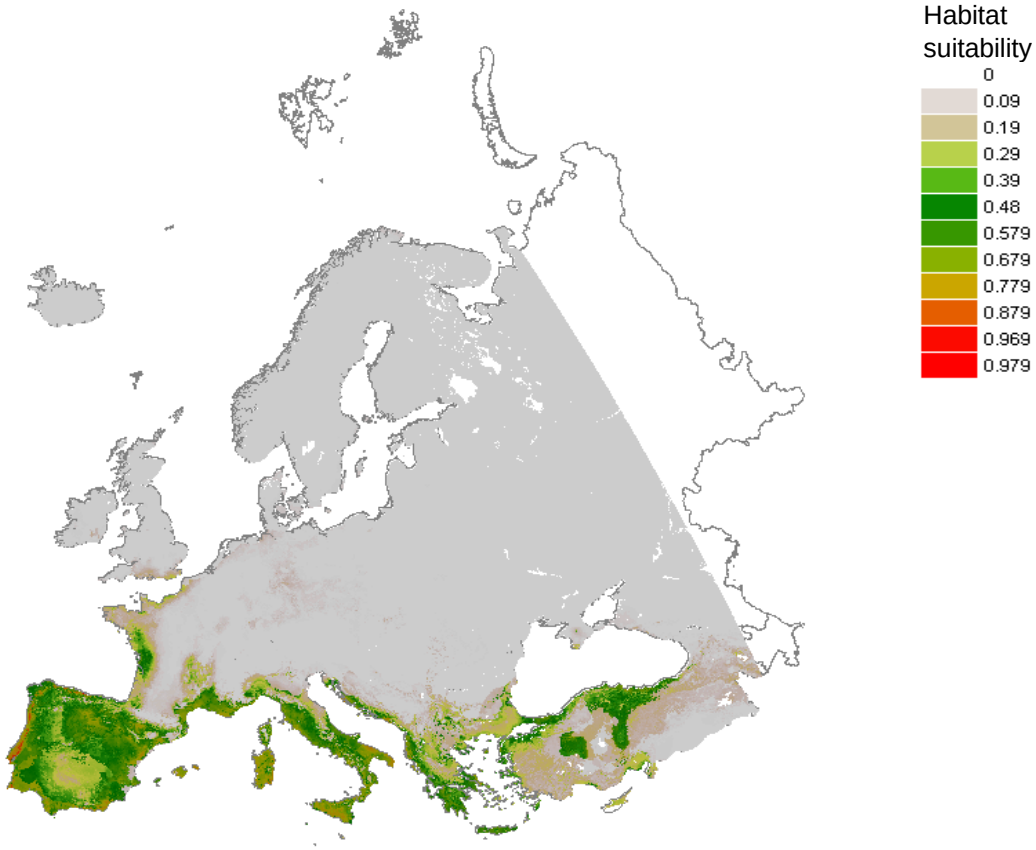
AUC training (0-1)	0.6966
AUC test (0-1)	0.6903
Contribution variables to the Maxent model (%)	
Precipitation of Warmest Quarter	48.869
Solar radiation	13.4084
Mean Temperature of Wettest Quarter	11.6554
Potential Evapotranspiration	7.685
Annual Precipitation	6.7515
Temperature Seasonality (stdev * 100)	6.2496
Precipitation Seasonality (coef. of var.)	2.7453
Soil pH	2.5529
Distance to water	0.0829

Comment

Suitable areas in the Temperate zone and especially in Central and Eastern Europe, reflecting relatively warm climates with high summer precipitation, thus excluding the Mediterranean region.

G2.1 - Mediterranean evergreen Quercus woodland* [Mediterranean evergreen [Quercus] woodland]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

AUC training (0-1)	0.9184
AUC test (0-1)	0.9068
Contribution variables to the Maxent model (%)	
Precipitation of Warmest Quarter	58.7016
Potential Evapotranspiration	17.7312
Precipitation Seasonality (coef. of var.)	7.9341
Temperature Seasonality (stdev * 100)	7.5346
Mean Temperature of Wettest Quarter	7.2427
Soil pH	0.4114
Annual Precipitation	0.2254
Distance to water	0.1675
Solar radiation	0.0516

Comment

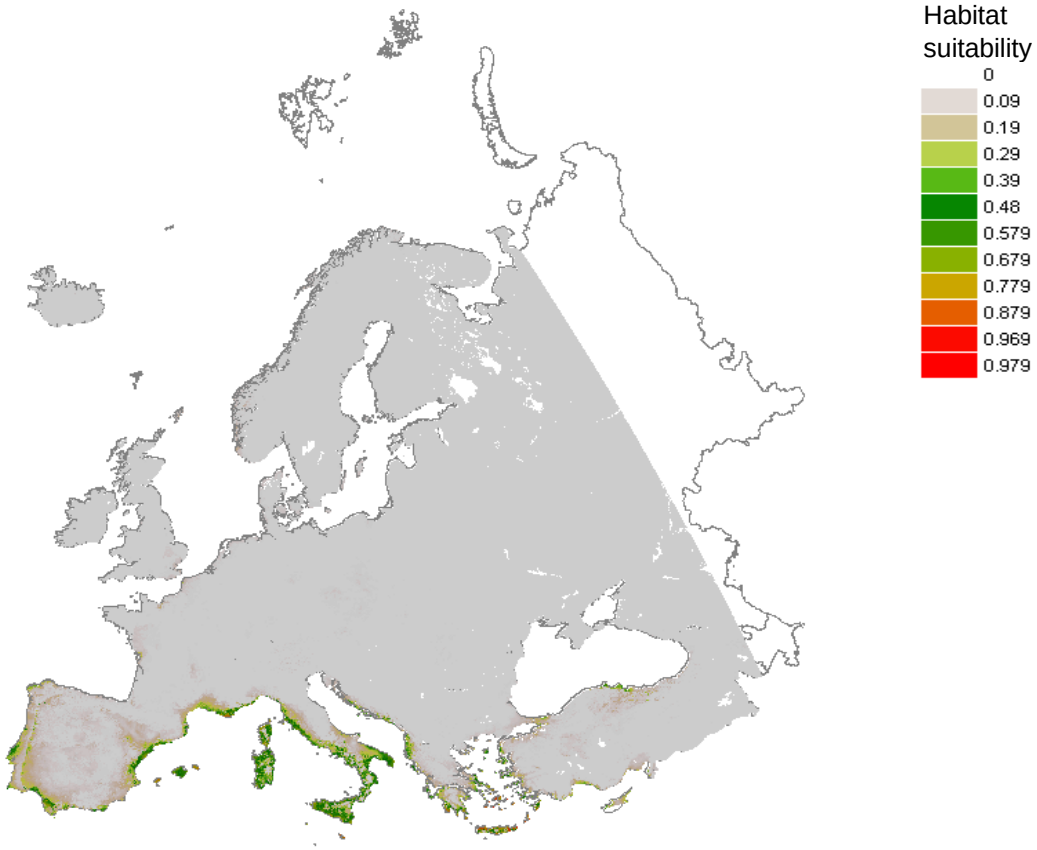
Suitable areas match with the Mediterranean region by reflecting the decrease in summer precipitation. Predictions for France and Turkey fit well with the known distrinution of evergreen Quercus species in submediterranean climates.

G2.2 - Mainland lauriphyllous woodland* [Eurasian continental sclerophyllous woodland]

Comment
Not enough data to create a reliable model.

G2.4 - Olea oleaster-Ceratonia siliqua woodland* [Olea europaea] - [Ceratonia siliqua] woodland]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

AUC training (0-1)	0.9854
AUC test (0-1)	0.983
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	38.9364
Precipitation of Warmest Quarter	29.1226
Precipitation Seasonality (coef. of var.)	13.7568
Mean Temperature of Wettest Quarter	8.5614
Potential Evapotranspiration	3.6343
Distance to water	3.2349
Solar radiation	2.3759
Soil pH	0.2087
Annual Precipitation	0.1689

Comment

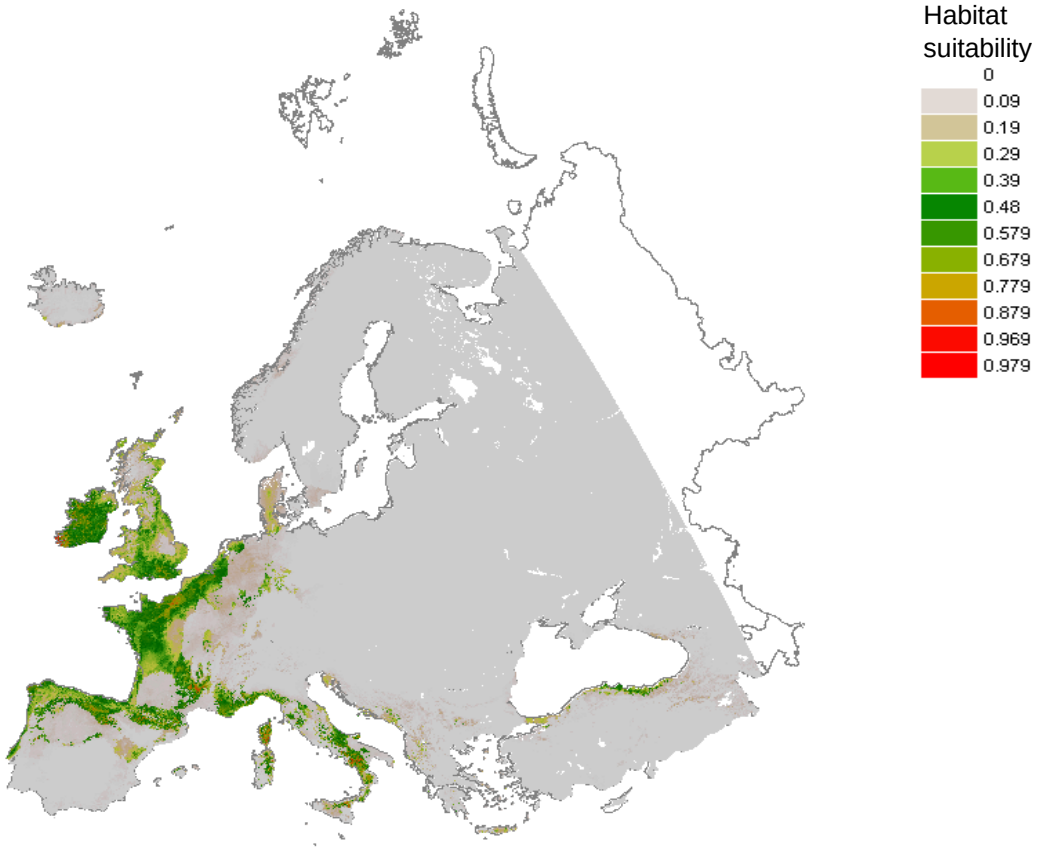
Suitable areas mainly predicted in coastal Mediterranean areas. Predictions for inland regions of Southern Spain and Italy fit well with the known distribution of the habitat.

G2.5 - Phoenix groves* [[Phoenix] groves]

Comment
Not enough data to create a reliable model.

G2.6 - Ilex aquifolium woodland* [[Ilex aquifolium] woods]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

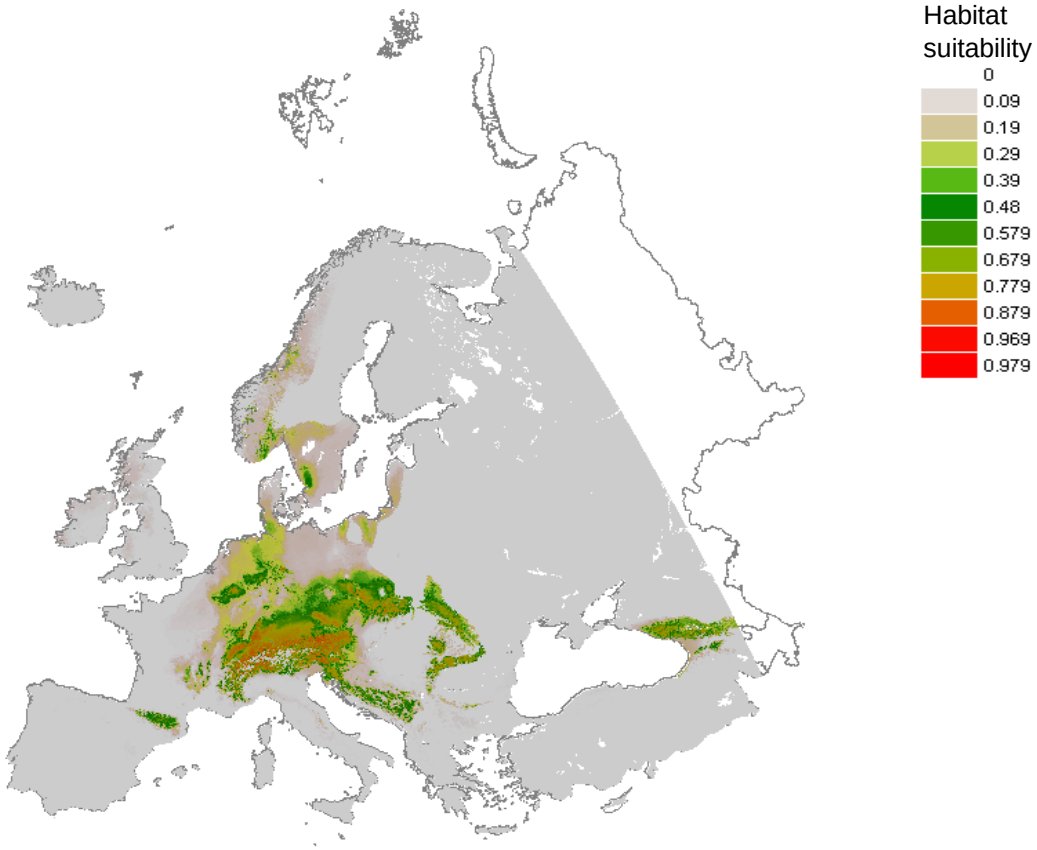
AUC training (0-1)	0.975
AUC test (0-1)	0.9567
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	57.3421
Potential Evapotranspiration	19.9521
Mean Temperature of Wettest Quarter	14.5124
Precipitation of Warmest Quarter	3.1735
Solar radiation	1.5147
Precipitation Seasonality (coef. of var.)	1.5128
Annual Precipitation	1.481
Soil pH	0.3936
Distance to water	0.1179

Comment

Suitable areas in relatively warm and humid regions without pronounced seasonality. Predictions seem to indicate optimal refugial zones for Ilex aquifolium in Europe.

G3.1a - Temperate mountain Picea woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

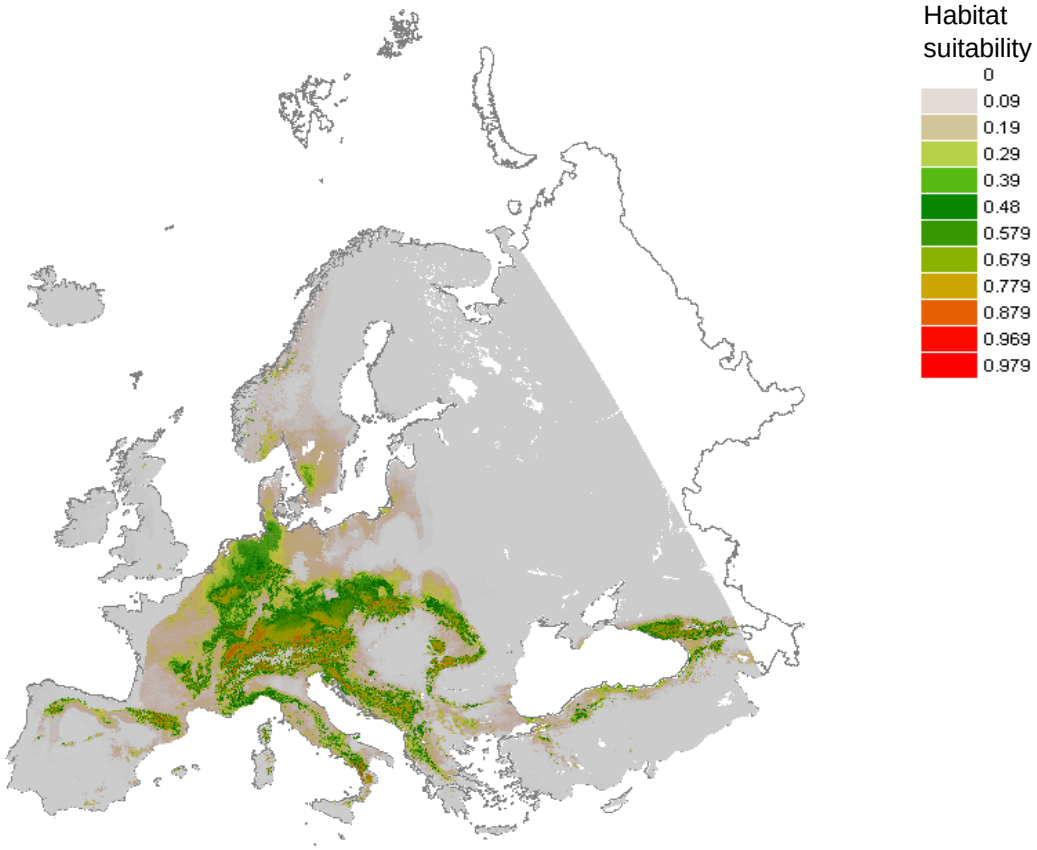
AUC training (0-1)	0.9085
AUC test (0-1)	0.9115
Contribution variables to the Maxent model (%)	
Precipitation of Warmest Quarter	69.6796
Temperature Seasonality (stdev * 100)	19.2195
Potential Evapotranspiration	10.1659
Precipitation Seasonality (coef. of var.)	0.4403
Annual Precipitation	0.2503
Solar radiation	0.1241
Mean Temperature of Wettest Quarter	0.0561
Distance to water	0.0463
Soil pH	0.018

Comment

Suitable areas mainly distributed in continental regions of Central Europe with high summer precipitation. Natural distribution is overestimated in the Pyrenees and Central France due to occurrence data from plantations, but in any case these regons are climatically suitable.

G3.1b - Temperate mountain Abies woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

AUC training (0-1)	0.9028
AUC test (0-1)	0.9051
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	34.5811
Precipitation of Warmest Quarter	31.3979
Potential Evapotranspiration	15.594
Annual Precipitation	14.8453
Solar radiation	2.0337
Precipitation Seasonality (coef. of var.)	1.027
Mean Temperature of Wettest Quarter	0.3405
Distance to water	0.1393
Soil pH	0.0413

Comment

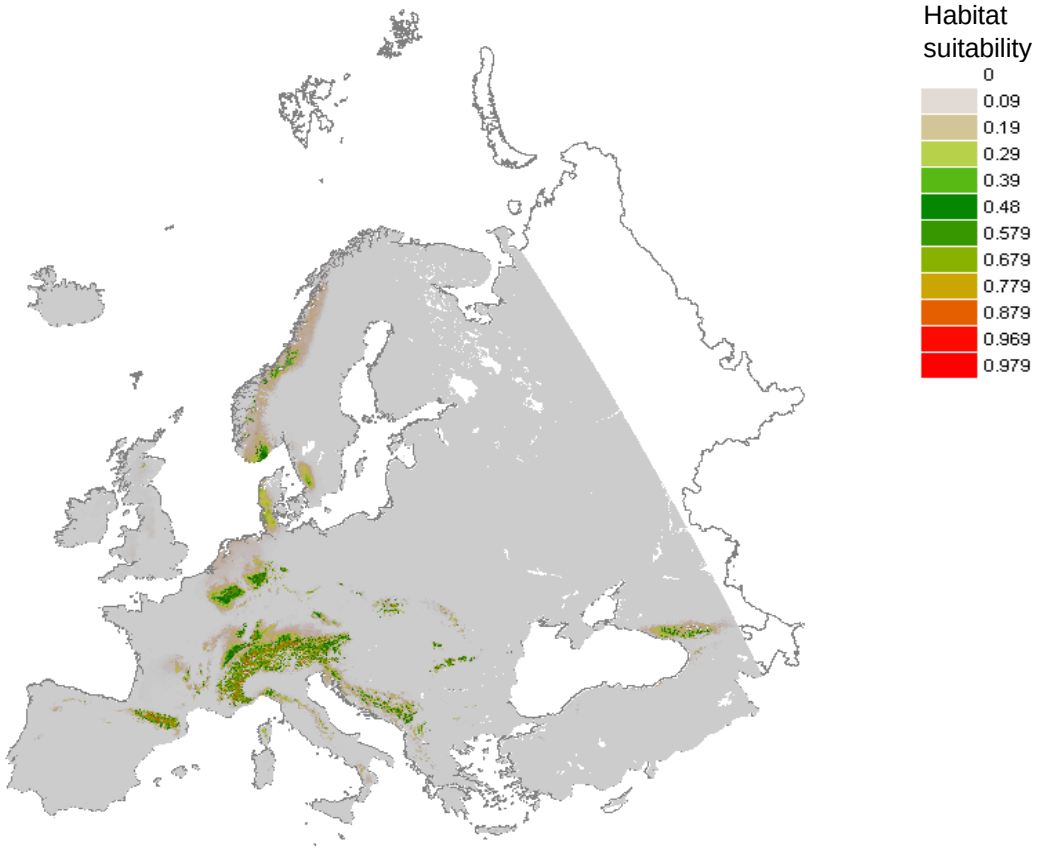
Suitable areas mainly distributed in the European Mountain System and lowlands of Central Europe, reflecting relatively continental climates with high summer precipitation.

G3.1c - Mediterranean mountain Abies woodland

Comment
Not enough data to create a reliable model.

G3.2 - Temperate subalpine Larix-Pinus woodland* [Alpine [Larix] - [Pinus cembra] woodland]

Distribution based on vegetation relevés



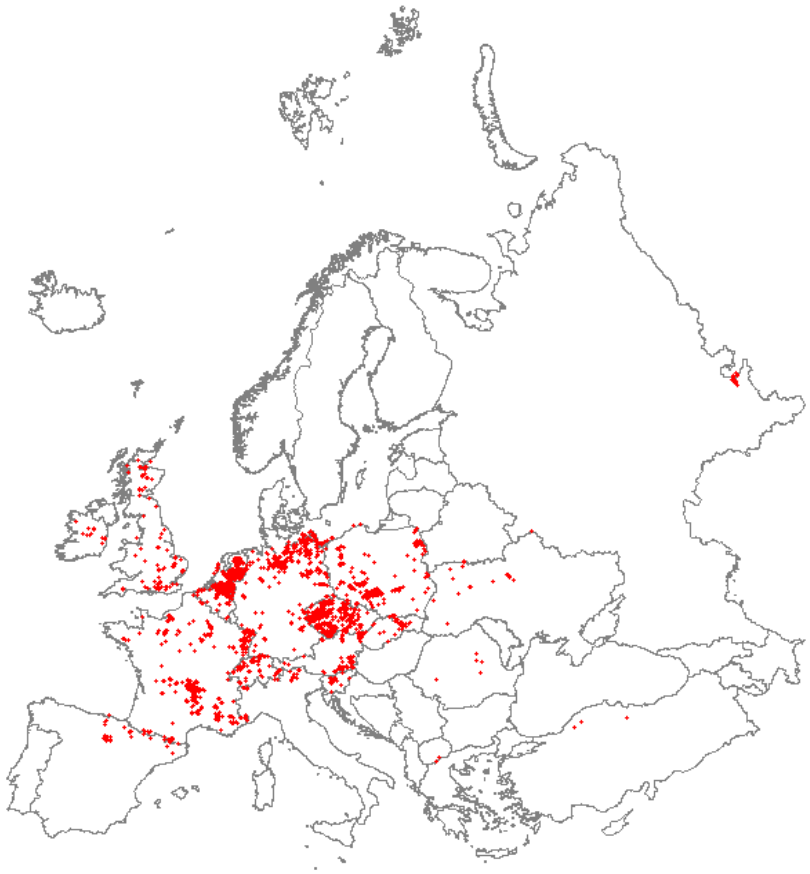
Model prediction. Background data randomly selected from the study area

AUC training (0-1)	0.9679
AUC test (0-1)	0.9613
Contribution variables to the Maxent model (%)	
Annual Precipitation	58.0386
Temperature Seasonality (stdev * 100)	18.8005
Potential Evapotranspiration	15.6623
Precipitation of Warmest Quarter	5.9122
Precipitation Seasonality (coef. of var.)	0.6514
Distance to water	0.4643
Solar radiation	0.2095
Soil pH	0.1338
Mean Temperature of Wettest Quarter	0.1274

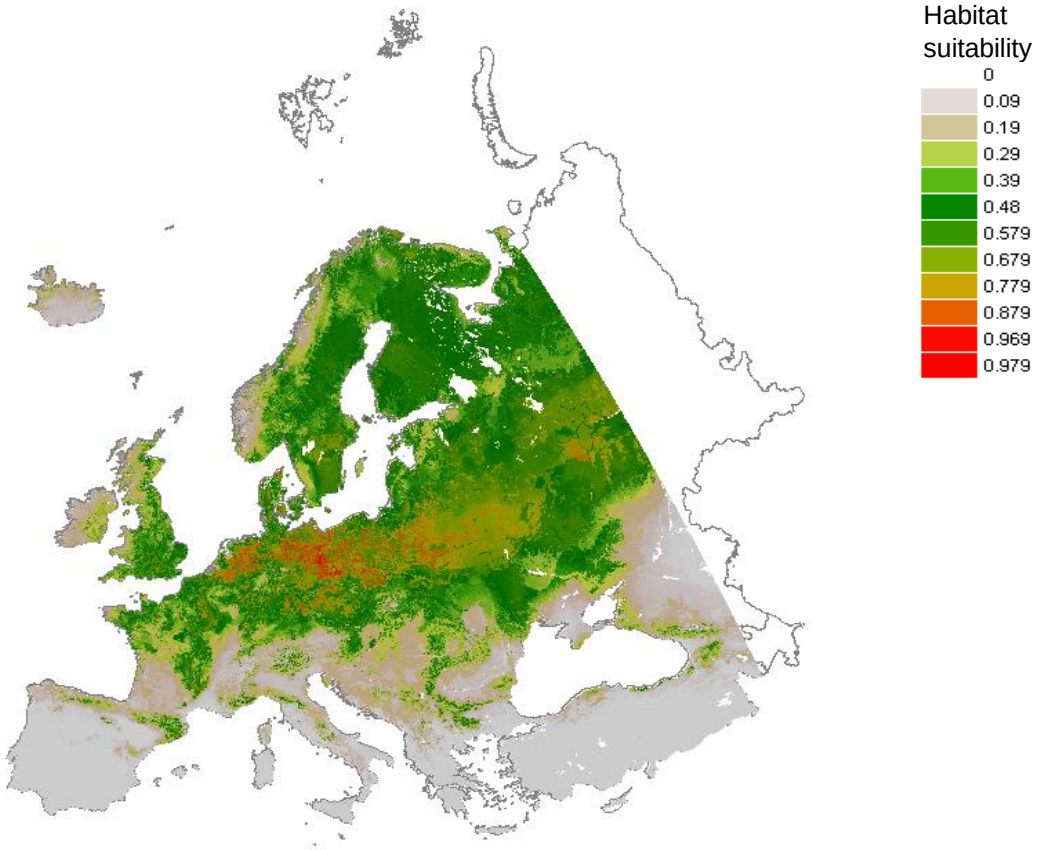
Comment

Suitable areas mainly represented in the highest altitudes of the Alps and nearby mountains. Overpredictions in the Pyrenees and Scandinavia (where this particular habitat does not occur) reflect climatic similarities rather than present distribution.

G3.4a - Temperate continental Pinus sylvestris woodland



Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

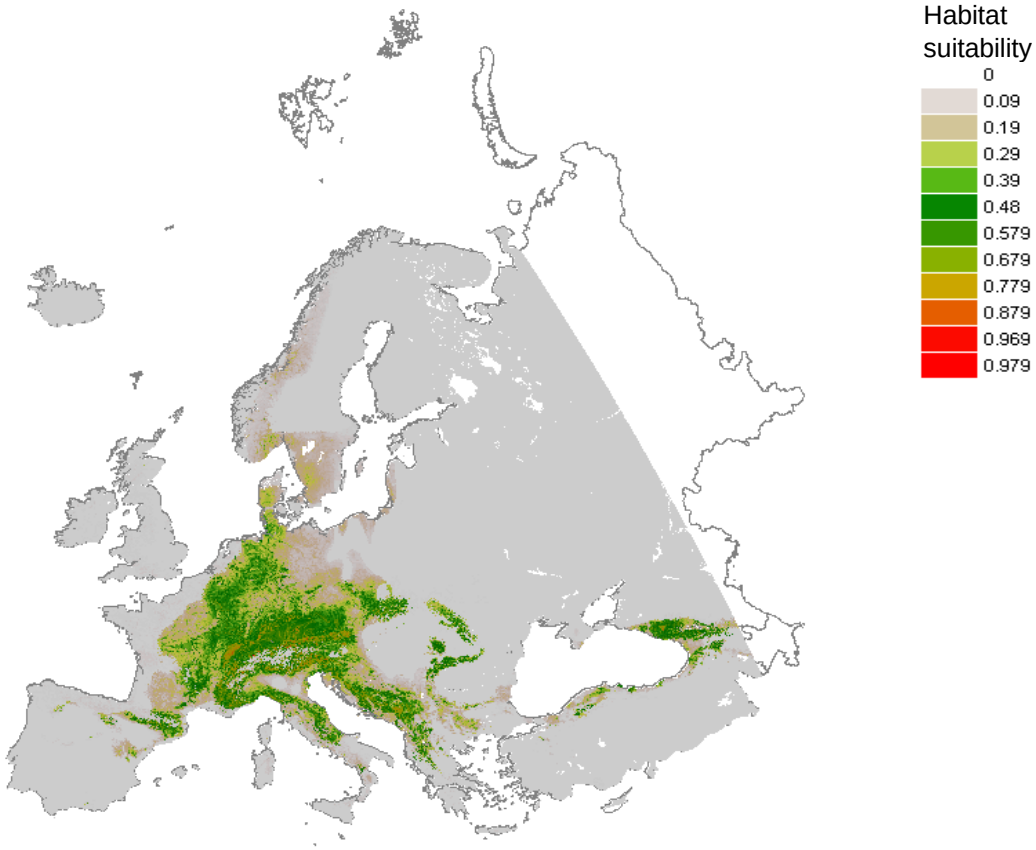
AUC training (0-1)	0.8068
AUC test (0-1)	0.7929
Contribution variables to the Maxent model (%)	
Potential Evapotranspiration	23.9712
Annual Precipitation	21.6615
Soil pH	16.9529
Mean Temperature of Wettest Quarter	15.5528
Precipitation of Warmest Quarter	13.583
Temperature Seasonality (stdev * 100)	4.9024
Precipitation Seasonality (coef. of var.)	1.8676
Solar radiation	1.3987
Distance to water	0.11

Comment

Most suitable areas are represented in the transition between temperate and boreal regions, matching with the known distribution of Pinus sylvestris. Predictions for southern Europe and Scandinavia are realistic in terms of climatic conditions but they are probably overestimating the current distribution of this particular habitat.

G3.4b - Temperate and submediterranean montane Pinus sylvestris-nigra woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

AUC training (0-1)	0.9407
AUC test (0-1)	0.9227
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	43.4162
Annual Precipitation	22.076
Precipitation of Warmest Quarter	12.9617
Potential Evapotranspiration	11.6566
Soil pH	5.7035
Distance to water	2.2883
Solar radiation	1.2367
Precipitation Seasonality (coef. of var.)	0.5145
Mean Temperature of Wettest Quarter	0.1465

Comment

Suitable areas mainly representing the European Mountain System and nearby regions of Central Europe. Best predictions are expected for those regions with a submediterranean influence.

G3.4c - Mediterranean montane Pinus sylvestris-nigra woodland

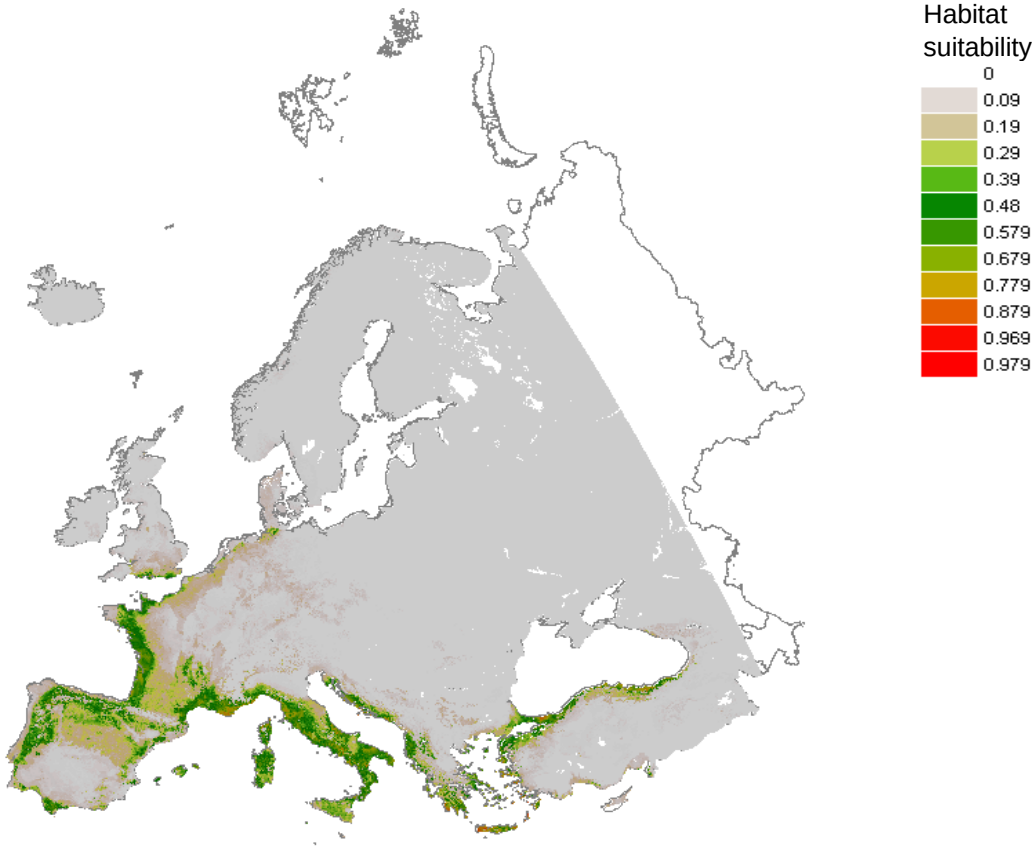
Comment
Not enough data to create a reliable model.

G3.6 - Mediterranean and Balkan subalpine Pinus heldreichii-peucis woodland* [balpine

Comment
Not enough data to create a reliable model.

G3.7 - Mediterranean lowland to submontane Pinus woodland* [Lowland to montane mediterranean [Pinus] woodland (excluding [Pinus nigra])]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

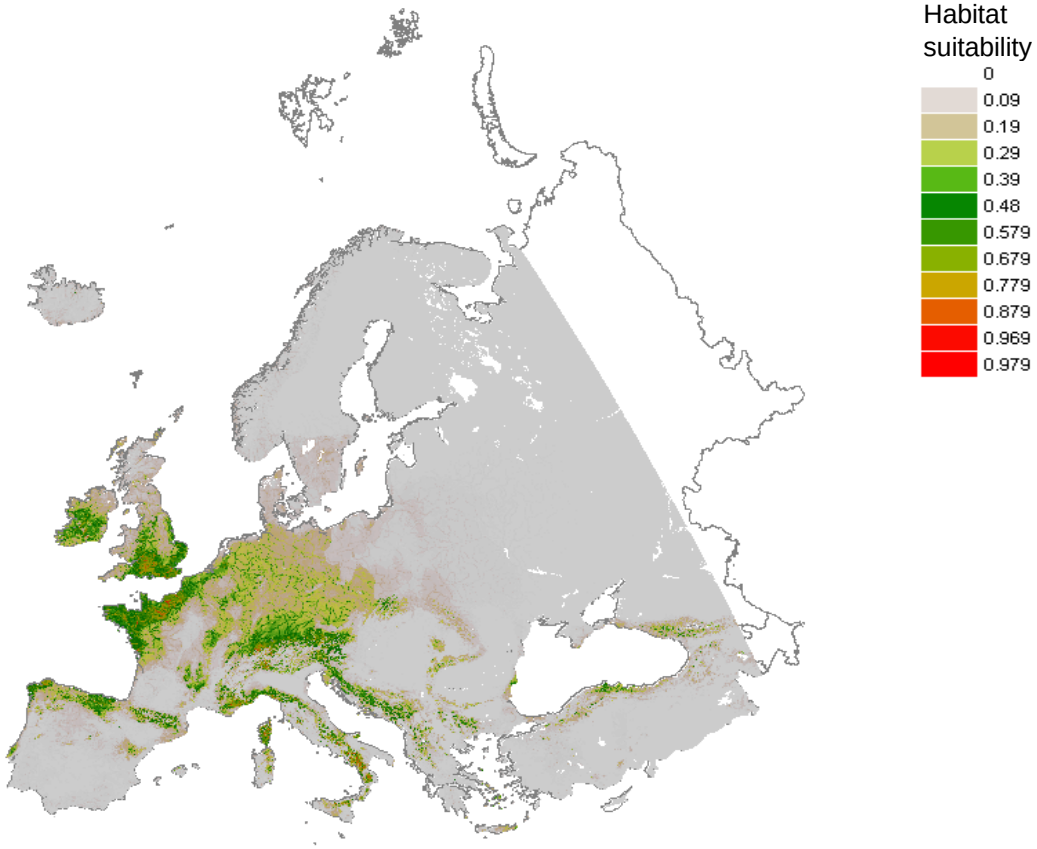
AUC training (0-1)	0.9617
AUC test (0-1)	0.957
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	50.976
Potential Evapotranspiration	17.4106
Mean Temperature of Wettest Quarter	12.802
Precipitation of Warmest Quarter	5.8938
Precipitation Seasonality (coef. of var.)	4.7735
Annual Precipitation	3.8205
Distance to water	2.7684
Solar radiation	0.9681
Soil pH	0.5871

Comment

Suitable areas mainly represented in warm regions with low seasonality of the Mediterranean basin. More accurate predictions within the suitable areas would require high-resolution layers to reflect soil conditions.

G3.9a - Taxus baccata woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

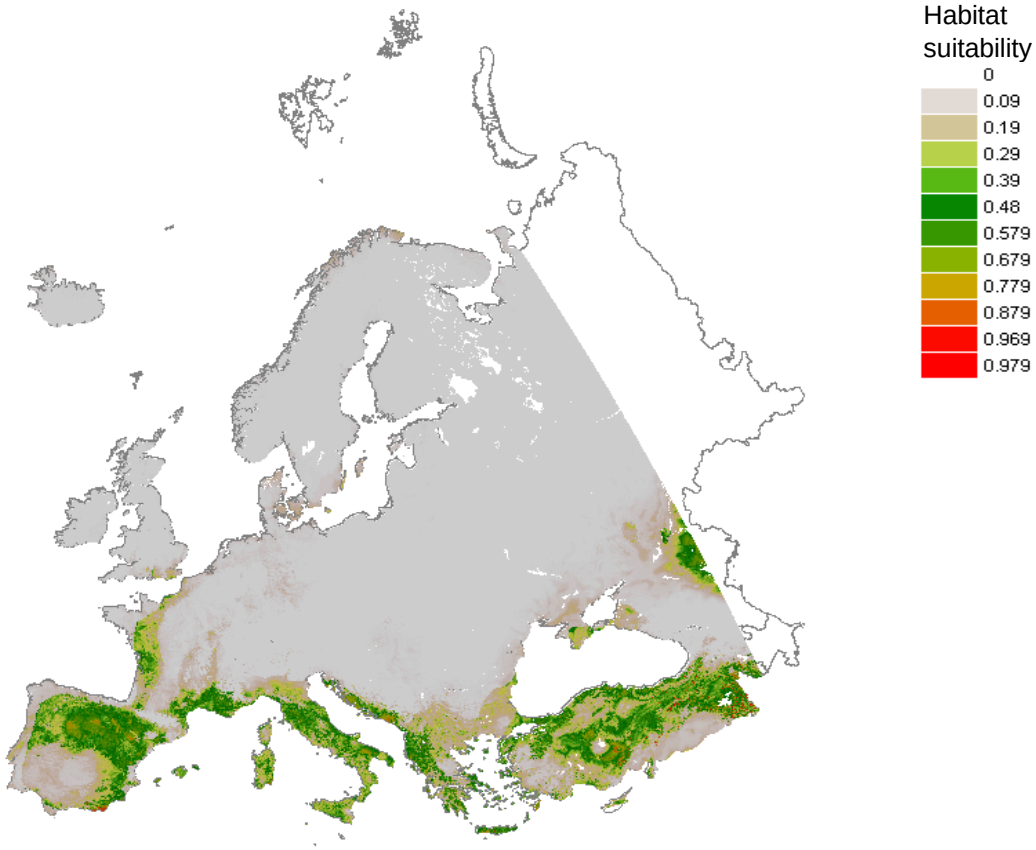
AUC training (0-1)	0.9576
AUC test (0-1)	0.964
Contribution variables to the Maxent model (%)	
Temperature Seasonality (stdev * 100)	43.4382
Potential Evapotranspiration	34.4928
Precipitation of Warmest Quarter	6.4517
Mean Temperature of Wettest Quarter	4.5974
Distance to water	3.3867
Precipitation Seasonality (coef. of var.)	2.9875
Solar radiation	2.5543
Soil pH	1.1712
Annual Precipitation	0.9202

Comment

Sutiable areas are mainly represented in the Southern mountains and the Atlantic region. Given the complex historical biogeography of Taxus baccata, predictions are probably reflecting refugial areas together with climatic optima.

G3.9b - Mediterranean Cupressaceae woodland

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the complete forest data set

AUC training (0-1)	0.938
AUC test (0-1)	0.9235
Contribution variables to the Maxent model (%)	
Precipitation of Warmest Quarter	59.8598
Potential Evapotranspiration	12.6501
Mean Temperature of Wettest Quarter	6.6394
Soil pH	4.9473
Distance to water	4.6239
Precipitation Seasonality (coef. of var.)	4.5698
Temperature Seasonality (stdev * 100)	3.0765
Solar radiation	1.9085
Annual Precipitation	1.7246

Comment

Suitable areas restricted to Mediterranean regions with dry and continental climates, reflecting well the distribution of the habitat. Within each region, occurrence is related to specific species and soil factors not considered here.

G3.A - Picea taiga woodland* [[Picea] taiga woodland]

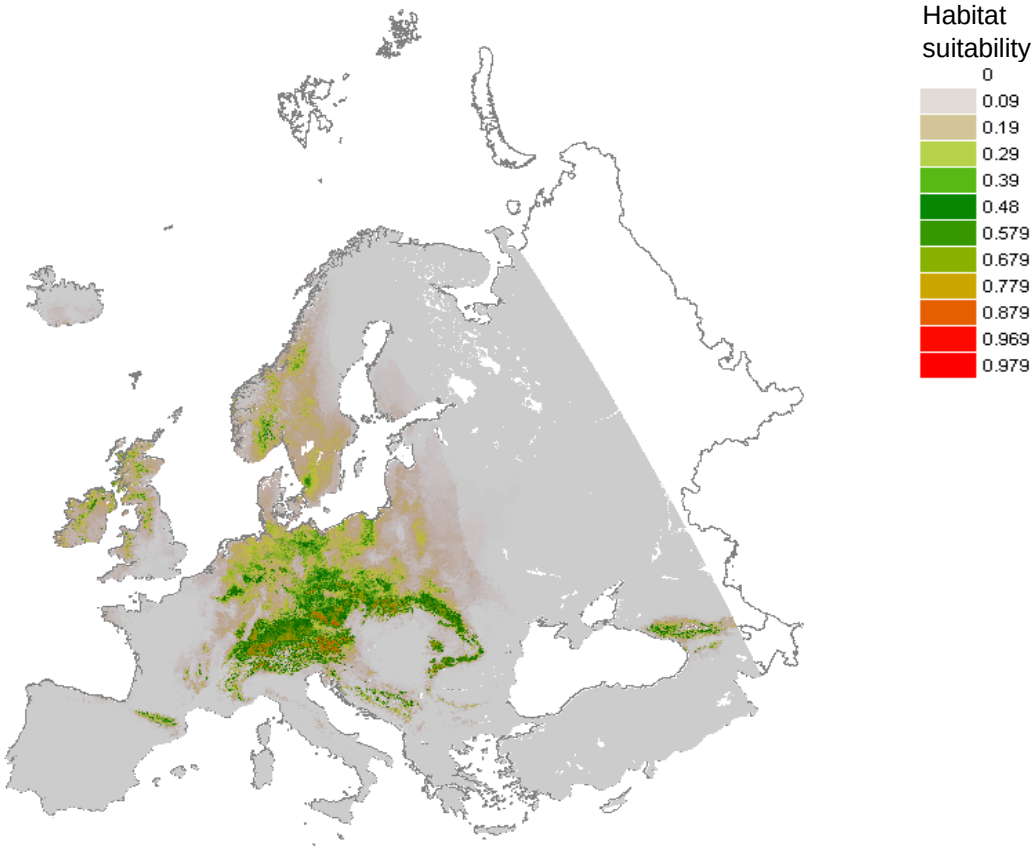
Comment
Not enough data to create a reliable model.

G3.B - Pinus sylvestris taiga woodland* [[Pinus] taiga woodland]

Comment
Not enough data to create a reliable model.

G3.E - Temperate bog conifer woodland* [Nemoral bog conifer woodland]

Distribution based on vegetation relevés



Model prediction. Background data randomly selected from the study area

AUC training (0-1)	0.952
AUC test (0-1)	0.9356
Contribution variables to the Maxent model (%)	
Precipitation of Warmest Quarter	54.2453
Temperature Seasonality (stdev * 100)	17.9736
Potential Evapotranspiration	15.7111
Mean Temperature of Wettest Quarter	6.9313
Solar radiation	1.915
Soil pH	1.4725
Precipitation Seasonality (coef. of var.)	0.9937
Annual Precipitation	0.6425
Distance to water	0.1149

Comment

Suitable areas are distributed in Central European regions with high summer precipitation, reflecting well the known distribution of the habitat. Local distribution is probably limited to soil conditions not considered here.