Appendix S4. Grades for ecological traits for **W** (Water), **Ca/Mg** (Calcium and Magnesium Content), **N** (Nutrients), **D** (Dynamics), **Hem** (Hemeroby), **St** (Stress), **Salt**, **Al** (Altitude), **Hei** (Height), and **An** (Annuals); acronyms of phytosociological classes in parenthesis; for explanations see below.

Anhang S4. Ränge ökologischer Merkmale für **W** (Wasser), **Ca/Mg** (Calcium- und Magnesium-Gehalt), **N** (Nährstoffe), **D** (Dynamik), **Hem** (Hemerobie), **St** (Stress), **Salt** (Salz), **Al** (Meereshöhe), **Hei** (Vegetationshöhe) und **An** (Annuelle); Akronyme pflanzensoziologischer Klassen in Klammern; Erklärung s. unten.

	Grade for ecological traits									
Alliance (Class)	W	Ca/Mg	N	D	Hem	St	Salt	Al	Hei	An
Abieto-Piceion (VA-PI) s.l. incl. Chrysanthemo rotundifolii-Piceeion	3	2	3	1	1	3	1	4	5	1
Adenostylion alliariae (BE-AD)	4	3	4	2	1	1	1	4	2	1
Aegopodion podagrariae (ART)	4	3	5	3	4	1	1	3	2	2
Agropyro-Henkenyion peploides (CAK)	2	4	2	3	1	4	5	1	2	2
Agropyro-Rumicion (MO-AR)	4	3	4	4	3	3	2	3	1	4
Alnion glutinosae (ALN)	5	3	3	1	1	2	1	2	5	1
Alnion incanae (QU-FA)	4	3	4	2	1	2	1	3	5	1
Alysso-Sedion (KO-CO)	1	5	1	2	1	5	1	3	1	4
Ammophilion arenariae (AMM)	2	4	2	2	1	4	3	1	2	2
Androsacion alpinae (THL)	3	1	1	2	1	5	1	5	1	1
Androsacion vandellii s.l. (ASP) incl. Asarinion procumbentis and Asplenion septentrionalis	3	1	1	1	1	5	1	4	1	1
Aperion spicae-venti (STE)	3	2	3	5	5	1	1	2	2	5
Arabidion caeruleae (THL)	4	5	3	2	1	5	1	5	1	1
Arction lappae (ART)	3	3	5	4	5	1	1	3	2	4
Armerion halleri (VIO)	2	4	2	2	1	5	1	3	1	2
Armerion maritimae (AST)	3	3	3	3	4	4	4	1	1	1
Arrhenatherion (MO-AR)	3	3	3	3	4	3	1	3	2	3
Asplenion serpentini (ASP)	2	5	1	1	1	5	1	3	1	1
Atriplicion littoralis (CAK)	4	4	5	5	1	1	5	1	1	5
Atropion belladonnae (EPI)	3	4	3	4	1	1	1	3	2	2
Berberidion vulgaris s.l. (RH-PR) incl. Prunion fruticosae	2	4	3	2	3	2	1	3	3	1
Betulion pubescentis (VA-PI)	4	1	1	1	1	4	1	2	4	1
Bidention tripartitae (BID)	4	3	5	5	1	1	1	3	2	5
Bolboschoenion maritimi (PHR)	5	3	4	3	1	1	3	2	3	1
Bromion erecti s.l. (FE-BR) incl. Seslerio-Mesobromion	2	5	2	2	3	4	1	3	2	4
Calamagrostion villosae (BE-AD)	4	4	3	2	1	2	1	5	2	1
Calthion (MO-AR)	4	3	4	3	4	3	1	2	2	2
Cardamino-Montion s.l. (MO-CA) incl. Philonotidion serriatae	5	1	1	2	1	2	1	3	1	3
Carici piluliferae-Epilobion angustifolii (EPI)	3	2	3	4	1	2	1	3	2	3
Caricion atrofusci-saxatilis (SC-CA)	5	5	1	3	1	5	1	5	1	1
Caricion curvulae (CAR)	3	1	1	1	1	5	1	5	1	1
Caricion davallianae (SC-CA)	5	5	2	2	2	5	1	3	1	1
Caricion ferrugineae s.l. (EL-SE) incl. Calamagrostion variae	3	5	2	2	1	4	1	5	2	2
Caricion firmae (EL-SE)	3	5	1	1	1	5	1	5	1	2
Caricion lasiocarpae (SC-CA)	5	3	2	2	1	5	1	2	2	1
Caricion nigrae (SC-CA)	5	2	2	2	2	5	1	3	1	1
Caricion remotae (MO-CA)	5	3	2	1	1	3	1	3	1	1
Carpinion betuli (QU-FA)	3	3	3	1	1	2	1	3	5	1

	Grade for ecological traits									
Alliance (Class)	W	Ca/Mg	N	D	Hem	St	Salt	Al	Hei	An
Carpino-Prunion (RH-PR)	3	3	3	2	4	1	1	3	3	1
Caucalidion platycarpi (STE)	2	5	3	5	5	1	1	3	2	5
Centrantho-Parietarion (ASP)	3	4	4	3	4	1	1	2	1	2
Chelidonio-Robinion (ROB)	3	3	4	4	5	1	1	2	5	2
Chenopodion rubri (BID)	4	3	5	5	1	1	2	2	2	5
Cirsio-Brachypodion (FE-BR)	2	4	2	2	3	4	1	2	2	4
Cnidion dubii (MO-AR)	4	3	2	3	4	3	1	2	2	2
Convolvulo-Agropyrion repentis (ART)	3	3	4	4	5	2	3	3	2	3
Corynephorion canescentis (KO-CO)	1	1	1	4	1	4	1	2	1	5
Cratoneurion commutati (MO-CA)	5	5	1	2	1	4	1	4	1	1
Cynosurion cristati (MO-AR)	3	3	3	3	4	3	1	3	1	3
Cystopteridion fragilis (ASP)	3	5	1	1	1	5	1	4	1	1
Cytiso ruthenici-Pinion (ER-PI)	2	4	2	1	1	5	1	2	5	1
Dauco-Melilotion (ART)	2	3	5	4	5	1	1	3	2	4
Dicrano-Pinion (VA-PI)	2	2	1	1	1	5	1	2	5	1
Digitario-Setarion (STE)	2	2	4	5	5	1	1	2	2	5
Drabion hoppeanae (THL)	2	4	1	2	1	5	1	5	1	1
Eleocharition acicularis (LIT)	5	4	4	3	1	3	1	3	1	1
Elynion myosuroides (CA-KO)	3	4	1	1	1	5	1	5	1	1
Empetrion nigri (CA-UL)	3	1	1	2	1	5	1	1	1	2
Epilobion fleischeri (THL)	3	5	2	5	1	2	1	4	2	1
Ericion tetralicis (OX-SP)	4	1	1	2	1	5	1	2	2	1
Erico-Pinion sylvestris (ER-PI)	2	5	2	1	1	5	1	4	5	1
Erico-Pinion mugi (ER-PI)	3	5	1	1	1	3	1	5	3	1
Fagion sylvaticae (QU-FA)	3	3	3	1	1	2	1	3	5	1
Festucion valesiacae (FE-BR)	1	5	1	2	2	5	1	2	2	4
Festucion variae (CAR)	3	1	1	2	1	5	1	5	1	1
Filipendulion (MO-AR)	4	3	4	2	3	2	1	3	2	1
Fumario-Euphorbion (STE)	3	4	5	5	5	1	1	3	2	5
Galio-Alliarion s.l. (ART) incl. Impatienti noli-tangere-Stachyon sylvaticae	4	3	4	3	3	1	1	3	2	3
Genistion pilosae (CA-UL)	3	1	1	2	2	5	1	2	2	2
Geranion sanguinei (TR-GE)	2	4	2	2	2	2	1	2	2	2
Glycerio-Sparganion (PHR)	5	3	3	3	2	1	1	3	2	1
Hydrocharition morsus-ranae (POT)	5	2	3	3	2	1	1	2	1	1
Hydrocotylo-Baldellion s.l. (LIT) incl. Samolo-Baldellion	5	3	2	3	1	3	2	2	1	1
Juncion squarrosi (CA-UL)	4	1	1	3	2	5	1	3	1	1
Juncion trifidi (CAR)	3	1	1	1	1	5	1	5	1	1
Koelerion arenariae (KO-CO)	1	4	1	3	1	3	1	1	2	4
Koelerion glaucae (KO-CO)	1	5	1	3	2	5	1	2	2	4
Koelerio-Phleion phleoides (FE-BR)	2	2	1	2	2	5	1	3	2	4
Lemnion minoris s.l. (LEM) incl. Lemnion gibbae, Lemno minoris-Salvinion natantes, and Riccio-Lemnion trisulcae	5	3	4	5	2	1	1	2	1	1
Littorellion uniflorae (LIT)	5	1	1	2	1	4	1	2	1	1
Loiseleurio-Vaccinion (LO-VA)	2	1	1	1	1	5	1	5	1	1
Lolio-Plantaginion (MO-AR)	3	3	4	5	5	4	2	3	1	3
Lonicero-Rubion silvatici (FRA)	3	1	3	3	4	1	1	2	3	1
Luzulo-Fagion (QU-FA)	3	1	2	1	1	4	1	3	5	1

	Grade for ecological traits									
Alliance (Class)	W	Ca/Mg	N	D	Hem	St	Salt	Al	Hei	An
Magnocaricion elatae (PHR)	5	3	3	3	2	1	1	2	2	1
Melampyrion pratensis (TR-GE)	3	1	2	2	2	3	1	3	2	2
Molinion (MO-AR)	4	4	2	3	4	4	1	3	2	2
Nanocyperion flavescentis s.l. (IS-NA) Elatino-Eleocharition and Radiolion linoidis	4	3	4	5	1	1	1	2	1	5
Nardion strictae (CA-UL)	3	1	1	2	2	5	1	4	1	2
Nymphaeion albae (POT)	5	3	5	3	2	1	1	2	2	1
Onopordion acanthii s.l. (ART) incl. Artemisio absinthii-Agropyrion intermedii	2	3	5	4	5	1	1	2	3	4
Oxycocco-Ericion tetralicis (OX-SP)	5	1	1	1	1	5	1	2	1	1
Petasition paradoxi (THL)	3	4	3	2	1	3	1	4	1	1
Phalaridion arundinaceae (PHR)	5	3	4	3	2	1	1	3	3	1
Phragmition australis (PHR)	5	3	4	3	2	1	1	2	2	1
Piceion excelsae (VA-PI)	3	1	3	1	1	4	1	4	5	1
Plantagini-Festucion ovinae (KO-CO)	3	2	2	3	3	3	1	2	2	3
Poion alpinae (MO-AR)	3	3	4	3	3	3	1	4	1	3
Polygono-Chenopodion polyspermi (STE)	3	2	5	5	5	1	1	2	2	5
Polygono-Trisetion (MO-AR)	3	3	3	3	4	3	1	3	2	2
Potamogetonion pectinati (POT)	5	3	3	3	2	1	1	3	2	1
Potentillion caulescentis (ASP)	2	5	1	1	1	5	1	4	1	1
Pruno-Rubion radulae (RH-PR)	3	3	3	2	4	1	1	3	3	1
Puccinellion maritimae s.l. (AST) incl. Puccinellio-Spergularion	4	3	3	3	1	4	5	1	1	2
Quercion pubescentis s.l. (QU-FA) incl. Potentilla albae-Quercion petraeae and Aceri tatarici-Quercion	1	4	2	1	1	4	1	3	4	1
Quercion roboris (QUE)	3	2	2	1	1	4	1	2	5	1
Ranunculion fluitantis s.l. (POT) incl. Ranunculion aquatilis	5	3	2	2	2	1	1	3	2	1
Rhododendro-Vaccinion (LO-VA)	3	2	1	1	1	3	1	5	3	1
Rhynchosporion albae (SC-CA)	5	1	1	1	1	5	1	2	1	1
Rumicion alpini (ART)	4	3	5	3	4	1	1	4	2	1
Saginion maritimae (SAG)	4	3	3	5	1	1	4	1	1	4
Saginion procumbentis s.l. (PO-PO) incl. Eragrostion minoris and Matricario discoideae-Polygonion arenastri	3	3	4	5	5	3	3	3	1	3
Salicion albae (SAL P)	5	3	4	2	1	1	1	2	4	1
Salicion arenariae (RH-PR)	2	4	3	3	1	2	2	1	3	1
Salicion cinereae (FRA)	4	2	2	2	1	1	1	2	3	1
Salicion eleagni (SAL P)	5	4	3	2	1	1	1	4	3	1
Salicion herbaceae (SAL H)	4	1	3	1	1	5	1	5	1	1
Salsolion ruthenicae (STE)	2	3	3	5	5	1	4	2	2	5
Sambuco-Salicion capreae (RH-PR)	3	3	4	4	4	1	1	3	4	1
Scorpidio-Utricularion (UTR)	5	1	1	2	1	4	1	2	1	1
Sedo albi-Veronicion dillenii (KO-CO)	1	2	1	2	1	3	1	3	1	5
Sedo-Scleranthion biennis (KO-CO)	2	2	1	1	1	5	1	5	1	4
Senecionion fluviatilis (ART)	4	3	5	3	3	1	1	2	3	2
Seslerio-Festucion pallentis (KO-CO)	1	4	1	1	1	5	1	3	2	4
Seslerion albicantis s.l. (EL-SE) incl. Seslerio-Xerobromion	4	4	3	2	1	3	1	5	2	2
Sisymbrion (STE)	2	3	4	5	5	1	2	3	2	5
Spartinion maritimae (SPA)	5	3	4	2	1	2	5	1	2	1

Alliance (Class)	Grade for ecological traits									
	W	Ca/Mg	N	D	Hem	St	Salt	Al	Hei	An
Sphagnion magellanici s.l. (OX-SP) incl. Oxycocco-Empetrion hermaphroditi	5	1	1	1	1	5	1	2	1	1
Sphagno-Utricularion (UTR)	5	1	1	2	1	4	1	2	1	1
Stipion calamagrostis (THL)	3	4	2	2	1	4	1	4	2	3
Stipo-Poion carniolicae (FE-BR)	1	5	1	1	1	5	1	4	2	4
Stipo-Poion xerophilae (FE-BR)	1	4	1	1	1	5	1	4	2	4
Thero-Airion (KO-CO)	1	2	1	5	1	1	1	2	1	5
Thero-Salicornion strictae s.l. (TH-SA) incl. Salicornion ramosissimae and Thero-Suaedion	5	3	4	5	1	1	5	1	1	5
Thlaspion calaminariae (VIO)	2	4	2	2	1	5	1	3	1	2
Thlaspion rotundifolii (THL)	3	5	2	2	1	5	1	5	1	1
Tilio platyphylli-Acerion pseudoplatani (QU-FA)	4	3	4	1	1	2	1	4	5	1
Trifolion medii (TR-GE)	3	3	3	2	2	2	1	3	2	2
Vaccinion myrtilli (CA-UL)	3	1	1	2	2	5	1	4	2	2
Violion caninae (CA-UL)	3	1	1	3	3	5	1	3	1	2
Xerobromion (FE-BR)	1	4	1	2	2	5	1	2	2	4
Zannichellion pedicellati (POT)	5	3	2	3	2	1	3	1	1	1

Water content of soil

The availability of water is crucial for the spatial differentiation of plant communities. Even as this factor changes between seasons and years, it is in most cases possible to assign grades for this factor.

5 = Alliance growing in very wet habitats or in water.
4 = Alliance growing in wet or temporarily very wet habitats.
3 = Alliance growing in intermediate habitats.
2 = Alliance growing in dry habitats.
1 = Alliance growing in very dry habitats.

Calcium and Magnesium ions

The availability of calcium (Ca^{2+}) and, to a lesser extent, magnesium (Mg^{2+}) is an important differentiation factor for vegetation.

5 = Alliance growing in very base-rich habitats.
4 = Alliance growing in base-rich habitats.
3 = Alliance growing in habitats with medium base levels.
2 = Alliance growing in base-poor habitats.
1 = Alliance growing in very base-poor habitats.

Nutrients

The amount of nutrients (ammonium, nitrate, phosphate, potassium) is a prominent factor for the distribution of plant communities in Central Europe. Due to human influences, nutrient-rich habitats, rare before 1900, are now widely distributed in Central Europe. The availability of nutrients is often important for the differentiation of associations into subassociations.

5 = Alliance growing in very nutrient-rich habitats.
4 = Alliance growing in nutrient-rich habitats.
3 = Alliance growing in habitats with medium nutrient content.
2 = Alliance growing in nutrient-poor habitats.
1 = Alliance growing in very nutrient-poor habitats.

Environmental dynamics

Due to the seasonality of the climate Central Europe has a general high degree of environment variability, very expressed in high altitudes, less so near coasts. The site of a forest community may remain more or less unchanged for decades, at least at the alliance level. Conditions in fields or settlements may change drastically between years. Environmental dynamics may be so strong that communities are unable to exist for more than a few months (e.g. Bidentetea, Isoeto-Nanojuncetea, or Stellarietea). Alliances growing at sites with a high degree of environmental dynamics are rich in species with ruderal strategies, while those at sites with a low degree of environmental dynamics are rich in species with competitive strategies (GRIME 1974).

5 = Alliance growing on sites with very high degree of environmental dynamics.
4 = Alliance growing on sites with high degree of environmental dynamics.
3 = Alliance growing on sites with medium degree of environmental dynamics.
2 = Alliance growing on sites with low degree of environmental dynamics.
1 = Alliance growing on sites with very low degree of environmental dynamics.

Hemeroby

Hemeroby is an integrated measure of human impact (SUKOPP 1972). It is positively correlated with the frequency of neophytes (Sukopp 2001), the frequency of annuals (KOWARIK 1988), and soil degradation (BLUME & SUKOPP 1976).

5 = Very strong dependency on human influence (polyhemerob).
4 = Strong dependency on human influence (euhemerob).
3 = Moderate dependency on human influence (mesohemerob).
2 = Low dependency on human influence (oligohemerob).
1 = No dependency on human influence (ahemerob).

Frequency of stress-tolerant species

GRIME (1974, 1988) developed the C[ompetion]-S[tress]-R[uderal] model for life strategies of plants. Competitive species are successful at exploiting light, water, nutrients, and space, thereby exhibiting high rates of production and reproduction. They are found in long-term stable habitats. Stress-tolerant species grow in stable habitats where life is relatively harsh. Limited resources of light, water, minerals, or temperature permit only low rates of production and reproduction. Disturbance may arise from human activities or grazing animals. Stress-tolerant species are typically relatively small and long lived. Many protect their tissues against herbivores. Ruderal species are typically annual or biennial and occur in habitats with a high degree of environmental dynamics. They exhibit rapid growth and early reproduction. Competitive and ruderal species correlate with low or high degrees of environmental dynamics.

5 = Alliance where stress-tolerant species dominate or are characteristic.
4 = Alliance with high abundance of stress-tolerant species.
3 = Alliance with intermediate abundance of stress-tolerant species.
2 = Alliance with low abundance of stress-tolerant species.
1 = Alliance with very low abundance of stress-tolerant species.

Salt tolerance

High concentrations of salt, e.g. of sodium chloride (NaCl) or sodium carbonate (Na_2CO_3), are lethal for most plants. Only specialized plants grow at such sites.

5 = Alliance occurring at sites with very high concentrations of salt ions.
4 = Alliance occurring at sites with high concentrations of salt ions, as found in the open sea.
3 = Alliance occurring at sites with moderate concentrations of salt ions.
2 = Alliance occurring at sites with low concentrations of salt ions.
1 = Alliance occurring at sites with very low concentrations of salt ions.

Altitude

Many alliances show a clear correlation with altitude ranges, especially at very low and high altitudes. Other alliances span several altitude ranges.

5 = Alliance occurring predominantly in subalpine, alpine, or nival zone (> 1500 m a.s.l.).
4 = Alliance occurring predominantly in montane zone (700–1500 m a.s.l.).
3 = Alliance occurring predominantly in hill zone (300–700 m a.s.l.).
2 = Alliance occurring in lowland areas (< 300 m a.s.l.).
1 = Alliance occurring near sea level.

Height of vegetation

Alliances may be grouped by their average height. This feature is correlated with the occurrence of phanerophytes, but also with the stratification and, more generally, with the complexity of an alliance.

5 = Alliance with vegetation higher than 15 meters.
4 = Alliance with vegetation between 5 and 15 meters in high.
3 = Alliance with vegetation between 2 and 5 meters in high.
2 = Alliance with vegetation between 0.5 and 2 meters in high.
1 = Alliance with vegetation lower than 0.5 meters.

Frequency of annual taxa

Plants, that germinate in autumn and complete their life cycle in the following year, are also classified as annuals.

5 = Alliance with very high frequency of annuals.
4 = Alliance with high frequency of annuals.
3 = Alliance with moderate frequency of annuals.
2 = Alliance with low frequency of annuals.
1 = Alliance with very low frequency of annuals.

References

BLUME, H.-P. & SUKOPP, H. (1976): Ökologische Bedeutung anthropogener Bodenveränderung. – Schriftenreihe Vegetationskd. 10: 75-89.

GRIME, J.P. (1974): Vegetation classification by reference to strategies. – Nature 250: 26-31.

GRIME, J.P. (1988): The C-S-R model of primary plant strategies. Origins, implications and tests. – In: GOTTLIEB, L.D. & JAIN, S.K. (Eds.): Plant evolutionary biology: 371-393. Chapman & Hall, London.

KOWARIK, I. (1988): Zum menschlichen Einfluß auf Flora und Vegetation. Theoretische Konzepte und ein Quantifizierungsansatz am Beispiel von Berlin (West). – Landschaftsentwickl. Umweltforsch. 56: 1-280.

SUKOPP, H. (1972): Wandel von Flora und Vegetation in Mitteleuropa unter dem Einfluss des Menschen. – Ber. Landwirtschaft 50: 112-139.

SUKOPP, H. (2001): Neophyten. – Bauhinia 15: 19-37.