Kragujevac J. Sci. 25 (2003) 107-120.

THE VASCULAR FLORA OF THE GRUŽA RESERVOIR IN THE ŠUMADIJA REGION OF SERBIA

Marina Topuzović and Dragana Pavlović

Faculty of Science, P.O. Box 60, 34000 Kragujevac, Serbia and Montenegro

(Received February 10, 2003)

ABSTRACT. The paper presents results of research on vascular flora of the Gruža reservoir in the Kragujevac basin. Analysis of floristic composition of vascular plants of this reservoir indicates presence of 162 species belonging to 37 families. The gratest number of species have ranges of the holarctic and cosmopolitan types, and hemicriptophytes life form. Macrophytes are represented by 28 species. The floristic composition of vascular plants with floral elements, life forms and ecological indexes is given in the paper.

INTRODUCTION

Reservoirs represent very interesting ecosystems owing to the manner of their formation and subsequent management. In Serbia 85 reservoirs have been constructed to date.

Their quality and future are determined by a series of factors and depend of the extent to which the optimal ecological state is realized. This state can be achieved through action based on the results of complex multi-disciplinary study of reservoirs and their watersheds encompassing geomorphological properties, characteristics of the plant cover, etc. Such study can provide an indicator of the starting state of reservoirs, suggest directions for further development, and clarify the dynamics of eutrophication. However, much also depends on the degree of human influence, i.e., the role played by antropogenic ecosystems as opposed to natural ones in the watershed as a wholw (determined especially by the number of settlements, presence of rural households, way of life led by their inhabitants, economic activity, etc).

The reservoir Gruža (formed in 1985) is located in the Kragujevac basin in the Šumadija region of Serbia.

Since it′s formation, this reservoir have been continuously studied from several aspects (chemical, microbiological, phytoplankton, zooplankton etc). Owing to the part played by plants, especially macrophytes in maintaining stability of the dynamic equilibrium of reservoirs, study of the vascular flora of this reservoir has also been studied since it′s formation.

The literature contains a fairly extensive body of data on flora and vegetation in the watershed of the Gruža Reservoir. They had been studied in detail even before the reservoir was formed. The first investigations of this region were conducted by PANČIĆ (1884) and RUDSKI (1949), and studies were subsequently carried further by VELJOVIĆ et al. (1967, 1984), who gave a detailed survey of vegetation in the neighborhood of the future reservoir. Formation of its hydrophilic flora was studied immediately after the reservoir's creation by VELJOVIĆ et al. (1986, 1990), and SIMOVIĆ et al. (1990) also devoted part of their efforts to consideration of this problem.

The purpose of the present work was to investigate development of the vascular flora on the Gruža reservoir as a significant factor in preservation of the stability of this aquatic ecosystem.

MATERIAL AND METHODS

<u>Description of investigated locality</u>

We studied vascular flora of the Gruža reservoir, which is located in the Kragujevac basin in Serbia (Fig.1).

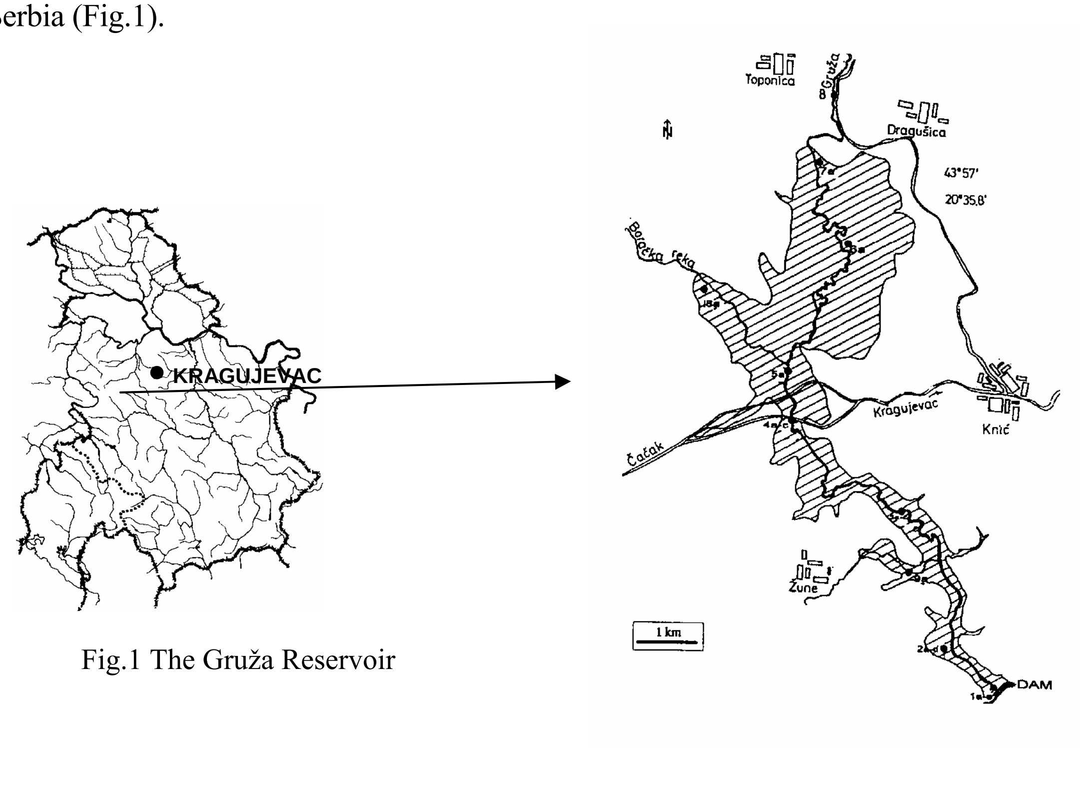

Fig.1 The Gruža Reservoir

The freshwater systems of this basin belong to the Euro-Mediterranean subregion as a natural zoogeographic whole in the framework of the Holarctic. The recent vegetation of the basin belongs to the Euro-Siberian and North American region. According to VELJOVIĆ (1967), the natural plant cover constitutes 35% of the basin, land under cultivation is constantly expanding, erosion is on the increase, and vegetation is becoming more uniform.

The Gruža reservoir was formed on fertile flatland at an elevation of 238m above sea level. The lake is 10km long and 0.2-1.5km wide (Fig.1), with surface area of 934ha, oscillations of the water level comprise 3-5m. Two thirds of the Gruža Reservoir is given over to its shallower part (2-9m), where the shoreline is very indented, with numerous bays, inlets, and a well developed muddy littoral. This part is surrounded by cultivated land.

Research on the vascular flora of the Gruža Reservoir was carried out during the period 1999-2002. The collected plant material was herbarized or conserved in 4% formaldehyde. It is preserved in the collection of the Institute of Biology (Faculty of Science, University of Kragujevac). Determination of species was conducted according to The Flora SR Serbia (JOSIFOVIĆ, 1970-1980) and JAVORKA & CHAPODY (1975).

A biogeographical and ecological characterization of hydrophilic flora is given in presentation of their flora. Flora elements were determined in accordance with principles of the division developed by MEUSEL et al. (1965, 1978), which is based on coincidence of species ranges with the corresponding floristic chorions.

Life forms are given according to the Rauncke principle as elaborated by MUELLER-DUMBOIS and ELLENBERG (1974) and partially modified by STEVANOVIĆ (1992) in the Flora of Serbia. Ecological factors (soil moisture and acidity, light, and temperature) were determined according to KOJIĆ (1997).

RESULTS

The composition of vascular flora of the Gruža reservoir is given in Table 1, from which it can be seen that 162 species belonging to 37 families are present.

With respect to the number of families and species, Magnoliopsida are dominant with 63% of the families (61,54% of the species), while Liliopsida are present with 33,3% of the families and 35,8% of the species. Four of these families stand in regard to the number of species represented, namely Asteraceae with 18, and Poaceae with 17, Fabaceae with 9 and Lamiaceae with 8 species, which taken together constitutes 32,10% of the total number of species.

Phytogeographic analysis of the vascular flora of the Gruža Reservoir confirmed several flora elements grouped into five areal types. The greatest number of species have ranges of the holarctic (65,15%) and cosmopolitan (24,24%) area types, but species with the Mediterranean-continental (4,55%), Central European-Mediterranean (3,79%), Central European (1,54%) and adventive types (0,76%) are also represented.

Analysis of life forms showed that 51,54% of plants of the Gruža Reservoir are hemicryptophytes, 12,86% are therophytes, 7,58% are geophytes, 3,03% are Chamaephytes and Scandentophytes each, 0,76% are Phanerophytes and 21,21% are hygro-heliophytes and amphibious, flotant, and submersed hydrophytes. Within these categories emersed plants constitute 53.57%, submersed plants 32.14%, and flotant plants 14.29% of the species.

With respect to flowering time, summer species are dominant among plants of the Gruža reservoir (75,76%), but spring-summer (8,33%), summer- fall (8,33%), spring- fall (3,79%), fall (3,03%) and spring (0,76%) species are also represented. As for height, tall plants are dominant.

Submesophilic (34,86%), mesophilic (28,03%), subxerophilic (15,15%) and hygro-heliophytic (12,87%) species are dominant in the vascular flora of the Gruža Reservoir, while amfibius and flotant (3,03%) and submersed (5,3%) species are also represented.

With respect to plant affinity for the soil chemical reaction, neutrophilic plants (74,24%) and plants transitional between neutrophilic and basophilic (22,73%) are dominant, ones transitional between acidophilic and neutrophilic (3,03%) being less well represented. In regard to the presence of nitrogen in the soil, mesotrophic plants (58,33%) and plants in transition to eutrophic (25%) are dominant, while plants in translation between oligotrophic to mesotrophic (12,12%), eutrophic plants (3,79%) and oligotrophic (0,76%) plants are less well represented. As for light, semi-sciophytes (50,76%) and plants transitional to heliophytes (42,42%) are dominant, whereas plants in translation to semisciopyites (4,55%), heliophytes are represented with 1.51% and sciophytes with 0,76%.

In relation to temperature, mesothermal plants (73,49%) and ones in transition to thermophilic species (21,21%) are dominant, while species transitional between frigoriphilic and mesothermal plants (3,79%) and thermophilic species (1,51%) are less well represented.

DISCUSION

Flora and vegetation of Kragujevac basin had been studied by VELJOVIĆ et al. (19984) before the reservoir was formed. They state that larger fragments of bog vegetation are absent in that part, and that such vegetation can be found 10km upstream from the reservoir. In the river valley subject to flooding, dry and moderately damp valley meadows are present, whereas hill meadows occupy small areas and steppe vegetation is increasingly represented. Todey, the vegetational cover of the Gruža watershed is very heterogeneous and exceptionally mosaic, being composed of agrarian ecosystems, hill and valley meadows, thermophilic and mesophilic forests, remains of inundated forests, fragments of steppe vegetation, hedges, ecosystems of settlements, neglected cleared land and bogs of a fragmentary nature (VELJOVIĆ et al., 1990).

In the vegetative sence, elements of all types of surrounding vegetation are present in our results, because on the great part of the reservoir´s is edge the natural vegetation of the wider area desends to the coast and represents the best protective belt.

Of the antropogenic terciar vegetation elements of all classes can be found: wet dumps cl. Bidentetea-tripartitii Tx., Lohm. et Prsg. 1950.; dry dumps cl. Artemisietea-vulgaris Lohm.; Prsg. et Tx. 1950; pioneer ruderal vegetation of covered terrains cl. Agropiretea-repentis Oberd.; Mull et Gors 1967; moderately wet and nitrified areas cl Chenopodietea- albae Br.-Bl. 1951 em. Lohm. et Tx. 1961; ruderal vegetation of the stepedin areas cl Plantaginetea-majoris Tx. et Prsg. 1950 and weed vegetation of the cultivated areas cl. Stellarietea-mediae Tx.; Lohm. et Prsg. 1950.

Large presence of the antropogen tercial vegetation could be explained by the presence of significant cultivated areas in the region of Gruža Reservoir, and also by bringing of the weed and ruderal species seeds from the basins of this reservoir.

The great indentation of the shoreline of the Gruža Reservoir, its muddy banks, and the shallow depth of two thirds of the lake have caused hydrophilic vegetation to develop in the numerous inlets. Further favorable conditions for its development were created during the period of investigation by the presence of an adequate quantity of nutrients and less pronounced variation of the water level. Mass development of submersed plants occurred in the shallowest parts of the Gruža Reservoir and in bays. VELJOVIĆ (1986) discovered 27 species of heterogeneous floristic composition, in contrast to the uniformity typical of bogs and swamps. This is understandable in view of the fact that the reservoir was then at the outset of its existence, while dry and moderately damp meadows were formerly present on the land that was flooded. Already in the third year after formation of the reservoir, the entire shallow and muddy littoral was overgrown with larger or smaller stands of hydrophilic vegetation, most extensively in the lake's inlets. This confirms the fact that the degree of indentation of the shoreline is a very significant factor in the formation of macrophytic vegetation. The species cited by VELJOVIĆ et al. (1986) are of different ecological types, indicating heterogeneous floristic composition of littoral stands still in the phase of formation. Analysis of the degree of similarity with results given in the present work shows that most of the species registered earlier are still present today, together with many species that were not then recorded.

With 98% of all the species in the vascular flora of Serbia, Magnoliophyta are the most common. Among them 4/5 of all the species are Magnoliopsida (STEVANOVIĆ, 1995). The results gathered in this work show these relations in full- 96,3% of the vascular flora of the Gruža reservoir are Magnoliophyta, and 63% of them are Magnoliopsida.

Our results indicate that species of the families Asteraceae, Poaceae Fabaceae and Lamiaceae are best represented, which confirms the data about family representation in the vascular flora of Serbia (STEVANOVIĆ, 1995), where families Asteraceae, Poaceae and Fabaceae also are best represented. Our results also confirm the presence in quantity of the species *Polygonum amphibium* L., which occurs at depths as great as 3.5 m and could play a significant role in filling of the reservoir with vegetation. Flotant vegetation is represented by moderately thermophilic species (*Lemna minor* L.). The species *Myryophyllum verticilatum* L. and *Polygonum amphibium* L. are conspicuously present in this reservoir and represent biological indicators of water quality category II. Species of the genera *Ceratophilum* and *Lemna* indicate accelerated eutrophication of the lake. Hydrophilic vegetation tends to render the littoral zone shallower, is present in temporarily inundated zones, and has developed especially in the shallow initial part of the reservoir, which has the characteristics of a swamp.

The flora of the coastal area of the Gruža Reservoir is not stable despite it´s old age. The areas of the water level variatiens are inhabited by the flora only ephemeraly after the water with draws from it´s higest level. I time of the water level vising the flora already inhabitad in that area is floodrd, and their survival depends upon the length of the floods. In that area there are also waves which take away lighter fragments of supstratus. Changing the water level also washes of the smaller and lighter fragments, thus leaving only the rough gravel which is cemented during the summer drought. That enables the presence of thermophilic species.

The flat areas around the reservoir that stay flooded for a long time are inhabited by a swamp vegetation or some of its elements. These areas have been cultivated until recently evidence of which are the remains of the corn and numerous presence of *Cirsium arvense* L. species which the large dreas have an appearance of monoculture.

Not even the most basic ecological principles were considered in creation of the Gruža Reservoir. Thus, it was formed by flooding of fertile land and has remained surrounded by cultivated fields around two thirds of its shoreline. The lake is polluted by nutrients and chemicals washed into it from cultivated fields, by the proximity of slaughterhouses and mushroom farms, by high density of traffic on the bridge crossing it, and by the presence of many fishermen and bathers. These factors have led to accelerated aging and eutrophication of the reservoir, and thereby shortened the period of its exploitation. Together with the great indentation of its shoreline and shallowness of most of the lake, the indicated factors have brought about intensive development of hydrophilic vegetation. The hydrophilic flora of the Gruža Reservoir includes an especially great number of emersed species, which contain greater amounts of structural tissues than in submersed and flotant species. Their death results in accumulation of large quantities of cellulose and lignin, which are considerably more resistant than other tissues to bacterial decomposition (WETZEL, 1983).

Nevertheless, this development is still not enormous, although it does indicate an adequate amount of nutrients and a favorable thermal regime. In this stage, macrophytes represent a desirable component, both as competitors with algae for nutrients and regulators of phytoplankton development and for the important role of macrophytes as biological filters (WETZEL, 1992, PARFENOV, 1992), since a large influx of allochthonous nutrients enters the lake from tributaries and cultivated fields. Development of the macrophytic flora in this reservoir needs to be constantly monitored because increased biomass of macrophytes together with high production of phytoplankton can additionally burden the reservoir with autochthonous organic matter. For systems from which water is obtained for drinking purposes, all of this is of exceptionally great significance.

Results of the work confirm the significant role played by physical organization of the site of reservoir formation in ecological processes and interactions between plant communities and the surroundings. Lasting changes of ecological conditions are particularly crucial for ecosystem dynamics and water quality in reservoirs.

ACKNOWLEDGMENTS

This work was supported by the Ministry for Science and Technology of Serbia, grant No. 1252 – project "Biomonitoring and Ecological protection of Reservoirs for water supply of Kragujevac".

References

[1] JAVORKA, S., CSAPODY,V. (1975): *Iconographia Florae Partis Austro-Orientalis Europae Centralis,* Academiai Kiado, Budapest.

[2] JOSIFOVIĆ, M. (ed) (1970-1980): *Flora SR Srbije I-X*. SANU, Beograd,

[3] KOJIĆ, M., POPOVIĆ,R., KARADŽIĆ, B. (1997): *Vaskularne biljke Srbije kao indikatori staništa*, Institut za istraživanja u poljoprivredi »Srbija«, Institut za biološka istraživanja »Siniša Stanković«, Beograd.

[4] MEUSEL, H., JÄGER, E., WEINERT, E. (1965): *Vergleichende Chorologie der Zentraleuropäischen flora*.VEB Gustav Fischer Verlag, Band 1. Jena

[5] MEUSEL, H., JÄGER, E., WEINERT, E. (1978): *Vergleichende Chorologie der Zentraleuropäischen flora*. VEB Gustav Fischer Verlag, Band 2. Jena

[6] MUELLER-DOMBOIS, D., ELLENBERG, H. (1974): *Aims and Methods of Vegetation Ecology*. John Wiley and Sons. New York.

[7] OSTOJIĆ,A. (2000): *Uporedno ekološka studija zooplanktona akumulacija Grošnica i Gruža,* Doktorska disertacija, Univerzitet u Beogradu, 186pp.

[8] PANČIĆ, J. (1884): *Dodatak flori Knezevine Srbije*. Kraljevska drzavna stamparija. Beograd.

[9] PARFENOV, P. (1992): *Ecological role of aquatic vegetation in the evolution of temperate zone lakes of various origin*. Miensk, Belorusia, 287 pp.

[10] RUDSKI, I. (1949): *Tipovi lišćarskih šuma jugoistočnog dela Šumadije*. Prirodnjački muzej srpske zemlje 25. Posebno izdanje. Beograd.

[11] Simović, S. Marković, A. (1996): *Hidrobiološke karakteristike akumulacionog jezera Gruža i zaštita*. Zbornik radova. Zaštita voda 96. Jugoslovensko društvo za zaštitu voda, Beograd, 334- 339.

[12] STEVANOVIĆ, V. (1992): *Klasifikacija životnih formi flore Srbije*- In Saric,M.ed. Flora Srbije, I (2.ed.): 39-46, SANU, Beograd.

[13] STEVANOVIĆ, V. (1995): *Biogeografska podela teritorije Jugoslavije*. In: Stevanović,V., Vasić,V.(ur): Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja, Biološki fakultet i Ekolibri, Beograd.

[14] VELJOVIĆ,V. (1967): *Vegetacija okoline Kragujevca*, Glasnik Prirodnjačkog muzeja, Ser.B, 22: 1-180.

[15] VELJOVIĆ, V., MARKOVIĆ, A. (1984): *Ekološke karakteristike akumulacionog jezera na Gruži*.- III Kongres ekologa Jugoslavije. Radovi i rezimea, Knj.1: 141-146.

[16] VELJOVIĆ, V., MARKOVIĆ, A., VUKOMANOVIĆ,V. (1986): *Dijagnostički značaj pojave makrofitske flore i vegetacije u novoformiranim akumulacionim jezerima*, Konferencija »Zaštita voda 86«, Kragujevac, Zbornik radova, 82-86.

[17] VELJOVIĆ,V., MARKOVIĆ, A., VUKOMANOVIĆ,V. (1986): *Dijagnostički značaj pojave makrofitske flore i vegetacije u novoformiranim akumulacionim jezerima*, Konferencija »Zaštita voda 86«, Kragujevac, Zbornik radova, 82-86,

[18] VELJOVIĆ, V., MARKOVIĆ, A., OGNJANOVIĆ,R. (1990): *Vegetation of the river system Gruža with particular regard on the impoundment area Gruža*. Bilten Društva ekologa Bosne i Hercegovine. Ser. B, 5: 125-129.

[19] WETZEL, R.G. (1983): *Lymnology*, W.B. Saunders Co., Philadelphia, PA: 767 pp.

[20] WETZEL, R.G. (1992): *Gradient-dominated ecosystems: sources and regulatory functions of dissolved organic matter in freshwater ecosystems*. Hydrobiologia 229: 181-198.

Table 1. Review of vascular flora of the Gruža reservoir with floral elements, life forms and ecological index

Family and species	floral elements	life forme	ecological factors H	A	N	L	T
Fam. **Alismataceae**							
Alisma plantago- aquatica L.	cirkhol (subbor)	a Mes-Meg emer HydG rad	6	3	3	4	3
Fam. **Apiaceae**							
Daucus carota L.	me-med-pont-or-tur-afr	a MegH scap/ T scap	2	3	2	4	3
Oenanthe aquatica (L.) Poir	subme	a Alt emer HydG rhiz	5	4	3	4	3
Pastinaca sativa L.	me-med- pont- s.sib	a MegH scap bienn	3	4	3	4	3
Fam. **Asteraceae**							
Achillea millefolium L.	eu (bor-submerid)	a MegH scap	2	3	3	4	3
Arctium lappa L.	eu (temp-submerid)	aut Meg-AltH scap bienn	3	3	5	4	4
Artemisia vulgaris L.	eu-sam (subbor-merid)	aut Meg-AltH scap	3	3	4	4	3
Bidens cernuus L.	eu-sam (bor-merid)	aut Meg-AltT scap	5	3	4	4	3
*Bidens tripartitus*L.	eu (subbor-temp)	aut Mes-AltT scap	4	3	4	4	3
Cychorium inthybus L.	cosm (eu)	a-aut Meg-AltH scap	2	4	3	5	4
Cirsium arvense (L.) Scop	eu (subbor-merid)	a Meg-AltG rad scap	3	3	4	4	4
Cirsium lanceolatum (L.) Scop	eu (subbor-merid)	a Meg-AltH scap bienn	3	3	4	3	3
Crepis biennis L.	me-subm-pont	a Meg-AltH scap bienn	3	3	3	3	3
Crepis paludosa L. (L.) Mnch	me-subm-pont	v-a Meg-AltH rhiz scap	4	4	3	3	2
Eupatorium cannabinum L.	me-med-subm-pont-s.sib	a Meg-AltH scap	4	4	3	3	3
*Inula britanica*L.	eu (temp-merid)	a Mes-MegH scap	4	4	3	3	4
*Lactuca serriola*L.	eu (subbor-merid)-afr	a Meg-AltH scap /T scap	2	3	3	5	4
Soncus arvensis L.	cosm (eu)	a Meg-AltH scap	3	3	4	3	3
Sonchus oleraceus (L.) Gou.	cosm (med-subm)	a Meg-AltT/ H scap bienn	3	4	4	4	4
Stenactis annua (L.) Ness.	adv (sam)	a-aut Mes-MegT/ H scap bienn	3	3	3	4	4
Tanacetum vulgare L.	eu (temp-mer)	a Meg-AltH scap	3	3	3	4	3
Taraxacum officinale Web.	cosm (evr)	v-aut MesH ros	3	3	4	4	3
Fam. **Boraginaceae**							
Symphytum officinale L.	me-med-subm-pont-s.sib	a Mes-MegH scap	4	3	4	3	2
Fam **Brassicaceae**							
Barbarea vulgaris R. Br.	eu (subbor-merid)	a MegH scap	3	3	3	4	3

Table 1. Continued 1

Family and species	floral elements	life forme	ecological factors H	A	N	L	T
Cardamine pratensis L.	cirkumpol-bor	a Mes-MegH rhiz ros	4	3	3	3	2
Rorippa austriaca (Cr.) Bess.	med-w.pont	a MegH scap	4	3	3	3	4
Rorippa sylvestris (L.) Bess.	med-subm-pan-pont	a Mi-MesH scap	4	4	3	4	4
Thlaspi alliaceum L.	me-m.med-subm	v-a Mes-MegT semiros-scap	2	3	3	3	4
Fam **Butomaceae**							
Butomus umbellatus L.	eu (subbor-merid)	a Mes-Meg emer HydG rhiz	5	3	4	3	3
Fam **Caryophillaceae**							
Cerastium arvense L.	cirkumpol	a- aut MesCh herb caesp	2	3	2	4	3
Lychnis flos- cuculi L.	me-eu-subm-pont-j.sib	a Meg H scap	4	3	3	4	3
Silene alba (L.) Krause	eu (temp-submerid)	a MegH scap bienn/ a H scap	2	3	4	4	3
Stellaria media (L.) Vill	cosm (med)	v- aut MiT rept	3	3	4	3	3
Stellaria nemorum L.	subme	v- aut MegH rhiz scap	4	3	3	2	2
Fam. **Ceratophylaceae**							
Ceratophyllum demersum L.	cosm (bor-austtrop)-plan-col	a er sbm HydG	7	4	5	3	4
Ceratophyllum submersum L.	subme	a er sbm HydG	7	4	5	3	4
Fam. **Convolvulaceae**							
Calystegia sepium (L.) R. Br.	cosm (eu-sam)	a SH herb	4	4	4	3	3
Convolvulus arvensis L.	cosm (med)	a SG herb rhiz	2	4	3	4	3
Fam **Cyperaceae**							
Carex leporina L.	me (cirkumpol)	v-a MegH caesp	3	2	2	3	3
Carex remota L.	euas (med)	v-a MegH caesp	4	3	3	2	3
Carex silvatica Huds.	euas	v MegH rhiz caesp	3	3	3	1	3
Eleocharis palustris (L.) R.Br.	cosm (eu)	a-aut Mac-MegG rhiz caesp /emer HydG rhiz	5	3	2	4	3
Scirpus silvaticus L.	euas	v-a Meg-AltG rhiz/ emer HydG rhiz	4	3	2	3	3
Fam. **Euphorbiaceae**							
Euphorbia amygdaloides L.	eu-med-subm-hirc-karp-subatl-atl-brit	v-a Mac-MegCh herb	3	4	3	2	3
Euphorbia cyparissias L.	atl-me-subm-pan-sarm	v-a Mes-MegH scap	2	3	2	4	3
Euphorbia virgata W. et K.	me-pont-subm-sarm	v-a Mac-AltH rad	3	3	3	4	4

Table 1. Continued 2

Family and species	floral elements	life forme	ecological factors H	A	N	L	T
Fam. **Equisetaceae**							
Equisetum telmateia Erhart.	me-med-subm-pont-s.sib	a MegG rhiz scap	4	3	2	4	3
Equisetum palustre L.	cirkhol (eu-sam)-plan-mont	a MegG rhiz	4	3	2	4	3
Fam. **Fabaceae**							
Lathyrus palustris L.	eu (subbor-merid)	a MegG rhiz	4	4	2	4	3
Lathyrus pratensis L.	eu (subbor-merid)	a MegH scap	3	3	3	3	3
Lathyrus tuberosus L.	me-subm-pont-s.sib- tur	a MegG tub rept	2	4	2	4	4
Medicago lupulina L.	eu (temp- merid)-afr	a MesT scap/ a H scap	2	4	3	3	4
Trifolium hybridum L.	eu-med-subm-pont-s.sib	a MesH scap	3	4	3	4	3
Trifolium incarnatum L.	subatl-med-subm	a Mes-MegT scap	2	3	3	4	5
Trifolium pratense L.	eu-med-subm-pont-s.sib	a MesH scap	3	3	3	3	3
Trifolium repens L.	cosm (eu)	a MiH rept	3	3	4	4	3
Vicia cracca L.	eu (bor- merid)	a Meg-AltSH herb	3	3	3	4	3
Fam. **Geraniaceae**							
Geranium dissectum Jusl.	atl-meu-med-subm-pan-or	a Mi-MegT scap	2	3	3	4	4
Geranium pyrenaicum Burm	atl-m.eu-med-subm	a Mes-MegH scap	3	3	3	3	4
Fam. **Halorrhagidaceae**							
Myriophyllum spicatum L.	cirkborarkt-(subarkt-merid)	a- aut subm Hyd T rad	7	4	3	3	3
Myriophyllum verticilatum L.	eu (bor-merid)	a- aut subm Hyd G rad	7	3	3	3	3
Fam **Hypericaceae**							
Hypericum perforatum L	me-med-pont-s.sib-or-tur	a Mes-MegH scap	2	3	3	3	3
Fam **Iridaceae**							
Iris pseudacorus L.	me-med-subm- pont	v Meg emer Hyd G rhiz	5	3	4	3	3
Fam. **Juncaceae**							
Juncus compressus Jacq.	eu-med-subm-pont-s.sib	a MesG rhiz caesp	4	3	3	4	3
Juncus conglomeratus L.	me-med (mont)-subm-norv	v-a Mi-AltH rhiz caesp	4	2	3	4	3
Juncus effusus L.	cosm (me-merid)	a Mes-Meg G rhiz caesp	4	2	3	3	3
Juncus inflexus L.	euas-med-or-tur-pont-atl-sarm	a Mes-MegH rhiz caesp	4	4	3	4	3
Juncus lampocarpus Ehrh.	me-med-tur-pont-boratl-m.sib	a Mi-MesH rhiz caesp	4	3	2	4	3

Table 1. Continued 3

Family and species	floral elements	life forme	ecological factors H	A	N	L	T
Fam. **Lamiaceae**							
Lycopus europaeus L.	eu (subbor- merid)	a Mes- MegH scap/ emer HydG rhiz	5	3	3	3	3
Lycopus exaltatus L.	subm (i)-pan-pont- m.sib-or-tur	a Mes-MegH scap/ emer HydG rhiz	4	3	3	3	3
Mentha aquatica L.	eu (subbor-submerid)-afr	a Mes-MegH scap/ emer HydG rhiz	5	3	3	3	3
Mentha longifolia (L.) Huds	eu (temp-mer)-afr	a Mes-MegH scap	4	4	4	3	3
Mentha spicata ssp. *tomentosa* Urv.	subm (eu)	a Mes- MegH scap/ emer HydG rhiz	5	4	4	5	5
Scutelaria galericulata L.	eu-sam (bor-temp)	a Mi-MegG rhiz scap	4	3	3	3	3
Stachis palustris L.	eu-sam (bor-submerid)	a Mes-MegH scap	4	3	3	3	3
Stachis silvatica L.	euras	a MegG rhiz	4	3	4	2	3
Fam**. Lemnaceae**							
Lemna gibba L.	cosm	a er nat HydT	6	4	4	4	3
Lemna minor L.	cosm	a er nat HydT	6	3	3	4	3
Fam. **Lythraceae**							
Lythrum salicaria L.	cosm (evr)	a Meg-AltH scap	4	3	3	3	3
Fam. **Najadaceae**							
Najas marina L.	cosm	a rad sbm HydT	6	3	3	3	4
Fam. **Oenotheraceae**							
Epilobium hirsutum L.	eu (subbor-merid)-afr	a Meg-AltH scap	5	2	2	4	3
E. parviflorum (Schr.) With.	euas (med)	a Meg H rhiz ros	4	3	3	4	3
Fam. **Plantaginaceae**							
Plantago lanceolata L.	eu (subbor-temp)	a Mi-MegH ros	3	3	3	3	3
Plantago major L.	cosm (eu-sam)	a Mes-MegH ros	3	3	3	4	3
Fam. **Poaceae**							
Agropyrum repens (L.) P.B.	cosm (eu)	a Mes-MegG rhiz caesp	3	3	3	3	3
Agrostis alba L.	cosm (eu)	a Meg-AltH rhiz caesp	4	3	3	4	3
Agrostis tennuis Sibth.	me-subm-m.eu-m.sib	a-aut MesH rhiz caesp	3	2	2	3	3
Alopecurus pratensis L.	eu (subbor- submerid)	a Meg-AltH caesp	3	3	4	3	3
Bromus arvensis L.	subm- sarm- m.sib	a Mes-MegT scap	2	3	3	3	4

Table 1. Continued 4

Family and species	floral elements	life forme	ecological factors H	A	N	L	T
Bromus mollis L.	me-med-m.med-pont (w)	a Mi-MegT scap	3	3	3	3	3
Bromus sterilis L.	me-sarm-med-subm-pont-or	a Mes-MegT caesp	2	3	4	3	3
Calamogrostis epigeios (L.) Roth	eu (subbor- merid)	a Meg-AltH caesp	3	3	3	3	3
Dactylis glomerata L.	me-med-subm- pont-m.sib - or- tur-ca	a MegH caesp	3	3	4	3	3
Festuca pratensis Huds.	eu-subm- pont- j.sib- ca	a MegH caesp	3	3	3	4	3
Glyceria fluitans (L.) R. Br.	subm- w.pont- atl- sarm	v-aut Meg-AltG rhiz rept/ emer HydG rhiz	5	3	3	3	3
Phragmites communis Trin.	cosm (eu- sam)	a-aut Alt emer Hyd G rhiz	5	3	3	3	3
Poa compressa L.	cosm (eu)	a MesH caesp	2	4	2	4	3
Poa nemoralis L.	eu (bor- submerid)	a MesH caesp	3	3	2	2	3
Poa palustris L.	circhol (bor-merid)	a MesH caesp	5	4	3	4	3
Poa pratensis L.	cosm (eu-sam)	a Mes-MegH caesp	3	3	3	3	3
Poa trivialis L.	cosm (eu)	a Mes-MegH caesp	3	3	4	3	2
Fam. **Polygonaceae**							
Polygonum amphibium L.	eu-sam (bor-merid)	a Mes-MegG rhiz scap/ nat HydG rhiz	5	3	4	3	3
Polygonum aviculare L.	cosm (trop)	a-aut Mi-MegT rept	3	3	4	4	3
Rumex acetosa L.	eu-sam (bor-submerid)	a MegH scap	3	3	3	4	3
Rumex conglomeratus Murr.	me-med-subm-or-tur	a MegH scap	4	3	4	4	4
Rumex crispus L.	cosm (eu)	a Meg-AltH scap	3	3	3	4	3
Rumex sanguineus L.	atl-me-med-subm-pont-tur	a MegH scap	4	3	4	3	3
Fam. **Potamogetonaceae**							
Potamogeton crispus L.	cosm	a rad sbm Hyd T	7	3	3	3	3
Potamogeton fluitans Roth	cirkumpol	a rad sbm HydT	7	3	3	3	3
Potamogeton pusillus L.	cosm	a rad sbm Hyd T	7	4	4	4	3
Fam **Primulaceae**							
Lysimachia nummularia L.	me-subm-pont-w.s.sib	v-a N-Mi Ch herb rept	4	3	3	2	3
Lysimachia vulgaris L.	eu (subbor-submer)	a MesH scap	4	3	3	3	3
Fam. **Ranunculaceae**							
Ranunculus arvensis L.	me-med-or-tur-ca	a Mes-MegT scap-semiros	2	4	3	3	4

Table 1. Continued 5

Family and species	floral elements	life forme	H	A	N	L	T
			ecological factors				
Ranunculus repens L.	eu (bor-submerid)	a Mes-Meg H rept	4	3	3	4	4
Ranunculus sardous Cr.	me-med-subm	a Mes-MegT scap-semiros	4	3	3	4	4
Fam. **Rosaceae**							
Fragaria vesca L.	eu (subbor-submerid)-sam	a MesH rept	3	3	3	3	3
Potentilla argentea L.	eu (temp- submerid)	a Mes-MegH scap	1	3	1	4	3
Potentilla reptans L.	cosm (eu)	a Mi-MesH rept	3	3	2	3	3
Fam. **Rubiaceae**							
Galium aparinae L.	cosm (eu)	a- aut Mes-MegST herb	3	3	5	3	4
Galium mollugo L.	me-med-subm	a Meg-AltH scap	3	3	3	3	3
Galium palustre L.	eu-sam (subbor- temp)	a Mes-MegH scap	5	3	2	3	3
Fam **Salicaceae**							
Salix alba L.	me-med-subm-or-pont-s.sib	a fo dec MesP scap	4	4	4	3	3
Fam. **Scrophulariaceae**							
Linaria vulgaris Mill.	eu (subbor- submerid)	a-aut Mes- MegH scap	3	3	3	4	3
Verbascum blattaria L.	eu (temp- submerid)	a Meg- AltH scap bienn/T	2	4	3	4	4
Veronica anagalis-aquatica L.	cosm (eu)	a Mes- MegH scap/ sbm HydG rhiz	5	3	3	4	3
Veronica beccabunga L.	euas- med	v-a Mes- MegH scap/ sbm HydG rhiz	5	3	4	3	3
Veronica chamaedrys L.	me-subm-pont- s.sib	v-a Mi- MesH scap	3	3	3	3	3
Veronica persica Poir.	cosm (med- subm)	v-aut N- MesT scap	3	4	4	3	3
Fam. **Typhaceae**							
Typha angustifolia L.	eu-nam (subbor-temp)	a Alt emer HydG rhiz	5	3	3	3	4
Typha latifolia L.	cosm (eu- sam)	a Alt emer HydG rhiz	5	3	3	4	4
Fam. **Urticaceae**							
Urtica dioica L.	eu-sam (bor- temp)	a Meg-AltH scap	4	3	5	3	3
Fam **Verbenaceae**							
Verbena officinalis L.	cosm (eu-m.afr)	a Mes-MegH scap	2	3	4	4	3
Fam **Violaceae**							
Viola tricolor L.	me-bor (eu)	a Mi-MesT scap	3	3	3	3	3