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Hypotheses of changes in palustrian plant communities under climate change.
Specification of a model for European wetland habitats.

Bernard Clément & Ahmed Aidoud (UMR Ecobio, UR1)

Abstract

Marginal wetlands are particularly vulnerable to climate change. Changes in precipitation and temperature will impact on flooding patterns and water table fluctuations and will therefore modify vegetation communities and other ecological factors such as nutrient availability. A Space for time substitution was used as an approach dealing with the European scale. Inference of successional dynamic stages is only possible by relying on synchronic studies of multiple sites at different stages in dynamic trajectories. Because of this large scale, another surrogate was the Ellenberg indicator values used as a homogenous system to derive environmental factors. Multivariate analytical techniques (DCA/CCA) were used to depict the general pattern of wetland distribution and therefore to predict possible changes in plant communities, driven by climate change. In this deliverable, a test is made on palustrian standing water systems and perennial plant communities, from available phytosociological data sets through the European range. The objectives are bring out (1) the role/place of climate in the current distribution of wetland habitats in Europe in relation with other factors and (2) the possible changes in the distribution of European palustrian wetland habitats, that could be predicted regarding direct or indirect effects of climate change.

Data analyses shown that moisture is the main factor controlling ordination of plant communities both of meso-eutrophic and oligotrophic habitats. Other factors such as reaction, nutrient availability shown a clear distinction between meso-eutrophic and oligotrophic habitats. The widespread geographical distribution of plant species, and plant assemblages of the meso-eutrophic habitats in comparison with to the restricted distribution of most plant species and plant assemblages of oligotrophic habitats suggests that the ecological drivers, and then sensitivity to environmental change would be significantly different. Meso-eutrophic wetland habitats with a fertility value of N>5, would not be affected by eutrophication process in relation with climate change and/or induced land-use changes. Oligotrophic habitats (fertility, N<4) would be highly sensitive to climate change at a regional scale, both in terms of temperature increase, and of hydrological change. They would be also highly affected by increasing fertility in the palustrian wetlands in relation with eutrophication processes. A temperature increase might induce a shift from temperate or Atlantic oligotrophic habitat types towards eu-Mediterranean habitat types (oligo- or meso-eutrophic). Increasing nutrient availability, as an indirect consequence of increasing

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temperature, might induce a shift from oligotrophic habitat types (either temperate or Mediterranean) to mesotrophic habitat types (temperate or Mediterranean), without change in hydrological functioning.

Introduction

It is now admitted through scientific studies that climate change is underway and could have a major impact on the nature and distribution of vegetation in the future (IPCC, 1996). The predicted changes in Europe are different between locations (*e.g*. Southern and Northern Europe, Semmler & Jacob, 2004). In addition to an increase of precipitation, as a result of a warmer climate (IPCC, 2001), increasing global surface temperatures are very likely to alter the hydrological cycle (Dore, 2005). In wetlands, hydrology, *i.e*. water level and water movement, is among the main factors that provide plant species growth and survival and therefore, determine the plant community composition, structure and dynamics (Clément & Proctor, 2006). Climate change will significantly influence wetlands by altering hydrologic regimes (increasing or decreasing water level, depth, duration, frequency, and seasonality of flooding). These changes will affect all wetland functions such as biological, biogeochemical, hydrologic and socio-economic functions (IPCC, 1996). Moreover, climate change may have, through change in land use, indirect effects that can worsen alteration. Geographical distribution of the wetland plant communities is likely to shift.

The objective of EUROLIMPACS WP1-Task 4 is to investigate the likely changes in wetland hydrology and to develop a simple model to predict changes in European habitats mainly based on plant communities typology depicted by the European habitat classification system (CORINE / EUNIS, Devillers *et al.,* 1991; Davies *et al*. 2004).

Plant composition of the wetland communities is an integrative mirror of the ecosystem functioning and can be used as valuable predictors of number of fundamental ecosystem functions. According to different scales, plant assemblages, representing a plant community typology, may play a useful role as indicators of ecosystem status or ecosystem response to changing environmental conditions in the palustrian wetlands (Murphy *et al.*, 1994).

Wheeler and Shaw (1995) consider plants as “hydrologists”. Using plants and vegetation as indicators is a helpful tool for assessing the nature and effect on past or on-going hydrological change in wetlands (Ellenberg *et al.* 1992 ; Newbold & Mountford 1997).

The impact of climate change on vegetation has usually been analysed at an individual species level (Thuiller *et al*., 2005) or on vegetation at a large zonal scale (e.g. Ozenda & Borel, 1990; Smith *et al.*, 1992). Few studies were carried on the response of plant communities or habitats to climate change. Comparisons of vegetation were done under similar climate but different regarding some constraints (temperature, hydrology…), as a basis to predict possible changes (Hill *et al.*, 1994; Duckworth *et al*., 2000). In this deliverable we collected from the literature, available vegetation data on wetlands but restricted to palustrian habitats as a first stage of vegetation gradient analyses that may allow generating hypotheses regarding habitat and climate relationships.

Based on vegetation analyses, this deliverable aims to answer the following questions:

To what extent the climate is involved in the current distribution of wetland habitats in Europe in comparison with other factors such as nutrient availability, acidification and internal land-use?

What changes due to climate warming, could be predicted in the distribution of European palustrian wetland habitats?

1 Material and methods

1.1 What are palustrian wetlands?

The term « wetland » is relatively recent and has a variety of definitions. According to the WP objectives, we retained the definition summarised through the figure 1. In this context, we are concerned especially with telmatic wetlands.

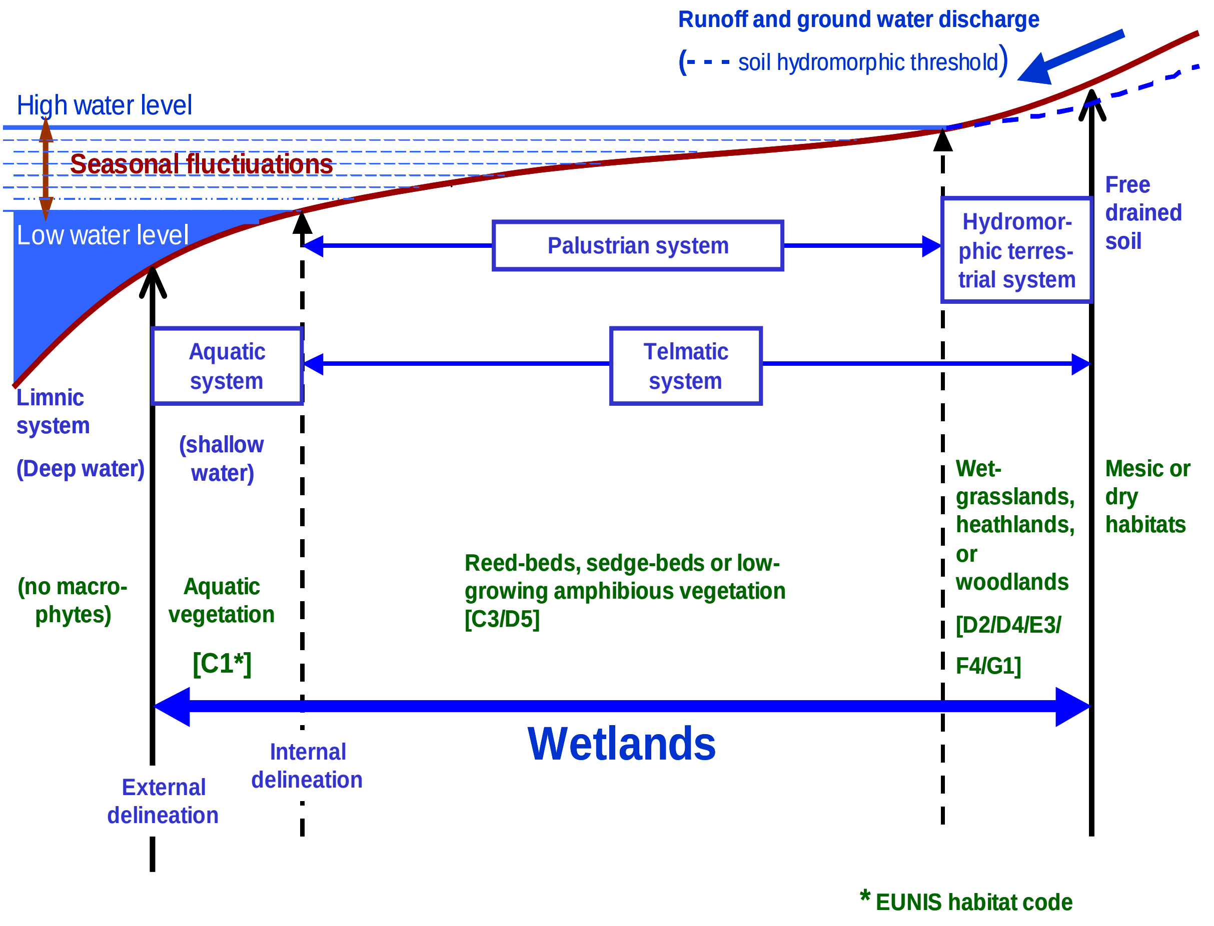


Figure 1. Wetland delineation in a hydrological ecocline,

Freshwater wetlands could be represented in a hydrological gradient, between limnic and free drained ecosystems.with two main types: aquatic wetlands (shallow water) and telmatic wetlands that are semi-terrestrial (Wheeler, 1999). Each subdivision along the hydrological gradient (or ecocline) corresponds to an hydroperiod or ecophase in time and an hydro-geomorphic unit (HGMU) in space. Telmatic wetlands can be subdivided in permanent, seasonal, and fluctuating wetlands, according to fluctuations in water flooding or waterlogging (Wheeler and Proctor, 2000).

According to EUNIS classification, habitats (higher levels) that can be encountered along the hydrological ecocline are as follow:

C1 : Surface standing waters (with aquatic macrophytes); C3 : Littoral zone of inland surface waterbodies (palustrian systems); D5 : Sedge and reedbeds, normally without free-standing water; D2 : Valley mires, poor fens and transition mires D4 : Base-rich fens and calcareous spring mires; E3 : Seasonally wet and wet grasslands; F4: Temperate shrub heathland; G1 : Broadleaved deciduous woodland. (For more detail, see annex 1)

1.2 Data

Available vegetation data have been collected mainly from phytosociological literature published about European wetlands. Data are represented by synoptic (syntaxonomic) tables of plant assemblages. These tables consist in a list of species (rows) and their occurrences in different syntaxa (columns). Each syntaxon was established on a number of relevés (or samples).

In this primary study, we have selected information only on palustrian wetlands that are classified in term of vegetation, into 4 phytosociological classes:

- *Phragmiti australis – Magnocaricetea elatae* (**Reed and large Sedge beds**)
- *Agrostietea stoloniferae p.p*. (**Spikrush beds**)
- *Littorelletea uniflorae* (**non Mediterranean Low growing amphiphytic vegetation**)
- *Isoetetea velatae p.p.* (**Mediterranean low growing amphiphytic vegetation**)

(For more information see annex 2)

Homologous class of *Littoreletea* for the temperate zone (non-Mediterranean) was represented by the class of *Isoeto-Nano-Juncetea bufonii* for the Mediterranean and South-Eastern Europe. But this class includes both perennial and annual plant species. Therefore it was preferable to separately distinguish these two groups (de Foucault, 1988). So, we chose to include only perennial plant communities in this primary analysis. Those plant communities belong to the new class proposed by de Foucault (1988) and called *Isoetetea vellatae*.(syn *Isoetion*, *Isoeto-Nano-Juncetea p.p.*); this class is only represented in the Mediterranean zone.

The corresponding EUNIS data base of European palustrian habitats was classified in two main categories:

- C: littoral zone of inland freshwater and
- D: Mire, bog and fen habitats (see annex 1 for details)

Reed beds, Sedge beds were found in this two main categories: C3 (Water- fringing reed beds and tall helophytes other than canes) and D5 (Sedge and Reed beds, normally without free-standing water.

The database have been built on the basis of 336 syntaxa (plant assemblages) with an average of 30 relevés sampled per syntaxon (total of 9977 relevés). The syntaxa have been gathered from European wetlands and some from adjoining countries (see figure 2). A letter was assigned to each syntaxon according to its physiognomic pattern (dominant plants).

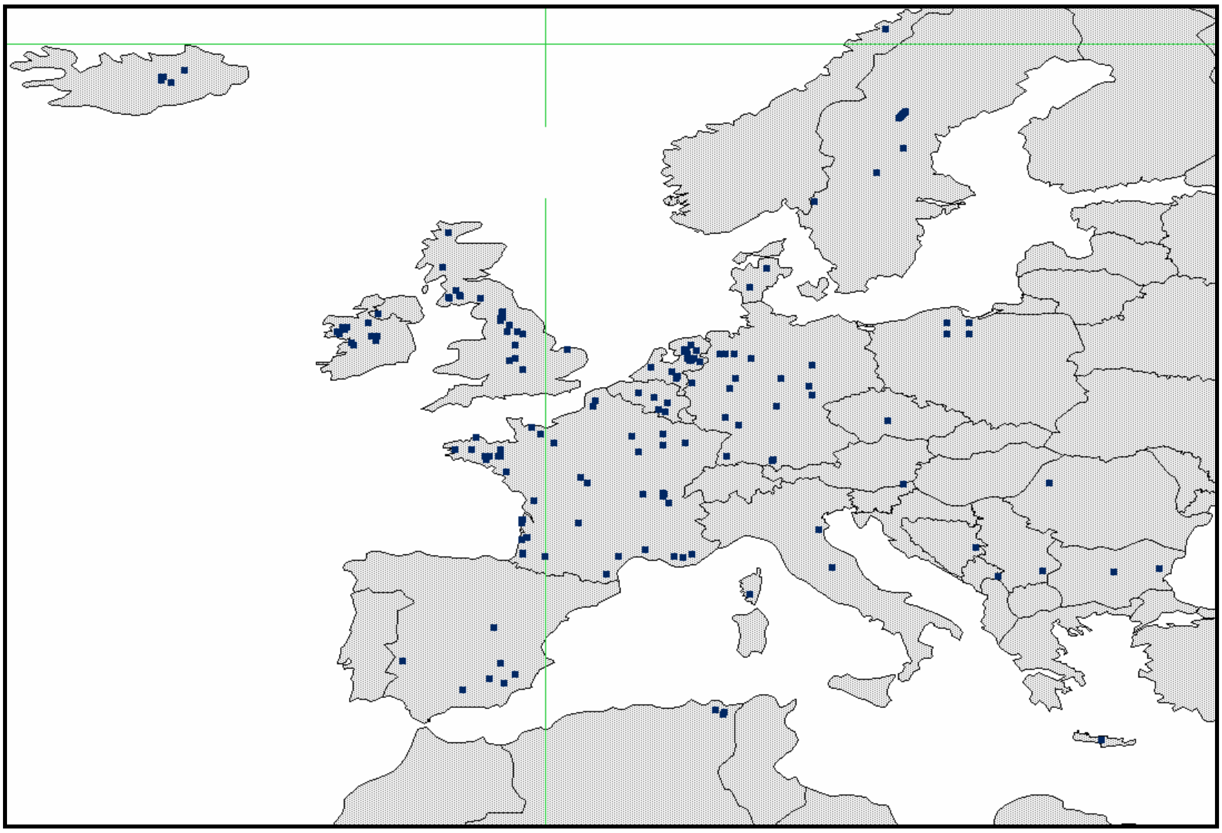


Figure 2. Map showing the mean central location of the collected data of palustrian wetland plant assemblages from Europe and the Mediterranean basin.

In order to reduce inherent bias of such data compilations from several studies, the data base was built according to the following criteria:

- data consistency : eco-climatic and biogeographical representativity;
- syntaxonomy validation according to the phytosociological status in relation with the used sampling design;
- taxonomic relevance: because of existing species synonyms, the taxonomic list was standardised according to current used nomenclature of *Flora Europea* (Tutin *et al.*, 1964–80)..

1.3 Methods

Such vegetation data, based on phytosociological surveys, constitute a valuable source of information regarding the objective of the task at the scale of European area. Originally, the CORINE Biotope classification had been based on the hierarchical phytosociological classification (Devillers *et al.,* 1991).

This approach is based on the floristic composition using the concept of degree of fidelity of plant species to a plant community (Moravec, 1992). Characteristic groups of species are used to organize communities as plant assemblages into a hierarchical classification of syntaxa. A syntaxon is a classification unit at any level of the hierarchy. In the present case, syntaxa are used rather than relevés. Syntaxon groups were determined in phytosociological matrixes by successive rearrangement of rows (species) and columns (syntaxa) until a clear hierarchical pattern. Columns (syntaxa) were compared to assess their degree of similarity, according to multi-dimensional analyses (see below) rather than the classical phytosociological procedure (Gehu and Rivas-Martinez, 1981). A group with a high degree of similarity constitutes a syntaxon group i.e. a community type. The final result of this procedure is a synoptic table representing the identified syntaxon groups. Each species is characterized by a frequency class indicated by a roman numbering from I to V as follows:

I: 1 - 20 % frequency, II: 21 - 40 %, III: 41 - 60 %, IV: 61 - 80 %, V: 81 - 100 %.

"Constant" species are those present in most of the plant associations, often with a high frequency level. The most important species for diagnostic are those which are present with a medium to high frequency, only in few syntaxa in those associations. They are called "differential species or "characteristic" species.

Syntaxa allow detection of multi-species responses along environmental gradients. Syntaxa can be regarded as 'fuzzy sets in an operational context for describing vegetation along ecological gradients in synthetic ways and can further the understanding of vegetation variation' (Biondi et al.,2004). Syntaxon groups are characterized by a recurrent combination of species which can be found in similar ecological conditions. Hence an important and valuable rule in the traditional phytosociological method is primarily the rigorous sampling of homogeneous stands of vegetation.

In order to point out the pattern of the syntaxon distribution, the vegetation data were analysed using Detrended Correspondence Analysis with detrending by segments (DCA, Hill, 1979; CANOCO package, ter Braak and Šmilauer, 1998). The extracted ordination can be interpreted as an environmental gradient that explain affinities between syntaxa regarding their species composition similarity.

To evaluate the importance of environmental and geographical factors, CCA (canonical correspondence analysis) was used. We chose the Ellenberg Indicator Values (IVs see below): F (moisture), N (productivity) and R (reaction/pH) as Environmental factors. Only these information is available through the whole European range as homogenous environmental features.

Latitude and longitude were used as geographical factors that could be linked with ecoclimatic / biogeographic zonation in Europe. Since we analysed syntaxa rather than relevés, the coordinates of syntaxon locations were estimated as a central point according to the importance of the sampling area of the syntaxon (fig. 2).

We used Ellenberg IVs introduced by Ellenberg for Central Europe (Ellenberg et al., 1992) and updated for British plants by Hill et al. (1999, available to download) that give the definition and derivation of Ellenberg values and a list of Ellenberg scores for British plant species. They are derived from the relationship between the presence of species and a characterisation of its environment. The three EIVs used in the present paper, are defined as follows:

F - Moisture

The F (from the German 'Feuchtigkeit') scale runs from 1 (plants living under extreme dryness) to 12 (plants permanently or almost continually under water). Intermediate conditions of moisture are: 5 Moist-site indicator, mainly on fresh soils of average dampness; 7: Dampness indicator, mainly on constantly moist or damp, but not on wet soils, 9: wet-site plant indicators with often waterlogged soil; 11: Plants rooted under water, or floating plants.

N - Nitrogen

Ellenberg N-values are considred as indicators of general fertility (Hill et al., 2000) rather than nitrogen availability in particular. Other authors (e.g. Shaffers & Sykora, 2000) found high correlation between N value and biomass production. The N value is used as indicator of trophic conditions. Its scale is between 1 indicating extremely low trophy and 9, indicator of extremely rich conditions.

R – Reaction

R value indicates soil pH, or water pH but does not mean pH values. The R scale, arbitrary defined, reflects conditions of acidity vs. alkalinity through the plant species composition of a given habitat, with values from 1 indicator of extreme acidity to 9 indicating basic reaction found in calcareous or other high-pH soils or water.

The use of Ellenberg IVs can usefully replace direct measurements of the variables of interest that are usually costly time consuming and therefore expert knowledge is often used instead. An advantage of Ellenberg IVs is that they may be more sensitive to the requirements of plants than it is to a selected variable.

Ellenberg IVs are used at plant community level rather than individual species. Although it is generally claimed that species respond individually to the environment, a vegetation community, representative of a local habitat, can be expressed as a species combination which is more integrative regarding the environment and therefore it is likely to have a stronger indicator value than any individual species (Clément & Proctor, 2006).

In habitat assessment the use of expertises based on indicator values is widespread. IVs can be used to provide information about abiotic environment of a certain plant species assemblage. Usually, many species occur together and one can expect that combinations of their IVs would give more reliable assessment of the environmental conditions than each of the species IVs.

The approach used is definitely a 'space for time substitution' which allows explaining time succession (diachronic process) using space gradients through synchronic approach.

In the context of the present task (WP1, task 4-2) objectives, this approach is based on the assumption that if a species is present in conditions of a warmer part of Europe, it is potentially able to spread into currently colder parts if temperatures increase. The same assumption or hypothesis could be made for plant communities and *in fine* habitats.

The aim of the 24 months investigation (this deliverable) is to determine the pattern of syntaxon distribution of habitats that are now designated by the European EUNIS classification (See annex 1 for details), which replaced the CORINE one. The habitats that are considered in this deliverable are palustrian wetlands.

2 Results

The first division retained separated meso-eutrophic habitats from oligotrophic ones.

2.1 Meso-eutrophic habitats

The first axis of the CCA ordination diagram of meso-eutrophic habitats (fig. 3) has an eigenvalue of 0.548 (Table 1) and represents a clear gradient of moisture, running from mainly common spikerush beds (C3.24A Eunis code) to those wetter of reed beds (C3.21/22/23 Eunis code) or *Cladium* beds (C3.28 Eunis code) (table 2). Regarding the F value, this gradient runs from 7/8 value in the negative part of the axis to 8/10.5 in the positive one. This is confirmed by the high correlation of 0.9344 ($p<0.001$) between the first axis and the F variable (fig. 4).
The second axis (eigenvalue=0.345) is less clearly defined but appears to distinguish habitats with lower trophic level in the top of the diagram. This axis is highly correlated ($p<0.001$) with the N and R values, respectively of 0.9582 and 0.8653 (table 1).

Table . 1 CCA axis eigenvalues and correlations for Meso-Eutrophic habitats.

		Axis 1	Axis 2	Axis 3	Axis 4	Total inertia
Eigenvalues		0.548	0.345	0.263	0.219	16.298
Correlations						
Longitude		-0.275	-0.517	-0.477	-0.294	
Latitude		0.383	0.460	-0.089	0.650	
Ellenberg Iv :	F	0.934	-0.042	-0.163	-0.137	
	N	0.064	-0.958	0.125	0.068	
	R	-0.210	-0.865	-0.208	0.035	

		long	lat	F	N	R
Longitude		1.000				
Latitude		-0.578	1.000			
Ellenberg Iv :	F	-0.123	0.251	1.000		
	N	0.405	-0.388	0.062	1.000	
	R	0.508	-0.447	-0.104	0.818	1.000

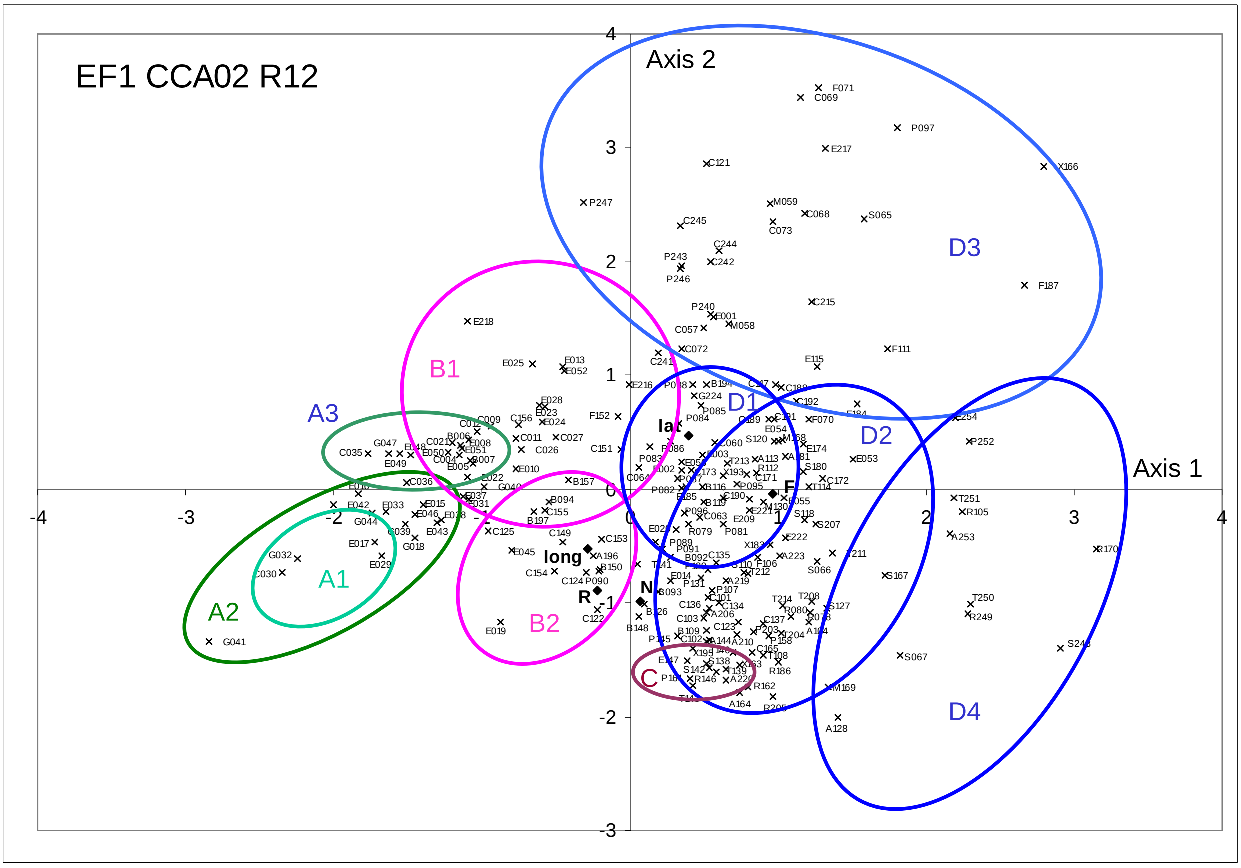


Figure 3. CCA Ordination diagram of the meso-eutrophic habitats

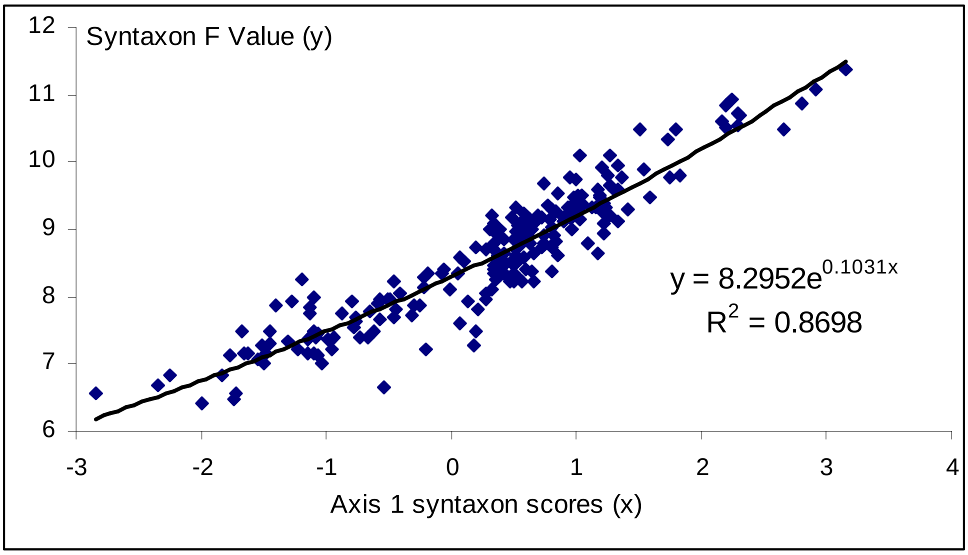


Figure 4. Regression between Ellenberg F value and the first ordination axis scores for the meso-eutrophic habitats.

Table 2. Identified syntaxon groups of meso-eutrophic habitats (see annex 4 for details)

Syntaxon groups	eA1	eA2	eA3	eB1	eB2	eC	eD1	eD2	eD3	eD4
Ellenberg IVs: Moisture (F)	7.1	7.0	7.3	7.6	8.0	8.7	8.4	9.1	9.2	10.4
Productivity (N)	5.4	5.4	5.0	5.0	5.5	5.9	5.6	5.6	3.9	5.7
Réaction (R)	6.6	6.4	6.5	6.2	6.4	6.6	6.4	6.4	5.6	6.5
Common/dominant Species										
Bromus racemosus, Cyperus longus										
Inula britannica, Beckmannia eruciformis.										
Allium angulosum, Cnidium dubium.										
Carex disticha, Senecio aquaticus										
Carex vulpina, C. otrubae, Filipendula ulmaria, Glyceria fluitans.										
Eleocharis palustris, Phalaris arundinacea, Carex acuta										
Phragmites australis, Equisetum fluviatile, Sparganium erectum, Typha latifolia, Glyceria maxima, Carex riparia, Schoenoplectus lacustris, Carex vesicaria, Carex acutiformis.										
Typha angustifolia, Cladium mariscus, Carex elata, Carex paniculata.										
Menyanthes trifoliata, Potentilla palustris, Carex rostrata, Hydrocharis morsus-ranae.										
Hippuris vulgaris, Apium nodiflorum										
Undetermined differential species										
Accidental species										
EUNIS references	**EUNIS codes** (frequent habitat in bold)									
Common spikerush beds	**C3.24A**					C3.24A				
Large sedge beds	D5.21					**D5.21**				
Phalaris beds				**C3.26**						
Phragmites, Schoenoplectus, Typha, water-fringing beds				C3.21/.22/.23				**C3.21/.22/.23**		
Phragmites, Schoenoplectus, Typha normally without free-standing-water				**D5.11/.12/.13**				D5.11/.12/.13		
Cladium beds						**C3.28**				

Density of frequency = total species frequency in the group / number of cells (in %)

(white)	<10	25	10-50	80	50-100	117	>100

The table 2 shows a summary of the synoptic table (annex 4) of meso-eutrophic syntaxon groups. This table is based on the ordination obtained from the multidimensional analyses (DCA and CCA, fig. 3).

The general structure of this table shows that the groups of syntaxa eA and eB mainly correspond to sedge beds with *Carex otrubae*, *C. vulpina*, *C. melanostachya*, *C. disticha*, and *Cyperus longus* (Large sedge beds: D5.21 Eunis code *p.p.*). These vegetation types are characterised by a lot of wet grassland plants that tolerate no more than four months of flooding, during winter to mid spring, growing on longer time waterlogged and medium rich nutrient soils.

The eA1, eA2 and eA3 groups all encompass Mediterranean syntaxa, but their particularities are related to geographical variation from Balkans (eA1), Pannonian (see annex 3) region (eA2) to Central Europe (eA3).

The eB groups reflect a higher moisture level in comparison with the eA groups. No geographical gradient can explain the difference between eB1 and eB2. The group eB2 is differencieted by low frequencies of some reeds such as *Phragmites*, *Typha*, *Glyceria maxima* and large sedges such as *Carex riparia*, *C. vesicaria*. Presence of such tall helophytes indicates that eB2 may represent an intermediate group between medium tall beds and tall reed beds.

This eB2 group could be interpreted as a dynamic stage in term of succession, i.e. an early stage of reed beds predicting a possible change in relation with an increase in the flooding period, in late spring.

The eD groups represent reed beds, tall helophytes and large sedge beds, but also some common spikerush beds. No geographical variation could explain the difference between groups. The major difference is due to a moisture gradient (flooding duration) from about more than 5/6 months (for eD1) to permanently flooded (eD4). The F value (moisture) indicates a gradient (fig. 5) from 8.4 (eD1) to 10.4 (eD4).

eD1 group represents reed beds and large sedge beds associated with tall-herbs or forbs such as *Filipendula ulmaria*, *Valeriana officinalis*, *Epilobium hirsutum*, *Eupatorium cannabinum*… which indicate that those syntaxa belong to the Reed-Beds habitats (D5.1 Eunis code) or large sedge beds (D5.2 Eunis code) 'normally without free standing water'. The higher frequency of forbs and of some grassland plants shows the possible dynamics toward seasonally wet grasslands and tall forb habitats (E3 Eunis code).

eD2 group is a combination of standard or typical reed-beds and large sedge-beds. Moisture value of about 9 (fig. 5) could be considered as the moisture value of optimum development of such plant assemblages.

eD3 group corresponds to reed-beds and large sedge-beds and shows a similar requirement for moisture, but it is differentiated from eD2 by a lower reaction value R and a lower productivity value N (fig. 5). The high frequencies of *Menyanthes trifoliata*, *Potentilla palustris*, *Carex rostrata* and *Epilobium palustre* underline this observation.

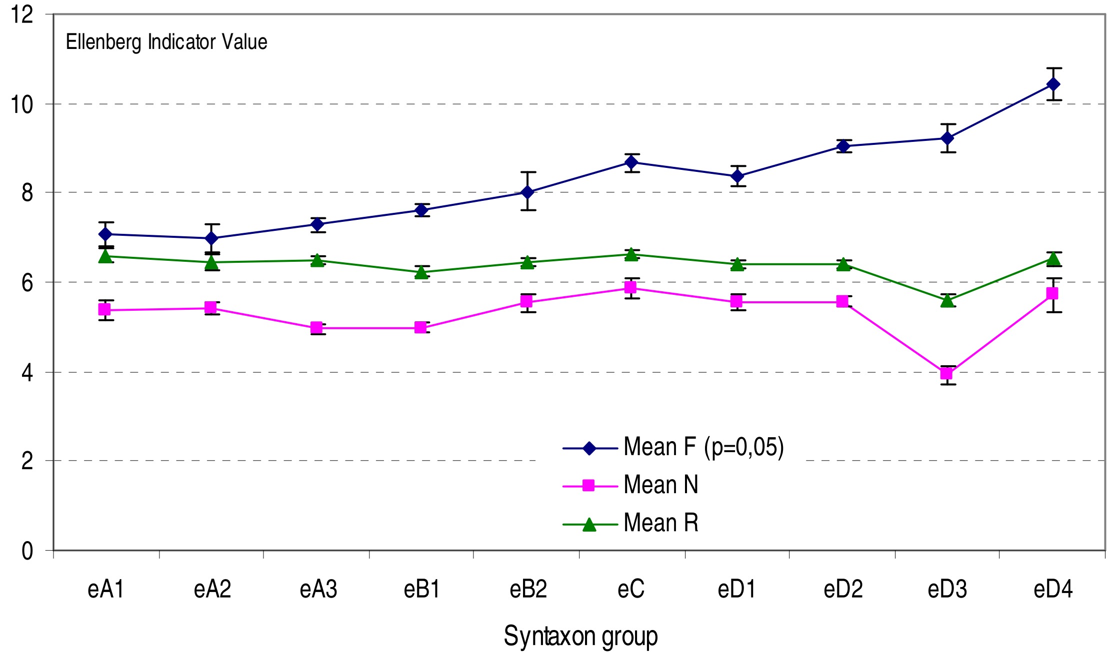


Figure 5. Ellenberg Indicator Values of the meso-eutrophic syntaxon groups.

eD4 group is characterised by the higher moisture value (mean F=10.5) and corresponds to early stage of colonisation of permanent standing water. This group is differentiated by associated aquatic plant species such as *Potamogeton spp*., *Nymphea alba*, *Nymphea lutea*, *Hydrocharis morsus-ranae*…

The eC group is located in the middle of the first ordination axis (fig. 3) and the synoptic table (tabl. 2 and annex 4). All the syntaxa in this group represent reed-beds and sedge-beds from Romania. Each syntaxon is characterised by both aquatic plants and grassland plants. The number of plants per syntaxon is about twice those of all other syntaxa. The explanation hypothesis is that most of the samples had been probably realized on large and non homogeneous area. Each syntaxon had been built on the basis of plant dominance; in consequence such data have been involved in the analyses as a heterogeneous data set, which amplified the species richness by association of grassland and aquatic plant species. For any of these reasons, the C group may be not used as a reference source.

2.2 *Oligotrophic habitats*

The ordination axis 1 of the CCA (fig. 6), with an eigenvalue of 0.753 (tabl. 3), corresponds, as for meso-eutrophic habitats, to a moisture gradient (fig. 7) with a highly significant correlation of this axis with the F value ($r=-0.929$; $p<0.0001$). The first axis represents also a geographic gradient, running from Northern European oligotrophic habitats to Mediterranean ones. The correlation of this axis with latitude is of $r=-0.644$ ($p<0.0001$). Hence, it appears a correlation between F value and latitude which can explained by the existence within the Mediterranean group, of habitats with very short hydrophases indicating a low degree of moisture. The second axis with an eigenvalue of 0.345 but less clearly defined, is correlated with the N value. The CCA ordination diagram (fig. 6) and the synoptic matrix summary (tabl. 4) show a clear disjunction between the temperate and North-West plant communities (*Littoreletea uniflorae* Eunis code C3.41) and the Mediterranean plant communities (*Isoetea velatea* Eunis code C3.42).

Table 3. CCA axis eigenvalues and correlations for Oligotrophic habitats.

		Axis 1	Axis 2	Axis 3	Axis 4	Total inertia
Eigenvalues		0.753	0.453	0.348	0.243	11.759
Correlations						
Longitude		0.171	0.088	0.286	-0.103	
Latitude		-0.644	0.298	-0.188	0.403	
Ellenberg Iv :	F	**-0.929**	-0.104	0.061	-0.045	
	N	**0.530**	**-0.518**	0.431	0.204	
	R	0.427	0.073	**0.724**	0.219	

		long	lat	F	N	R
Longitude		1.000				
Latitude		-0.012	1.000			
Ellenberg Iv :	F	-0.174	**0.585**	1.000		
	N	0.031	**-0.567**	-0.470	1.000	
	R	0.226	-0.319	-0.418	**0.717**	1.000

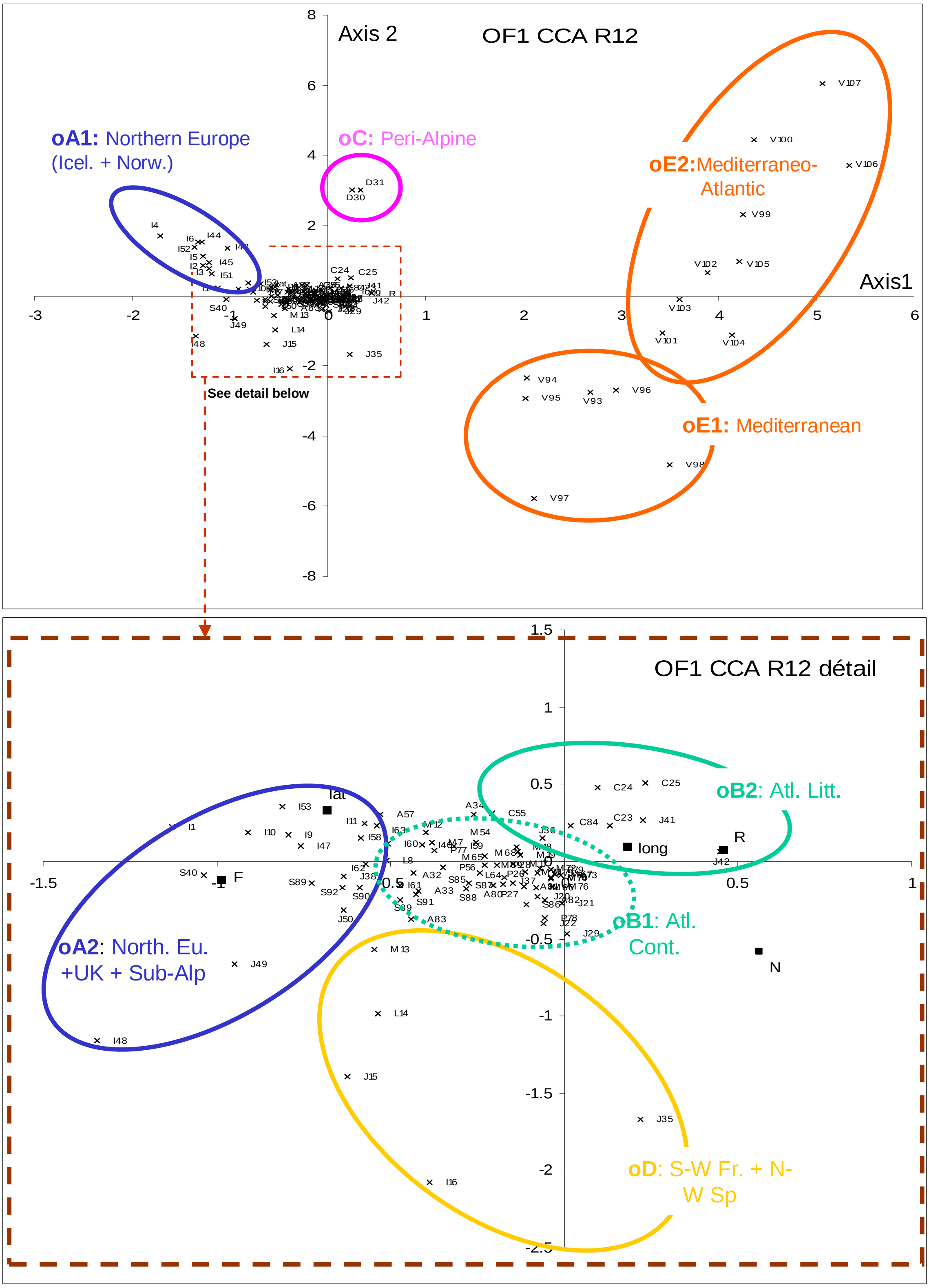


Figure 6. CCA Ordination diagram of the oligotrophic habitats

Table 4. Identified syntaxon groups of oligotrophic habitats (see annex 5 for details)

Syntaxonomical groups	oA1	oA2	oB1	oB2	oC	oD	oE1	oE2
Ellenberg IVs: Moisture (F)	10.8	10.6	9.8	9.0	9.0	10.2	8.1	5.7
Productivity (N)	2.6	2.9	3.1	3.6	3.4	4.0	5.1	3.9
Réaction (R)	5.2	5.1	5.1	5.8	6.5	5.5	5.9	5.7
Characteristic Species Group								
Isoetes muricata, Subularia aquatica, Ranunculus reptans, Ranunculus hyperboreus	>100	10-50			50-100			
Isoetes setacea , Isoetes lacustris, Isoetes echinospora, Lobelia dortmanna , Sparganium angustifolium , Sparganium minimum , Eriocaulon aquaticum	50-100	>100	10-50			10-50		
Carex viridula subsp viridula, Samolus valerandi , Salix repens , Carex trinervis			10-50	>100	50-100			
Deschampsia cespitosa subsp. littoralis , Myosotis rehsteineri, Juncus alpino-articulatus, Allium schoenoprasum					>100			
Juncus heterophyllus , Schoenoplectus americanus, Caropsis verticillatinundatum , Isoetes boryana , Ranunculus omiophyllus						>100		
Eryngium galioides, Eryngium corniculatum, Eryngium pusillum , Mentha cervina, Pilularia minuta , Marsilea pubescens							50-100	
Mentha pulegium, Isoetes velata , Isoetes delilei							>100	>100
Ranunculus paludosus, Ophioglossum lusitanicum, Serapias lingua , Isoetes histrix , Isoetes durieui								>100
Baldellia ranunculoides, Antinoria agrostidea			10-50				50-100	
Littorella uniflora , Juncus bulbosus, Myriophyllum alterniflorum , Eleocharis acicularis, Pilularia globulifera	50-100	>100	>100	>100	50-100	>100		
Baldellia ranunculoides subsp. repens, Hydrocotyle vulgaris , Apium inundatum , Eleocharis multicaulis, Potamogeton polygonifolius , Eleogiton fluitans , Luronium natans, Hypericum elodes		10-50	>100	>100		10-50		
Deschampsia setacea, Ranunculus ololeucos, Molinia caerulea, Eriophorum angustifolium , Potentilla palustris , Anagallis tenella , Carex lasiocarpa, Utricularia intermedia, Carex panicea , Carum verticillatum			10-50	10-50	10-50			
Ranunculus flammula, Eleocharis palustris , Glyceria fluitans , Phragmites australis		10-50	10-50	50-100	50-100	10-50		
Accidental species					10-50		10-50	
Eco-climatical zones	Northern Europ (Icel, Norw)	Northern Europ + North. UK + Sub-Alpine	Atlantic Continental	AtlanticLittoral	S-W Fr + N-W Sp	Peri-Alpine	Mediterranean	Mediterraneo-Atlantic
EUNIS Codes (see annex 1 for references)	C3.4115	C3.4112, 4114	C3.411,412,413	C3.4132	C3.4212 X C3.4112	C3.415	C3.4212	C3.4211
	C3.4113							

Density of frequency = total species frequency in the group / number of cells (in %)

(white) <10	25	10-50	80	50-100	117	>100

Only two characteristic plant species of oligotrophic habitats, *Baldellia ranunculoides* and *Antinoria agrostidea* represent the linkage between the two classes. A wide ecological amplitude is also shown by *Eleocharis palustris*, a companion species, both found in oligotrophic and meso-eutrophic habitats. The Mediterraneo-atlantic group oD (S-W France) also indicates the transition between the temperate and the Mediterranean classes.

A synthesis of the synoptic table (annex 5) is given by the table 4, which identifies syntaxon groups of oligotrophic habitats and their link with the EUNIS classification.
Except for the group oB1 which represent a complex of different syntaxa from temperate area, an appropriate relationship is shown (Figures 6 and 7 and table 4) between syntaxon groups (oA1 to oE2) and their geographical location. The ordination of the oB1 syntaxon (table 4) is more or less linked with a hydrological gradient, the wetter on the left (Physiognomic plant assemblage 'S' with *Sparganium minimum*) to the wettest on the right (Physiognomic plant assemblage 'M' with *Eleocharis multicaulis*) (see annex 5).

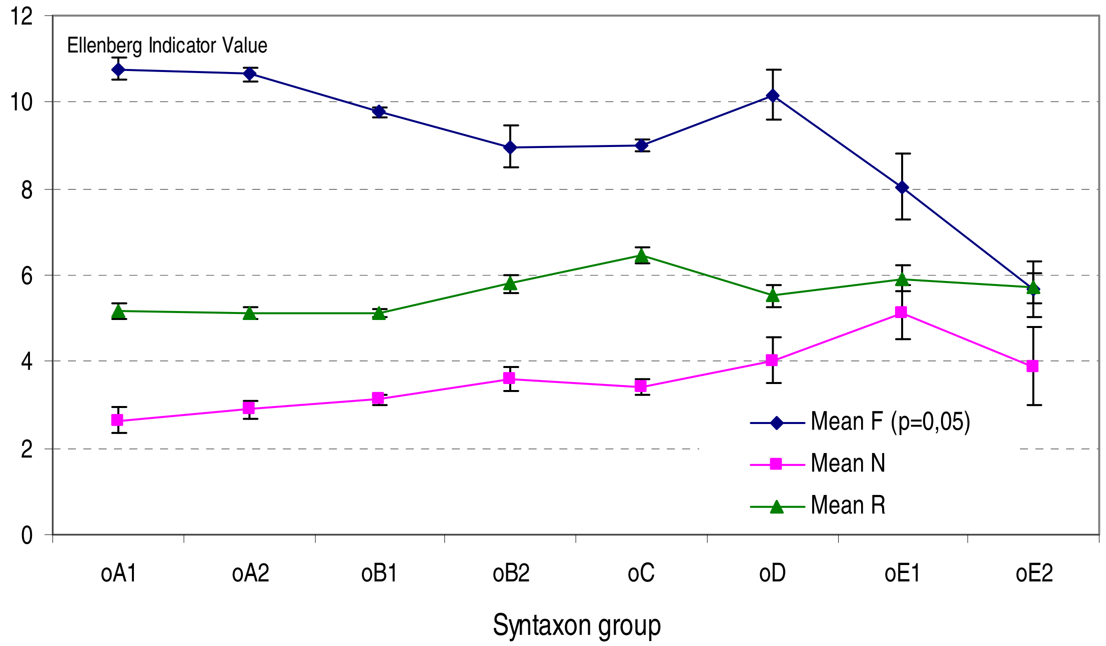


Figure 7. Ellenberg Indicator Values of the oligotrophic syntaxon groups.

3 Discussion

Hydrological factor is the main ecological driver which control plant responses in wetlands (Clément & Proctor, 2006). To minimize this huge factor, we chose to limit the data analysis, at the present stage, to palustrian wetlands as a reduced part of the hydrological gradient. Nevertheless, moisture was the main factor in controlling ordination of plant communities in the analyses both in meso-eutrophic and oligotrophic habitats. As predictive assumption, such responses show clearly that palustrian vegetation and therefore palustrian habitats would be highly sensitive to hydrodynamic variations due to both direct (hydrophase variation) or indirect (hydromorphological change) effects of climate changes.

About other factors, data analyses shown a clearly major differences between meso-eutrophic and oligotrophic habitats.

Comparison of the respective CCA ordination diagrams (tabl. 2, 4 and fig. 3, 6) shown:

- firstly that syntaxon groups of oligotrophic habitats are well discriminated and corresponding to different geographical locations while meso-eutrophic syntaxa shown fuzzy ordination groups.
- secondly that latitude appears as the second factor in the distribution of the oligotrophic syntaxa while fertility (N values) and reaction (R values) are the second drivers in the meso-eutrophic data set.

Comparison of the synoptic tables (tabl. 2 and 4) reinforces this observation. The relative heterogeneity shown in the oligotrophic plant communities (tabl.4) could be explained by the clear distinction between each syntaxon group. This distinction is supported by characteristic plant species defining each group. The relative homogeneity of the table 2 of meso-eutrophic plant communities could be associated with the large assemblage of companion plant species, which belong to most syntaxon groups. The variability is mainly due to associated species (e.g. grassland plant species in eA and eB groups, and aquatic plant species in eD groups).

In conclusion, the widespread geographical distribution of plant species, and plant assemblages of the meso-eutrophic habitats in comparison with to the restricted distribution of most plant species and plant assemblages of oligotrophic habitats suggests that the ecological drivers, and then sensitivity to environmental change would be significantly different.

One can predict that meso-eutrophic wetland habitats that show a fertility value N>5 would not be affected by eutrophication process in relation with climate change and/or land-use change; for instance, Typha beds (EUNIS code C3.23) were found either in northern temperate and Mediterranean regions. Such habitat is considered as the most fertile and the most productive and then it is always associated with eutrophic conditions. This does not mean that all reed or sedge beds respond in the same way; e.g. *Phragmites australis* beds, in spite of its known eutrophy, show a greater variation along the trophic gradient regarding other factors or characteristics.

Oligotrophic habitats (fertility, N<4) would be highly sensitive to climate change at a regional scale, both in terms of temperature increase, and of hydrological change. They would be also highly affected by increasing fertility in the palustrian wetlands in relation with eutrophication processes. This ecological process is linked with increase of temperature in shallow water.and increase of fertilising in surrounding areas of aquatic systems. These results confirm the hypotheses mentioned by Dierssen (1983), considering the loss of *Littorellettea* communities in most European temperate areas

In Mediterranean areas, climate change will be reinforced by the risk of hydrological change, and reduction of the hydrophase in such amphiphytic oligotrophic habitat types.

Littorelletea and *Isoetetea* communities are characterised by small perennial limnophytic and amphiphytic plants, growing in the littoral (eulitoral to infralitoral) of oligotrophic to slightly mesotrophic tarns, lakes and pools, often surrounded by acid heathlands, swamps or mire communities.

The characteristic species have a low competitive ability and the communities are elements of the most endangered ecosystems.

The water table normally shows characteristic changes between the hydrophase and the terrestrial phase during parts of the vegetation period. Productivity is low because of the low concentration of nutrients. A long hydrophase and anaerobic conditions in the sediment might promote the availability of phosphorus and in this way an slight eutrophication. A long terrestrial phase and aerobic conditions results in the higher availability of nitrogen an in a sulfide oxidation. A slight eutrophication is, in most cases, greatly accelerated by artificial eutrophication processes.

A dystrophisation happens mainly in smaller pools, surrounded of acid heathlands and mires.

Isoetid growth forms disappear as soon as pressure of more competitive species, reed swamp species i. e., as well as bentic algae, mud accumulation occurring during eutrophication, and by overgrowing of *Sphagnum* species in dystrophic sites (*Isoetion* and *Lobelion*).

In the three other alliances, helophytic or amphiphytic species predominate but the more productive helophytes (reeds and/or sedges) occupy to some extent the same ecological niche on mesotrophic sites and may succeed in the course of eutrophication through higher competitive ability of meso-eutrophic species.

At the European scale, distinction between meso-eutrophic habitats and oligotrophic ones were done according to their sensitivity to climate characteristics and nutrient availability.

Nevertheless, a hypothesis could be tested in an European area in which the transition between the two systems could be observed. The South-West of Europe offers this opportunity.

Both, the shift of characteristic species and, in contrast, the invariable species could be used for modelling. Invariable or companion species between two habitat types justify the link between the tow different systems.

Figure 8 represents a model built according to comparisons between those systems, on the basis, both of phytosociological and EUNIS classifications. Homologous habitat types exist in Mediterranean area (Southern France and Spain and temperate area N-W Spain and S-W France). Two main ecological gradients explain the link between the four habitats types. Notice that in EUNIS structure, only one type (C3.24A, Common Spikerush beds) represent the two vicariant alliance categories in the high trophic level. Only one species (Common Spikerush: *Eleocharis palustris*) is a constant species belonging to the four different habitat types with different frequency and abundance.

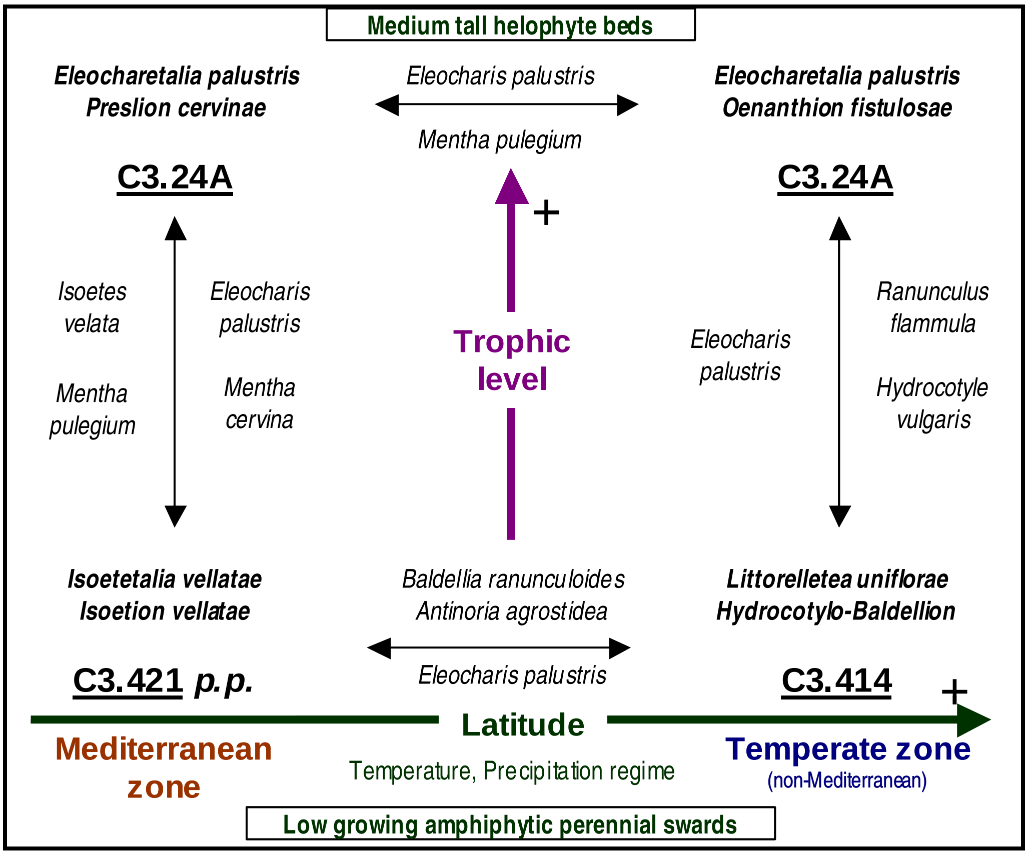
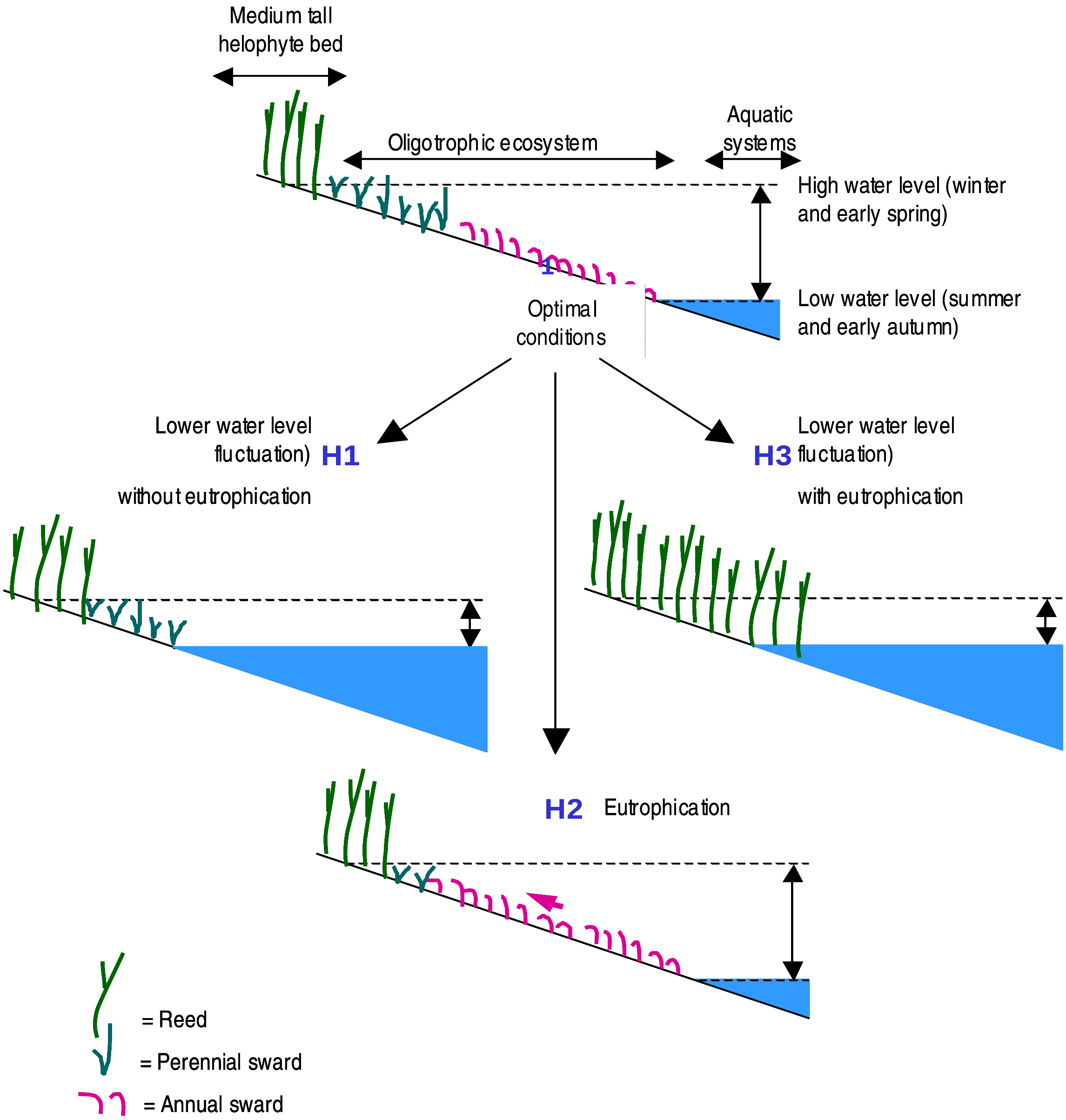


Figure 8. Model specification of potential shift in palustrian habitat types in response to climate and nutrient availability changes.
Inderlined: EUNIS habitat codes
Species between the main habitats are their common invariable or companion species

A temperature increase might induce a shift from temperate or Atlantic oligotrophic habitat types towards eu-Mediterranean habitat types (oligo- or meso-eutrophic).

Increasing nutrient availability, as an indirect consequence of increasing temperature, might induce a shift from oligotrophic habitat types (either temperate or Mediterranean) to mesotrophic habitat types (temperate or Mediterranean), without change in hydrological functioning.

In case of hydrological change, other shifts are likely to occur (fig. 9). Longer standing water or reduction of water level balance might cause development and growth of reed beds (C3.21). By contrast, reducing standing water or increasing terrestrial phase might cause the substitution of perennial beds or swards by annual plant communities: dwarf annual swards of the *Nano-Juncetea bufonii* [EUNIS code C3.51) in oligotrophic systems and tall annual non-graminoid communities of the *Bidentetea tripartitae* [EUNIS code C3.52] in meso-eutrophic systems, within periodically inundated shores [C3.5]. This hypothesis needs to be validated later by empirical analyses.



Figue 9. Ecological trend hypotheses in palustrian system dynamics in response to hydrological or/and trophic changes.

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Annex 1

Part 1: EUNIS habitats referring to wetlands (levels 1 & 2)

EUNIS habitats

A – Marine habitats | out of Eurolimpacs

B - Coastal habitats

C – Inland surface water habitats

C_1 – Surface standing waters | partly wetlands

C_2 – Surface running waters

C_3 - Littoral zone of inland surface waterbodies (e.g. Freshwater *Phragmites* beds, EUNIS code C3.2111 or Common spikerush beds, EUNIS code C3..24A)

D – Mire, bog and fen habitats

D_1 – Raised and blanket bogs

D_2 – Valley mires, poor fens and transition mires

D_3 – Aapa, palsa and polygon mires

D_4 – Base-rich fens and calcareous spring mires

D_5 – Sedge and reedbeds, normally without free-standing water (e.g. Dry Freshwater *Phragmites* beds, EUNIS code D5.111)

D_6 – Inland saline and brackish marshes and reedbeds

E – Grassland and tall forb habitat

E_3 – Seasonally wet and wet grasslands

E_5 – Woodland fringes and clearings and tall forb stands

E_6 – Inland saline and herb-dominated habitats

F – Heathland, scrub and tundra habitats

F_1 – Tundra

F_4 – Temperate shrub heathland

F_9 – Riverine and fen scrubs

G – woodland, forest and other wooded land

G_1 – Broadleaved deciduous woodland

G_3 – Coniferous woodland

G_4 – Mixed deciduous and coniferous woodland
Part 2: EUNIS habitats involved in deliverable 51

C – Inland surface water habitats

- C_3 - Littoral zone of inland surface waterbodies
  - $C_{3.2}$ – Water-fringing reedbeds and tall helophytes other than canes
    - $C_{3.21}$ – [Phragmites australis] beds
      - $C_{3.211}$ – Flooded [Phragmites] beds
    - $C_{3.22}$ – [Scirpus lacustris] beds
    - $C_{3.23}$ – [Typha] beds
      - $C_{3.231}$ – [Typha latifolia] beds
      - $C_{3.232}$ – [Typha angustifolia] beds
    - $C_{3.24}$ – Medium-tall non-graminoïd waterside communities
      - $C_{3.241}$ – Arrowhead communities
      - $C_{3.242}$ – Neglected bur-reed communities
      - $C_{3.243}$ – Erect bur-reed communities
      - $C_{3.244}$ - Sweet flag communities
      - $C_{3.245}$ – Flowering rush communities
      - $C_{3.246}$ – Dropwort-great yellowcress communities
      - $C_{3.247}$ – Water horsetail beds
      - $C_{3.248}$ – Water parsnip communities
      - $C_{3.249}$ – Marestail beds
      - $C_{3.24A}$ – Common spikerush beds
      - $C_{3.24B}$ – Iris beds
    - $C_{3.25}$ – Water-fringe medium tall grass beds
      - $C_{3.251}$ – Sweetgrass beds
      - $C_{3.252}$ – Eurasian [Leersia] beds
      - $C_{3.253}$ – Eurasian [Scolochloa] beds
      - $C_{3.254}$ – Water-fringe [Calamagrostis] beds
    - $C_{3.26}$ – [Phalaris arundinacea] beds
    - $C_{3.28}$ – Riparian [Cladium mariscus] beds
  - $C_{3.4}$ – Species-poor beds of low-growing water-fringing or amphibious vegetation
    - $C_{3.41}$ – Euro-Siberain perennial amphibious communities
    - $C_{3.411}$ – Shoreweed lawns, lobelia ponds, quillwort swards
      - $C_{3.4111}$ - Shoreweed lawns
      - $C_{3.4112}$ - Lobelia ponds
      - $C_{3.4113}$ - Euro-Siberain quillwort swards
        - $C_{3.4114}$ – Floated bur-reed communities
        - $C_{3.4115}$ – Boreo-Arctic lake mud communities

$C_{3.4116}$ – [Myriophyllum alterniflorum] communities

$C_{3.412}$ – Spike-rush shallow-water swards

$C_{3.413}$ – Acid pool fringe shallow-water swards

$C_{3.4131}$ – [Eleocharis multicaulis] communities

$C_{3.4132}$ – Dune slack shoreweed swards

$C_{3.4133}$ – [Pilularia] swards

$C_{3.4134}$ – [Juncus bulbosus] communities

$C_{3.4135}$ – [Scirpus fluitans] communities

$C_{3.4136}$ – [Apium inundatum] communities

$C_{3.414}$ – [Baldellia] shore swards

$C_{3.415}$ – Shore hairgrass swards

$C_{3.42}$ – Mediterraneo-Atlantic amphibious communities

$C_{3.421}$ – Short Mediterranean amphibious communities

$C_{3.4211}$ – Terrestrial quillwort swards

$C_{3.4212}$ – Mediterranean aquatic quillwort swards

D – Mire, bog and fen habitats

D_{5} – Sedge and reedbeds, normally without free-standing water

$D_{5.1}$ – Reedbeds normally without free-standing water

$D_{5.11}$ – [Phragmites australis] beds normally without free-standing water

$D_{5.111}$ – Dry freshwater [Phragmites] beds

$D_{5.12}$ – [Scirpus lacustris] beds normally without free-standing water

$D_{5.13}$ – [Typha] beds normally without free-standing water

$D_{5.131}$ – [Typha latifolia] beds normally without free-standing water

$D_{5.132}$ – [Typha angustifolia] beds normally without free-standing water

$D_{5.2}$ – Beds of large sedges normally without free-standing water

$D_{5.21}$ – Beds of large [Carex] ssp.

$D_{5.211}$ – Brown sedge beds

$D_{5.212}$ – Slender tufted sedge beds and related communities

$D_{5.2121}$ – Slender tufted sedge beds

$D_{5.2122}$ – Lesser pond sedge beds

$D_{5.2123}$ – Inn sedge beds

$D_{5.2124}$ – Banat sedge beds

$D_{5.2125}$ – Water sedge beds

$D_{5.2126}$ – Brotero sedge beds

$D_{5.2127}$ – [Carex melanostachya] beds

$D_{5.2128}$ – [Carex hispida] beds

$D_{5.213}$ – Greater pond sedge beds

$D_{5.214}$ – Bottle, bladder and slender sedge beds

$D_{5.214\ 1}$– Bottle sedge beds

$D_{5.214\ 2}$– Bladder sedge beds

$D_{5.214\ 3}$ – Slender sedge beds

$D_{5.215}$ – Tufted sedge and sward sedge tussocks

$D_{5.2151}$ – Tufted sedge tussocks

$D_{5.2152}$ – Sward sedge tussocks

$D_{5.216}$ – Greater tussock sedge tussocks

$D_{5.217}$ – Smaller tussock sedge tussocks

$D_{5.218}$ – Cyperus sedge tussocks

$D_{5.219}$ – Fox sedge tussocks

$D_{5.2191}$ – True fox sedge tussocks

$D_{5.2192}$– False fox sedge tussocks

Annex 2

Phytosociological hierarchical classification of palustrian vegetation in Europe

- Class *Phragmiti australis – Magnocaricetea elatae* (**Reed and large Sedge beds**)
    - Order *Phragmitetalia australis* (**Reed beds**)
        - § Alliance *Phragmition communis*
        - § Alliance *Oenanthion aquaticae*
        - § Alliance *Phalaridion arundinaceae*
    - Order *Magnocaricetalia elatae* **(large Sedge beds**)
        - § Alliance *Magnocaricion elatae*
        - § Alliance *Caricion gracilis*
- Class *Agrostietea stoloniferae p.p.* (**Spikerush beds**)
    - Order *Eleocharitetalia palustris* (**Spikerush beds**)
        - § Alliance *Oenanthion fistulosae*
        - § Alliance *Cnidion venosi p.p.*
        - § Alliance *Preslion cervinae*
        - § Alliance *Beckmannion eruciformis*

- Class *Littorelletea uniflorae* (**non-Mediterranean low growing amphiphytic vegetation**)
    - Order Littorelletalia uniflorae
        - § Alliance *Littorellion uniflorae*
        - § Alliance *Lobelion dortmannae*
        - § Alliance *Elodo palustris-Sparganion* (syn *Hydrocotylo-Baldellion*)
        - § Alliance *Eleocharition acicularis*
        - § Alliance *Deschampsion littoralis*
        - §
- Class *Isoetetea velatae p.p.* syn. *Isoeto-Nano-Juncetea buffonii p.p.* (**Mediterranean low growing amphiphytic vegetation**)
    - Order *Isoetetalia vellatae*.(syn *Isoetetalia durieui*)
        - § Alliance *Antinorio agrostidae – Isoetion velatae (syn. Isoetion p.p.*)
        - § Alliance *Ophioglosso lusitanici – Isoetion histricis (syn. Isoetion p.p.*)

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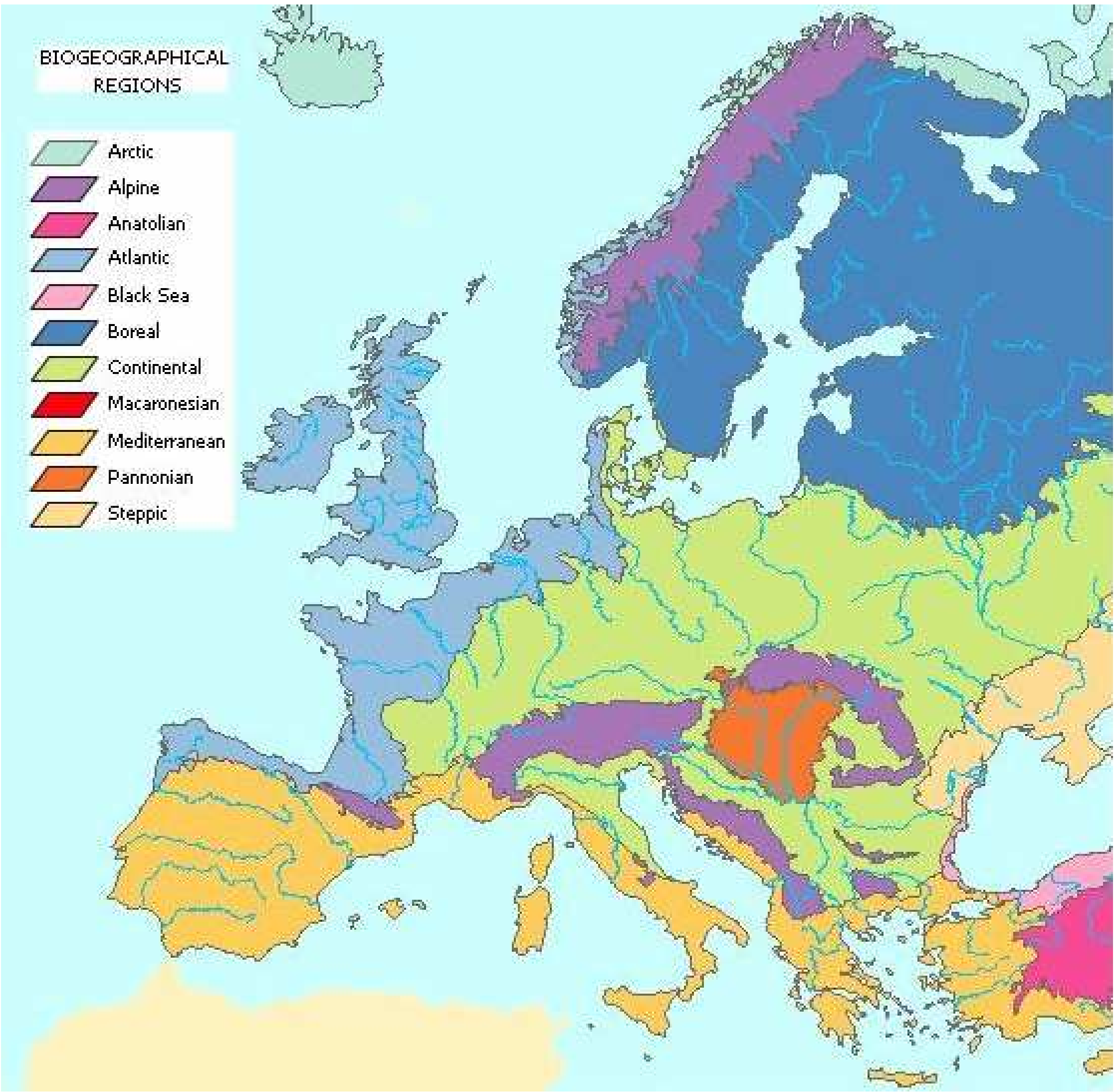
Annex 3

Biogeographical regions in Europe



Annex 4

Synoptic table of European Meso-Eutrophic Palustrian Habitats

Meso-Eutrophic habitats (e)			eA1	eA2	eA3	eB1	eB2	eC	eD1	eD2	eD3	eD4
			Syntaxon Groups									
Syntaxon number			ECGEC	EEECEGGEEG	EGEEEBEEE	CCEEGCECECCCEEEEEEEECBE	CECCBCABE	CCSTTTSTAPFEBBCFC	PPPPPPPPSPEMPCCCCPPPBBEPPCCCRR	RSFGEEEEEEECCCAFPTBSRATBCSBCBPPRXACMCCCEPSAXFERCCCCCXBXPTRASTEATTTTAAEEAG	CCECMMSCCFCPFECXFCEPCPCCPR	SFTTPAEMRSSARS
			00000	0000000000	000000000	00000000000010000002000	101111101	11111111111111111	000000001101111110000020000000	000000000011111111111111111111111111111111111111111111122222222222222222222	20000000000011111222222222	22222221111110
			23333	1123334444	444450005	12334011422522221510010	215495995	22334444444445555	888888882253333338999919966677	786712100555000000001111111225666666777778888888899999900000000111111122222	47055566677911268114444444	44555556726206
			90235	6726891234	678907851	21170901567643853284650	594975647	24890123456780123	123456780960145679012365603489	060804233451234678902346789368123458123470134568901234534567890123490123 4	12178958913715167570234567	89012349077857
Number of relevés per syntaxon			2131 1	11112 111	171 1541	12 25 2 118622 10 1	11 515 1	21 11011639234 32 9	111211 2111 1 1 1 63227 41 2	12 12241 1 1 1 2 122 11 2 1 9 39101143222 251 0111 3	1 32 23 1 121 2 1	11
			30170	8690297805	90541693	7557436706580787347169	337715905	5028524240529233	21127676483211422084105623508	858278676523644492273472111273213232168935967705732007542816591163546915 1	42870481174832428513737497	3635555
Number of species per syntaxon >			34443	1142221221	456 64432	21232322243524544113 1	6 2848312	1 7819638474463760	1 44467423234 131411342222 34323	2 1 323123222211 22323134513 12111 21351211114212111 1 1 112 313221442 4	223211312 111 5 115526344	1123432 131111
Nb sp. occurrences v			21178	6689093809	72957384 5	22020177647430067597 1	097220625	8264042969352337	036502714979277089874096 32930	061953132086104788472618468323850324373143629012807806415280216194123900 1	35092824599979285679800397	35245979122069
Galium debile	Gade	8	II V IV I							I I I	II	
Alopecurus rendlei	Alre	5	II V V II V									
Poa trivialis ssp sylvicola	Pots	5	II V V V III									
Trifolium patens	Trpa	5	III II V	I		II						
Ranunculus marginatus	Rama	4	II V V I									
Tragopogon pratensis	Trpp	4	II V IV III									
Bromus racemosus	Brra	6	V IV I V			III I						
Cyperus longus	Cylo	5	II III III V IV									
Lythrum virgatum	Lyvi	25	V V I I	II IV I	II III I IV	II	I I I	III I I I # I I I				
Festuca pratensis	Fepr	23	V I II V	I	II III III I I II	I II I I I IV I III	II I I					
Trifolium fragiferum	Trfr	23	II V V V V	I II I II V II	I I I	V I II I II I I	I	I				
Inula britannica	Inbr	21	II IV II	III III I II IV I	III IV V IV V I I III	III	III I	I				
Mentha pulegium	Mepu	20	V V IV I	I IV IV IV IV II		III IV	II	I I I I I		IV	I	
Plantago lanceolata	Plla	19	V III II IV	II II II	III I III III I	I I II III II	I					
Plantago major	Plma	19	II I I I	I I I I I III	II I II I	I I I		I				
Ranunculus sardous	Rasa	19	I I II	IV II II II I I III		III	I I	I I I I II I				
Lotus tenuis	Lote	13	I II	III III II I	II III I				I	I		
Trifolium resupinatum	Trrs	13	II V V III IV	II III II		IV III V	II I					
Leucojum aestivum	Leae	12	I III	I	II III II III	IV IV	II I					
Juncus compressus	Juco	11	IV	I II II		II	II II I	I I				
Juncus gerardii	Juge	10	V II	III I II	III I I	II	I					
Prunella vulgaris	Prvu	10	I III	II	I III III II		I					
Scutellaria hastifolia	Scha	10	II I I		I I III			I II I				
Beckmannia eruciformis	Beer	9	III II	V II I IV II		III IV						
Rorippa kerneri	Roke	8	V II II	III II V III				I				
Carex distans	Cads	7	V III			III	II I I					
Elytrigia repens	Elre	24		I IV	II II I III I III II III	II I I I I	IV III	I	II I I	I I II		
Rorippa sylvestris	Rosy	19		II IV	IV II II II II	III V	I I III I	I V I I			III	
Achillea ptarmica	Acpt	16		III	II III III	II I II II I II II III IV	III I			I		
Leontodon autumnalis	Leau	16		II I II	III II II I III	I I I II I I II II						
Juncus atratus	Juat	11	II		III I II V	I	I	I I I				
Serratula tinctoria	Seti	6			I V II IV V II							
Veronica longifolia	Velo	6			III II II III II	IV						
Sanguisorba officinalis	Saof	4			III II III II							
Carex tomentosa	Cato	3			III I I							
Trifolium dubium	Trdu	3			I II I							
Cnidium dubium	Cndu	4			III III V	II						
Inula salicina	Insa	3			I I I							
Allium angulosum	Alan	8			I IV IV IV II I I II							
Iris sibirica	Irsi	3			I I I							
Senecio aquaticus	Seaq	15			II II III III I	IV II I III V	II				II I I I	
Carex disticha	Cadt	20			II I IV II	IV IV V II I II	IV III	I		I I II	I IV I II	
Trifolium pratense	Trpr	15			II II II I	I I I I I	I II I IV	I I				
Lathyrus palustris	Lapa	14			I I I I V V	II III	I	I	I IV III I			
Trifolium hybridum	Trhy	14			II I V III II	III	II I II II	I I I				
Euphorbia palustris	Eupa	12			II	I V	I	I I I I I I I				
Silaum silaus	Sisi	7			I I II II	I I	II					
Myosotis laxa subsp. caespitosa	Mvlc	25	IV III III IV	I II	I I	IV III IV I III II IV			II I II I II	I I I	I I	
Carex otrubae	Caot	14	V II V	IV		III IV I I	II	III I	II II	I		
Carex hirta	Cahi	37	III I II IV	I I	II II	IV II II II I I I I I II	III II I II	I I I III I II I I I	I	II I I I		
Oenanthe fistulosa	Oefi	37	V II III IV	V	I I IV V V	V V V V IV V III V III V V	III II	I III	II IV IV I	I IV I III I I		
Lysimachia nummularia	Lynu	62	I IV I V V	II II III III II I II	II V V V V I III II	II III I IV I III III I I III IV I IV	III III III III II	IV II II I I II III I II I I I II I II I II	I	III I II I III I		
Rumex crispus	Rucr	48	V V	III IV I II II	III II III IV V II	III II V I III II I II II II I I	I I IV I I	I I I I I	I II I I I	I III I I I I I		
Potentilla reptans	Pore	45	IV V V II	II II III III II II	IV IV V V V V II II III	IV IV III I I III I II I I II III	I V III III I II	I I I	I	II I # # #		
Gratiola officinalis	Grof	41	IV V III I II	IV IV IV I II	IV V III V V I V III V	V IV V IV II	I III II	II II I I I I I I I II		II I I	I	
Oenanthe silaifolia	Oesi	34	III V III I II	I II I II I III	I I I I I II I	IV V II I II II IV	II II	I I III I I I I				
Taraxacum officinale	Taof	33	II V IV IV IV	I I II II	III V IV IV III I II	II I I I I I II I I I I III	I I	I I				
Carex melanostachya	Came	24		III I II III	II I III I	V	II V II I	III II I I I I II I I II		I		
Trifolium repens	Trre	37	II	II II II I IV II	I I III III I III IV	III III III I I I II IV IV II II II	II II II	I I I I	I	I	I II	
Alopecurus pratensis	Alpr	36	I	II I II II V I V	IV V V V V II III II	III III II II I I I II V	I II II I I II	I I II I I II				
Carex vulpina	Cavu	36	V	III I I II	IV IV V II I II	III V IV V II II V	V III II IV V I V	II III I I I I II III I I				
Alopecurus geniculatus	Alge	35		III V II III II	I II II I	III I V I II II I II I	I	I I I I II I I	I I	I I III I I	II II	
Potentilla anserina	Poan	33		I	I I I III I	II I III I I II II I III II	I I I	II I I	II II I	I I II	III I I	
Mentha arvensis	Mear	28		III	II III IV V I II II	I I V III	III II	I I I III I I		II IV II III III I		
Ranunculus acris	Raac	26	V	II	IV III III III III	I III I I	II I I I	I I I I	I I I	I I	I I	
Stellaria palustris	Stpl	25		I	I II IV I I II	IV I I II V I I II II I IV	III I	I I II III	I II III		III	
Poa pratensis	Popr	19		IV	II V III IV II	I I I I	II II I I	I I III I I				
Deschampsia cespitosa	Dece	14			I III II	III II I II	I I II	II I I			I	
Rumex acetosa	Ruac	14			I II I I	I I II I V I			I II		II I	
Anthoxanthum odoratum	Anod	13	V		I I I	II I I IV I			I		I I II	
Eleocharis uniglumis	Elun	13		V	II	II I I I II V I II	III		II	II		
Poa trivialis	Potr	55		I I II	I II I IV IV II V	IV V II I III I I II II IV II I I I I III	II III I I II II	I I I III I IV I I II	I I I I I I I I I I I I	I I		
Cardamine pratensis	Capr	54		III	III V V V II IV I	III I II II IV I II IV V II II III III	I I I II I	I I I I II II I	I II II II III II I I I I I		III III I I I II II III V II II	
Lychnis flos-cuculi	Lyfl	38	V	I	I IV IV II III III	II III I II I III II IV I III	II I II	I III II I I II II	I II II II I I I I	I V	I II I	
Symphytum officinale	Syof	39	III	I	II III V V V	I IV I IV I	III III V I III	III III II I I I # II II I I V III I II	I II II	I V I III		
Poa palustris	Popa	32			II II V IV V V	I II I	III III I V	II II I I II I II I I I I IV III II II		III V V		
Teucrium scordium	Tesc	23			I I I I I I	I III I	II III	I I I I I I		II I III II II		

Lathyrus pratensis	Lapr	19
Valeriana officinalis	Vaof	21
Galium uliginosum	Gaul	18
Carex panicea	Capn	18
Vicia cracca	Vicr	17
Holcus lanatus	Hola	30
Equisetum palustre	Eqpa	37
Filipendula ulmaria	Fiul	53
Lotus uliginosus	Loul	25
Scirpus sylvaticus	Scsy	18
Juncus acutiflorus	Juac	23
Glyceria fluitans	Glfl	49
Hydrocotyle vulgaris	Hyvu	40
Carex nigra	Cani	22
Agrostis canina	Agcn	19
Galium palustre	Gapa	147
Lythrum salicaria	Lysa	127
Eleocharis palustris	Elpa	122
Agrostis stolonifera	Agst	107
Mentha aquatica	Meaq	106
Phalaris arundinacea	Phar	103
Polygonum amphibium	Poam	91
Ranunculus repens	Rare	83
Lysimachia vulgaris	Lyvu	82
Caltha palustris	Capu	62
Carex acuta	Caac	30
Ranunculus flammula	Rafl	62
Myosotis scorpioides	Mysc	75
Rorippa amphibia	Roam	63
Juncus effusus	Juef	58
Stachys palustris	Stpa	47
Juncus articulatus	Juar	48
Veronica scutellata	Vesc	36
Bolboschoenus maritimus	Boma	19
Senecio paludosus	Sepa	20
Thalictrum flavum	Thfl	12
Veronica anagalloides	Vean	9
Phragmites australis	Phau	100
Alisma plantago-aquatica	Alpl	82
Equisetum fluviatile	Eqfl	82
Lycopus europaeus	Lyeu	82
Iris pseudacorus	Irps	78
Sparganium erectum	Sper	72
Lemna minor	Lemi	67
Typha latifolia	Tyla	62
Solanum dulcamara	Sodu	62
Glyceria maxima	Glmx	58
Carex riparia	Cari	54
Schoenoplectus lacustris	Scla	48
Scutellaria galericulata	Scga	48
Carex vesicaria	Cave	46
Oenanthe aquatica	Oeaq	40
Carex acutiformis	Caaf	31
Epilobium hirsutum	Ephi	37
Eupatorium cannabinum	Euca	25
Calystegia sepium	Case	41
Rumex hydrolapathum	Ruhy	42
Berula erecta	Beec	24
Carex pseudocyperus	Caps	22
Typha angustifolia	Tyan	43
Urtica dioica	Urdi	25
Calamagrostis canescens	Caca	13
Alnus glutinosa	Algl	11
Peucedanum palustre	Pepl	7
Sisymbrium officinale	Siof	6
Arrhenatherum elatius	Arel	5
Impatiens capensis	Imca	5
Cirsium arvense	Ciar	19
Galium aparine	Gaap	18
Nasturtium officinale	Naof	11
Scrophularia auriculata	Scau	10
Galium palustre subsp. elongatum	Gape	9
Salix cinerea	Saci	31
Angelica sylvestris	Ansy	28
Juncus subnodulosus	Jusu	21
Cladium mariscus	Clma	16
Thelypteris palustris	Thpa	15
Cirsium palustre	Cipa	23
Carex elata	Cael	27
Carex paniculata	Capc	25
Ranunculus lingua	Rali	21
Oenanthe crocata	Oecr	8
Menyanthes trifoliata	Metr	29
Potentilla palustris	Popl	40
Carex rostrata	Caro	36
Epilobium palustre	Eppa	26
Nymphaea alba	Nyal	21
Carex lasiocarpa	Cala	15
Potamogeton natans	Pona	24
Sagittaria sagittifolia	Sasa	21
Lemna trisulca	Letr	28
Spirodela polyrhiza	Sppo	23
Cicuta virosa	Civi	26
Hydrocharis morsus-ranae	Hymo	21
Ceratophyllum demersum	Cede	11
Lobelia dortmanna	Lodo	7
Potamogeton perfoliatus	Popf	8
Nuphar lutea	Nulu	13
Elodea canadensis	Elca	11
Potamogeton lucens	Polu	6
Myriophyllum spicatum	Mysp	7
Ranunculus circinatus	Raci	8
Stratiotes aloides	Stal	7
Potamogeton friesii	Pofr	7

Hippuris vulgaris	Hivu	15							II	II II II V I # II	II I I V I I	I
Apium nodiflorum	Apno	11							I I I I II I	I	I II I II	
Potamogeton gramineus	Pogr	11								II II II II I I II I	I	I II
Ranunculus peltatus	Rape	8								I II II II II I I	II	
Utricularia australis	Utau	8								V I III II II I	III	I
Baldellia ranunculoides	Bara	12								III I I IV II	II IV I I II II II	
Utricularia vulgaris	Utvu	12						I I I I I	I I		II I I I I	
Eriophorum angustifolium	Eran	10						I I I	I		II I II I I II	
Molinia caerulea	Moca	10							II I I II	I	I IV I I IV	
Carex diandra	Cadi	9						I II I	I		II I I II II	
Potamogeton polygonifolius	Popo	9								II I I	I II II III I I	
Utricularia minor	Utmi	7									I I I IV I I I	
Littorella uniflora	Liun	6							I	I I	V I IV	
Schoenus nigricans	Scni	6							I		V I I I II	
Sparganium emersum	Spem	16								I I I V II II I I # I III	V II II	V V
Sium latifolium	Sila	21					I I	II II I I II I I V I	I IV I	I IV III IV	I I I	
Polygonum hydropiper	Pohy	21				I		I I III I III I I	I I II	I II II II I I II	II II	V
Carex gracilis	Cagr	19				I	II I V I	II V I I I I IV I I		II		I
Alisma lanceolatum	Alla	18					I I I I	I I I I I II I I I		IV I III II		
Juncus inflexus	Juin	15				III	III I	II I I I III I I I	I I I			
Bidens tripartita	Bitr	19						I II I III I III II I I I I		II I I III I I I		
Butomus umbellatus	Buum	16					II	I II II III II II II II II II		I II II		
Veronica anagallis-aquatica	Veaa	16					II	I I I I I I III I I	I II	I I III		
Glyceria plicata	Glpl	15					I I	I I I I I I II I I I I		I I		
Veronica beccabunga	Vebe	13				I		I I I I I II I I	I	II I		
Leersia oryzoides	Leor	12						I I I I I I I I		I II I V		
Ranunculus sceleratus	Rasc	10						I I I II I I I		V II		
Alopecurus aequalis	Alae	9						I I I I		II I I I I		
Salvinia natans	Sana	8						I I II I # I II		I		
Lycopus exaltatus	Lyex	8						I I I I I I		I		
Rorippa austriaca	Roau	8					I	I I I II I I I				
Myosoton aquaticum	Myaq	7					I	I I I I I				
Epilobium parviflorum	Eppr	18						I I I I III I I	I I I I II I	I I I I	I	I
Lysimachia thyrsiflora	Lyth	16						I		II IV I II I III II I V IV I		II I I I
Pedicularis palustris	Pepa	15				II		I I I	I III I		I I I I I II I II	
Succisa pratensis	Supr	11			I I			I I		I	I I II I II V	
Epilobium obscurum	Epob	8								V I I	II I IV I I	
Carex viridula subsp. Brachyrrhyncha	Cavi	7						I	I		I I I III	
Festuca rubra	Feru	6				II II			I		I II V	
Veronica serpyllifolia	Vese	4		II II	II II							
Juncus bulbosus	Jubu	16							I	I II I I I I IV I	I II III III	I I II
Schoenoplectus tabaernaemontani	Scta	10				I	I II	I I I I		I I I		
Acorus calamus	Acca	10					I I	I IV		V I II		I I I
Polygonum persicaria	Pope	9							II I	I II I I I I I		
Rubus fruticosus	Rufr	9					I		I I I I I I II I			
Myosotis palustris	Mypa	8						I I		III I II III IV	II	
Achillea millefolium	Acmi	7			I I	I	I I	I I				
Bidens cernua	Bice	7						I I		II II I II	II	
Dactylorhiza incarnata	Dain	7					II	I I I	I I			
Eleocharis acicularis	Elac	7								II I I V I II		I
Glyceria declinata	Glde	7								V II V II III II	II	
Lolium perenne	Lope	7	V I		I I	I I						
Callitriche hamulata	Caha	6							I	II IV II II	II III	
Callitriche palustris subsp. stagnalis	Capt	6							I I I II	I I		
Carex appropinquata	Caap	6						III	I II		II I I	
Cirsium canum	Cica	6	I II		I I		I					
Cirsium rivulare	Ciri	6				I	I I	I I I				
Echinochloa crus-galli	Eccr	7					I	I I # I I I		I		
Eriophorum latifolium	Erla	7					I	II # I I			I IV	
Hordeum secalinum	Hose	6	V	II	I I	II I						
Juncellus serotinus	Juse	6					I	I I I I I				
Juncus conglomeratus	Jucn	6		I II			I	I I				
Mentha longifolia	Melo	7					I	I # I I I				
Peplis portula	Pepo	6								II II I II I	II	
Polygonum lapathifolium	Pola	6					I	I I I I				
Urtica kioviensis	Urki	6						I I I		I IV III		
Carex ovalis	Caov	5	V			I I	I	I				V
Centaurea jacea	Ceja	5			II II I	II IV						
Hypericum tetrapterum	Hyte	5						I	I I I		I	
Marsilea quadrifolia	Maqu	5						I I II I I				
Mentha cervina	Mece	5		V V		V	II			III		
Myrica gale	Myga	5							I II II		I II	
Myriophyllum alternifolium	Myal	5								I	I V II	I
Orchis palustris	Orpa	5	II				I I	I	I			
Potamogeton pectinatus	Popc	5								I		I I I II
Ranunculus ophioglossifolius	Raop	5	I II	I		V				I		
Rubus caesius	Ruca	5					I II		I	I V		
Juncus bufonius	Jubf	4								I I	II I	
Myriophyllum verticillatum	Myve	4						I I II				I
Alisma gramineum	Algr	4						I		I II		II
Althaea officinalis	Alof	4					I I I	I				
Calamagrostis epigejos	Caep	4					I	I I	II			
Carex praecox agg.	Capx	4		II	II V II							
Cerastium dubium	Cedu	4		I III	II I							
Cynodon dactylon	Cyda	4	V I I		III							
Cyperus fuscus	Cyfu	4						I I I II				
Elatine alsinastrum	Elal	4								II II I I		
Frangula alnus	Fral	4							I I	II	II	
Glechoma hederacea	Glhe	4					I	I	I	I		
Lemna gibba	Legi	4							I I I			I
Orchis laxiflora	Orla	4				III		I I I				
Polygonum mite	Pomt	4						I II I		I		
Potentilla erecta	Poer	4									I I IV V	
Pulicaria dysenterica	Pudy	4	V						I I I			
Rumex aquaticus	Ruaq	4				II	I	I I				
Rumex conglomeratus	Ruco	4								I II I I		
Salix repens	Sare	4							II I I		II	
Stellaria graminea	Stgr	4					I	I I I				
Teucrium scordium subsp. scordioides	Tess	4	V I			III II						
Thalictrum lucidum	Thlu	4			II I	III I						
Trapa natans	Trna	4								II I I I		
Typha laxmanii	Tylx	4						I I I V				
Valeriana dioica	Vadi	4							I I I		I	
Agrostis tenuis	Agte	3								I I II		
Armoracia macrocarpa	Arma	3						I I I				
Bidens vulgatus	Bivu	3						I I I				
Cardamine amara	Caam	3							I	II II		
Carex cespitosa	Cace	3					I	I I				

Carex cuprina	Cacu	3			II	IV IV						
Carum verticillatum	Cavr	3				I			I	I		
Catabrosa aquatica	Caat	3						I I		V		
Cichorium intybus	Ciin	3	V II				I					
Clematis integrifolia	Clin	3			II II	I						
Eleogiton fluitans	Elfl	3							II	I I		
Epilobium angustifolium	Epan	3							I	I I		
Epipactis palustris	Epip	3							I		III III	
Festuca arundinacea	Fear	3				II	III		II			
Galega officinalis	Gaof	4						I # I I				
Myosotis laxa	Myla	3									II I I	
Oenanthe globulosa	Oegl	3				IV				II III		
Oenanthe peucedanifolia	Oepe	3	V			III I						
Polygonum aviculare	Poav	3						I	I	I		
Polygonum minus	Pomi	3						I		I I		
Potamogeton compressus	Pocm	3								I I		I
Pulicaria paludosa	Pupa	3		V			V			V		
Ranunculus aquatilis	Raaq	3						I	I		II	
Rhinanthus minor	Rhmi	3							I I I			
Rorippa islandica	Rois	3						I		I I		
Rumex maritimus	Ruma	3								I I I		
Rumex palustris	Rupa	3						I I		I		
Samolus valerandi	Sava	3							I		I I	
Scrophularia umbrosa	Scum	3						I I		III		
Sparganium angustifolium	Span	3									I	I I
Sparganium erectum subsp. neglectum	Spen	3						I I I				
Sparganium natans	Spna	3								I II	III	
Trifolium michelianum	Trmi	3	III III			IV						
Triglochin palustris	Trpl	3				I		I I				
Verbena officinalis	Veof	3	I I I									
Viola palustris	Vipa	3				I			II		I	
Potamogeton pusillus	Popu	3										I I I
Polypogon maritimus	Poma	2		III		II						
Alopecurus myosuroides	Almy	2	V I									
Alopecurus utriculatus	Alut	2			I	I						
Apium inundatum	Apin	2								I	II	
Athyrium filix-femina	Atfi	2							I II			
Atriplex prostrata	Atpr	2							I I			
Betula pubescens	Bepu	2							I I			
Bidens radiata	Bira	2								I I		
Callitriche obtusangula	Caob	2								I I		
Callitriche palustris	Capl	2								II	IV	
Carex aquatilis	Caaq	2									I II	
Carex curta	Cacr	2								II	I	
Carex flava subsp. Tumidicarpa	Caft	2									I I	
Carex limosa	Cali	2									I I	
Carex spicata	Casp	2					II	I				
Centaurea pannonica	Cepa	2		I II								
Cerastium fontanum subsp. holosteoides	Cefo	2				II I						
Chenopodium album	Chal	2								I I		
Cirsium dissectum	Cidi	2							II	I		
Cirsium oleraceum	Ciol	2					I	II				
Cynosurus cristatus	Cycr	2	V			I						
Dactylorhiza majalis	Dama	2							I I			
Dipsacus fullonum	Difu	2						I	II			
Dryopteris dilatata	Drdi	2							II I			
Eleocharis multicaulis	Elmu	2								I	I	
Eleocharis ovata	Elov	2								I		III
Epilobium ciliatum	Epci	2								II II		
Epilobium tetragonum	Epte	2						I I				
Equisetum arvense	Eqar	2						I I				
Eryngium galioides	Erga	2					III			III		
Euphorbia lucida	Eulu	2			II	V						
Galium boreale	Gabo	2			I II							
Gentiana pneumonanthe	Gepn	2			II II							
Heracleum sphondylium	Hesp	2							I I			
Humulus lupulus	Hulu	2						I I				
Hypericum elodes	Hyel	2								I	II	
Isoetes velata	Isve	2		I			IV					
Juncus pygmaeus	Jupy	2								I	I	
Lotus corniculatus	Loco	2					II	I				
Lotus pedunculatus	Lopd	2				I II						
Lysimachia punctata	Lypu	2						I I				
Nymphoides peltata	Nype	2								I		I
Oenanthe banatica	Oeba	2					II	I				
Ophioglossum vulgatum	Opvu	2			I I							
Phleum pratense	Phpr	2				I I						
Polygonum bistorta	Pobi	2				I						I
Potamogeton coloratus	Poco	2									I II	
Potamogeton crispus	Pocr	2								I		I
Ranunculus lateriflorus	Rala	2						I I				
Rumex pulcher	Rupu	2					I			II		
Salix alba	Saal	2						I I				
Salix multinervis	Samu	2							I			I
Schoenoplectus mucronatus	Scmu	2								I II		
Selinum carvifolia	Seca	2							II I			
Silene dioica	Sidi	2							I III			
Sisymbrella aspera	Sias	2		III						V		
Sparganium minimum	Spmi	2									I	I
Stellaria uliginosa	Stul	2				I			I			
Utricularia intermedia	Utin	2									I I	
Utricularia neglecta	Utne	2								III II		
Veronica catenata	Veca	2									I I	
Viola elatior	Viel	2			V I							
Wolffia arrhiza	Woar	2								I III		
Isoetes lacustris	Isla	2										I I
Luronium natans	luna	2										I I
Nymphaea candida	Nyca	2										I I
Potamogeton *nitens*	Poni	2										I I
Cotula coronopifolia	Coco	1							I			
Hottonia palustris	Hopa	1								I		
Zannichellia palustris	Zapa	1										I
Aegopodium podagraria	Aepo	1						I				
Agrostis capillaris	Agca	1								I		
Agrostis pourretii	Agpo	1		IV								
Alisma ranunculoides	Alra	1							III			

Alopecurus bulbosus	Albu	1		I								
Anagallis arvensis	Anar	1								I		
Apium graveolens	Apgr	1								I		
Arctium minus	Armi	1							I			
Aster tripolium	Astr	1								I		
Aster tripolium subsp. Longicaulis	Astl	1		IV								
Betula pendula	Bepe	1									I	
Bromus commutatus	Brco	1					I					
Calamagrostis stricta	Cast	1						I				
Caldesia parnassifolia	Capa	1										II
Cardamine parviflora	Capi	1		II								
Carex bohemica	Cabo	1										IV
Carex divisa	Cadv	1	V									
Carex echinata	Caec	1									I	
Carex flava	Cafl	1									II	
Carex hispida	Cahs	1				V						
Carex leporina	Cale	1						I				
Carex remota	Care	1						I				
Chenopodium polyspermum	Chpo	1								I		
Cirsium arvense var. maritimum	Ciam	1								I		
Cirsium creticum	Cicr	1								V		
Colchicum autumnale	Coau	1			I							
Cornus sanguinea	Cosa	1							I			
Corylus avellana	Coav	1						I				
Crepis paludosa	Crpa	1					I					
Dactylis glomerata	Dagl	1							I			
Dactylorhiza traunsteineri	Datr	1									I	
Dipsacus laciniatus	Dila	1						I				
Dorycnium rectum	Dore	1								V		
Drosera longifolia	Drlo	1									II	
Elatine hexandra	Elhe	1								II		
Elatine hydropiper	Elhy	1								I		
Eleocharis quinqueflora	Elqu	1				I						
Erigeron canadensis	Erca	1						I				
Eriocaulon aquaticum	Eraq	1									I	
Eryngium corniculatum	Erco	1					V					
Galium mollugo	Gamo	1						I				
Gaudinia fragilis	Gafr	1		III								
Geranium palustre	Gepa	1				I						
Glaux maritima	Glma	1				III						
Glyceria pedicellata	Glpe	1		V								
Gnaphalium luteo-album	Gnlu	1								I		
Gnaphalium uliginosum	Gnul	1								I		
Groenlandia densa	Grde	1								I		
Gypsophila muralis	Gymu	1								I		
Hesperis matronalis	Hema	1								I		
Holcus mollis	Homo	1								II		
Hordeum murinum	Homu	1		III								
Inula germanica	Inge	1						I				
Iris halophila	Irha	1		II								
Isoetes duriei	Isdu	1		II								
Juncus tenageia	Jute	1								I		
Leucanthemum vulgare	Levu	1			II							
Leuzea altaira	Leal	1		V								
Liparis loeselii	Lilo	1									I	
Lythrum hyssopifolium	Lyhy	1								I		
Lythrum portula	Lypo	1								I		
Melissa officinalis	Meof	1								II		
Mentha suaveolens	Mesu	1								II		
Moenchia mantica	Moma	1	V									
Oenanthe lachenalii	Oela	1							I			
Ononis pseudohircina	Onps	1						I				
Parnassia palustris	Papa	1									IV	
Picris echioides	Piec	1								II		
Plantago altissima	Plal	1			V							
Plantago maritima	Plmr	1				I						
Platanthera bifolia	Plbi	1									I	
Potamogeton acutifolius	Poac	1										II
Pteridium aquilinum	Ptaq	1								IV		
Puccinellia maritima	Puma	1							I			
Pulmonaria officinalis	Puof	1						I				
Ranunculus ficaria	Rafi	1								I		
Ranunculus hyperboreus	Rahy	1								III		
Rhinanthus angustifolius	Rhan	1				I						
Rhinanthus rumelicus	Rhru	1					I					
Rhynchospora alba	Rhal	1									I	
Rhynchospora fusca	Rhfu	1									I	
Romulea uliginosa	Roul	1				II						
Rorippa prolifera	Ropr	1	V									
Rubus discolor	Rudi	1								IV		
Rumex sanguineus	Rusa	1						I				
Sagina nodosa	Sano	1									I	
Salix fragilis	Safr	1						I				
Salix purpurea	Sapu	1				I						
Scorzonera cana	Scca	1		II								
Scrophularia nodosa	Scno	1						I				
Sium sisarum	Siss	1						II				
Solanum nigrum	Soni	1										I
Sonchus arvensis	Soar	1							II			
Sonchus oleraceus	Sool	1								I		
Stachys sylvatica	Stsy	1						I				
Taraxacum bessarabicum	Tabe	1		II								
Trfolium cinctum	Trci	1	V									
Trifolium balansae	Trba	1	V									
Trifolium ornithopodioides	Tror	1		III								
Triglochin maritimum	Trma	1				III						
Typha shuttleworthii	Tysh	1						V				
Vicia sativa subsp. nigra	Visa	1					I					
Viola pumila	Vipu	1			I							
Zingeria pisidica	Zipi	1						I				
Potamogeton alpinus	Poal	1										I

Annex 5

Synoptic table of European Oligotrophic Palustrian Habitats

Synataxon groups

Oligotrophic habitats (o)			oA1										oA2																				
Syntaxon number			I005	I006	I043	I044	I045	I052	I051	I002	I003	I004	I063	I061	I048	S090	I047	I010	I053	I001	I011	I062	I009	S040	J050	I058	I060	A057	L008	J049	S092	S039	S091
Number of relevés per syntaxon			5	4	19	5	4	19	137	44	55	10	7	16	37	9	35	18	447	34	33	19	66	19	42	7	12	226	115	27	21	30	9
Number of species per syntaxon > / Nb sp. occurrences v			6	5	8	6	6	7	11	9	10	6	18	25	17	23	14	12	15	8	18	23	11	8	11	12	14	10	15	16	8	10	16
Isoetes muricata	Ismu	4	IV	IV				V				IV																					
Subularia aquatica	Suaq	20	I	IV	V	IV	IV	IV	III	IV	IV	V	V		I		I		I		I							I					
Ranunculus reptans	Rarp	20	I	IV	IV	III	IV	III	II	III	III	II							I					I				I	I				
Callitriche palustris	Capl	3			III	III	II																										
Potamogeton filiformis	Pofi	2	I									II																					
Ranunculus hyperboreus	Rahy	1				V																											
Ranunculus trichophyllus	Ratr	2			I	II																											
Isoetes setacea	Isse	5											I	V	II	II	I																
Isoetes lacustris	Isla	16						II	IV	IV	IV	V				I	II	II	III	IV	I	V	V	I									
Isoetes echinospora	Isec	7							IV	IV	III							V	II	III	I												
Lobelia dortmanna	Lodo	45							II		V		III	III	I	III	V	V	V		V	V	V			V	V	I	V	I			
Sparganium angustifolium	Span	28					IV		II	II	II				I	V		I	I	II	I	I		V	I				I	III	V	V	V
Sparganium minimum	Spmi	13																												I			
Eriocaulon aquaticum	Eraq	17											III	I							V	I				V	I						
Carex viridula subsp viridula	Cavr	17																															
Samolus valerandi	Sava	11																															
Salix repens	Sare	7																															
Carex trinervis	Catr	4																															
Deschampsia cespitosa subsp. littoralis	Deli	3																															
Myosotis rehsteineri	Myre	3																															
Juncus alpino-articulatus	Jual	2																															
Allium schoenoprasum	Alsc	2																															
Ranunculus omiophyllus	Raom	1																															
Isoetes boryana	Isbo	2																															
Caropsis verticillatinundatum	Thve	4																															
Schoenoplectus americanus	Scam	5																															
Juncus heterophyllus	Juhe	5																															
Antinoria agrostidea	Anag	8																															
Baldellia ranunculoides	Barn	18																															
Isoetes velata subsp. adspersia	Isva	1																															
Isoetes velata subsp. dubia	Isvd	1																															
Eryngium galioides	Erga	2																															
Eryngium corniculatum	Erco	1																															
Eryngium pusillum	Erpu	3																															
Mentha cervina	Mece	3																															
Pilularia minuta	Pimi	3																															
Marsilea pubescens	Mapu	4																															
Mentha pulegium	Mepu	12																															
Isoetes velata	Isve	5																															
Isoetes delilei	Isse	4																															
Ranunculus paludosus	Rapa	3																															
Ophioglossum lusitanicum	Oplu	5																															
Serapias lingua	Seli	4																															
Isoetes histrix	Ishi	6																															
Isoetes duriei	Isdu	4																															
Littorella uniflora	Liun	75	V		I			II	II	II	I		III	IV	II		V	III	IV	IV	II	IV	IV				V	II	IV		I	I	
Juncus bulbosus	Jubu	83		IV	I			II	I	I	I		V	IV	II	IV	III	III	III	I	IV	IV	II	I	V		V	I	IV	V	II	III	IV
Myriophyllum alterniflorum	Myal	52	V	I			II	III	II	I	I	II	I	II	III	II	V	I	II	IV	I	I	II	II	I	I	V	I	II	II			
Eleocharis acicularis	Elac	31							I	I	I			I				I	I		I	I	I					V	I				
Pilularia globulifera	Pigl	30							I							I			I			I							I				
Baldellia ranunculoides subsp. repens	Bara	50											II	I			I		I		II	I					I	I	I			I	I
Hydrocotyle vulgaris	Hyvu	48											I						I		I							I					
Apium inundatum	Apin	45											III	I		I					II	I				I	I	I					
Eleocharis multicaulis	Elmu	43												I		I	I		I			I	I								I	I	
Potamogeton polygonifolius	Popo	43											II	I		I		I			I		I		II				I	II		II	III
Eleogiton fluitans	Elfl	41												I	I	I	I	I			I				I				I	I		I	II
Luronium natans	Luna	36												I		III		I		I		II	I						I			I	
Hypericum elodes	Hyel	33																			I	I											

Oligotrophic habitats (o)			oB1																																														
Syntaxon number			S089	S086	S087	S085	S088	M012	M065	I046	I059	M007	L064	A032	A033	A034	A080	A081	A082	A083	A108	A109	J038	J020	J021	J022	J029	J036	J037	P026	P027	P028	P056	P077	P078	P079	M017	M018	M019	M054	M066	M067	M068	M069	M070	M071	M072	M073	M074	M075	M076
Number of relevés per syntaxon			3	4	5	11	9	19	51	31	43	55	28	140	15	71	3	9	8	6	9	12	18	38	28	24	20	42	119	66	47	31	144	2	10	10	214	156	120	496	10	24	10	10	6	5	32	23	36	90	9
Number of species per syntaxon > / Nb sp. occurrences v			4	26	20	32	22	13	39	16	31	13	22	17	12	18	25	29	28	10	21	23	3	21	19	23	13	12	14	26	22	22	12	14	18	21	27	25	19	12	28	51	28	14	30	24	43	39	47	47	36
Isoetes muricata	Ismu	4																																																	
Subularia aquatica	Suaq	20												I																I		I		II																	
Ranunculus reptans	Rarp	20												I	I	I																																			
Callitriche palustris	Capl	3																																																	
Potamogeton filiformis	Pofi	2																																																	
Ranunculus hyperboreus	Rahy	1																																																	
Ranunculus trichophyllus	Ratr	2																																																	
Isoetes setacea	Isse	5																																																	
Isoetes lacustris	Isla	16								I							I																																		
Isoetes echinospora	Isec	7																																																	
Lobelia dortmanna	Lodo	45				I	I	V	V	IV	V	V	V	I	I													I		I	I	I	I				I	I	I	I						II	I		I	I	
Sparganium angustifolium	Span	28															I													I	I		I				I	I	I	I					I		I				
Sparganium minimum	Spmi	13	III	IV	V	V	V												II															I								II		I					I	I	
Eriocaulon aquaticum	Eraq	17						V	II	I	II																			I				II			I	I				I	II							I	
Carex viridula subsp viridula	Cavr	17										I			I	I												I		I	I	I					I	II	I												
Samolus valerandi	Sava	11																																			I			I			I		II	I			I		
Salix repens	Sare	7																																		I												I	I		
Carex trinervis	Catr	4																																															I		I
Deschampsia cespitosa subsp. littoralis	Deli	3														I																																			
Myosotis rehsteineri	Myre	3														I																																			
Juncus alpino-articulatus	Jual	2																																																	
Allium schoenoprasum	Alsc	2																																																	
Ranunculus omiophyllus	Raom	1																																																	
Isoetes boryana	Isbo	2																																																	
Caropsis verticillatinundatum	Thve	4																																																	
Schoenoplectus americanus	Scam	5																																																	
Juncus heterophyllus	Juhe	5																				II																													
Antinoria agrostidea	Anag	8																			II	I																													
Baldellia ranunculoides	Barn	18			II				I										V	I	IV	V																			II	II		I			I	I	I	I	II
Isoetes velata subsp. adspersia	Isva	1																																																	
Isoetes velata subsp. dubia	Isvd	1																																																	
Eryngium galioides	Erga	2																																																	
Eryngium corniculatum	Erco	1																																																	
Eryngium pusillum	Erpu	3																																																	
Mentha cervina	Mece	3																																																	
Pilularia minuta	Pimi	3																																																	
Marsilea pubescens	Mapu	4																																																	
Mentha pulegium	Mepu	12																																																	
Isoetes velata	Isve	5																																																	
Isoetes delilei	Isse	4																																																	
Ranunculus paludosus	Rapa	3																																																	
Ophioglossum lusitanicum	Oplu	5																																																	
Serapias lingua	Seli	4																																																	
Isoetes histrix	Ishi	6																																																	
Isoetes duriei	Isdu	4																																																	
Littorella uniflora	Liun	75		I	;		I	II	IV	V	IV	IV	V			V	II	III	III		III	III	V	I	I	I	III	I	I	III	I	I	II	I	I	V	II	III	I	II		I			V	V	IV	V	II	I	II
Juncus bulbosus	Jubu	83	I	III	V	IV	IV	III	IV	III	V	III	V	I	I	I	III	II	III		III	IV		IV	III	III	V	V	V	IV	IV	IV	IV	II	IV	III	IV	III	V	IV	IV	V	III	IV	V	V	V	IV	IV	IV	V
Myriophyllum alterniflorum	Myal	52	III			I	I		I	I	I	I		I		I			I	V		I	V	I							I		I				I	I			II		I					I			
Eleocharis acicularis	Elac	31				I	I							V	V	V	III	V	V	V	V	V										V	II				I	I		I											
Pilularia globulifera	Pigl	30		I		I						I		I		I	III	I			II	III						I		V	V	V	V	II	V	V	I	I		I					II	I	I		I		V
Baldellia ranunculoides subsp. repens	Bara	50		II	I	I	IV	I	I	I	I	I		I			II	IV						II	I	I				II	I	I	I	II		IV	III	I	I	II	I	I			IV	III	II	I	I	I	III
Hydrocotyle vulgaris	Hyvu	48		II	I	II	II	I	I		I		II				II		II		III	I		II	III	II	III	II	I	III		I	II		III	V	III	III	II	III	III	IV		I	V	II	V	III	III	II	III
Apium inundatum	Apin	45		IV			I	I	I		I		I	I	I	I	I	III	I		III	I		I	I	II	V			IV		I	II	II		V	II	I		I	V	I			V	II	II	I	II		V
Eleocharis multicaulis	Elmu	43		II	II	III		V	V	II		V	II				II	I	I									I	I	II		I	I				V	V	V	V	III	IV	V	IV	V	V	V	V	IV	V	IV
Potamogeton polygonifolius	Popo	43		II	III	I		II	I		I	I						III			II			III	III	II			I	II	I	I		I		I	II		I		V	V	V	V	I		I		I		II
Eleogiton fluitans	Elfl	41		III	I	II	III	I	I	I	I	I					I	I	I			I		V		V			I	II	I	I		I	I		III	I			V	V			V	V		I	V		IV
Luronium natans	Luna	36					II				I		I	I	I	I	I	II	I	II	II	I		I	I	II	I		I	I	I						I	I			III						I	I	I	I	
Hypericum elodes	Hyel	33		II	I	I	I	I	I			I					I					I		V	V					I	I	I			I		V	I	I		IV	IV	III	IV	V	III	IV	II	IV	I	IV

Oligotrophic habitats (o)			oB2							oC		oD					oE1						oE2								
Syntaxon number			C055	C084	C023	C024	C025	J041	J042	D030	D031	M013	L014	J015	I016	J035	V093	V094	V095	V096	V097	V098	V099	V100	V101	V102	V103	V104	V105	V106	V107
Number of relevés per syntaxon			72	26	29	30	15	18	9	13	17	33	19	6	8	5															
Number of species per syntaxon > / Nb sp. occurrences v			10	35	24	19	21	13	15	19	19	11	9	10	9	9	11	8	11	14	7	7	13	3	3	6	4	5	8	4	4
Isoetes muricata	Ismu	4																													
Subularia aquatica	Suaq	20																													
Ranunculus reptans	Rarp	20								V	V	I																			
Callitriche palustris	Capl	3																													
Potamogeton filiformis	Pofi	2																													
Ranunculus hyperboreus	Rahy	1																													
Ranunculus trichophyllus	Ratr	2																													
Isoetes setacea	Isse	5																													
Isoetes lacustris	Isla	16																													
Isoetes echinospora	Isec	7																													
Lobelia dortmanna	Lodo	45	I		I							V	V	V																	
Sparganium angustifolium	Span	28																													
Sparganium minimum	Spmi	13		I																											
Eriocaulon aquaticum	Eraq	17																													
Carex viridula subsp viridula	Cavr	17			III	II	II	I	II	I	V																				
Samolus valerandi	Sava	11	IV	III	III	V	V																								
Salix repens	Sare	7		II	IV	I			IV																						
Carex trinervis	Catr	4		III	V																										
Deschampsia cespitosa subsp. littoralis	Deli	3								V	V																				
Myosotis rehsteineri	Myre	3								IV	V																				
Juncus alpino-articulatus	Jual	2								II	IV																				
Allium schoenoprasum	Alsc	2								III	V																				
Ranunculus omiophyllus	Raom	1														V															
Isoetes boryana	Isbo	2												V	V																
Caropsis verticillatinundatum	Thve	4										I	I	I	IV																
Schoenoplectus americanus	Scam	5			II							III	V	III	V																
Juncus heterophyllus	Juhe	5										IV	V	II	I																
Antinoria agrostidea	Anag	8																III	IV	I	I	III						V			
Baldellia ranunculoides	Barn	18															II	II	I	I											
Isoetes velata subsp. adspersia	Isva	1																			V										
Isoetes velata subsp. dubia	Isvd	1																				III									
Eryngium galioides	Erga	2																I	IV												
Eryngium corniculatum	Erco	1																	IV												
Eryngium pusillum	Erpu	3																		II	I								I		
Mentha cervina	Mece	3															II	III	I												
Pilularia minuta	Pimi	3															I			I	II										
Marsilea pubescens	Mapu	4															II		I		III	III									
Mentha pulegium	Mepu	12															V	II	III	III	I	IV	IV		II	III	II	IV	II		
Isoetes velata	Isve	5																V	III	V					IV		III				
Isoetes delilei	Isse	4															V		II								II	I			
Ranunculus paludosus	Rapa	3																					II			III			II		
Ophioglossum lusitanicum	Oplu	5																					I	II			III		I		V
Serapias lingua	Seli	4																					II	I		III				II	
Isoetes histrix	Ishi	6																				I				II		IV	V	V	V
Isoetes duriei	Isdu	4																					V	V		II			I		
Littorella uniflora	Liun	75	IV	V	V	V	II	V	V	III	II	III	IV	IV	IV																
Juncus bulbosus	Jubu	83	III	III	I	II	IV	II	III			I			I	IV															
Myriophyllum alterniflorum	Myal	52	I	I								III	III	IV																	
Eleocharis acicularis	Elac	31	II				V			I						IV															
Pilularia globulifera	Pigl	30																													
Baldellia ranunculoides subsp. repens	Bara	50	IV	III	IV	V	IV																								
Hydrocotyle vulgaris	Hyvu	48	III	IV	V	III	II	I	V																						
Apium inundatum	Apin	45	I	I		II																									
Eleocharis multicaulis	Elmu	43	I	I		I						V																			
Potamogeton polygonifolius	Popo	43		I	II	I										II															
Eleogiton fluitans	Elfl	41																													
Luronium natans	Luna	36		I	I																										
Hypericum elodes	Hyel	33			I							II																			

Deschampsia setacea	Dese	24		I I I	I I I I I I I I I II I II I I II I V V I I II					
Ranunculus ololeucos	Raol	20		I	I I I I I I I I II I I I I I I I I I II					
Carex flava subsp. oederi	Caoe	13			I I I II I I IV II III II I I	II				
Agrostis canina	Agcn	27		I	I I I I I I II II II II I II I I II I II II II III III II II II II	V				
Molinia caerulea	Moca	19			II I I I II I II II II II III I I III I II II I	II				
Eriophorum angustifolium	Eran	20		I II	I I I I I II I I III I I II II II II II II II					
Potentilla palustris	Popl	14			I I I I I I I I I I I I	I				
Carex nigra subsp. nigra	Cani	10			II I I I I II I I	I II				
Anagallis tenella	Ante	9			I I I I I I I I	I				
Carex lasiocarpa	Cala	9		I	I III I I I V I I					
Drosera intermedia	Drin	9			I I I I I I I I I					
Utricularia intermedia	Utin	9			III I I I II II I I I					
Carex panicea	Capn	7			I II I I I	II	IV			
Carum verticillatum	Cavr	6			I I I I I	I				
Ranunculus flammula	Rafl	52		III I I II II	III ; II I II I I I II I II II ; I II II II II V III I III III III I IV II III III I III IV III V III III III III I V	II III II V II V		V		
Eleocharis palustris	Elpa	59		I I I II I I II I III I II II	III I I II I II II I III I III II I II III II II II III I II III II II I I IV III I I II I II II I III	IV III III I II IV		III	III III I III	
Glyceria fluitans	Glfl	39		I I I I I I II II	IV II I I I II I I III I I II I III III II II I IV I III II III I I I II I III	I		IV		
Phragmites australis	Phau	38		I I I I I I	III II I I I I II II III I I II II II I I I III I I I II	I III I III	I II	III V IV V		
Agrostis stolonifera	Agst	33	II	I	I I I I I II II II I II I I I I II I II III I I II II I II	II II III IV II	V V			
Alisma plantago-aquatica	Alpl	27		I I	IV II I I I II I I II II II I III II II II I I I II II I I I III					
Equisetum fluviatile	Eqfl	25		I I I I III	II II I I I I I II I II II I I I II I I I II	I				
Juncus articulatus	Juar	23		I	I I I I II I I II II I I I I I I III	III III III IV	IV V			
Potamogeton natans	Pona	23		I II I II I III I I	I III V I I I V I II I I I I I II					
Galium palustre	Gapa	22			III II II I III III I I II II I I V III I I I I III	I	I III			
Mentha aquatica	Meaq	22			I I II I II I II I I III III I I II I I II	IV IV IV I V				
Elatine hexandra	Elhe	21		I I I I II I I	I I II I I II II III I I I			II II IV		
Carex rostrata	Caro	18	I	I II I I I I	I II I I I I II I I	II				
Lycopus europaeus	Lyeu	19			I I I II I I I II I II I I I	I II I I I III				
Lythrum salicaria	Lysa	18			I I I I II I I I I I I I I I I	I III I				
Potamogeton gramineus	Pogr	16		I I I I I	I III I I I I	III I III	II II			
Polygonum amphibium	Poam	16		I I I II	I I II I II I I I I II I I	II				
Lysimachia vulgaris	Lyvu	14			I I I I I I I I I I I I I I					
Veronica scutellata	Vesc	14			II I I I I I III I I I I I	III V				
Ranunculus aquatilis	Raaq	15		I I	I II II II II II IV III III I I I	III				
Utricularia minor	Utmi	12		I I I IV	II V I I I I I I					
Utricularia neglecta	Utne	12		I I	I I II I I I I I II	I				
Nymphaea alba	Nyal	12		I I I	I I I I I I I I I					
Lemna minor	Lemi	10			I III I II I I I I I	I				
Juncus effusus	Juef	9			I I I I I I I I II					
Cladium mariscus	Clma	8		I II I	I I I I	I				
Iris pseudacorus	Irps	7			I I I I I I I					
Myrica gale	Myga	7			I I II II I I	I				
Menyanthes trifoliata	Metr	6		II	I I I I I					
Callitriche hamulata	Caha	4		I I	II II					
Utricularia vulgaris	Utvu	4		I I I IV						
Juncus acutiflorus	Juac	3			I II I					
Myosotis palustris	Mypa	3			II I I					
Sagittaria sagittifolia	Sasa	3			I III I					
Callitriche palustris subsp. stagnalis	Capt	2		I I						
Equisetum palustre	Eqpa	2	I II							
Nuphar pumila	Nupu	2		I II						
Callitriche truncata	Catr	1		I						
Elodea canadensis	Elca	1		I						
Elodea nutallii	Elnu	1		I						
Hottonia palustris	Hopa	1			II					
Peplis portula	Pepo	3			I I III					
Potamogeton crispus	Pocr	1		I						
Potamogeton perfoliatus	Popf	1		II						
Potamogeton berchtoldii	Pobe	2		I I						
Potamogeton obtusifolius	Poob	2		I II						
Bolboschoenus maritimus	Boma	2				I II				
Juncus bufonius	Jubf	3			III	II		II		
Potentilla anserina	Poan	2				I IV				
Radiola linoides	Rali	1				III				
Gnaphalium uliginosum	Gnul	1				II				
Hippuris vulgaris	Hivu	1				II				
Juncus compressus	Juco	1				II				
Leontodon saxatilis	Lasa	1				II				
Myosotis laxa subsp. caespitosa	Mylc	1						II		
Nitella batrachospermum	Niba	1						II		
Nuphar lutea	Nulu	1				II				
Polygonum lapathifolium	Pola	1						II		
Sagina apetala	Saap	1				II				

Schoenoplectus lacustris	Scla	2			I					II												
Armeria maritima subsp. purpurea	Arpu	2						I	I													
Cardamine pratensis	Capr	2						III	II													
Carex elata	Cael	2						II	III													
Leontodon autumnalis	Leau	2						I	II													
Saxifraga oppositifolia	Saop	2						I	I													
Typhoides arundinacea	Tyar	2						I	III													
Oenanthe lachenalii	Oela	1																IV				
Oenanthe silaifolia	Oesi	1									V											
Eleocharis uniglumis	Elun	2				II					IV											
Carex divisa	Cadv	2									III			I								
Carex flacca	Cafc	2														II					III	
Romulea columnae	Roco	2														I						III
Trifolium resupinatum	Trrs	2												III	I							
Linum bienne	Libi	3														I			III		V	
Ranunculus ophioglossifolius	Raop	3												III		I				I		
Scilla automnalis	Scat	3														II	I					II
Sisymbrella aspera	Sias	3										II	I			I						
Cynodon dactylon	Cyda	4									III			II		I				I		
Ranunculus sardous	Rasa	4									II			II	II	I						
Apium crassipes	Apcr	1												I								
Oenanthe fistulosa	Oefi	1												II								