SUPPORT TO EUNIS HABITAT CLASSIFICATION REVISION V

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1 Introduction

1.1 The context of the Specific Contract

To underpin Europe's Biodiversity Strategy, the European Council has committed itself to a long-term vision and headline target. It is impossible to measure progress to the formulated targets without reliable and timely information on the status and trends of biodiversity across Europe. Within the European Union, indicators on status and trends of species and ecosystems are reported under the Birds Directive (BD), the Habitats Directive (HD), the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). Additional information is needed, however, to establish a more comprehensive assessment of state of ecosystems and their trends, covering the whole territory of Europe and the whole range of natural and semi-natural landscapes.

The EUNIS habitat classification, developed by the European Topic Centre for Biodiversity (ETC/BD) for the European Environment Agency (EEA) at the end of the last century (Davies & Moss 1999; see Davies et al. 2004; Moss 2008), is covering both the marine and terrestrial realm. In recent years, this classification has been revised, aiming at establishing more hierarchical consistency, removing ambiguity and overlap in definitions of types, and extending the typology for the complete European continent and seas (Chytrý et al. 2020). A preliminary, 2014 revised classification has been used in the DG ENV project Red List of European Habitat (Janssen et al. 2016).

One of the main aims of the EEA Framework contract is to support EEA and other European institutions with data and tools for the assessment of ecosystem status and trends, including their provided services and functions. Task 1 of the contract focuses on enhancing ecosystem maps using vegetation plot data. It was decided to split up the workload according to the EUNIS habitat groups, with specific contracts per year. The present contract focuses on refining the wetlands and sparsely vegetated habitat groups with suggestions for defining aquatic plant communities.

Under specific contract 3417/B2018/EEA.57264 implementing the above Framework Contract, EEA received updated crosswalks with the 2016 EuroVegChecklist, formal query routines and indicator species lists for the revised EUNIS habitat groups of forest, heathland, scrub and tundra and grassland. Initial work on these habitat groups was undertaken under four separate contracts between 2013 and 2016. EEA also received updated crosswalks between the Red List of Habitats (finalised by the end of 2016) and the current EUNIS terrestrial habitat types of version 2012, Annex I habitats, and the revised EUNIS forests, heaths and grasslands.

Under specific contract 3417/B2019/EEA57.640, EEA received updated crosswalks with the 2016 EuroVegChecklist, formal query routines and indicator species lists for the revised habitat groups of coastal habitats and mires. EEA also received updated crosswalks between Red List of Habitats and the revised EUNIS coastal habitats and mires.

Under specific contract 3417/B2019/EEA57.806, EEA received updated crosswalks with the 2016 EuroVegChecklist, formal query routines and indicator species lists for the revised EUNIS habitat groups of vegetated man-made habitats. Where appropriate, EEA also received aligned crosswalks between Red List of Habitats and Annex I habitats that were delivered in 2018 with crosswalks between revised EUNIS habitats and Annex I habitats for forests/heaths/grasslands/mires/coastal/marine habitats. EEA also received qualifiers between the revised EUNIS marine habitats and Red List habitats.

Under specific contract 3417/B2019/EEA58.022, EEA received updated crosswalks with the 2016 EuroVegChecklist, formal query routines and indicator species lists for the revised EUNIS habitat groups of saltmarshes and inland habitats with no or little soil and mostly with sparse vegetation. This project also comprised aligning crosswalks between Red List habitats and Annex I habitats with crosswalks between revised EUNIS habitats and Annex I habitats. The EEA also received updated crosswalks between the Red List of Habitats (finalised by the end of 2016) and the revised EUNIS sparsely vegetated habitats.

This present work will provide the next steps to the ongoing EUNIS habitat revisions, dealing with seven EUNIS habitats from different groups (Aquatic, Wetland and Inland sparsely vegetated group) that were not considered yet. The last habitat groups (inland waters and habitat complexes) will be revised at a later stage.

1.2 Aim and objectives of the Specific Contract

The support to EUNIS habitat classification revision comprises two specific tasks (A and B), respectively divided into three and four subtasks. The work of task A comprises the identification of the complete list of helophyte habitats that can be included in the Wetlands habitat group using the European Red List as a starting point, the identification and the description of the aquatic plant communities of water bodies, and the inclusion in the habitat group of Inland habitats with no or little soil and mostly with sparse vegetation the Red List habitats of unvegetated or sparsely vegetated shores; codes and descriptions will be provided for the added habitat types. The work of task B comprises for the helophyte habitats and unvegetated or sparsely vegetated shores the preparation of crosswalks of revised EUNIS habitat groups with EuroVegCheckList 2016, formal query routines and characteristic species lists.

An updated version of EuroVegChecklist was published in 2016 (Mucina et al. 2016). All EUNIS groups that have been under revision through the European Vegetation Survey (EVS) projects were crosswalked with older versions of EuroVegChecklist. Further to this, the final EUNIS review is based on the public consultation and some revised habitat types differ from the ones proposed from the European Vegetation Survey (EVS) projects. Therefore, there is a need for an update of the crosswalk with EuroVegChecklist 2016. In earlier projects to support the EUNIS classification revision (Part I-IV), the habitat groups of forests, heathlands, grasslands (I), coastal habitats and mires (II), vegetated man-made habitats (III), and inland sparsely vegetated habitats and coastal saltmarshes (IV) were considered. The present project (Part V) focuses on helophyte habitats, sparsely vegetated shore habitats and aquatic plant communities. The development of the crosswalks will be done in close communication with ETC/BD. This task is a prerequisite to the following subtask on the identification of indicator species and to the production of maps (the maps will be produced by ETC/BD).

To define indicator species for the individual habitat types, small-scale plot data on plant species composition and cover are applied, in line with the phytosociological tradition, where such in situ data are used for 'bottom-up' fine-grained delimitation and characterisation of so-called plant associations (Braun-Blanquet 1928). Estimates suggest that there are several millions of such plots in Europe (Schaminée et al. 2009) and there is an enormous amount of phytosociological publications describing and classifying vegetation types from many countries in the EU and beyond. Making use of the capacity of in situ vegetation recording is part of the ongoing review of information relating to habitat types and ecosystems by the EEA, anticipating a revision of the existing scientific basis for the EUNIS Habitat Classification.

Characteristic species lists and formal query routines (that define the habitats based on a combination of coverage of species) were developed for the revised habitat groups through the EVS projects. The updated European Vegetation Archive (EVA; Chytrý et al. 2016) database includes an increased number of plot data, including regions like Scandinavia and Russia, where data were and partly still are scarce. The updated EVA database will be used to provide the lists of indicator species and the query routines for sparsely vegetated habitats (inland habitats with no or little soil and mostly with sparse vegetation) and marine saltmarshes, in line with the procedures applied for the habitat groups forests, heathlands, grasslands, coastal habitats, wetlands, vegetated man-made habitats, sparsely vegetated habitats and saltmarshes in earlier projects.

2 Update of the lists of the Helophyte habitats and Inland habitats with no or little soil and mostly with sparse vegetation, and identification and description of aquatic plant communities

2.1 Background

During the process of reviewing the EUNIS habitat classification, it became obvious that an update was required for a couple of habitats with plant communities dominated by helophytes within the Wetland habitats (Group Q) and a small group of communities within the Inland habitats with no or little soil and mostly with sparse vegetation (Group U). Furthermore, the project also asked for identification and description of plant communities that will be used to characterize aquatic habitats.

In 2023, it will be discussed how the proposed aquatic plant communities will fit in the final classification of (inland) aquatic habitats. The first results of the EUNIS classification of aquatic habitats, which is presently under review, propose a division in standing and running waters at level 2, while level 3 further divides these types into habitats based on physio-chemical parameters such as size, altitude and geology; the latter reflecting the natural trophic status (Watson et al. 2021). It is planned to base level 4 on parameters such as depth, stratification (lakes) and slope (rivers) with species composition as a discriminating factor. In this proposal, the aquatic habitats at level 4 hierarchically correspond with level 3 habitat types of EUNIS classification of terrestrial habitats. From a vegetation point of view, the types at level 4 can be seen as vegetation mosaics, with components dealing with helophyte communities and aquatic communities. At level 4, it will be described which habitats of the Wetlands habitat group can be assigned to these types next to the aquatic habitats that are defined in the present project and next to other biological elements (e.g. invertebrates, fish etc.). Some of the EUNIS habitats in the final classification will be even more complex, such as floodplains, where besides helophyte and aquatic types, also alluvial shrubs and forest have to be considered, as well as pioneer communities from Group U, the Inland habitats with no or little soil and mostly with sparse vegetation. As such, the broadly defined EUNIS aquatic habitat types can be aligned with the typology of the Water Framework Directive.

2.2 Update of the list of Helophyte habitats (Task A1)

The list of helophyte habitat types has been reviewed and extended, using the European Red List of Habitats as a starting point and taking into account all relevant suggestions from the EEA. As communities dominated by helophytes are not always related to water bodies, it is preferable to evaluate them

separately from the aquatic habitat classification. Such communities may even occur in wet depressions far from water bodies and their ecology is more similar to that of mires than to that of aquatic environments. For this task, the Wetlands habitat group (Q), as studied under specific contract 3417/B2019/EEA.57640, was revisited.

During the kick-off meeting on 15-06-2021 (online), it was proposed to include the additional helophyte habitats as a new group at level 2 in the Wetlands: Q6 Periodically exposed shores. This group comprises three types at level 3, in line with the habitat types C35a, C35b and C35c of the Red List classification. A final check has been carried out to guarantee that all habitat types of the Red Lists and current EUNIS habitat types of the group C3 are taken into account within the EUNIS classification.

The list of revised helophyte habitats is presented in Appendix A, their descriptions in Appendix B, and crosslinks to the relevant EUNIS habitat types of the 2012 classification as well as to the *EuroVegChecklist* 2016 in Appendix C.

2.3 Update of the list of Inland habitats with no or little soil and mostly with sparse vegetation (Task A3)

In the habitat group of Inland habitats with no or little soil and mostly with sparse vegetation (EUNIS Group U), two habitat types were added, in line with the Red List habitats C3.5d and C3.5e. Names, codes and descriptions are presented in Appendix A and B, whereas crosslinks to the relevant EUNIS habitat types of the 2012 classification as well as to the *EuroVegChecklist* 2016 are given in Appendix C.

During the kick-off meeting, it was proposed to include the additional (two) types in the U7 group, as new numbers U71 and U72. The name of the new level 2 habitat is 'Unvegetated or sparsely vegetated shores with mobile sediments'. The habitats were not included in the level 2 group 'Miscellaneous inland habitats usually with very sparse or no vegetation' as their vegetation can be more than 'very sparse'.

2.4 Identification and description of aquatic plant communities (Task A3)

The aquatic plant communities have been identified and described. These communities may be used for the description of the inland water habitats at level 4, which is currently under development (group P). For this task, also the spring Red List habitats C2.1a, C2.1b were taken into consideration.

During the kick-off meeting, the level of detail in the aimed classification was discussed, ultimately resulting in a set of eight types for the purely aquatic habitats and two types for spring communities. The aquatic types concern one type for brackish-water communities, four types for fresh-water communities (with small pleustophytes, large pleustophytes, submerged vegetation and

nymphaeids), one type for oligotrophic communities, one type for dystrophic communities, and a separate type for stonewort communities. The spring communities concern two types, one for base-poor springs and one for calcareous springs. To avoid misunderstanding, the word amphibious has to be deleted in the description of helophyte type Q52. The types are presented in Appendix A, B and C with provisional codes (Pa up to Pj).

3 Update of crosswalks between 1) aquatic plant communities, 2) Periodically exposed shores, 3) Unvegetated or sparsely vegetated shores with mobile sands and EuroVegChecklist 2016

3.1 Background

The update of the crosswalks of EUNIS with *EuroVegChecklist 2016* will replace earlier crosswalks based on previous versions of both classification systems. The updated version is presented in Appendix C.

The changes in the EUNIS Habitat Classification over the years were for a long time relatively modest, but more substantial revisions took place as a result of the work carried out through a number of European Vegetation Survey projects for the EEA (Schaminée et al. 2012, 2013, 2014, 2016a, 2016b, 2018, 2019, 2020a, 2020b), the DG-ENV analysis of the European Red List of Habitats (Janssen et al. 2016), further meeting and consultation by the EEA and ETC-BD of the vegetation experts involved, and public consultation in the 39 Eionet partnership countries.

The overview of European syntaxa has undergone substantial expert revision after the publication of *The Diversity of European Vegetation* in 2002, which was a first attempt to achieve a respectable level of stability in the classification of European vegetation (Rodwell et al. 2002), based on a list of European vegetation classes by Mucina, published in 1997 in a bundle of case studies by the EVS (Mucina in Rodwell et al. 1997). This major enterprise, an initiative of the EVS, was carried out by a team under the leadership of Ladislav Mucina, resulting in a new overview, the so-called *EuroVegChecklist*, which was published in 2016. Compared to the 2002 overview, *EuroVegChecklist* is geographically more comprehensive, scientifically more robust, and better grounded within current phytosociological understanding and data.

3.2 EuroVegChecklist 2016

The published version of *EuroVegChecklist* provides floristic hierarchical classification systems of vascular plant, bryophyte, lichen, and algal communities. The vascular plant communities include 109 classes, 300 orders, and 1,105 alliances. It offers "The first comprehensive and critical account of European syntaxa and synthesizes more than a hundred years of classification effort by European phytosociologists. It aims to document and stabilize the concepts and nomenclature of the syntaxa for practical use, such as calibration of the habitat classification used by the European Union, standardization of terminology for environmental assessment, management and conservation of natural areas, landscape planning and education. The presented classification systems provide a baseline for future development and revision of European

syntaxonomy", as stated in the summary of the paper (Mucina et al. 2016). The revised overview not only gives the lists of syntaxa, but it also briefly characterizes – in ecological and geographic terms – the accepted syntaxonomic concepts, links of available synonyms to the accepted syntaxonomic concepts, and provides lists of diagnostic species for all classes.

The plant communities of the "Conspectus of the high ranked syntaxa of the European vegetation dominated by vascular plants" are divided into three main groups (Zonal and intrazonal vegetation, Azonal vegetation and Anthropogenic vegetation), which are further ordered along the main geographic zones. The group of the Zonal and intrazonal vegetation, for instance, comprises seven subgroups of vegetation types for respectively the arctic zone, boreal zone, nemoral forest zone, steppe zone, continental desert zone, Mediterranean zone, and the Canary Islands, Madeira and Azores.

EuroVegChecklist is also published on the web (www.synbiosys.alterra.nl/evc), where the publication can be downloaded, and comments can be posted. Within the EVS, a committee has been established and procedures formulated and approved by the EVS Business Meeting in Bilbao on 14 September 2017, to guide and harmonize proposals for future changes to the European vegetation classification.

3.3 Some remarks on the crosswalks

During the Kick-off meeting, it was decided that all newly defined and described habitat types would be crosswalked with the EUNIS habitats of the 2012 classification, the Red List types and the EuroVegChecklist 2016, including qualifiers. The crosswalks with the syntaxa of the *EuroVegChecklist* are a prerequisite for the identification of indicator species for each habitat type.

As in the 2020 project on 'Saltmarshes' and 'Inland habitats with no or little soil and mostly with sparse vegetation' (Schaminée et al. 2020b), the SynBioSys Taxon Database (being in use in EVA, Turboveg, and EEA and ETC-BD projects) has been linked with the Euro+Med PlantBase to have one general taxonomy and (even more important) to make use of all the links that are already synonymised within the SynBioSys list (more than 25 national and regional standardised floras).

4 Formal query routines and characteristic species combinations for 1) aquatic plant communities 2) Periodically exposed shores and 3) Unvegetated or sparsely vegetated shores with mobile sands

4.1 Background

In our previous work (Schaminée et al. 2012, 2013, 2014, 2016a, 2016b, 2018, 2019, 2020a, 2020b), we produced lists of characteristic species combinations (called 'indicator species' in the previous reports) for EUNIS habitat types of coastal saltmarshes (group MA), coastal habitats (habitat group N), wetlands (group Q), grasslands (group R), heathlands, scrub and tundra (group S), forests (group T), and Inland habitats with no or little soil and mostly with sparse vegetation (group U), man-made habitats (group V). For the identification of EUNIS habitats in the vegetation-plot databases, we created an electronic expert system EUNIS-ESy, based on the principles and methods developed by Bruelheide (1995, 1997, 2000), Kočí et al. (2003), Chytrý (2007; see also Chytrý & Tichý 2018), Landucci et al. (2015), Mucina et al. (2016) and Tichý et al. (2019), with further modifications. The previous work was also summarised in a reviewed scientific paper (Chytrý et al. 2020). Here we use the term 'characteristic species combination' instead of 'indicator species' because the latter term was criticised as inappropriate by reviewers of the paper Chytrý et al. (2020).

The expert system was developed as a software tool implemented in the Juice 7.1 software (Tichý 2002), the Turboveg 3 software (Hennekens 2015) and the R software (Bruelheide et al. 2021). The software uses formal definitions of individual habitats, which are written as logical formulas in an editable expert system script stored as a TXT file (see Appendix D). Each plot from a vegetation database submitted to the software is checked to test whether it meets the conditions of some of the formal definitions of habitats included in this script. If it does, it is assigned to this habitat. For further details on the expert system and the way it operates, we refer to Chytrý et al. (2020).

Vegetation plots (phytosociological relevés) belonging to individual habitat types (henceforth 'habitats') were identified in the databases of the European Vegetation Archive (Chytrý et al. 2016) and some other databases obtained for this project (see Appendix F).

4.2 Data sources

The primary data source for producing lists of characteristic species combinations were European vegetation-plot records. Such plots typically

contain a full list of vascular (and often also non-vascular) plant species, estimation of cover-abundance of each species, location and various additional information on vegetation structure and environmental features in the plot (Dengler et al. 2011). These plots were compiled from the EVA database (Chytrý et al. 2016) and several other databases not included in EVA but provided for this analysis (see Appendix F). We used an export from the EVA database, version 17 April 2021, containing 1,451,629 vegetation plots.

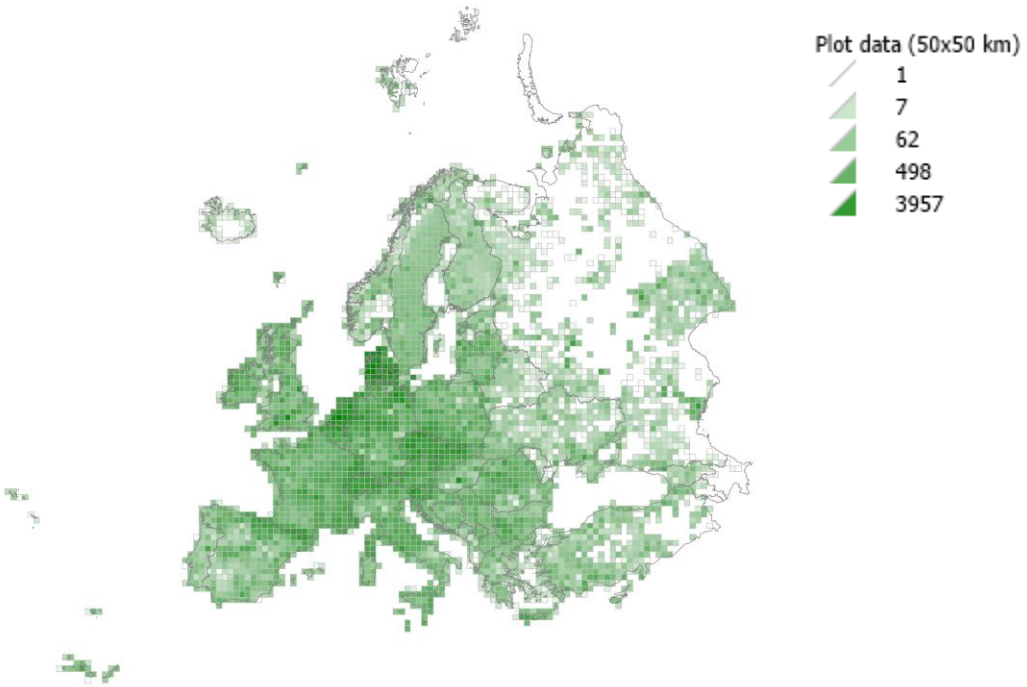

Figure 3.1. Density of georeferenced plots in EVA and other plots provided for this project in 50 x 50 km grid cells (accessed on 17 April 2021).

The taxon names in this dataset originated from several source databases managed in Turboveg 2 (Hennekens & Schaminée 2001), which use different taxon lists with partly inconsistent taxonomic concepts and nomenclature. Taxon names were unified using the Turboveg 3 program (Hennekens 2015), applying a two-step approach as described by Chytrý et al. (2020). The documentation of the first step is provided in the archive Nomenclature-translation-from-Turboveg-2-databases.zip published at *https://doi.org/10.5281/zenodo.3841729*. The documentation of the second step is provided in Section 1 of the updated EUNIS-ESy expert system in Appendix D.

4.3 Formal query routines

We developed the formal query routines using the same methodology as described in our previous work on other habitat types, in which formal definitions of habitat types are based on plant species composition, the dominance of specific plant species, and optionally also geographical criteria (Chytrý et al. 2020). These query routines were added to the updated EUNIS-ESy expert system (Appendix D).

For aquatic plant communities, we proposed ten types, provisionally coded as Pa to Pj, that will be used for defining the botanic component of the EUNIS Aquatic habitat types, currently under revision. Based on the recommendation from the Kickoff meeting, spring communities were also included here, although they are not strictly aquatic. The spring communities were defined based on the prevalence of a group of spring species and a total cover of this group larger than 15 %. The two groups of spring communities, base-poor and calcareous, were separated by specialist groups of spring species related to base-poor and calcareous conditions, respectively. The other community types included aquatic plant communities in a narrow sense, defined based on the combination of dominant life form (i.e. vegetation physiognomy) and water chemistry (brackish, meso-eutrophic, oligotrophic and dystrophic). The groups of species representing specific life forms were combined based on the hierarchical principles proposed for the formalised classification of aquatic plant communities by Landucci et al. (2015). We used a three-level hierarchy, in which large pleustophytes (e.g. *Hydrocharis* and *Stratiotes*) and nymphaeids (e.g. *Nuphar* and *Nymphaea*) were given the highest priority, whereas small pleustophytes (e.g. *Lemna* and *Spirodela*) were given the lowest priority. All the other plant groups were given intermediate priority. Vegetation plots were assigned to plant community types based on the prevalence of a specific species group at a given hierarchical level.

For Wetland habitats, we identified three habitat types that needed to be added to the classification, coded as Q61 to Q63. They included periodically exposed shores. These shores were divided into three types: eutrophic, mesotrophic and saline. Each of these types was characterised by a group of specialist species based on the literature and our field experience. Vegetation plots were assigned to the types based on the prevalence of its specific species group.

For Inland sparsely vegetated habitats, we identified two habitats of sparsely vegetated shores that needed to be added to the classification. One of them is typical for montane and alpine regions of the nemoral and boreal zones, and the other is Mediterranean. We identified groups of typical species of these two habitats and used them in formal definitions. These definitions were further fine-tuned by constraining them by the occurrence in the non-Mediterranean vs Mediterranean areas. As one of the specialist species of these habitats, *Calamagrostis pseudophragmites*, often forms dense stands that exclusively indicate these habitat types, we also created alternative definitions based on the dominance of this species.

A total of 1,451,629 vegetation plots were used for the analysis (Figure 4.1). Excluded were plots that did not meet certain criteria, such as very small and very large plots and plots with a location uncertainty greater than 10 km. Of the resulting dataset set, 39,272 plots were classified as aquatic plant communities. Further, 8,776 plots were classified as Periodically exposed shores and 317 plots as Unvegetated or sparsely vegetated shores with mobile sediments. An overview of the number of vegetation plots classified to individual habitats is shown in Table 4.1).

Table 4.1. Number of vegetation plots classified to individual habitats of EUNIS groups Q and U and to aquatic plant communities that will be used to describe inland water habtiats (group P).

Code	Name	Number
P	Aquatic plant communities	
Pa	Base-poor spring and spring brook	4842
Pb	Calcareous spring and spring brook	1250
Pc	Brackish-water vegetation	1084
Pd	Fresh-water small pleustophyte vegetation	4001
Pe	Fresh-water large pleustophyte vegetation	1064
Pf	Fresh-water submerged vegetation	14084
Pg	Fresh-water nymphaeid vegetation	5934
Ph	Oligotrophic-water vegetation	4381
Pi	Dystrophic-water vegetation	179
Pj	Stonewort vegetation	2453
Q6	Periodically exposed shores	
Q61	Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation	3873
Q62	Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation	4162
Q63	Periodically exposed saline shore with pioneer or ephemeral vegetation	741
U7	Unvegetated or sparsely vegetated shores with mobile sediments	
U71	Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions	269
U72	Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region	48

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Appendix A: List of aquatic plant communities and Periodically exposed shores and Unvegetated or sparsely vegetated shores with mobile sands with links to EUNIS 2012 and Red List

EUNIS-code	EUNIS 2012	EUNIS-name	Red List code	Red List name
Pa	C2.1	Base-poor spring and spring brook	C2.1a	Base-poor spring and spring brook VU NT CD1 CD1
Pb	C2.1	Calcareous spring and spring brook	C2.1b	Calcareous spring and spring brook VU VU A3, CD1 A3, CD1
Pc	C1.5	Brackish-water vegetation		
Pd	C1.2, C1.3	Fresh-water small pleustophyte vegetation		
Pe	C1.2, C1.3	Fresh-water large pleustophyte vegetation		
Pf	C1.2, C1.3	Fresh-water submerged vegetation		
Pg	C1.2, C1.3	Fresh-water nymphaeid vegetation		
Ph	C1.1, C1.6	Oligotrophic-water vegetation		
Pi	C1.4	Dystrophic-water vegetation		
Pj	C1.1, C1.2, C1.6	Stonewort vegetation		
Q6		Periodically exposed shores		
Q61	C3.5;C3.6;C3.7	Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation	C3.5a	Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation
Q62	C3.5;C3.6;C3.7	Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation	C3.5b	Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation

Q63	C3.5;C3.6;C3.7	Periodically exposed saline shore with pioneer or ephemeral vegetation	C3.5c	Periodically exposed saline shore with pioneer or ephemeral vegetation
U7		Unvegetated or sparsely vegetated shores with mobile sediments		
U71	C3.5;C3.6;C3.7	Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions	C3.5d	Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions
U72	C3.5;C3.6;C3.7	Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region	C3.5e	Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region

Appendix B: Descriptions of aquatic plant communities, Periodically exposed shores and Unvegetated or sparsely vegetated shores with mobile sands

New code	Habitat name	Description
Pa	Base-poor spring and spring brook	Base-poor springs and spring brooks develop throughout Europe, from lowlands to the alpine belt, at sites where base-poor groundwater emerges from bedrock or superficial deposits. Individual patches of this habitat are usually small in size, and they can occur both in open areas or at sites shaded by trees. The species composition of flora and fauna depends on the speed, volume and chemistry of the water and the degree of shading. Moss carpets often prevail in vegetation, though specialised vascular plants also occur in this habitat.
Pb	Calcareous spring and spring brook	Calcareous springs, spring brooks and associated tufa cascades of karstic rivers occur across Europe in areas with calcareous bedrock, from lowlands to the alpine belt. Their water is hard, with a high calcium content and near-neutral to alkaline pH. These springs can be well-insolated or shaded by trees. Usually, they occur in small patches. Vegetation is rich in moss carpets and at many sites, also in calcicolous herbs.

Pc	Brackish-water vegetation	This habitat includes the submerged vegetation of both coastal and inland brackish, saline or hypersaline lakes, ponds, pools and Mediterranean saline streams. In coastal areas, it develops due to the effect of seawater, whereas in the inland areas, it occurs in dry lowlands of the steppe and forest-steppe regions and some Mediterranean areas. Salinity varies according to rainfall, evaporation and the type of substrate.
Pd	Fresh-water small pleustophyte vegetation	This habitat includes communities of small pleustophytes, plants that either flow on the water surface or in the water column below the water surface but do not root in the bottom. Dominant species include seed plants (genera Azolla, Landoltia, Lemna, Spirodela, Utricularia and Wolffia), ferns (Salvinia) or liwerworts (Riccia, Ricciocarpos).
Pe	Fresh-water large pleustophyte vegetation	This habitat includes communities of large pleustophytes flowing on the water surface and often covering it over large areas. It is usually dominated by native European species Hydrocharis morsus-ranae and Stratiotes aloides, but in some areas of southern Europe, large alien pleustophytes (Eichhornia, Heteranthera and Pistia) can also occur.
Pf	Fresh-water submerged vegetation	This habitat includes submerged vegetation of mesotrophic, eutrophic and hypertrophic water bodies with both running and standing water. Dominant plants root in the bottom, but their stems and leaves are submerged, although flowers or fruits can emerge from the water.
Pg	Fresh-water nymphaeid vegetation	This habitat includes vegetation of mesotrophic and eutrophic lakes, pools, ponds, lentic stream sections and ditches dominated by nymphaeids, i.e. species rooting in the bottom with leaves floating on the water surface (Nelumbo nucifera, Nuphar spp., Nymphaea spp., Nymphoides peltata, Persicaria amphibia, Potamogeton natans, P. nodosus, Sagittaria natans and Trapa natans).

Ph	Oligotrophic-water vegetation	Oligotrophic lakes and pools, and rarely also artificial ponds, occur mainly in the boreal zone, Atlantic region of Europe and in mountain areas. They are sensitive to the input of nutrients from agriculture, atmospheric deposition and natural sources. Their aquatic vegetation is characterised by low productivity and the occurrence of highly specialised species, which usually decline after eutrophication due to competition from more productive, nutrient-demanding aquatic species.
Pi	Dystrophic-water vegetation	Dystrophic pools occur in bog complexes. Their water originates mainly from rainfall and has an extremely low amount of nutrients and a high amount of humic substances. Vegetation is represented by floating carpets of specialised mosses, namely Cladopodiella fluitans, Sphagnum cuspidatum, Sphagnum lindbergii, Sphagnum majus and Warnstorfia fluitans. Vascular plants have a low cover or are absent.
Pj	Stonewort vegetation	This habitat includes aquatic vegetation in non-brackish water dominated by macrophytic green algae of the class Charophycae, including the genera Chara, Lychnothamnus, Nitella, Nitellopsis and Tolypella. They occur in lakes, ponds, and both permanent and periodic pools. They are competitively weaker than vascular plants, therefore, they often colonize initial successional stages or aquatic habitats of short duration.
Q6	Periodically exposed shores	These habitats include wetlands with periodically changing states of flooding and bottom exposure. They occur on shores of rivers, lakes and ponds, in river channels, ditches, oxbows and on wet arable land. After water draw-down, the exposed wet substrate is quickly colonised by annual herbaceous plants. Depending on the substrate and water quality, the habitats can be eutrophic, mesotrophic or saline.

Q61	Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation	This habitat includes periodically exposed shores of rivers or islets of accumulated sediment in river channels, drying out oxbows, lakes and fishponds. Similar environmental conditions occur in ditches, wet places in villages or shallowly inundated and drying out arable land. Soils are muddy or sandy-muddy, usually with a high concentration of nutrients from natural sedimentation or human input. Vegetation is dominated by annual herbs, mainly of the genera Bidens, Chenopodium and Persicaria. In the Mediterranean areas where the drying out is faster, the vegetation can also be dominated by perennial stoloniferous species tolerant to prolonged flooding. In contrast to habitat Q62, this habitat occurs at sites with quick draw-down and drying out or on more nutrient-rich sediments.
Q62	Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation	This habitat type is found along the periodically emergent shorelines of rivers, on exposed bottoms of permanent lakes and ponds, in wetlands at the edges of arable fields and ephemeral flush habitats (vernal pools). In rivers and lakes, the timing of exposure of their shoreline depends on the precipitation seasonality and snowmelt time. This habitat type also includes artificial ponds drained in summer in intervals of several years as a part of their management. Vegetation is dominated by annual, low-growing and competitively weak plant species. After water draw-down on exposed pond bottoms and river shores, this vegetation can be overgrown by competitively stronger tall annuals, which indicate a successional development towards habitat Q61.

Q63	Periodically exposed saline shore with pioneer or ephemeral vegetation	This habitat includes periodically flooded, saline and muddy, nutrient-rich shores and dried-up bottoms of saline standing water bodies and saline river banks. It occurs in the lowlands of continental Europe and arid Mediterranean regions. The bottom of these water bodies dries in summer, and salt efflorescence appear on the surface. The vegetation often starts to grow only in summer. There is a low to moderate cover of short salt-adapted plants, primarily grasses, but also sedges and dicot herbs. Most of these plant species are annuals, developing during the exposure phase, though some perennials tolerant of temporary inundation with brackish water also occur.
U7	Unvegetated or sparsely vegetated shores with mobile sediments	These habitats with the accumulation of gravel, sand or silt are typical of wandering or braided river systems. They develop on rivers with significant variation in discharge and are maintained by torrents that regularly disturb or rearrange river banks and bring new sediments. They occur in mountainous areas from glacial river floodplains in the alpine belt to broad floodplains in the piedmonts and from boreal to Mediterranean Europe. The erosion–accumulation processes and fluctuating water level, including periods of submersion, cause spatio-temporal heterogeneity resulting in a mosaic of different successional stages ranging from very sparse pioneer vegetation to more closed stands of forbs and graminoids with scattered shrubs.

U71	Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions	Bare or sparsely vegetated streambeds and banks are distributed in all high mountain ranges and their foothills in temperate and boreal Europe. The habitat is highly dynamic due to periodical floods and a considerable variation in speed and intensity of the water current. The sediment includes mainly gravel deposits poor in organic material and nutrients. These gravel deposits are covered by sparse pioneer vegetation with several specialised plant species. Succession leads to willow scrub, but in the river systems with natural dynamics, the next flood causes disturbance of the shrubby stages and returns succession to an early stage. The habitat also includes periodically exposed gravelly shores of mountain lakes. Species composition of this habitat varies with elevation.
U72	Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region	This habitat includes silt, sandy and gravel banks and shores in the Mediterranean region in which sediments are exposed in summer and redeposited by winter floods. It occurs both in the channels of intermittently flowing rivers and on the bottoms or at the edges of lakes. Where vegetation develops, it includes plants tolerant of either extremely dry or very wet conditions, often pioneer and nitrophilous species, both annual and perennial. The occurrence of particular species also depends on the physical and chemical character of the debris.

Appendix C: Crosswalk between 1) aquatic plant communities, 2) Periodically exposed shores,3) Unvegetated or sparsely vegetated shores with mobile sands and EuroVegChecklist 2016

Pa - Base-poor spring and spring brook

> MON-01A - Caricion remotae Kästner 1941
> MON-02A - Mniobryo-Epilobion hornemannii Nordhagen 1943
> MON-02B - Koenigio-Microjuncion (Sörensen 1942) Hadač 1971
> MON-02C - Cardamino-Montion Br.-Bl. 1926
> MON-02D - Swertio perennis-Anisothecion squarrosi Hadač 1983
> MON-02E - Epilobio nutantis-Montion Zechmeister in Zechmeister et Mucina 1994
> MON-02H - Myosotidion stoloniferae Rivas-Mart. et al. 1984
> MON-02I - Pinguiculo balcanicae-Cardaminion acris Čarni et Matevski 2010

Pb - Calcareous spring and spring brook

> MON-02F - Cratoneurion commutati Koch 1928
> MON-02G - Lycopodo europaei-Cratoneurion commutati Hadač 1983

Pc - Brackish-water vegetation

> RUP-01A - Ruppion maritimae Br.-Bl. ex Westhoff in Bennema et al. 1943
> POT-03A - Zannichellion pedicellatae Schaminée, Lanjouw et Schipper ex Passarge 1996
<> CHA-01 - Charion canescentis Krausch 1964

Pd - Fresh-water small pleustophyte vegetation

> LEM-01A - Lemnion minoris O. de Bolòs et Masclans 1955
> LEM-01B - Utricularion vulgaris Passarge 1964

Pe - Fresh-water large pleustophyte vegetation

> LEM-01C - Stratiotion Den Hartog et Segal 1964

Pf - Fresh-water submerged vegetation

> POT-01A - Potamogetonion Libbert 1931
> POT-01D - Potamogetonion graminei Westhoff et Den Held 1969
> POT-01E - Ranunculion confervoidis Béguin et Theurillat ined.
> POT-02A - Batrachion fluitantis Neuhäusl 1959

> POT-02B - Ranunculion aquatilis Passarge ex Theurillat in Theurillat et al. 2015

Pg - Fresh-water nymphaeid vegetation

> POT-01B - Nymphaeion albae Oberd. 1957

> POT-01C - Nelumbion nuciferae Losev et Golub in Golub et al. ex Mucina et Theurillat in Theurillat et al. 2015

Ph - Oligotrophic-water vegetation

> LIT-01A - Subularion aquaticae Hadač 1971

> LIT-01B - Rorippion islandicae Béguin et Theurillat ined.

> LIT-01C - Deschampsion litoralis Oberd. et Dierßen in Dierßen 1975

> LIT-01D - Lobelion dortmannae Vanden Berghen 1964

> LIT-01E - Littorellion uniflorae Koch ex Klika 1935

> LIT-01F - Hyperico elodis-Sparganion Br.-Bl. et Tx. ex Oberd. 1957

> LIT-01G - Sphagno-Utricularion T. Müller et Görs 1960

> LIT-01H - Scorpidio-Utricularion minoris Pietsch 1965

Pi - Dystrophic-water vegetation

> LIT-01G - Sphagno-Utricularion T. Müller et Görs 1960

> LIT-01H - Scorpidio-Utricularion minoris Pietsch 1965

> SCH-04A - Scheuchzerion palustris Nordhagen ex Tx. 1937

Pj - Stonewort vegetation

> CHA-01A - Charion intermediae Sauer 1937

> CHA-01B - Charion vulgaris (W. Krause et Lang 1977) W. Krause 1981

> CHA-02A - Nitellion flexilis W. Krause 1969

> CHA-02B - Nitellion syncarpo-tenuissimae W. Krause 1969

Q61 - Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation

> BID-01A - Bidention tripartitae Nordhagen ex Klika et Hadač 1944

> BID-01B - Chenopodion rubri (Tx. in Poli et J. Tx. 1960) Hilbig et Jage 1972

Q62 - Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation

> ISO-02D - Eleocharition soloniensis Philippi 1968

> ISO-02B - Radiolion linoidis Pietsch 1973

> ISO-02A - Nanocyperion Koch 1926

Q63 - Periodically exposed saline shore with pioneer or ephemeral vegetation

> CRY-01A - Cypero-Spergularion salinae Slavnić 1948

> CRY-01B - Heleochloion schoenoidis Br.-Bl. ex Rivas Goday 1956

U71 - Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions

> THL-08C - Epilobion fleischeri G. Br.-Bl. ex Br.-Bl. 1950

> THL-08B - Calamagrostion pseudophragmitis Rivas-Mart. et al. 1984

U72 - Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region

> DRY-03D - Euphorbion rigidae S. Brullo et Spampinato 1990

> THL-09A - Glaucion flavi Br.-Bl. ex Tchou 1948

> the type left of the qualifier is defined as a broader than and completely including the type right of the qualifier

<> both types have a large part that overlaps, but also parts that do not overlap

Appendix E: Characteristic species combinations of 1) aquatic plant communities, 2) Periodically exposed shores and 3) Unvegetated or sparsely vegetated shores with mobile sands

Pa – Base-poor spring and spring brook

*Diagnostic species (phi coefficient * 100)*

Saxifraga stellaris	46.1	Philonotis seriata	44.5
Epilobium alsinifolium	40.3	Cardamine amara	36.1
Scapania undulata	35.6	Brachythecium rivulare	29.4
Dichodontium palustre	29.3	Chrysosplenium oppositifolium	26.1
Philonotis fontana	25.4	Montia fontana	25.2
Stellaria alsine	25.0	Pohlia wahlenbergii	22.4
Blindia acuta	20.8	Bryum schleicheri	20.0
Rhizomnium punctatum	19.7	Hygrohypnum molle aggr.	17.3
Palustriella decipiens	17.2	Chrysosplenium alternifolium	17.0
Scapania uliginosa	16.9	Epilobium nutans	16.9
Epilobium anagallidifolium	15.7		

Constant species (percentage occurrence frequencies)

Cardamine amara	37.0	Deschampsia cespitosa aggr.	34.0
Saxifraga stellaris	33.0	Caltha palustris	28.0
Philonotis seriata	24.0	Brachythecium rivulare	24.0
Epilobium alsinifolium	22.0	Stellaria alsine	20.0
Rhizomnium punctatum	18.0	Myosotis scorpioides aggr.	18.0
Bryum pseudotriquetrum	18.0	Scapania undulata	17.0
Ranunculus repens	17.0	Philonotis fontana	17.0
Chrysosplenium oppositifolium	16.0	Chrysosplenium alternifolium	16.0
Viola biflora	15.0	Stellaria nemorum	15.0
Chaerophyllum hirsutum	15.0	Palustriella commutata aggr.	12.0
Montia fontana	11.0	Dichodontium palustre	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Cardamine amara	16.0	Chrysosplenium oppositifolium	11.0
Saxifraga stellaris	8.0	Philonotis seriata	8.0
Caltha palustris	7.0	Philonotis fontana	6.0
Scapania undulata	5.0	Montia fontana	5.0

Pb - Calcareous spring and spring brook

*Diagnostic species (phi coefficient * 100)*

Palustriella commutata aggr.	70.5	Cratoneuron filicinum	43.2
Epilobium alsinifolium	42.2	Saxifraga aizoides	40.2
Bryum pseudotriquetrum	35.6	Heliosperma pusillum	33.4
Eucladium verticillatum	31.4	Pellia endiviifolia	31.0
Saxifraga stellaris	30.1	Philonotis calcarea	29.2
Arabis soyeri	27.0	Carex frigida	26.2
Brachythecium rivulare	20.7	Bryum schleicheri	20.4
Doronicum carpaticum	20.1	Viola biflora	18.2
Palustriella decipiens	17.5	Jungermannia atrovirens	16.7
Cirsium spinosissimum aggr.	16.6	Didymodon tophaceus	16.5
Rhynchostegium riparioides	16.2	Cardamine rivularis	16.1
Arabis pumila	15.9	Juncus triglumis	15.8
Cardamine amara	15.8		

Constant species (percentage occurrence frequencies)

Palustriella commutata aggr.	78.0	Bryum pseudotriquetrum	46.0
Deschampsia cespitosa aggr.	39.0	Saxifraga aizoides	34.0
Cratoneuron filicinum	30.0	Epilobium alsinifolium	27.0
Agrostis stolonifera	23.0	Saxifraga stellaris	22.0
Caltha palustris	22.0	Viola biflora	20.0
Heliosperma pusillum	19.0	Brachythecium rivulare	17.0
Pellia endiviifolia	16.0	Cardamine amara	16.0
Philonotis calcarea	15.0	Crepis paludosa	14.0
Chaerophyllum hirsutum	14.0	Bistorta vivipara	14.0
Poa alpina	13.0	Bellidiastrum michelii	13.0
Eucladium verticillatum	12.0	Carex frigida	12.0
Tussilago farfara	11.0	Parnassia palustris	11.0
Arabis soyeri	11.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Palustriella commutata aggr.	60.0	Saxifraga aizoides	17.0
Cratoneuron filicinum	11.0		

Pc - Brackish-water vegetation

*Diagnostic species (phi coefficient * 100)*

Zannichellia palustris	53.0	Ruppia maritima	44.4
Ruppia cirrhosa	40.8	Enteromorpha species	32.2
Fucus vesiculosus	29.9	Chara canescens	29.4
Stuckenia pectinata	27.3	Zostera marina	26.4
Chaetomorpha linum	22.8	Ruppia species	22.6
Chara baltica	21.6	Ceramium diaphanum	19.7
Enteromorpha intestinalis	19.6	Tolypella nidifica	18.8
Chara aspera	18.1	Zostera noltii	18.0
Eleocharis parvula	17.3	Chorda filum	16.9
Zannichellia pedunculata	15.6		

Constant species (percentage occurrence frequencies)

Zannichellia palustris	36.0	Stuckenia pectinata	24.0
Ruppia maritima	21.0	Ruppia cirrhosa	17.0
Enteromorpha species	16.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Zannichellia palustris	27.0	Ruppia maritima	17.0
Ruppia cirrhosa	13.0	Enteromorpha species	10.0

Pd - Fresh-water small pleustophyte vegetation

*Diagnostic species (phi coefficient * 100)*

Lemna minor	51.0	Spirodela polyrhiza	49.5
Lemna gibba	42.9	Lemna trisulca	41.4
Wolffia arrhiza	32.8	Azolla filiculoides	24.9
Ceratophyllum demersum	24.4	Riccia fluitans	22.1
Salvinia natans	21.5	Lemna species	20.1
Hydrocharis morsus-ranae	19.7		

Constant species (percentage occurrence frequencies)

Lemna minor	74.0	Spirodela polyrhiza	54.0
Lemna trisulca	42.0	Lemna gibba	28.0
Ceratophyllum demersum	23.0	Hydrocharis morsus-ranae	15.0
Wolffia arrhiza	14.0	Glyceria maxima	14.0

Lemna species	12.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Lemna minor	44.0	Spirodela polyrhiza	23.0
Lemna trisulca	17.0	Lemna gibba	17.0
Wolffia arrhiza	6.0	Salvinia natans	6.0
Lemna species	6.0		

Pe - Fresh-water large pleustophyte vegetation

*Diagnostic species (phi coefficient * 100)*

Stratiotes aloides	76.3	Hydrocharis morsus-ranae	75.3
Lemna trisulca	46.9	Lemna minor	40.4
Spirodela polyrhiza	35.6	Ceratophyllum demersum	28.7
Utricularia vulgaris	26.6	Nuphar lutea	26.6
Elodea canadensis	23.5	Salvinia natans	19.8
Potamogeton natans	18.2	Nymphaea alba	17.7

Constant species (percentage occurrence frequencies)

Hydrocharis morsus-ranae	81.0	Stratiotes aloides	67.0
Lemna minor	59.0	Lemna trisulca	51.0
Spirodela polyrhiza	39.0	Ceratophyllum demersum	28.0
Nuphar lutea	22.0	Utricularia vulgaris	16.0
Elodea canadensis	16.0	Potamogeton natans	14.0
Sparganium erectum aggr.	11.0	Phragmites australis	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Stratiotes aloides	61.0	Hydrocharis morsus-ranae	47.0
Lemna trisulca	6.0		

Pf - Fresh-water submerged vegetation

*Diagnostic species (phi coefficient * 100)*

Stuckenia pectinata	37.7	Ceratophyllum demersum	31.4
Myriophyllum spicatum	30.7	Potamogeton perfoliatus	30.0
Elodea canadensis	25.8	Potamogeton crispus	24.4
Potamogeton pusillus	21.2	Potamogeton lucens	21.2
Ranunculus circinatus	20.4	Elodea nuttallii	19.1

Lemna minor	18.5	Spirodela polyrhiza	17.9
Najas marina	17.7	Lemna trisulca	17.0
Zygnematophycae species	16.4	Potamogeton trichoides	15.3

Constant species (percentage occurrence frequencies)

Stuckenia pectinata	27.0	Ceratophyllum demersum	26.0
Lemna minor	24.0	Myriophyllum spicatum	20.0
Spirodela polyrhiza	16.0	Potamogeton perfoliatus	15.0
Lemna trisulca	15.0	Elodea canadensis	14.0
Potamogeton crispus	11.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Stuckenia pectinata	15.0	Ceratophyllum demersum	13.0
Potamogeton perfoliatus	8.0	Myriophyllum spicatum	8.0
Elodea canadensis	7.0	Potamogeton lucens	6.0
Elodea nuttallii	6.0		

Pg - Fresh-water nymphaeid vegetation

*Diagnostic species (phi coefficient * 100)*

Nuphar lutea	50.9	Potamogeton natans	41.9
Nymphaea alba	40.6	Ceratophyllum demersum	26.3
Trapa natans	25.6	Nymphoides peltata	23.3
Potamogeton nodosus	21.6	Myriophyllum spicatum	20.8
Myriophyllum verticillatum	20.1	Potamogeton lucens	18.4
Lemna minor	18.4	Spirodela polyrhiza	17.6
Nymphaea candida	17.0	Elodea canadensis	16.2
Sagittaria sagittifolia	15.8		

Constant species (percentage occurrence frequencies)

Nuphar lutea	42.0	Potamogeton natans	33.0
Lemna minor	25.0	Nymphaea alba	24.0
Ceratophyllum demersum	24.0	Persicaria amphibia	18.0
Spirodela polyrhiza	17.0	Myriophyllum spicatum	15.0
Lemna trisulca	13.0	Phragmites australis	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Nuphar lutea	31.0	Potamogeton natans	22.0
Nymphaea alba	16.0	Persicaria amphibia	12.0

Nymphoides peltata	7.0	Trapa natans	6.0
Potamogeton nodosus	6.0	Ceratophyllum demersum	5.0

Ph - Oligotrophic-water vegetation

*Diagnostic species (phi coefficient * 100)*

Juncus bulbosus	49.1	Plantago uniflora	39.4
Eleocharis multicaulis	35.5	Potamogeton polygonifolius	33.5
Hypericum elodes	30.5	Lobelia dortmanna	29.2
Isolepis fluitans	26.3	Baldellia ranunculoides	26.3
Potamogeton gramineus	20.0	Sparganium angustifolium	19.6
Eriocaulon aquaticum	18.8	Anagallis tenella	18.7
Pilularia globulifera	18.4	Utricularia minor	18.3
Isoetes lacustris	16.8	Helosciadium inundatum	16.6
Sparganium natans	16.3	Hydrocotyle vulgaris	15.8
Isoetes longissima	15.7	Myriophyllum alterniflorum	15.1

Constant species (percentage occurrence frequencies)

Juncus bulbosus	45.0	Ranunculus flammula	24.0
Eleocharis multicaulis	20.0	Plantago uniflora	19.0
Hydrocotyle vulgaris	19.0	Potamogeton polygonifolius	17.0
Molinia caerulea aggr.	16.0	Eleocharis palustris	14.0
Juncus articulatus	13.0	Hypericum elodes	13.0
Baldellia ranunculoides	12.0	Eriophorum angustifolium	11.0
Anagallis tenella	11.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Juncus bulbosus	23.0	Plantago uniflora	13.0
Potamogeton polygonifolius	10.0	Eleocharis multicaulis	10.0
Utricularia minor	6.0	Hypericum elodes	6.0

Pi - Dystrophic-water vegetation

*Diagnostic species (phi coefficient * 100)*

Sphagnum cuspidatum	71.1	Warnstorfia fluitans	42.9
Juncus bulbosus	20.6	Cladopodiella fluitans	19.7
Sphagnum majus	18.9	Scheuchzeria palustris	15.9

Constant species (percentage occurrence frequencies)

Sphagnum cuspidatum	82.0	Warnstorfia fluitans	32.0
Juncus bulbosus	18.0	Eriophorum angustifolium	18.0
Vaccinium oxycoccos	12.0	Carex limosa	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Sphagnum cuspidatum	72.0	Warnstorfia fluitans	21.0
Sphagnum majus	7.0		

Pj - Stonewort vegetation

*Diagnostic species (phi coefficient * 100)*

Chara tomentosa	43.1	Chara aspera	43.1
Nitellopsis obtusa	34.7	Chara species	32.6
Chara vulgaris	32.3	Chara globularis	32.0
Stuckenia pectinata	31.3	Chara hispida	24.8
Cladophora glomerata	23.4	Chara contraria	20.8
Chara rudis	20.5	Potamogeton perfoliatus	20.2
Chara canescens	19.6	Chara pedunculata	18.4
Nitella flexilis	17.0	Myriophyllum spicatum	15.7
Chara virgata	15.7		

Constant species (percentage occurrence frequencies)

Stuckenia pectinata	28.0	Chara aspera	21.0
Chara tomentosa	20.0	Chara species	16.0
Chara vulgaris	15.0	Nitellopsis obtusa	14.0
Chara globularis	14.0	Potamogeton perfoliatus	12.0
Myriophyllum spicatum	12.0		

Dominant species (percentage frequencies of occurrences with cover > 25%)

Chara aspera	19.0	Chara species	16.0
Chara tomentosa	13.0	Chara vulgaris	12.0
Nitellopsis obtusa	9.0	Chara globularis	8.0

Q61 - Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation

*Diagnostic species (phi coefficient * 100)*

Rumex maritimus	46.3	Persicaria lapathifolia	44.6
Bidens tripartita	43.9	Oxybasis rubra	42.6
Rorippa palustris	39.5	Persicaria hydropiper	33.4
Alopecurus aequalis	33.3	Cyperus fuscus	32.5
Ranunculus sceleratus	32.0	Bidens radiata	30.0
Bidens cernua	28.6	Oxybasis glauca	26.0
Bidens frondosus	25.4	Persicaria dubia	23.5
Gnaphalium uliginosum	23.1	Carex bohemica	22.9
Oenanthe aquatica	22.8	Limosella aquatica	22.5
Echinochloa crus-galli	20.9	Potentilla supina	20.0
Eragrostis albensis	19.4	Lipandra polysperma	16.6
Myosoton aquaticum	16.3	Juncus bufonius aggr.	16.0
Eleocharis ovata	15.2		

Constant species (percentage occurrence frequencies)

Persicaria lapathifolia	61.0	Bidens tripartita	49.0
Persicaria hydropiper	44.0	Plantago major	33.0
Rumex maritimus	31.0	Rorippa palustris	30.0
Oxybasis rubra	27.0	Ranunculus sceleratus	26.0
Echinochloa crus-galli	25.0	Alopecurus aequalis	22.0
Gnaphalium uliginosum	21.0	Agrostis stolonifera	21.0
Phalaroides arundinacea	20.0	Oenanthe aquatica	20.0
Tripleurospermum maritimum aggr.	19.0	Bidens frondosus	18.0
Bidens cernua	18.0	Urtica dioica	17.0
Lycopus europaeus	17.0	Juncus bufonius aggr.	17.0
Cyperus fuscus	17.0	Ranunculus repens	16.0
Lythrum salicaria	16.0	Rorippa sylvestris	14.0
Rorippa amphibia	14.0	Polygonum aviculare aggr.	14.0
Persicaria dubia	14.0	Alisma plantago-aquatica	14.0
Oxybasis glauca	13.0	Lipandra polysperma	13.0
Chenopodium album aggr.	13.0	Bidens radiata	13.0
Atriplex prostrata	13.0	Persicaria maculosa	12.0
Myosoton aquaticum	12.0	Ochlopoa annua	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Persicaria hydropiper	17.0	Persicaria lapathifolia	15.0
Bidens tripartita	13.0	Oxybasis rubra	10.0
Rumex maritimus	7.0	Persicaria dubia	6.0
Bidens cernua	6.0	Alopecurus aequalis	6.0

Q62 - Periodically exposed shore with stable, mesotrophic sediments with pioneer or ephemeral vegetation

*Diagnostic species (phi coefficient * 100)*

Juncus bufonius aggr.	42.4	Lythrum portula	40.2
Gnaphalium uliginosum	38.6	Eleocharis acicularis	34.5
Eleocharis ovata	32.0	Limosella aquatica	30.1
Lythrum hyssopifolia	29.1	Juncus pygmaeus	25.6
Carex bohemica	25.6	Illecebrum verticillatum	25.1
Cyperus fuscus	23.9	Rorippa palustris	22.3
Cicendia filiformis	22.0	Callitriche palustris	21.9
Juncus tenageia	21.6	Juncus capitatus	21.5
Bidens radiata	21.0	Solenopsis laurentia	20.4
Isolepis setacea	20.2	Alopecurus aequalis	20.0
Mentha pulegium	19.8	Elatine hydropiper	19.6
Elatine triandra	19.4	Radiola linoides	19.0
Coleanthus subtilis	18.4	Lotus hispidus	18.3
Isoetes histrix	17.8	Polypogon subspathaceus	17.6
Elatine hexandra	17.1	Corrigiola litoralis	16.9
Rumex maritimus	16.8	Isolepis cernua	16.5
Bellis annua	16.5	Helosciadium crassipes	16.3
Spergularia rubra	15.4	Lindernia procumbens	15.2
Isoetes durieui	15.2	Cyperus michelianus	15.1

Constant species (percentage occurrence frequencies)

Juncus bufonius aggr.	47.0	Gnaphalium uliginosum	36.0
Plantago major	23.0	Lythrum portula	22.0
Eleocharis acicularis	21.0	Persicaria lapathifolia	17.0
Juncus articulatus	17.0	Rorippa palustris	15.0
Alisma plantago-aquatica	15.0	Mentha pulegium	14.0
Bidens tripartita	14.0	Polygonum aviculare aggr.	13.0
Persicaria hydropiper	13.0	Lythrum hyssopifolia	13.0
Limosella aquatica	13.0	Eleocharis ovata	13.0
Cyperus fuscus	12.0	Alopecurus aequalis	12.0
Agrostis stolonifera	12.0	Ochlopoa annua	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Juncus bufonius aggr.	18.0	Eleocharis acicularis	13.0
Lythrum portula	6.0	Eleocharis ovata	5.0

Q63 - Periodically exposed saline shore with pioneer or ephemeral vegetation

*Diagnostic species (phi coefficient * 100)*

Crypsis aculeata	65.0	Crypsis schoenoides	50.1
Oxybasis glauca	28.8	Crypsis alopecuroides	26.7
Cressa cretica	26.5	Cyperus pannonicus	26.0
Bolboschoenus maritimus	22.8	Lepidium latifolium	20.9
Heliotropium supinum	20.9	Polypogon monspeliensis	20.2
Atriplex intracontinentalis	19.7	Polypogon maritimus	19.0
Alisma gramineum	19.0	Xanthium strumarium	18.6
Atriplex aucheri	18.6	Spergularia marina	18.5
Suaeda acuminata	18.3	Oxybasis chenopodioides	17.5
Atriplex prostrata	17.4	Cotula coronopifolia	17.3
Polygonum arenarium	17.1	Lythrum hyssopifolia	15.2

Constant species (percentage occurrence frequencies)

Crypsis aculeata	46.0	Crypsis schoenoides	30.0
Bolboschoenus maritimus	26.0	Atriplex prostrata	20.0
Tripolium pannonicum	17.0	Oxybasis glauca	16.0
Xanthium strumarium	13.0	Echinochloa crus-galli	13.0
Suaeda maritima aggr.	12.0	Plantago major	12.0
Spergularia marina	11.0	Polygonum aviculare aggr.	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Crypsis aculeata	29.0	Crypsis schoenoides	22.0
Cyperus pannonicus	7.0	Crypsis alopecuroides	6.0
Cressa cretica	5.0		

U71 - Unvegetated or sparsely vegetated shore with mobile sediments in montane and alpine regions

*Diagnostic species (phi coefficient * 100)*

Calamagrostis pseudophragmites	83.9	Salix purpurea	50.7
Myricaria germanica	47.4	Epilobium fleischeri	34.2
Tussilago farfara	33.2	Salix eleagnos	30.6
Mentha longifolia	29.6	Tolpis staticifolia	29.0
Epilobium colchicum	28.2	Epilobium dodonaei	27.9
Gypsophila repens	24.5	Petasites hybridus	22.6
Saxifraga aizoides	22.1	Barbarea vulgaris	20.3

Tripleurospermum caucasicum	20.1	Vicia sosnowskyi	19.8
Salix daphnoides	19.4	Petasites kablikianus	18.6
Trisetum rigidum	18.0	Petasites paradoxus	17.4
Erigeron acris	17.1	Salix euxina	16.7
Scrophularia variegata	16.4	Chondrilla chondrilloides	16.3
Alnus incana	16.3	Trifolium pallescens	16.1
Betula litwinowii	16.1	Rumex scutatus	15.9
Xanthium species	15.4	Melilotus albus	15.4
Linaria alpina	15.4	Lactuca racemosa	15.2
Cerastium polymorphum	15.1		

Constant species (percentage occurrence frequencies)

Calamagrostis pseudophragmites	75.0	Salix purpurea	51.0
Tussilago farfara	43.0	Agrostis stolonifera	39.0
Mentha longifolia	32.0	Ranunculus repens	27.0
Myricaria germanica	27.0	Trifolium repens	26.0
Salix eleagnos	22.0	Equisetum arvense	22.0
Plantago major	21.0	Taraxacum sect. Taraxacum	20.0
Lotus corniculatus	19.0	Anthyllis vulneraria	18.0
Alnus incana	18.0	Saxifraga aizoides	17.0
Prunella vulgaris	17.0	Petasites hybridus	17.0
Phalaroides arundinacea	16.0	Cirsium arvense	16.0
Cerastium fontanum subsp. vulgare	16.0	Myosotis scorpioides aggr.	15.0
Deschampsia cespitosa aggr.	15.0	Trifolium pratense	14.0
Poa alpina	14.0	Medicago lupulina	14.0
Lycopus europaeus	14.0	Juncus articulatus	14.0
Gypsophila repens	14.0	Epilobium fleischeri	14.0
Plantago lanceolata	13.0	Dactylis glomerata	13.0
Achillea millefolium aggr.	13.0	Tolpis staticifolia	12.0
Salix euxina	12.0	Melilotus albus	12.0
Leucanthemum vulgare aggr.	12.0	Erigeron acris	12.0
Barbarea vulgaris	12.0	Artemisia vulgaris	12.0
Veronica beccabunga	11.0	Poa nemoralis	11.0
Leontodon hispidus	11.0	Epilobium dodonaei	11.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Calamagrostis pseudophragmites	64.0	Myricaria germanica	8.0
Saxifraga aizoides	7.0	Epilobium fleischeri	7.0
Gypsophila repens	6.0		

U72 - Unvegetated or sparsely vegetated shore with mobile sediments in the Mediterranean region

*Diagnostic species (phi coefficient * 100)*

Epilobium dodonaei	73.7	Scrophularia canina	53.1
Ptychotis saxifraga	50.4	Plantago sempervirens	46.3
Rumex scutatus	45.7	Calamagrostis pseudophragmites	39.5
Achnatherum calamagrostis	39.2	Melilotus albus	34.4
Saponaria officinalis	33.5	Centranthus angustifolius	32.7
Salix eleagnos	31.6	Laserpitium gallicum	30.6
Melica ciliata aggr.	29.3	Salix salviifolia	26.7
Tolpis staticifolia	25.8	Dysphania botrys	25.0
Sedum sediforme	22.6	Clinopodium nepeta	22.1
Satureja montana aggr.	21.9	Dittrichia viscosa	20.7
Glaucium flavum	20.2	Mentha longifolia	20.0
Echium vulgare	20.0	Linaria repens	19.4
Campanula speciosa	18.8	Centranthus lecoqii	18.7
Sedum ochroleucum	18.4	Galeopsis angustifolia	18.4
Lactuca viminea	18.1	Artemisia campestris	18.1
Papaver rhaeticum	18.0	Erucastrum nasturtiifolium	18.0
Santolina etrusca	17.9	Salix purpurea	17.8
Scrophularia lucida	17.7	Chaenorhinum rubrifolium	17.7
Diplotaxis tenuifolia	17.4	Polypogon viridis	17.2
Galium pusillum	16.7	Epilobium obscurum	16.4
Cytisophyllum sessilifolium	15.7	Melilotus neapolitanus	15.5
Plantago arenaria	15.2	Lactuca perennis	15.2

Constant species (percentage occurrence frequencies)

Epilobium dodonaei	58.0	Scrophularia canina	38.0
Rumex scutatus	33.0	Galium mollugo aggr.	31.0
Ptychotis saxifraga	29.0	Melilotus albus	29.0
Melica ciliata aggr.	29.0	Plantago sempervirens	27.0
Achnatherum calamagrostis	27.0	Echium vulgare	25.0
Clematis vitalba	25.0	Asperula cynanchica	25.0
Artemisia campestris	25.0	Silene vulgaris	23.0
Saponaria officinalis	23.0	Salix eleagnos	23.0
Plantago lanceolata	23.0	Mentha longifolia	21.0
Calamagrostis pseudophragmites	21.0	Sedum sediforme	19.0
Sanguisorba minor aggr.	19.0	Satureja montana aggr.	17.0
Laserpitium gallicum	17.0	Dittrichia viscosa	17.0

Daucus carota	17.0	Salix purpurea	15.0
Hypericum perforatum	15.0	Clinopodium nepeta	15.0
Amelanchier ovalis	15.0	Sonchus oleraceus	12.0
Sedum album	12.0	Scabiosa columbaria aggr.	12.0
Cytisophyllum sessilifolium	12.0	Centranthus angustifolius	12.0

Dominant species (percentage frequencies of occurrences with cover > 25%)

Epilobium dodonaei	29.0	Calamagrostis pseudophragmites	21.0
Achnatherum calamagrostis	15.0	Rumex scutatus	10.0
Scrophularia canina	6.0	Melilotus albus	6.0

Appendix F: List of databases and data providers

GIVD code	GIVD database name	Custodian	Deputy custodian	# of plots
00-RU-008	Database of antropogenic vegetation of Urals and adjacent territories	Yaroslav Golovanov	Larisa Abramova	86
00-TR-001	Forest Vegetation Database of Turkey - FVDT	Ali Kavgacı		17
00-TR-003	Non-Forest Vegetation Database of Turkey - NFVDT	Behlül Güler		497
AS-RU-005	Nenets Tundra	Igor Lavrinenko		5
AS-TR-001	Vegetation Database of the Grassland Communities in Anatolia	Deniz Işık Gürsoy		102
EU-00-002	Nordic-Baltic Grassland Vegetation Database (NBGVD)	Jürgen Dengler	Łukasz Kozub	22
EU-00-004	Iberian and Macaronesian Vegetation Information System (SIVIM) – Alpine	Borja Jiménez-Alfaro	Xavier Font	92
EU-00-004	Iberian and Macaronesian Vegetation Information System (SIVIM) – Sclerophyllous forests	Federico Fernández-González	Xavier Font	1
EU-00-004	Iberian and Macaronesian Vegetation Information System (SIVIM) – Grasslands	Maria Pilar Rodríguez-Rojo	Xavier Font	37
EU-00-004	Iberian and Macaronesian Vegetation Information System (SIVIM) - Shrublands	Rosario G Gavilán	Xavier Font	3
EU-00-004	Iberian and Macaronesian Vegetation Information System (SIVIM)	Xavier Font		68
EU-00-011	Vegetation-Plot Database of the University of the Basque Country (BIOVEG)	Idoia Biurrun	Itziar García-Mijangos	775
EU-00-016	Mediterranean Ammophiletea database	Corrado Marcenò	Borja Jiménez-Alfaro	37
EU-00-017	European Coastal Vegetation Database	John Janssen		33
EU-00-018	The Nordic Vegetation Database	Jonathan Lenoir	Jens-Christian Svenning	25
EU-00-019	Balkan Vegetation Database	Kiril Vassilev	Hristo Pedashenko	322
EU-00-022	European Mire Vegetation Database	Tomáš Peterka	Martin Jiroušek	1075
EU-00-025	Gravel Bar Vegetation Database	Veronika Kalníková	Helmut Kudrnovsky	104
EU-00-027	European Boreal Forest Vegetation Database	Anni Kanerva	Jašková	1
EU-00-028	European Weed Vegetation Database	Filip Küzmič	Urban Šilc	105
EU-00-031	Masaryk University's Gap-Filling Database of European Vegetation	Milan Chytrý	Ilona Knollová	6

EU-AL-001	Vegetation Database of Albania	Michele De Sanctis	Giuliano Fanelli	32
EU-AT-001	Austrian Vegetation Database	Wolfgang Willner		378
EU-BE-002	INBOVEG	Els De Bie		624
EU-BG-001	Bulgarian Vegetation Database	Iva Apostolova	Desislava Sopotlieva	86
EU-CH-011	Monitoring Effectiveness of Habitat Conservation in Switzerland	Ariel Bergamini	Steffen Boch	37
EU-CZ-001	Czech National Phytosociological Database	Milan Chytrý	Ilona Knollová	5901
EU-DE-001	VegMV	Florian Jansen	Christian Berg	4099
EU-DE-013	VegetWeb Germany	Florian Jansen	Jörg Ewald	185
EU-DE-013	VegetWeb Germany – Tüxen´s archive	Friedemann Goral	Florian Jansen	1826
EU-DE-014	German Vegetation Reference Database (GVRD)	Ute Jandt	Helge Bruelheide	359
EU-DE-020	German Grassland Vegetation Database (GrassVeg.DE)	Ricarda Pätsch	Jürgen Dengler	8
EU-DE-040	Database Schleswig-Holstein (Northern Germany)	Joachim Schrautzer		12
EU-ES-001	Iberian and Macaronesian Vegetation Information System (SIVIM) – Wetlands	Aaron Pérez-Haase	Xavier Font	1391
EU-FR-003	SOPHY	Emmanuel Garbolino		7315
EU-FR-004	VEGFRANCE	Jan-Bernard Bouzillé	Anne Bonis	19
EU-GB-001	UK National Vegetation Classification Database	John S. Rodwell		762
EU-GB-004	FloodplainMeadows	Irina Tatarenko		55
EU-GB-005	Scottish Coastal Survey	Robin Pakeman		7
EU-GB-006	Scottish Vegetation Resurvey	Ruth Mitchell	Robin Pakeman	194
EU-GR-001	KRITI	Erwin Bergmeier		104
EU-HR-001	Phytosociological Database of Non-Forest Vegetation in Croatia	Zvjezdana Stančić		35
EU-HR-002	Croatian Vegetation Database	Željko Škvorc	Daniel Krstonošić	262
EU-HU-003	CoenoDat Hungarian Phytosociological Database	János Csiky	Zoltán Botta-Dukát	345
EU-IE-001	Irish Vegetation Database	Úna FitzPatrick	Lynda Weekes	946
EU-IT-001	VegItaly	Roberto Venanzoni	Flavia Landucci	1162
EU-IT-010	Vegetation database of Habitats in the Italian Alps - HabItAlp	Laura Casella	Pierangela Angelini	13
EU-IT-010	Vegetation database of Habitats in the Italian Alps - HabItAlp	Laura Casella	Marco Massimi	141
EU-IT-011	Vegetation Plot Database - Sapienza University of Rome	Emiliano Agrillo	Fabio Attorre	1002
EU-IT-020	RanVegDunes	Alicia Acosta		4
EU-IT-021	AMS-VegBank - Alma Mater Studiorum - University of Bologna	Alessandro Chiarucci	Vanessa Bruzzaniti	272
EU-LT-001	Lithuanian Vegetation Database	Valerius Rašomavičius	Domas Uogintas	1055

EU-LV-001	Semi-natural Grassland Vegetation Database of Latvia	Solvita Rūsiņa		8
EU-NL-001	Dutch National Vegetation Database	Stephan Hennekens	Joop Schaminée	5859
EU-NL-003	Dutch Military Ranges Vegetation Database (DUMIRA)	Iris de Ronde	Rense Haveman	97
EU-PL-001	Polish Vegetation Database	Zygmunt Kącki		4218
EU-PT-001	Serra da Estrela database	Jan Jansen		140
EU-RO-007	Romanian Forest Database	Adrian Indreica	Pavel Dan Turtureanu	2
EU-RO-008	Romanian Grassland Database	Eszter Ruprecht	Kiril Vassilev	1698
EU-RS-002	Vegetation Database Grassland Vegetation of Serbia	Svetlana Aćić	Zora Dajić Stevanović	51
EU-RU-002	Lower Volga Valley Phytosociological Database	Valentin Golub	Andrei Chuvashov	811
EU-RU-003	Vegetation Database of the Volga and the Ural Rivers Basins	Tatiana Lysenko		3
EU-RU-011	Vegetation Database of Tatarstan	Vadim Prokhorov		14
EU-RU-014	Temperate Forests of European Russia	Larisa Khanina	Maxim Bobrovsky	4
EU-SI-001	Vegetation Database of Slovenia	Urban Šilc	Filip Küzmič	282
EU-SK-001	Slovak Vegetation Database	Milan Valachovič	Jozef Šibík	1563
EU-UA-001	Ukrainian Grassland Database	Anna Kuzemko	Yulia Vashenyak	34
EU-UA-005	Halophytic and coastal vegetation database of Ukraine	Tetiana Dziuba	Dmytro Dubyna	18
EU-UA-006	Vegetation Database of Ukraine and Adjacent Parts of Russia	Viktor Onyshchenko	Vitaliy Kolomiychuk	60
	Bogs GVRD	Ute Jandt		25
	CBNA	Sylvain Abdulhak	Jean-Michel Genis	1
	Grasslands GVRD	Ute Jandt		1141
	Private data European heaths	Corrado Marcenò		2
	Private data of Anna Kuzemko	Anna Kuzemko		1
	Private data of Borja Jiménez-Alfaro	Borja Jiménez-Alfaro		85
	Private data of Corrado Marcenò	Corrado Marcenò		1
	Private data of Daniel Dítě	Daniel Dítě		138
	Private data of Thomas Michl	Thomas Michl		38
	Teberda - Caucasus Database	Vladimir Onipchenko	Alexei Egorov	27
			Total	**48365**