Variation in species composition and ecological factors in and adjacent to 64 ponds in the agricultural landscape of SE Norway

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2 Abstract

All vascular plants were inventoried in 64 SE Norwegian landscape ponds and their adjacent margins; two separate species lists were made for each sampling unit. Individual study sites varied considerably in species richness, 1–20 and 13–81 for ponds and pond margins, respectively. A total of 56 explanatory variables were recorded for each pond and adjacent margin.

Data on species composition and species richness were analysed separately for ponds and pond margins. Vegetation gradients were found by parallel use of the two ordination methods DCA (Detrended Canonical Analysis) and GNMDS (Global Non-metric Multidimensional Scaling). Interpretation of ordination axes was made by using correlation analyses, GLM (generalised linear modelling) and by geostatistical analyses of spatial structure. Patterns of species richness were analysed by correlation analyses and GLM. The first DCA and GNMDS ordination axes both for ponds and pond margins were strongly correlated and the main gradient was related to geographical variables (such as UTM northing, altitude, distance to forest), pond age and water chemical variables. Water depth and soil depth also explained some of the variation in species composition in ponds and pond margins, respectively. The second DCA and GNMDS axes were different for the two data sets. The second gradient for pond margins was also related to geography and water chemistry in addition to some of the anthropological variables, whereas the second gradient for ponds was harder to find.

Correlations and GLM analyses of species richness revealed that mainly water chemistry, in addition to periodical pond drainage and liming were significant predictors of pond species richness, whereas area, if the pond had recently been expanded, some water chemical and geographical variables were significant for the species richness of ponds margins.

Different structuring processes which may contribute to explaining variation in species composition and richness are discussed. The analysis of spatial structure of species composition and explanatory variables showed that the ecological data were weakly spatially structured over large range of scales and particular patterns were hard to find. Together with the generally weak explanatory power of the selected variables, this indicates high importance of apparent randomness in this ecosystem, and, notably, that the ponds and their adjacent margins represent islands in the agricultural landscape that accumulate species more or less individualistically.

3 Contents

4 Introduction

Agricultural landscapes are, traditionally, landscapes of change. Formed by continuous human influence over generations, agricultural landscapes are living cultural ecosystems in which structural changes are brought about by changes in human use (Skånes & Bunce 1997). These changes have wide-ranging consequences, especially for biological diversity. The nature and extent of these biological effects of structural changes are largely unknown. The way we choose to utilize the landscape is often affected by conjunctures, technology and political aims (Anonymous 1987). After World War II the Norwegian authorities have encouraged farmers to change from farming based on domestic animals to production of grain in those parts of the country where the natural conditions make this possible. This is especially relevant for the south-eastern part of Norway where it has been encouraged by economical measures. Furthermore modern equipment and technology has made grain production a profession with small demands for manpower per unit area (Anonymous 1980; Aasbrenn 1985). This has brought about, among other things, removal of traditional farm ponds used for animal husbandry (Fig. 1). Such farm ponds have to some extent been replaced with ponds used for watering the fields (Fig. 2). Pond abandonment has also been assisted by the 50 % reduction of farms in Norway, 1960–2001 (Fremstad & Moen 2001).

Figure 1. Traditional farm pond at Olstad, Akershus.

Figure 2. Typical pond used for watering at Skjelve, Hedmark.

Another factor that has contributed to the abandonment of traditional agricultural ponds is the development of water conduit systems. In former times, farm ponds could be the only source of water and it commonly had multiple functions at a farm, e.g. as reported from Torskenes farm, Sarpsborg, SE Norway, where six types of ponds were present, named after their use (Grøndahl 1980): “barn pond” (“fjøsbrønn”), “potato-cellar pond” (“kjellerbrønn”), “washinghouse pond" ("bryggerhusbrønn"), "drinking-well/-pond" ("renvannsbrønn"), "stable pond" ("stallbrønn") and "forge pond" ("smiebrønn"). Legislation ("Brønnloven av 31. mai 1957"; Anonymous 1985a) enforced demands for improved securing and thereby indirectly promoted drainage and filling in of the ponds. This law therefore indirectly contributed to reduction of the biodiversity in the more traditional agricultural landscape. The same development has been promoted, indirectly, by the fact that the law for protection of cultural heritage sites ("Kulturminneloven"; Anonymous 1985b) does not include farm ponds.

About 5 % of the land area of Norway is covered by freshwater and there are ca. 440 000 lakes > 600 m^2 (Anonymous 1999a). In addition to this, lots of small ponds and streams give Norway an unusual density of both flowing and stagnant water even in a worldwide perspective (Anonymous 2000). The term farm pond will be used for a diverse group of more or less small ponds located in the agricultural landscape. These ponds vary a lot in appearance and shape depending on geographical, physical and chemical characteristics as well as historical events and use. Standing water is commonly classified on basis of climate, circulation, morphometry, formation, plant and animal communities and water chemistry. Farm ponds will typically be classified as eutrophic ponds (Anonymous 1999a) or *Potamogeton* ponds (Mjelde *et al*. 2000). Anonymous (1999a) does, however, make a distinction between farm ponds and *Potamogeton* ponds.

Natural eutrophic ponds are rare in Norway. *Potamogeton* ponds are considered an endangered type of vegetation and have declined over the last decades (Anonymous 1999a, Fremstad & Moen 2001), as exemplified by a survey in Spydeberg, Østfold, SE Norway, showing that 50-60% of the ponds present in 1964 were in the mid 1990s closed up (Spikkeland 1998), and that 30-50% of these ponds were lost during 1984–1994 (Wergeland Krog 1996). Furthermore one third of surveyed ponds in Ringerike, Buskerud, SE Norway, had disappeared within the decade 1978–88 (Dolmen *et al.* 1991). Surveys from Østerdalen, Gauldalen and the Trondheim area revealed lots of ponds at the risk of being filled in (Dolmen 1990; Dolmen & Strand 1991). Another survey did, however, conclude that there had been a slight increase in the number of ponds in Nes, Ringsaker, Hedmark, SE Norway, within the period 1960–2000 (A. Often pers. comm.).

One of the criteria used for categorising endangered vegetation types is the occurrence of species on the Red List (Anonymous 1999b). Because of the strong reduction of farm ponds, many of the species typically associated with ponds are red listed. According to the most recent Norwegian Red List 51 vascular freshwater plants (helophytes not included) are red listed, and freshwater is considered an important element adding to an area's conservation value regardless if presence of endangered or rare species is proved or not (Anonymous 1999a).

Through several national and international agreements, e.g. the Convention on Biological Diversity (1992) and Parliamentary White Paper no. 8 (1999–2000), Norway has agreed to conserve biodiversity. Conservation of farm ponds and the vascular plants living therein must be seen in an ecological context, in interaction with other biotic and abiotic factors. There are also other concerns for keeping farm ponds in the agricultural landscape. They may function as natural regulators of the water level, prevent communities from inundation as well as from drying up, and add to landscape beauty (Hodgson & Thayer 1980). Farm ponds is thus considered as an important element in the landscape, both from the point of view of biodiversity and cultural heritage conservation (Anonymous 1994a). One of the national intensions stated by the Norwegian government is to maintain the cultural history, the cultural environment and settings (Bye *et al.* 2003).

Vascular plants constitute an important part of agricultural landscape biodiversity (Hanski & Tianinen 1998) and many of the species found in agricultural areas are considered being culturally dependent (Stabbetorp & Often 2003). In cultivated landscapes small patches of remnant vegetation, e.g. farm ponds, hold a key position by serving as the only hospitable habitat islands for a wide range of species. A pond is characterised by the physical and chemical conditions like morphology, pH, turbidity and nutrient concentrations, as well as organisms like plants, fish and ducks. These factors provide both a biotic and an abiotic environment which will differ spatially and temporally along and within ponds. Only organisms possessing specific traits and adaptations will be able to establish and reproduce successfully under these conditions (Brønmark & Hansson 1998).

Patterns and determinants of freshwater biodiversity are poorly known compared to those of many terrestrial groups. Most research on species richness in the agricultural landscape has either focused on invertebrates like salamanders in ponds or plant species in meadows, e.g. Norderhaug (1987); Ekstam & Forshed (1992); Hamre & Austad (1999); few published data describe smaller natural or man-made ponds. Even though research into the ecology and conservation of British ponds has increased markedly over the last decades (cf. Biggs & Aistrop 1995; Hull 1997), ponds are considered as poorly studied compared to other freshwater habitats in the UK, despite they are common landscape features (Wood *et al.* 2003). It has been argued that their relatively small size and the high frequency of occurrence have led to the widely held belief that ponds were ecologically unimportant (cf. Wood *et al.* 2003). Japanese studies show that pond vegetation has disappeared or changed dramatically e.g. because of recent urbanization (Shimoda 1997). The same situation has also been reported in Europe, e.g. Møller and Rørdam (1985) in Denmark in addition to Barr *et al*. (1994) and Boothby & Hull (1997) in the UK.

Studies in which the plant species composition of Norwegian farm ponds is systematically surveyed are lacking, despite the recognition of the biological importance of the pond ecosystem. Furthermore, aquatic plants are expected to respond strongly to the environmental conditions within a pond because they are in close contact both with the sediments and the surrounding water. The chemical environment of many ponds has changed during the last century, due to intensified exploitation of the land by farming, urban expansion, and water pollution (cf. Boothby & Hull 1997; Heegaard *et al*. 2001). Improved knowledge of plants' responses to the environmental conditions can therefore be useful for identification of environmental conditions indicative of biodiversity change.

The objective of this thesis is to contribute to filling the knowledge gap with respect to plant species composition and ecological conditions of pond ecosystems in the Norwegian agricultural landscape. The main focus is on patterns of variation in species composition and species richness of vascular plants, as analysed by correlation analysis and multivariate methods. As a final point structuring processes in species composition will be addressed, notably, what processes are most likely to contribute to species composition seen in this study of ponds and adjacent pond margins.

5 Materials and methods

The investigation area

The 64 study sites were located in 25 municipalities in five different counties (Østfold, Vestfold, Akershus, Hedmark and Oppland) in the south-eastern part of Norway (Fig. 3). The investigation area belongs to two agricultural regions (in the national classifications by the Norwegian Institute of Land Inventory, NIJOS (Puschmann 1998)) and the study area is therefore considered sufficiently homogenous, e.g. with respect to agricultural processes, climatic factors and topography to allow common analysis of data. This part of Norway is characterised by an agricultural landscape that is mostly flat and open, or within a matrix of more or less extensive woodlands.

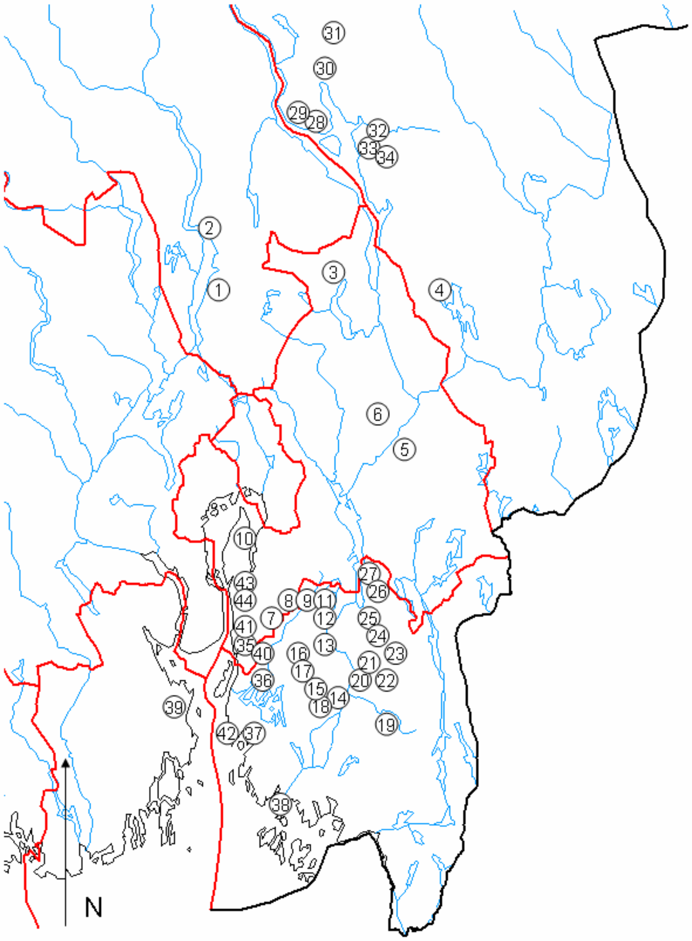

Figure 3. Map showing 44 sample squares containing 64 ponds in the south-eastern region of Norway. Descriptions of study sites (farm/site, municipality, county) are given in Appendix 1.

The sampling design

The study area was chosen to be similar to that in the Norwegian Research Council (NFR) project (*3Q-'Agricultural landscape change – effects on the species diversity of vascular plants'*) carried out by the University of Oslo and the Norwegian Institute of Land Inventory (NIJOS), see R. Økland *et al.* (submitted). The 3Q monitoring programme is a national sample-based survey consisting of 1475 sample squares of 1 km^2 (see Dramstad *et al*. 2002 for more details), distributed across the country in proportion to the area cover of agricultural land (3Q land type class A; Mathiesen *et al.* 2002). Each sample square with its land types is mapped based upon interpretation of true-colour aerial photographs.

The 64 ponds included in the present study were systematically selected from 44 randomly selected 1 km^2 3Q-vegetation plots situated in the boreo-nemoral and the southern boreal vegetation zones (Moen 1998) in five SE Norwegian counties Østfold, Vestfold, Akershus, Hedmark and Oppland. All freshwater ponds interpreted as farm ponds according to the 3Q definition (artificially created pond with an area of 4-5000 m^2 (Engan 2004)), were included. Field work was carried out in the summer of 2003, from ultimo June till ultimo August. Each site was visited at least two times for recording of full species lists, while environmental explanatory variables were recorded on one occasion.

Recording of species data

Separate species lists were obtained for the pond (P) and its surroundings, the pond margin (M), of each site. Only vascular plants were recorded. Each species on each sampling unit was assigned a quantitative abundance value: 0 – absent, 1 – infrequent, 2 – frequent and 3 – dominant. Plant species rooted in water were included on the pond species list. If present natural borders (rock wall, lawn etc.) were used to delimit the pond margin, otherwise it was given the maximum width of 3 meters. Plants which according to the owners of the properties were known to be introduced were not registered.

The nomenclature of vascular plants follows Lid & Lid (1994). Three genera (*Arctium, Hosta* and *Taraxacum*) were considered *species pluralis* (*spp.*) because further identification was generally not possible.

A total of 104 and 301 species, respectively, were recorded in ponds and pond margins. Plants were searched for by walking the pond perimeter, by wading, and from boat. A rake and a grapnel were used whenever necessary. The species data was organized in two primary species data matrices P1 for the pond and M1 for the margin (Appendices 2 and 3, respectively).

Recording of explanatory variables

A total of 56 explanatory variables were recorded in a standardised way for every sampling unit (Appendix 4). All variables were recorded in the field except numbers 6–10 and 19–36 which were based upon information from the land owners. The explanatory variables were divided into seven groups (Tab. 1): (1) area; (2) hydrology; (3) geography; (4) historical features; (5) anthropological impacts; (6) topography; and (7) water chemical and physical variables. Only six of them were considered relevant for each data set and will thus be included in the analyses of each pond and pond margin.

Variables 44–56 were recorded from water samples, analysed at VANNFORSK, Ås. The samples were taken ultimo August in a standardised way for all ponds. Clean plastic bottles were flushed with pond water and then lowered into the pond about 1.7 meters from its edge (using a stick) to a depth of about 0.5 meters. The samples were filtered by a net (mesh width about 1 mm) to avoid particulate matter. The samples were stored at 4° C for 1–10 days before analysed.

Editing and manipulation of explanatory variables

Explanatory variables were edited using Microsoft Excel Version 5.1 (Anonymous 2002a) and S-PLUS Version 6.0 (Anonymous 2001). For all recorded continuous explanatory variables skewness and kurtosis standardised by division with their standard deviations, $(6/n)^{0.5}$ and $(24/n)^{0.5}$, respectively (Sokal & Rohlf 1995), were calculated. Reduced skewness in the frequency distributions of the explanatory variables, and at the same time improved homoscedasticity, were achieved by transforming the continuous variables to zero skewness (R. Økland *et al.* 2001). Approximate homogeneity of variances was achieved by finding (by iteration) the value of c that gave the explanatory variables (y) zero skewness (|standardised skewness| $<10^{-5}$) using the following formulae:

(1) $y = e^{cx}$ applied to left-skewed variables

(2) $y = \ln(c + x)$ applied to right-skewed variables

Table 1. Environmental variables with their abbreviations and transformations. Cont. = continuous, categ. = categorical, * = ordered variable coded as follows: 0 – never, 1 – >5 yrs ago, 2 – 2–5 yrs ago and 3 – usage within 2003.

No	Explanatory variable (Abbr.)	Relevant for pond (P) or margin (M)	Method for quantification	Range	Type	Transf.	c value
Area (A)							
01	Pond area (PArea)	P	In m^2, rounded to integer numbers, based upon an accurate map made up in the field, calculated by using a digital planimeter.	19-3010	Cont.	ln (c+x)	-6.008
02	Pond margin area (MArea)	M	In m^2, rounded to integer numbers, based upon an accurate map made up in the field, calculated by using a digital planimeter.	5-600	Cont.	ln (c+x)	22.8
03	Average width (AvgWid)	M	In m, rounded to one decimal, found by assuming that the pond and its margins were circular, solving the equations $A_p = r^2_p$ and $A_{m+p} = r^2_{m+p}$ for r. $r_m = r_{m+p} - r_p$	0.2-600	Cont.	e^cx	0.6599
Hydrology (H)							
	Water depth	P	In cm, measured at 7-15 points along the long axis of the pond, by inserting into the water a line with a sinker at the end. Number of points depended on the length of the pond. Maximum depth (MaxDep) and median depth (MedDep) derived from the measurements.		Cont.		
04-	(MaxDep)			27-352.0		ln (c+x)	84.39
05	(MedDep)			16-252.5		ln (c+x)	104.1
06	Range of fluctuation (Fluct)	P	Estimated range of water level fluctuation in a normal season. The 2-logarithmic scale was used: 0: 0-25cm, 1: 25-50cm, 2: 50-100cm, 3: 100-200cm and 4: >200cm.	0-4	Categ. Ordered 0-4	None	
07	Periodically drained (Drain)	P	Known complete drainage either because of human use or for natural reasons.	0-3	Categ. Ordered 0-3 *	None	
08	Spring well (Well)	P	Presence (1) or absence (0) of a natural spring well in or near the pond.		Binary	None	
09-10	Outlet (Outl) and Inlet (Inl)	P	Presence (1) or absence (0) of at least one inlet or outlet, natural or artificial.		Binary	None	
Geography (G)							
11	Altitude (Alt)	P, M	Meters above sea level taken from maps with 5 m contour intervals.	20-440	Cont.	ln (c+x)	41.89
12-	UTM northing (UTMn)	P, M	UTM (Universal Transverse Mercator) northing and UTM easting coordinates for pond centres, found by using the geographical internet database of Statens Kartverk (Anonymous 2002b).	6569368-6761365	Cont.	ln (c+x)	-6555260
13	UTM easting (UTMe)			581012-638481		ln (c+x)	-406250
	Distance from pond margin to:	P, M	Distance from a pond's margin to the nearest		Cont.		
14	water (DistWat),		stagnant water (pond or lake),	10-2850		ln (c+x)	59.5
15	road (DistRoad),		road with a road verge,	2-373		ln (c+x)	4.795
16	farmland (DistAgr),		farmland area (meadow or field),	2-153		ln (c+x)	-1.71982
17	built-up area (DistBui),		built-up area (garden or courtyard) or	1-347		ln (c+x)	-0.999758
18	forest (DistForest)		forest.	1-405		ln (c+x)	1.047
			All distances are given in 1m accuracy except from DistWat which is given in 5m accuracy.				
History (Y)							
19	Pond age (Age)	P, M	Time since construction of the pond, recorded in years since 2003, if "old and unknown", set to 100 years.	5-100	Cont.	None	

Anthropological impacts (I)						
20	Fire pond (Fire)	P, M	Pond laid out or used in case of fire (1) or not (0).		Binary	None
21	Pond used for watering (Water)	P, M	Pond used for watering fields, gardens etc.	0-3	Categ. Ordered 0-3*	None
22	Drinking-water source (Drink)	P, M	Pond used for drinking by animals or humans.	0-3	Categ. Ordered 0-3*	None
23	Use: laundering (Laund)	P, M	Pond used for laundering of clothes.	0-1	Categ. Ordered 0-3*	None
24	Presence of fence (Fence)	P, M	Pond or pond margin fenced.	0-3	Categ. Ordered 0-3*	None
25	Liming (Lime)	P, M	Pond limed.	0-3	Categ. Ordered 0-3*	None
26	Depositions for garbage (Garb)	P, M	Waste deposited in or by the pond (e.g. here: cartridge, bicycles, motorcycles, felling waste, stoves and domestic waste).	0-3	Categ. Ordered 0-3*	None
27	Renovation (Renov)	P, M	Renovation (garbage removed from the pond).	0-3	Categ. Ordered 0-3*	None
28	Herbicides (Herbic)	P, M	Herbicides used to kill weed, mostly within the pond’s margin.	0-3	Categ. Ordered 0-3*	None
29	Constructed stony margin (StonyMarg)	P, M	Natural pond margin replaced by a constructed stone wall.	0-2	Categ. Ordered 0-3*	None
30	Cutting (Cut)	P, M	Herbs cut along the pond margin.	0-3	Categ. Ordered 0-3*	None
31	Tree felling (Fell)	P, M	Trees cut in the pond’s close surroundings.	0-3	Categ. Ordered 0-3*	None
32	Grazing (Graze)	P, M	Presence of cattle grazing around the pond.	0-3	Categ. Ordered 0-3*	None
33	Presence of fish (Fish)	P, M	Presence of fish in the pond.	0-3	Categ. Ordred 0-3*	None
34	Presence of ducks (Duck)	P, M	Presence of ducks in the pond.	0-3	Categ. Ordered 0-3*	None
35	Enlarging (Enlarge)	P, M	Pond manually made larger.	0-2	Categ. Ordered 0-3*	None
36	Diminishing (Diminish)	P, M	Pond manually made smaller.	0-2	Categ. Ordered 0-3*	None

Topography (T)							
	Slope	M	Slope (360° scale) measured along a 1.72-meter line from the water/land transition perpendicularly to		Cont.		
37-	(MaxSlp)		the margin of the pond. Maximum slope (MaxSlp) and	12-54		ln (c+x)	246.2
38	(MinSlp)		minimum slope (MinSlp) derived from measurements.	2-35		ln (c+x)	3.801
39	Mechanical composition of soil (Soil)	M	Dominating mechanical soil fraction within the pond margin where 0: clay and silt (<0.06mm), 1: sand (0.06-2mm) and 2: stone (>2mm).	0-2	Categ. Ordered 0-2	None	
	Soil depth	M	To the nearest cm, measured at 8 or 12 equally spaced positions along the margin, by a 100-cm peat		Cont.		
40-	(MaxSoil)		corer. Sites where rock was visible were avoided. For sites where the soil depth was more than 100cm,	25-100		e^cx	0.018063
41-	(MinSoil)		the value 100cm was used. Derived variables: maximum soil depth (MaxSoil), median soil depth	1-88		ln (c+x)	77.4
42	(MedSoil)		(MedSoil) and minimum soil depth (MinSoil).	5.5-100		ln (c+x)	164.78
Water chemical and physical variables (W)							
43	Median Secchi-depth (Secchi)	P	Median Secchi-depth (to the nearest half cm), of three equally spaced measurements along the pond's longest line. A specially made Secchi disc, about 20cm in diameter, lowered from the boat, was used for all measurements. When, interfering with measurements, plants were removed before the measurements were done. Where Secchi-depth exceeded the maximum depth of the pond, a value of Secchi-depth was estimated (to the nearest 50 cm) based upon experience from other ponds (maximum value 360 cm).	1-360	Cont.	ln (c+x)	6.6071
44	Conductivity (Cnd)	P, M	In microSiemens/cm, estimate of the total amount of dissolved ions in an electrical field in the water, using NS-ISO 7888 (Anonymous 1993). Because electric conductivity depends on temperature, all measurements were standardised to conductivity at 25° C.	18-911	Cont.	ln (c+x)	4.035
45	pH (pH)	P, M	pH, a measure of the hydrogen ion activity in the water, analysed at 25° C, using NS4720 (Anonymous 1979).	5.75-8.09	Cont.	ln (c+x)	0.96
46	Alkalinity (Alk)	P, M	The amount of hydrogen ions in µeqv/L needed to neutralise (pH = 7.0) the basic ions in the water. Determined by end-point titration at pH 4.5, using NS-EN ISO 9963-1 (Anonymous 1996)	32-5757	Cont.	ln (c+x)	262
47	Calcium (Ca)	P, M	In mg/L, analysed by atom absorption-spectroscopy (AAS), using NS 4776 (Anonymous 1994b, Skoog *et al*. 1992).	0.200-160.7	Cont.	ln (c+x)	1.0458
48	Colour (Clr)	P, M	In OD (Optical Density) 410 units, measured spectroscopically at a wavelength of 410 nm (Hongve & Åkeson 1996), using NS-EN ISO 7887 (Anonymous 1994c).	0.001-0.358	Cont.	ln (c+x)	0.18
49	Turbidity (Trb)	P, M	In Formazin Turbidimetric Units (FTU), estimates the concentration of inorganic matter, using NS-ISO 7027 (Anonymous 1994d). Formazin was used as a standard.	0.980-1070	Cont.	ln (c+x)	-0.86087
50	PO_4-P (PO_4-P)	P, M	In µg/L, using NS-EN 1189 (Anonymous 1997). The method uses the reaction between PO_4-P and antimony and molybdate in an acidic solution, and the further reaction by ascorbine acid produces a strong blue colour. Intensity was measured spectroscopically at 880 nm.	0-1300	Cont.	ln (c+x)	0.29221
51	Total-phosphorus (Tot-P)	P, M	In µg/L, determined as for PO_4-P (see above) but with treatment with peroxodisulphate-oxidation in an autoclave (1 atm, 121° C for 30 minutes).	3.049-1677	Cont.	ln (c+x)	1.725
52	Particulate-phosphorus (Part-P)	P, M	In µg/L, calculated out as the differences between Total-P and the orthophosphate.	2.684-717.9	Cont.	ln (c+x)	4.993
53	NH_4-N (NH_4-N)	P, M	In µg/L, measured by method slightly modified from NS4746 (Anonymous 1975a), using salicylic acid instead of phenol. Detection limit: 20 µg/L.	0-4287	Cont.	ln (c+x)	7.556
54	NO_3-N (NO_3-N)	P, M	In µg/L, measured spectroscopically at 525nm after a synthesis of an azo-colouring-matter where nitrite is included in the reaction. Using NS 4745 (Anonymous 1975b).	0-1656	Cont.	ln (c+x)	0.495586
55	Total-nitrogen (Tot-N)	P, M	In mg/L, using NS 4743 (Anonymous 1975c), determined as for NO_3-N (see above) after peroxodisulphate-oxidation in an autoclave (1 atm, 121° C for 30 minutes). Sulfuric acid was added to solve the precipitate and the solution was neutralised using NaOH.	0.102-4.300	Cont.	ln(c+x)	-0.0286
56	Particulate-nitrogen (Part-N)	P, M	In mg/L, calculated as the difference between the total N and the sum of nitrate-N and the ammonium-N.	0.002-2.311	Cont.	ln (c+x)	0.1078

After transformation all continuous variables (y) except Pond age (for which no value of c exist that made standard skewness equal to zero, because of the large number of observations with the maximum value of 100 years), were ranged to a new variable (z) on a 0–1 scale by the formula:

$$z = \frac{y - y_{\min}}{y_{\max} - y_{\min}}$$

Summary statistics for transformed variables are given in Appendix 5.

Relationships among explanatory variables

Two different methods were used to analyse relationships between explanatory variables:

Correlation analysis

Statgraphics Version 5.0 (Anonymous 1990) was used for this univariate statistical analysis. Kendall's non-parametric correlation coefficient, τ (Kendall 1938), was calculated between all pairs of explanatory variables for both sets of variables (Sokal & Rohlf 1995). Kendall's τ was chosen because many of the variables were rank-ordered (or intrinsically ordinal), and because it is unaffected by transformation.

PCA ordination

PCA (Principal Component Analysis) ordination (Pearson 1901; ter Braak & Prentice 1988) was applied to the two sets of explanatory variables, one for ponds and one for pond margins, using CANOCO Version 4.5 (ter Braak & Šmilauer 2002). The variables were centred and standardised by division by standard deviation prior to analysis. Correlation biplot scaling was used for optimising the fit of angles between variable vectors to inter-variable correlations.

Ordination of vegetation

Sampling units were ordered along axes of variation in vegetation composition (coenoclines) by using two different ordination methods which should be considered complementary: DCA (Detrended Correspondence Analysis; Hill 1979, Hill & Gauch 1980) and GNMDS (Global Non-metric Multidimensional Scaling; Kruskal 1964ab). One metric and one non-metric scaling technique were applied in parallel to enhance the probability of reaching a reliable gradient structure (R. Økland 1990a, 1996). DCA and GNMDS ordination methods serve a hypothesis-generating purpose; extraction of gradient structure in vegetation data sets with unknown structure (R. Økland 1990a). Initial analyses showed that two ponds were nearly devoid of species and that five other sample units acted as outliers in the ordinations. These seven sampling units (Nos 19, 24, 30, 45, 49, 54 and 58) were therefore removed before further ordination analysis of 57 sampling units. All outliers contained less than 5 species and their species compositions were thus not considered representative for the ecological conditions of the site (R. Økland 1990a).

DCA was applied to the full vegetation data set (pond + margin) as well as to pond and margin separately. Analyses were done by using CANOCO, Version 4.5 (ter Braak & Šmilauer 2002), using standard options: detrending by segments and non-linear rescaling.

GNMDS by the WinKYST programme, Special Version 1.0 (Šmilauer 2003) was performed separately for the pond and pond margin data sets. All dimensionalities from 2 to 6 were tested to find the most appropriate GNMDS ordination for each data set. The correlation coefficients, Kendall's τ, and the associated significance levels showed that sets of corresponding axes were almost perfectly correlated. The dimensionality of 6 was therefore chosen. The following options were used, as recommended by T. Økland (1996): distance measure = Bray-Curtis distance, initial configuration = 100, maximum iterations = 100 000 and convergence ratio for Stress = 0.99999.

The GNMDS axes were linearly rescaled in S.D. (standard deviation) units to enhance comparability with the corresponding DCA axes, as recommended by R. Økland (1990a). This was done by DCCA (Detrended Canonical Correspondence Analysis) in CANOCO Version 4.5. GNMDS scores were used, one axis at a time, as the only constraining variable. The linear rescaling was done by using the following formula:

$$x_{\text{new}} = \frac{(x_{\text{old}} - x_{\min})}{(x_{\max} - x_{\min})} \cdot \text{Grl}$$

where x_{new} is the linearly rescaled sample plot position, x_{old}, $x_{\min}$ and $x_{\max}$ refer to sampling unit scores along one of the original GNMDS axes, and Grl refers to the gradient length in DCCA given in S.D. units. Ordination axes were inverted, when necessary, to maximise positive correlations between corresponding axes.

Positions along ordination axes for ponds and pond margins located within the same sampling unit (1 km^2) were also compared to investigate the differences in species composition. Complete species turnover is considered to appear within 2 – 2.5 S. D. units (R. Økland 1986).

Comparison of ordination methods

Pair-wise correlations (Kendall's τ) between sampling unit scores (for each of pond and pond margin data in addition to the combined data set of ponds and pond margins) along 4 DCA- and 6 GNMDS-ordination axes were calculated by S-PLUS. In addition a PCA ordination with standard options implying centring, standardising and Euclidean distance biplot scaling was applied to the DCA and GNMDS axes. This was done separately for the ordinations of ponds and pond margins in order to sort the many axes into groups of correlated compositional gradients.

Relationships between ordination axes and explanatory variables

Correlation

DCA and GNMDS axes were interpreted ecologically by calculating Kendall's τ between explanatory variables and the ordination axes for 57 of the sampling units (ponds/pond margins). Correlation analyses were done using S-PLUS.

Multiple regression

Each ordination axis was also interpreted by determining the set of explanatory variables that best explained the relationship between sample scores along the DCA and GNMDS ordination axes (the dependent variable) as a response to one or more of the explanatory variables (the independent variables). Generalised multiple linear regression was carried out by GLM (McCullagh & Nelder 1989; Venables & Ripley 2002) with normal errors in S-PLUS. The categorical variables were specified as factors whereas continuous variables were used in the transformed and ranged forms. Significance of each variable upon inclusion in the model was judged by the F-test (significance level $\alpha = 0.05$).

Variation partitioning

Partial canonical correspondence analysis (CCA; ter Braak 1986) was used to partition the variation in species composition on groups of environmental variables (Borcard *et al.* 1992; R. Økland 1999, 2003). Variation, given in IU (Inertia Units), is additive and can be distributed on groups of variables. Total inertia (TI) is not considered as a reliable measure of total variation because of lack-of-fit of data to the response model (R. Økland 1999). The amount of compositional variation extracted on ecologically interpretable ordination axes is thus underestimated by the eigenvalue-to-total-inertia ratio, and the focus will therefore instead be on FTVE (fraction of the total variation explained).

Initially a forward selection of variables within each of six groups (in each data set) of environmental variables was performed using the Monte Carlo test (9999 permutations) in CANOCO Version 4.5. Only variables that made significant independent contributions to explaining the variation in species abundance ($\alpha = 0.05$ level) were included in further analyses. The variation partitioning was done separately for the pond and margin data sets.

The procedure for using partial CCA to distribute variation on groups of variables and for further simplification of results followed R. Økland (2003) and Qian *et al.* (2003). The total variation explained (TVE) was distributed on 2^s-1 unique, non-overlapping partial intersections among the s groups of variables. Results were simplified by distributing low and insignificant amounts of variation on intersections of successively lower order. The threshold limit was selected in two different ways (as recommended by R. Økland 2003): using the average VE = TVE/(2^n-1) where n represents the number of sets of explanatory variables, in addition to the single-variable $\alpha = 0.05$ criterion. The single-variable criterion is a stricter threshold limit than average VE and it refers to the approximate VE corresponding to a specified significance level in randomisation tests performed for each environmental variable relative to a null hypothesis of randomness (see R. Økland 2003 for details).

Spatial structure

Geostatistical methods were used to explore the spatial structure of explanatory variables and ordination axes. Spatial structure consists of two components: spatial dependence and spatial autocorrelation (Legendre & Legendre 1998), which are, however, often hard to separate in ecological data sets. Thus for ecological description, the total spatial structure of a variable is mostly of interest. The Euclidean distance between the ponds (based upon UTM co-ordinates) was used as a measure of geographical distance. Only continuous explanatory variables in addition to DCA ordination axes were used in the analyses.

The semivariance expresses the variation in a variable as a function of spatial scale (Phillips 1985; Palmer 1990) and was calculated by GS+ Version 5.1 (Anonymous 2001). Seven lag classes, grouping distances on a 2-logarithmic scale (<3 km, 3-6 km, …, >192 km), were used to ensure that all lag classes were represented by at least 30 pond pairs. The semivariance for each distance class was divided by the sample variance to obtain standardised values (Rossi *et al.* 1992).

Relationships between species richness and explanatory variables

Correlation

Kendall's correlation coefficient, τ, was calculated between the explanatory variables and the number of species recorded in each of the 64 sample plots in the two data sets. Correlation analyses were done using S-PLUS.

Multiple regression

Species number per pond/ pond margin was modelled separately as responses to the explanatory variables, using GLM, with log-link and Poisson errors. Poisson errors were used as the dependent variable represented a number of counts (McCullagh & Nelder 1989). The variance and the mean of the response variable did not increase in perfect parallel and therefore an F-test was used to test variables for inclusion in the models. As for the GLM analyses of ordination axes, the categorical variables were specified as factors whereas the transformed and ranged continuous variables were used.

6 Results

Explanatory variables: summary statistics

The ponds included in the analysis varied in area from 19 m^2 to 3010 m^2 and in median depth from 16 cm to 252.5 cm. Because of, among others, large study area, a wide variety of geographical, topographical (incl. geological) and water chemical conditions were represented in the data. The farm ponds were located between 20 and 440 meters above sea level. Concentrations of total phosphorous and total nitrogen varied from 3 to 1677 µg/L and from 0.1 to 4.3 mg/L, respectively, pH ranged between 5.8 and 8.1. The minimum Secchi-depth was 1 cm and the minimum age of the ponds was 5 years. Complete accounts of summary statistics and transformation formulae are given in Table 1 and further details are given in Appendices 4 and 5.

Relationships between explanatory variables

Correlation

From the Kendall's τ and corresponding significance levels for variables recorded for ponds in Table 2, some groupings of more or less strongly intercorrelated variables may be identified. Conductivity, Alkalinity, Calcium, pH, Particulate-N and Total-N made up one group with strongly correlated variables while Pond area, Maximum water depth, Median water depth, Pond age, Pond used for watering and Drinking-water source made up another. Colour, Turbidity, PO_4-P, Particulate-P, Total-P, Altitude, UTM northing and Pond age made up the largest group. In addition to the ones mentioned there were lots of smaller groups with three, four and even five variables.

The explanatory variables recorded for the pond margins in Table 2, to some extent, affiliated with the groups of correlated pond variables, mostly geographical and water chemical variables. Maximum, Minimum and Median soil depth together with UTM northing, Altitude and PO_4-P, consisting of both negatively and positively correlated variables, were one of the two largest groups unique to the pond margin data set. The other major group consisted of Maximum slope, Conductivity, Alkalinity, Calcium, Particulate-N and Total-N.

Notably Pond age was strongly correlated with many variables and had connections to most unique groups containing more than four components. The variables Periodically

Table 2. Kendall's correlation coefficients (lower triangle) and corresponding P values between explanatory variables for both pond and pond margin data set. P<0.05 in bold.

	PArea	MArea	AvgWid	MaxDep	MedDep	Fluct	Drain	Well	Outl	Inl	UTMn	UTMe	Alt	DistWat	DistRoa	DistAgr	DistBui	DistFore
PArea		**<.0001**	**<.0008**	**.0002**	**.0006**	.9783	.4111	.2517	.2535	.1674	.2659	.4008	.4295	.6633	.5458	.2181	.5937	.7706
MArea	.6312		**<.0001**	.0697	.2863	.6634	.9182	.9941	.2859	.0513	.0863	.0680	.5380	.7806	.1238	.3361	**.0299**	.6284
AvgWid	.2948	.6626		.9121	.6588	.4869	.5142	**.8309**	.4914	.1172	**.0125**	**.0224**	.2169	.4777	.0675	.5885	**.0016**	.5588
MaxDep	.3178	.1558	-.0097		**<.0001**	.0957	.1816	**.0473**	.8811	.7097	.9861	.3246	.5810	.3295	.8571	.2992	.5000	.5250
MedDep	.2934	.0915	-.0386	.7818		.2209	.0519	**.0337**	.5680	.5291	.6183	.2004	.9861	.6633	.9491	.3420	.8685	.9581
Fluct	-.0027	.0428	.0697	.1638	.1203		.6092	.2824	.4740	.1495	.2766	.8811	.1485	.3201	.7643	.9342	.0637	.7375
Drain	-.8380	-.0105	.0678	-.1362	-.1981	.0598		.2513	.4232	.9285	.2340	.7191	.3585	.4352	.4711	.1999	.9279	.2380
Well	.1189	.0008	-.0226	.2060	.2060	-.1281	-.1419		.2754	**.0183**	.1695	.9648	.4842	**.0004**	.2632	.9171	.6581	.5794
Outl	.1185	.1108	.0729	.0155	.0155	-.0854	.0990	-.1374		**<.0001**	.1057	.0855	.0710	**.0081**	.5176	.7992	.9943	.4238
Inl	.1432	.2023	.1659	-.0386	-.0386	-.1718	-.0111	-.2973	.6258		.3166	.1366	.5735	**.0022**	.1096	.2419	.6167	.2257
UTMn	.0954	.1471	.2184	.0015	.0015	.1069	-.1212	.1425	.1678	.1039		.8393	**<.0001**	**.0212**	.8571	.9066	**.0004**	.0501
UTMe	-.0720	-.1565	-.1996	-.0845	-.0845	.0147	-.0366	.0046	-.1783	-.1544	-.0174		.0575	.0981	.0756	.6857	**.0240**	.2435
Alt	.0689	.0537	.1098	.0481	.0481	.1443	-.0951	.0738	.1905	.0594	.6449	.1655		.1189	.8889	.4342	**.0361**	**.0216**
DistWat	-.0378	-.0242	.0628	-.0847	-.0847	.0989	-.0805	.3701	-.2781	-.3209	.1999	.1434	.1375		.9629	.1843	.9461	.6237
DistRoad	.0527	.1343	.1627	.0157	-.0056	-.0300	.0747	-.1181	.0683	.1689	.0157	-.1549	-.0124	-.0041		.6981	.1230	.1229
DistAgr	.1100	.0859	.0493	.0928	.0849	-.0084	.1361	-.0112	.0275	.1265	.0105	.0361	.0710	-.1200	.0352		.0834	**.0174**
DistBui	.0492	.2004	.2968	.0623	.0153	.1962	-.0099	-.0495	.0008	-.0559	.3268	-.2080	.1966	.0063	.1447	-.1663		**.0365**
DistForest	.0256	-.0426	-.0524	-.0559	-.0046	-.0338	-.1233	-.0590	.0851	.1289	-.1721	.1024	-.2052	-.0436	-.1379	-.2177	-.1978	
Age	-.2155	-.2357	-.2403	-.2902	-.2344	-.1282	-.0189	-.0587	-.2477	-.1821	-.3153	.2146	-.2982	-.0585	-.1635	-.0792	-.3362	.1841
Fire	.0562	-.1116	-.1332	.1259	.1402	-.0072	.0047	.1260	-.0760	-.1816	.1276	-.1409	.0864	.1257	-.1228	.0339	-.0538	-.0635
Water	.2820	.3039	.2684	.3078	.2633	.2871	.1056	.0969	.2828	.1827	.2631	-.2495	.2352	.1250	.1119	.1165	.2285	-.1008
Drink	-.3166	-.2716	-.1660	-.2205	-.2056	.0906	.0509	.0610	-.4169	-.5149	.0141	.1609	-.0151	.2499	-.0597	-.1044	-.0353	.0653
Laund	-.2139	-.2029	-.1039	.0646	.0897	.2121	-.1510	-.0917	-.2680	-.1756	-.0669	.1839	.0110	.0908	.0609	-.0264	-.1211	.0937
Fence	-.0185	-.0666	.0161	.1573	.1751	.0987	-.0699	.3380	-.0438	-.2337	.1420	.0761	.1783	.2873	-.0035	-.1128	-.0906	.0941
Lime	-.0964	-.2198	-.2510	-.0952	-.1208	-.1037	.1376	.0532	.1349	-.0145	.0475	.0835	.1113	-.0716	.0183	.2424	-.1975	-.1325
Garb	-.0012	.1377	.1869	-.0819	-.0392	-.1005	-.1500	-.0928	-.0556	.0352	.1316	.0296	.0907	.0950	.0181	.1325	.0243	-.1016
Renov	-.0950	-.1247	-.1261	-.0882	-.0696	.1778	.0109	-.0739	-.0332	.1323	-.1370	.1060	-.1186	.0782	-.1951	.0711	-.2743	.2741
Herbic	-.0653	-.0602	-.0275	-.0961	-.0846	.0121	.0270	-.0668	.1236	-.0163	.1856	-.1113	.1409	-.0584	-.0848	-.0324	.0583	.0145
StonyMarg	-.2182	-.2793	-.2016	-.1109	-.1086	-.0492	.0836	-.0119	-.0110	.0000	.0210	-.1140	-.0655	.0326	.1219	.0514	-.0958	-.0194
Cut	-.2232	-.2082	-.2013	-.2353	-.2410	-.1378	.0596	-.0714	.0366	.0844	-.1841	.0748	-.2294	-.2199	-.0692	-.0470	-.3779	.2198
Fell	.1377	.2511	.2327	.0528	.0586	.0880	-.0583	.0375	.0000	.1932	.1835	-.1191	.1851	-.0564	.2150	.0834	.2935	-.3142
Graze	-.1225	-.0963	-.0589	-.2847	-.2847	.0652	.2165	-.0278	-.0922	-.2289	.1110	.1208	.0888	.1308	.1324	-.0381	.0786	-.0899
Fish	.2767	.1245	-.0178	.1885	.1910	-.1093	.0215	.0772	.2023	.2087	-.1786	-.1991	-.2096	-.1706	.0697	.0387	-.2466	.2235
Duck	.0835	.0075	.0297	-.0507	-.0067	-.1273	-.1715	.3008	-.0878	-.1454	.2221	.0969	.1626	.1421	-.0806	.1163	-.0891	.0823
Enlarge	.0518	.0606	.0602	.2699	.2417	.1736	.1804	.2938	.0025	-.0025	.0650	-.0667	.0277	.1870	.0654	.1111	-.0240	-.0426
Diminish	-.1086	-.0942	-.0612	-.1452	-.0953	-.0849	.0836	-.0119	-.0110	.0986	-.0177	.2114	-.0147	.0314	-.1660	.2568	-.1715	.0663
MaxSlp	.0433	.1008	.9740	.0983	.0534	.2893	.0531	-.0951	.1931	.2733	-.1375	-.1475	-.1191	-.1665	-.0262	.0366	-.0241	.0862
MinSlp	-.1189	-.1546	-.1102	-.0443	-.0447	.1046	.0937	.0327	.1883	.1939	-.1006	.0554	-.1119	.0391	-.0850	-.1285	-.1452	.1955
Soil	-.0163	-.0343	-.0284	-.0278	-.0278	-.0538	.0201	-.0200	.0800	.0889	.0604	-.1183	.0841	-.0017	.0458	.1472	-.0158	-.1651
MaxSoil	.2584	.2207	.1122	.0299	.0581	-.0301	.0159	.0016	.0197	.2627	-.2119	-.1193	-.2687	-.0540	.0337	.1718	-.1443	.0423
MinSoil	.0937	.1208	.0922	-.0381	.0175	-.0640	.0132	-.1484	.1650	.1912	-.2910	-.1182	-.3620	-.0681	-.0337	-.0486	-.1124	.1793
MedSoil	.1186	.1127	.0494	-0733	-.0200	-.0617	-.0184	-.0757	.0000	.1592	-.3279	-.0314	-.3754	-.0278	-.0574	-.0489	-.1333	.1840
Secchi	.2991	.2773	.2058	.2879	.2353	.0430	-.0096	-.0720	.1545	.2632	.1233	-.1492	.1252	-.2166	.0621	.1915	.1398	-.0273
Cnd	.1099	.1567	.1439	-.1095	-.1000	.1130	.1579	-.1975	.1743	.2507	.0104	-.1560	-.0866	-.1451	.0476	-.0985	.1115	.1953
pH	.2197	.2018	.1472	-.0040	-.0194	.0991	.1390	-.0970	.2439	.2210	.0682	-.1593	-.0127	-.1343	.0812	-.0178	.0714	.2009
Alk	.1147	.1496	.1498	-.0885	-.0830	.0574	.0863	-.1531	.2100	.2168	.0432	-.1469	-.0744	-.1168	.0061	-.0686	.0673	.2330
Ca	.0914	.1431	.1615	-.0989	-.0895	.1309	.1308	-.1616	.2094	.2478	.6060	-.1703	-.0294	-.1294	.0349	-.0733	.0978	.1793
Clr	-.0836	-.0836	-.1277	-.0632	.0070	-.1244	-.0943	.0038	-.1737	-.1202	-.2705	.0741	-.2849	-.0136	-.0735	-.0121	-.1246	-.0077
Trb	-.2300	-.2181	-.1486	-.2476	-.1375	-.0763	-.1337	-.1558	-.1766	-.2194	-.2159	.0821	-.2434	.1004	-.0411	-.0677	-.1751	.0698
PO_4-P	-.0132	-.0199	-.0890	-.2073	-.1538	-.1759	-.0116	-.1218	.0455	.1100	-.3063	-.0626	-.4066	-.1718	.0093	-.0606	-.0869	.2840
Part-P	-.2093	-.2661	-.2516	-.2000	-.1189	-.1136	.0794	-.0747	-.1700	-.2690	-.4477	.0288	-.4762	.0025	.0243	-.1928	-.2309	.2415
Tot-P	-.1533	-.1684	-.1997	-.2249	-.1574	-.1793	.0789	-.1402	-.1318	-.1023	-.4587	.0409	-.5037	-.0602	.0229	-.1584	-.2075	.2838
NH_4-N	-.0349	.0200	.0408	-.1533	-.1867	-.0973	.1445	-.2304	.1232	.1325	-.0908	.1172	-.0463	-.1699	.0732	-.0841	.0011	.0921
NO_3-N	.1206	.1933	.2094	-.0777	-.1045	.1228	.0239	.0209	.2098	.3008	.4271	-.0343	.3922	.0010	.0540	.0452	.1924	-.1857
Part-N	.1291	.1888	.1726	-.0492	-.0387	.1969	-.0444	-.1196	.0923	.1193	.0615	-.1424	-.0010	.0075	.1462	-.0314	.1373	.0901
Tot-N	.00924	.1650	.1534	-.1486	-.1312	.0661	.1020	-.2431	.2221	.2688	-.0417	-.1127	-.0683	-.1475	.1969	-.1057	.0854	.1568

Table 2 cont.

	Age	Fire	Water	Drink	Laund	Fence	Lime	Garb	Renov	Herbic	StonyMa	Cut	Fell	Graze	Fish	Duck	Enlarge	Diminish	MaxSlp
PArea	**.0255**	.5879	**.0049**	**.0018**	**.0393**	.8533	.3486	.9908	.3399	.5240	**.0343**	**.0230**	.1749	.2289	**.0053**	.4015	.6130	.2923	.6178
MArea	**.0146**	.2823	**.0024**	**.0076**	**.0463**	.5065	**.0326**	.1819	.2107	.5570	**.0068**	**.0340**	**.0134**	.3447	.2094	.9403	.5541	.3610	.2459
AvgWid	**.0146**	.2082	**.0087**	.1094	.3265	.8746	**.0167**	.0757	.2147	.7926	.0552	**.0444**	**.0246**	.5710	.8603	.7696	.5648	.5608	.2715
MaxDep	**.0026**	.2252	**.0021**	**.0302**	.5340	.1168	.3551	.4271	.3761	.3487	.2825	**.0166**	.6034	**.0052**	.0576	.6105	**.0085**	.1592	..2579
MedDep	**.0151**	.1769	**.0086**	**.0433**	.3877	.0808	.2401	.7041	.4849	.4096	.2923	**.0141**	.5637	**.0052**	.0542	.9462	**.0184**	.3554	.5385
Fluct	.2470	.9518	**.0126**	.4379	.0752	.3909	.3801	.3961	.1200	.9184	.6781	.2213	.4504	.5770	.3373	.2653	.1401	.4734	**.0036**
Drain	.8696	.9697	.3763	.6746	.2220	.5584	.2615	.2223	.9269	.8252	.4961	.6101	.6298	.0743	.8555	.1481	.1395	.4961	.6070
Well	.6158	.3174	.4255	.6212	.4669	**.0055**	.6698	.4583	.5404	.5914	.9243	.5489	.7611	.8223	.5213	**.0127**	**.0182**	.9243	.3656
Outl	**.0342**	.5464	**.0200**	**.0007**	**.0334**	.7186	.2797	.6571	.7833	.3206	.9299	.7586	1.000	.4557	.0927	.4671	.9840	.9299	.0662
Inl	.1195	.1495	.1329	**<.0001**	.1634	.0547	.9074	.7785	.2735	.8959	1.000	.4785	.1169	.0641	.0829	.2287	.9841	.4308	**.0093**
UTMn	**.0011**	.2187	**.0086**	.8893	.5190	.1563	.6438	.2015	.1688	.0700	.8382	.0605	.0705	.2756	.0716	**.0256**	.5258	.8635	.1132
UTMe	**.0259**	.1742	**.0127**	.1133	.0761	.4472	.4166	.7736	.2869	.2770	.2684	.4459	.2405	.2352	**.0445**	.3302	.5147	**.0401**	.0891
Alt	**.0024**	.4129	**.0209**	.8838	.9173	.0801	.2870	.3870	.2415	.1762	.5322	**.0215**	.0729	.3909	**.0376**	.1081	.7900	.8887	.1772
DistWat	.5489	.2313	.2178	**.0152**	.3871	**.0046**	.4913	.3626	.4380	.5734	.7550	**.0269**	.5829	.2042	.0892	.1585	.0714	.7632	.0582
DistRoad	.0956	.2447	.2723	.5635	.5640	.9726	.8608	.8627	.0541	.4158	.2449	.4882	**.0373**	.2011	.4897	.4263	.5306	.1135	.7668
DistAgr	.4304	.7542	.2645	.3245	.8068	.2799	**.0237**	.2173	.4931	.7617	.6325	.6455	.4306	.7193	.7077	.2621	.2981	**.0168**	.6853
DistBui	**.0012**	.6301	**.0342**	.7473	.2788	.4012	.0746	.8267	**.0105**	.5974	.3882	**.0004**	**.0073**	.4735	**.0209**	.4058	.8279	.1225	.7965
DistForest	.0626	.5506	.3264	.5310	.3787	.3596	.2088	.3367	**.0073**	.8900	.8542	**.0289**	**.0025**	.3892	**.0280**	.4201	.6853	.5307	.3324
Age		.3924	**<.0001**	**.0002**	.2696	.7241	.5492	.3208	**.0457**	.4018	.8874	**.0011**	.0571	**.0143**	.4927	.7195	.0960	.0584	.9112
Fire	-.1000		.0893	.4386	.3402	.4234	.9117	.8782	**.0219**	.2088	.0951	.5630	.5499	.3639	.7728	.2144	.5943	.7385	.5935
Water	-.5230	.2066		**.0400**	.1293	.1703	.1702	.4485	.9644	.3577	.0987	**.0093**	.1295	.7229	.1606	.3236	**.0239**	.0987	.2179
Drink	.4304	.0956	-.2446		**.0117**	**.0061**	.6281	.8749	.5384	.1585	.2027	.2827	.0549	**<.0001**	**.0406**	.3052	.8603	.1113	**.0473**
Laund	.1291	.1202	-.1844	.3110		.2961	.4577	.4520	.0705	.4578	.6549	.4020	.3033	.5432	.2307	.4761	.8651	.6549	.7732
Fence	.0399	.0974	.1610	.3266	.1271		.7571	.2902	.8513	.1370	.3553	.8384	.1435	.0939	.7186	**.0285**	.1297	.2492	.1579
Lime	-.0694	.0138	-.1652	.0592	-.0927	.0373		.4580	.6771	.2708	**.0376**	.8795	.3519	.3759	.2031	**.0048**	.9853	.4883	.1649
Garb	.1154	-.0192	-.0916	.0193	.0942	.1278	-.0920		.2229	.4581	.6706	.1216	.1887	.7012	.1161	.8124	.2218	.6706	.4334
Renov	.2242	.2770	.0052	.0728	.2186	-.0219	-.0499	.1463		.2401	.1836	.8607	.0530	.9311	.8344	.6948	.1814	.0519	.1815
Herbic	.0969	.1564	.1104	.1719	-.0924	.1786	.1358	-.0917	-.1402		.4189	.0876	.3520	.3667	.8888	.7596	.9853	.4189	.1689
StonyMarg	.0165	.2089	-.1994	.1562	.0559	.1117	.2578	.0529	.1596	-.0999		.2007	.2625	.2209	.4855	.0542	**.0039**	.5918	.8549
Cut	.3618	-.0689	-.2987	.1253	.9980	-.0234	.0179	-.1831	.0200	.2009	.1514		.1292	.8867	.1019	.6200	.7479	.7943	.6169
Fell	-.2177	-.0737	.1803	-.2317	-.1268	-.1740	-.1136	.1609	-.2287	-.1133	-.1371	-.1767		.9893	.2277	.3522	.7227	.2625	.0919
Graze	.2810	.1122	-.0423	.5674	.0751	.1999	.1084	-.0471	.0103	.1102	.1503	.0166	.0016		.4263	.3595	.9146	.1605	.4050
Fish	.0766	.0347	.1629	-.2413	-.1442	.0419	-.1517	-.1878	-.0241	.0166	-.0834	.1860	-.1419	-.0939		.5856	.9007	.7182	**.0094**
Duck	-.0403	.1500	-.1151	.1213	-.0861	.2554	.3374	.0285	.0455	-.0365	.2310	.0566	-.1099	.1086	.0629		.2937	.3904	.0598
Enlarge	-.1922	.0663	.2711	.0214	-.0211	.1820	-.0023	-.1510	.1595	-.0023	.3564	.0378	.0432	.0131	-.0148	.1252		.9495	.2795
Diminish	.2199	-.0418	-.1994	.1952	.0559	-.1392	.0859	.0529	.2333	-.0999	.0667	.0308	-.1371	.1723	-.0431	.1030	-.0078		.5256
MaxSlp	.0109	-.0561	.1250	-.2042	.0303	-.1433	-.1446	.0818	.1347	-.1428	-.0191	-.0497	.1733	-.0859	.2608	-.1897	.1122	.0663	
MinSlp	.0563	-.0157	.0346	-.1185	-.0061	-.0056	.0552	-.1044	.2225	-.1559	.0351	.0270	-.0479	-.0858	-.0007	-.1006	.2156	-.0068	.2210
Soil	-.1313	.0337	.0457	-.0952	-.0491	-.0857	.1309	-.0234	.0973	-.1473	.5498	-.0641	.0144	-.0216	-.0752	.0331	.1285	.1802	.0323
MaxSoil	-.0036	-.0718	.0750	-.2629	-.1217	-.1869	.1074	.0229	.0605	-.1304	-.1437	-.0566	.1497	-.1657	.1825	-.0983	-.0970	.0997	.2722
MinSoil	.0142	-.0657	.0364	-.2588	-.1000	-.1218	-.0855	-.1320	.0687	-.1124	-.2290	.0317	.0049	-.1924	.1743	-.1286	-.1648	.0000	.1682
MedSoil	.0707	-.0976	-.0075	-.2047	-.1402	-.1150	-.0168	.0107	.0670	-.0963	-.1867	.0700	.0911	-.1476	.1009	-.1690	-.1066	.0456	.1678
Secchi	-.3325	-.0359	.1783	-.4055	-.0865	-.2186	.0129	-.0990	-.0650	-.0386	-.0100	-.1118	.1021	-.3859	.0752	-.0449	.1147	.0768	.2751
Cnd	-.1014	-.0803	.1369	-.2076	-.1387	-.0982	-.1182	.1472	.1219	.0269	-.1019	-.0704	.0361	.0049	.1329	-.1305	-.0536	-.0886	.2495
pH	-.1931	.0438	.1907	-.1681	-.1282	-.0089	.0386	.0155	.1712	-.0128	.0799	-.0933	-.0010	.0618	.1319	-.0105	.0634	-.0977	.1682
Alk	-.0684	-.0285	.1157	-.1548	-.0788	-.0501	-.0912	.1553	.1576	.0499	-.1207	-.1024	-.0527	.0255	.1695	-.0954	-.0843	-.0653	.2271
Ca	-.1141	-.0330	.1714	-.1879	-.1242	-.0453	-.0706	.1494	.1466	.0499	-.1163	-.1081	.0205	.0033	.1064	-.1036	-.0773	-.0731	.2196
Clr	.2117	-.1188	-.2326	.1807	.2189	-.0673	-.0888	.0618	-.0083	-.1077	-.0333	.0982	.0557	.1901	.0103	-.0090	.0246	.0621	.0504
Trb	.2440	.0384	-.2952	.2308	.2561	.0096	-.1145	.1355	.0903	-.0975	.0777	.1486	-.1252	.1680	-.0568	.0881	-.1364	.1520	-.0858
PO_4-P	.2619	-.1984	-.2411	-.0021	.0673	-.1582	-.0566	.1908	.1037	-.0931	-.1032	.1327	-.0180	.1061	.1942	-.0832	-.2717	.0079	.2028
Part-P	.3122	-.1000	-.3430	.2008	.1542	-.0467	-.0630	-.0985	.0220	-.0705	.0078	.2717	-.2628	.0806	.1632	.0052	-.1081	-.0211	-.0025
Tot-P	.3548	-.1731	-.3717	.0887	.0889	-.1090	-.0736	.0727	.0560	-.0849	-.0378	.2470	-.1511	.1421	.2099	-.0577	-.1968	-.0067	.1038
NH_4-N	.2291	-.1649	-.1933	.0277	.0540	-.0620	-.1703	.1894	-.0283	-.0090	-.0779	.0638	-.0235	.1181	.0512	-.1767	-.1861	.0856	.1270
NO_3-N	-.1533	-.0987	.1030	-.0602	-.1904	.1191	.0913	.1758	-.0888	.0260	.1169	-.0683	.3400	.1694	-.0956	.1075	.1070	.0124	.0798
Part-N	-.1509	-.1248	.0819	-.1245	-.0478	.0624	-.0193	.2478	-.0165	-.0013	-.0100	-.1476	.1512	.0337	.1037	.0119	-.0333	-.0764	.1923
Tot-N	.0315	-.2168	-.0684	-.1973	-.0872	-.0789	-.1040	.2336	-.0413	.0320	-.8530	-.0170	.1503	.0304	.1611	-.1297	-.1826	-.1284	.2639

Table 2 cont.

	MinSlp	Soil	MaxSoil	MinSoil	MedSoil	Secchi	Cnd	pH	Alk	Ca	Clr	Trb	PO_4-P	Part-P	Tot-P	NH_4-N	NO_3-N	Part-N	Tot-N
PArea	.1740	.8719	**.0040**	.2782	.1678	**.0005**	.2003	**.0106**	.1808	.2864	.3303	**.0074**	.8799	**.0147**	.0752	.6849	.1654	.1320	.2812
MArea	.0774	.7349	**.0139**	.1623	.1902	**.0013**	**.0680**	**.0189**	.0811	.0952	.3303	**.0111**	.8206	**.0019**	.0508	.8166	**.0262**	**.0277**	.0544
AvgWid	.2169	.7835	.2199	.2953	.5729	**.0191**	.1001	.0931	.0865	.0647	.1447	.0897	.3189	**.0040**	**.0230**	.6419	**.0181**	**.0482**	.0793
MaxDep	.6132	.7840	.7394	.6594	.3942	**.0008**	.2024	.9630	.3024	.2489	.4617	**.0040**	**.0180**	**.0164**	**.0091**	.0751	.3714	.5662	.0832
MedDep	.6092	.7840	.5173	.8392	.8167	**.0063**	.2441	.8212	.3332	.2970	.9353	.1097	.0791	.1661	.0679	.3020	.2296	.6513	.1261
Fluct	.2970	.6438	.7698	.5180	.5315	.6633	.2504	.3141	.5587	.1826	.2059	.4382	.0796	.2476	.0693	.3239	.2178	**.0449**	.5008
Drain	.3676	.8679	.8815	.8977	.8573	.9249	.1212	.1733	.3966	.1990	.3551	.1901	.9111	.4358	.4408	.1576	.8169	.6623	.3164
Well	.7571	.8705	.9880	.1559	.4669	.4896	.0570	.3507	.1397	.1193	.9707	.1339	.2504	.4715	.1786	.0269	.8425	.2487	**.0191**
Outl	.0754	.5155	.8564	.1146	1.000	.1382	.0932	**.0190**	**.0428**	**.0435**	.0945	.0892	.6676	.1014	.2060	.2368	**.0461**	.3732	**.0323**
Inl	.0671	.4700	**.0156**	.0675	.1261	**.0116**	**.0157**	**.0336**	**.0365**	**.0169**	.2472	**.0347**	.2992	**.0095**	.3264	.2032	**.0042**	.2500	**.0096**
UTMn	.2500	.5508	**.0181**	**.0008**	**.0001**	.1522	.9031	.4272	.6142	.4796	**.0016**	**.0119**	**.0005**	**<.0001**	**<.0001**	.2914	**<.0001**	.4725	.6265
UTMe	.5266	.2425	.1833	.1712	.7150	.0831	.0689	.0637	.0864	**.0469**	.3879	.3390	.4746	.7368	.6346	.1732	.6931	.0964	.1884
Alt	.2084	.4145	**.0032**	**<.0001**	**<.0001**	.1528	.3205	.8845	.3931	.7362	**.0011**	**.0053**	**<.0001**	**<.0001**	**<.0001**	.5969	**<.0001**	.9907	.4329
DistWat	.6583	.9871	.5519	.4364	.7495	**.0129**	.0946	.1226	.1782	.1358	.8755	.2481	.0525	.9768	.4896	.0511	.9907	.9306	.0890
DistRoad	.3396	.6569	.7121	.7013	.5115	.4784	.5851	.3527	.9444	.6886	.3997	.6380	.9165	.7804	.7938	.4028	.5414	.0933	**.0239**
DistAgr	.1582	.1633	.0659	.5892	.5853	**.0327**	.2702	.8419	.4423	.4116	.8927	.4492	.5062	**.0309**	.0774	.3479	.6176	.7249	.2361
DistBui	.1229	.8849	.1348	.2268	.1495	.1313	.2270	.4397	.4656	.2888	.1773	.0581	.3562	**.0124**	**.0252**	.9902	**.0397**	.1362	.3545
DistForest	**.0292**	.1120	.6454	**.0429**	**.0368**	.7572	**.0263**	**.0226**	**.0080**	**.0413**	.9303	.4277	**.0016**	**.0060**	**.0013**	.2964	**.0371**	.3048	.0744
Age	.5673	.2503	.9716	.8837	.4648	**.0006**	.2933	.0457	.4778	.2368	**.0284**	**.0115**	**.0078**	**.0012**	**.0003**	**.0179**	.1169	.1174	.7436
Fire	.1382	.7839	.5089	.5299	.3484	.7307	.4389	.6734	.7831	.7503	.2526	.7115	.0613	.3354	.0968	.1134	.3479	.2286	**.0366**
Water	.7350	.7001	.4747	.7185	.9402	.0764	.1720	.0576	.2478	.0871	**.0204**	**.0033**	**.0185**	**.0006**	**.0002**	.0546	.3104	.4134	.4947
Drink	.2533	.4292	**.0135**	**.0115**	**.0446**	**.0001**	**.0412**	.0989	.1275	.0645	.0757	**.0234**	.9841	**.0483**	.3852	.7858	.5593	.2202	.0522
Laund	.9540	.6897	.2625	.3389	.1777	.4068	.1816	.2178	.4472	.2310	**.0351**	**.0137**	.5253	.1374	.3940	.6042	.0702	.6450	.4005
Fence	.9562	.4703	.0748	.2279	.2527	**.0299**	.3275	.9290	.6172	.6513	.5021	.9236	.1223	.6415	.2791	.5376	.2410	.5332	.4310
Lime	.5989	.2826	.3181	.4092	.8709	.9005	.2503	.7077	.3749	.4919	.3885	.2660	.5900	.5403	.4761	.0989	.3811	.8513	.3114
Garb	.3213	.8481	.8320	.8992	.9175	.3393	.1536	.8811	.1317	.1471	.5495	.1895	.0700	.3395	.4826	.0672	.0925	**.0162**	**.0234**
Renov	**.0285**	.4093	.5614	.4934	.5023	.5155	.2210	.0863	.1133	.1408	.9339	.3650	.3080	.8249	.5753	.7767	.3792	.8682	.6782
Herbic	.1362	.2251	.2241	.2768	.3486	.7077	.7930	.9005	.6261	.6261	.2939	.3423	.3737	.4919	.4095	.9303	.8024	.9900	.7548
StonyMarg	.7385	**<.0001**	.1830	**.0275**	.0710	.9229	.3228	.4390	.2415	.2592	.7472	.4519	.3268	.9400	.7148	.4518	.2631	.9230	.4080
Cut	.7874	.5815	.5815	.7486	.4770	.2567	.4731	.3430	.2964	.2706	.3176	.1306	.1857	**.0057**	**.0122**	.5175	.4925	.1322	.8627
Fell	.6435	.9044	.1588	.9616	.3708	.3168	.7218	.9923	.6034	.8399	.5834	.2181	.8621	**.0096**	.1383	.8173	**.0010**	.1359	.1384
Graze	.4091	.8578	.1199	.0608	.1482	**.0002**	.9613	.5447	.8023	.9742	.0621	.0994	.3075	.4287	.1647	.2480	.1007	.7406	.7651
Fish	.9948	.5217	.0786	.0812	.3102	.4504	.1803	.1845	.0872	.2833	.9171	.5671	.0552	.0999	**.0351**	.6073	.3417	.2951	.1040
Duck	.3217	.7790	.3453	.2000	.0904	.6530	.1899	.9165	.3377	.2978	.9284	.3767	.4129	.9582	.5640	.0770	.2868	.9046	.1925
Enlarge	**.0392**	.2900	.3658	.1106	.2995	.2649	.6010	.5370	.4105	.4506	.8103	.1839	**.0094**	.2916	.0558	.0704	.3030	.7446	.0746
Diminish	.9485	.1401	.3552	1.000	.6595	.4582	.3900	.3443	.5261	.4782	.5473	.1409	.9399	.8382	.9486	.4079	.9058	.4584	.2126
MaxSlp	**.0126**	.7530	**.0027**	.0546	.0540	.2751	**.0041**	.0533	**.0089**	**.0114**	.5617	.3239	**.0222**	.9768	.2341	.1451	.3647	**.0267**	**.0024**
MinSlp		.8463	.0623	**.0038**	**.0043**	.2771	.0545	.1400	.0516	.0955	.3290	.5691	.1129	.3065	.0754	.2267	.5412	.5153	.4160
Soil	-.0200		.6438	.1443	.2946	.1295	.0936	.8656	.0561	.0735	.8592	.7902	.0943	.0735	**.0368**	.6987	.5887	.0921	**.0301**
MaxSoil	.1705	.0490		**<.0001**	**<.0001**	.2874	.0565	.0479	.1036	.0757	.7304	.3510	**.0221**	.5525	.3601	.9716	.5361	.2931	.1062
MinSoil	.2552	-.1491	.3932		**<.0001**	.9630	**.0131**	.1570	**.0042**	**.0161**	.3565	.1804	**.0004**	**.0487**	**.0048**	.6635	**.0103**	.3387	**.0241**
MedSoil	.2508	-.1065	.5857	.6802		.8573	**.0142**	.1457	**.0162**	**.0186**	.1573	.4723	**.0001**	.1490	**.0035**	.8301	.0532	.3133	.0884
Secchi	-.0955	.1543	.0958	.0040	-.0155		.7454	**.0358**	.8076	.5124	**<.0001**	**<.0001**	**.0194**	**<.0001**	**<.0001**	.0750	.1403	.3330	.7942
Cnd	.1683	-.1699	.1711	.2145	.2109	.0280		**<.0001**	**<.0001**	**<.0001**	.2889	.7412	**.0009**	.6182	.0604	**.0455**	.0625	**<.0001**	**<.0001**
pH	.1294	-.0172	.1778	.1226	.1254	.1812	.5969		**<.0001**	**<.0001**	**.0201**	**.0162**	**.0329**	.1573	.8347	.8301	**.0498**	**.0001**	**.0001**
Alk	.1701	-.1934	.1459	.2474	.2067	.0210	.8187	.6361		**<.0001**	.4548	.6723	**.0001**	.7988	.0679	.1695	.2458	**<.0001**	**<.0001**
Ca	.1458	-.1812	.1592	.2079	.2023	.0564	.8631	.6229	.8136		.0863	.4443	**.0031**	.7765	.2683	.1677	.0562	**<.0001**	**<.0001**
Clr	.0855	-.0180	.0309	.0798	.1218	-.3874	-.0911	-.2000	-.0641	-.1472		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**.0144**	.1534	.3722	.8257
Trb	.0499	.0270	-.0838	.1159	.0619	-.4061	-.0284	-.2070	-.0363	-.0657	.4126		**.0200**	**<.0001**	**<.0001**	**.0293**	**.0045**	.8348	.8711
PO_4-P	.1416	-.1732	.2095	.3121	.3329	-.2056	.2918	.1872	.3393	.2585	.3796	.2039		**<.0001**	**<.0001**	**.0030**	.0739	.2010	**<.0001**
Part-P	.0895	-.1814	-.0533	.1704	.1242	-.3981	.0428	-.1216	.0219	-.0243	.3648	.4665	.4124		**<.0001**	.0644	**<.0001**	.8574	.2086
Tot-P	.1563	-.2126	.0824	.2447	.2524	-.3748	.1618	.0180	.1572	.0953	.4134	.3896	.6639	.7607		**.0015**	**.0005**	.3567	**.0017**
NH_4-N	.1061	-.0394	.0032	.0377	.0185	-.1539	.1722	-.1850	.1182	.1187	.2108	.1879	.2607	.1592	.2753		.4609	.6263	**<.0001**
NO_3-N	-.0542	.0555	-.0562	-.2248	-.1685	.1287	.1620	.1709	.1008	.1659	-.1242	-.2476	-.1586	-.3916	-.3051	.0643		**.0132**	**.0034**
Part-N	-.0569	-.1705	.0942	.0826	.0867	.0833	.4236	.3469	.4054	.4427	-.0765	-.0179	.2034	-.0154	.0793	-.0419	.2152		**<.0001**
Tot-N	.0711	-.2196	.1448	.1948	.1465	-.0225	.5391	.3371	.4840	.4786	.0189	.0139	.3572	.1078	.2700	.3801	.2546	0.5469	

drained and Herbicides were not correlated with other variables in either of the pond or pond margin data sets.

PCA

The first four PCA ordination axes for the pond data set had eigenvalues of 0.163, 0.132, 0.075 and 0.069, respectively. Axes 1 and 2 thus explained only 29.5% of the total variation in recorded explanatory variables. The subsequent axes were not considered because of low interpretability. The PCA diagram axes 1 and 2 showed that the explanatory variables did not segregate into distinctive groups (Fig. 4). Instead they made up a more or less uniform cloud of scattered vectors with different lengths. About half of the 48 vectors, particularly the variables for anthropological influence, were relatively short which indicated weak relationships with the axes. Almost all of the water-chemistry variables were associated with long arrows indicating strong relationships with the axes.

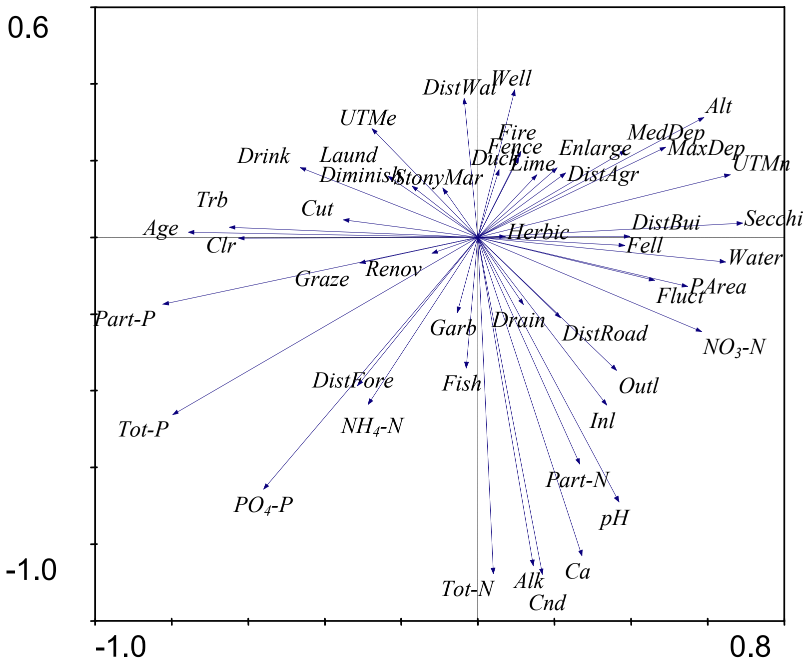

Figure 4. PCA ordination of 48 explanatory variables in the pond data set showing axes 1 and 2. Names of explanatory variables abbreviated in accordance with Tab. 1.

The first PCA axis for the pond margin data set (Fig. 5) accounted for 15.5% of the total variation and the second axis for 14.6%. The third and fourth axes with low eigenvalues of 0.075 and 0.064 were not interpreted further. As for the pond data set, the 47 vectors were well scattered in the two-dimensional diagram and no distinct groups of variables could be seen. The vectors representing the chemical variables were long whereas many vectors for human influence-variables were short.

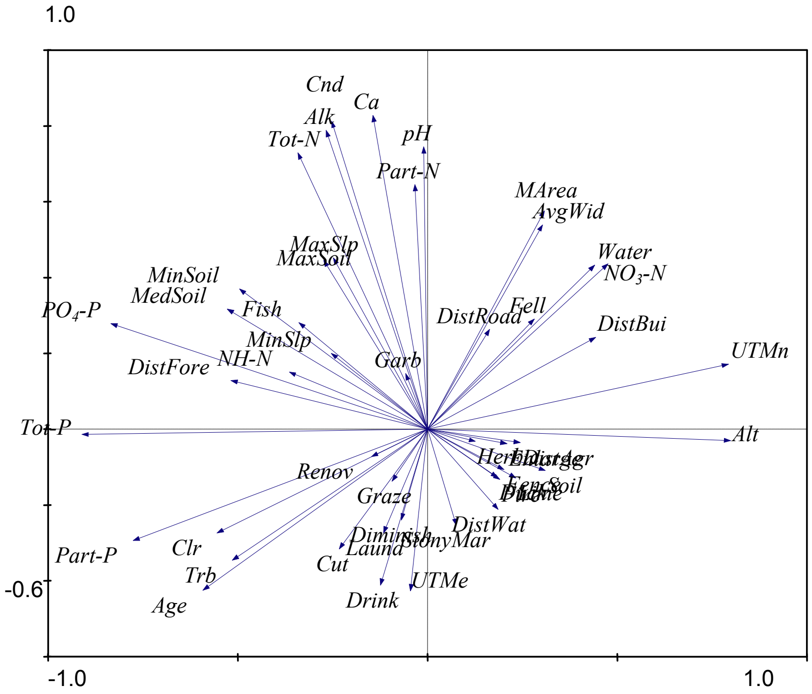

Figure 5. PCA ordination of 47 variables in the pond margin data set showing axes 1 and 2. Names of explanatory variables abbreviated in accordance with Tab. 1.

Ordination of vegetation

DCA ordination of the combined data sets (both ponds and pond margins) showed that ponds and pond margins made up two distinct groups (Fig. 6). This motivated separate ordination analyses of the two. The DCA ordination diagram of the combined data sets showed a more scattered distribution of the ponds compared to the pond margins. Note the relatively large eigenvalue of 0.618 for axis 1 (Tab. 3).

DCA

DCA axes (based upon 57 ponds) 1 to 4 had eigenvalues of 0.473, 0.392, 0.298 and 0.251, respectively (Tab. 3). Gradient lengths of axes 1 and 2 were 4.70 and 3.82 S.D. units, respectively. Plot scores were relatively evenly distributed along the two first ordination axes, although with somewhat lower density towards the fringe (Fig. 7).

Table 3. Characteristics of ordination axes.

Data set	Ordination method	Characteristics of axes			
		Axis No.	Gradient length (S.D. units)	Eigenvalue	Relative core length (%)
Pond + pond margin	DCA	1	4.68	0.618	83
		2	4.23	0.313	52
		3	3.84	0.259	76
		4	4.68	0.194	54
Pond	DCA	1	4.70	0.473	58
		2	3.82	0.392	54
		3	3.03	0.298	65
		4	3.09	0.251	70
Pond margin	DCA	1	2.63	0.319	72
		2	2.41	0.196	62
		3	2.28	0.164	39
		4	2.20	0.139	57
Pond	GNMDS	1	3.69		46
		2	4.99		27
Pond margin	GNMDS	1	2.56		67
		2	2.68		53

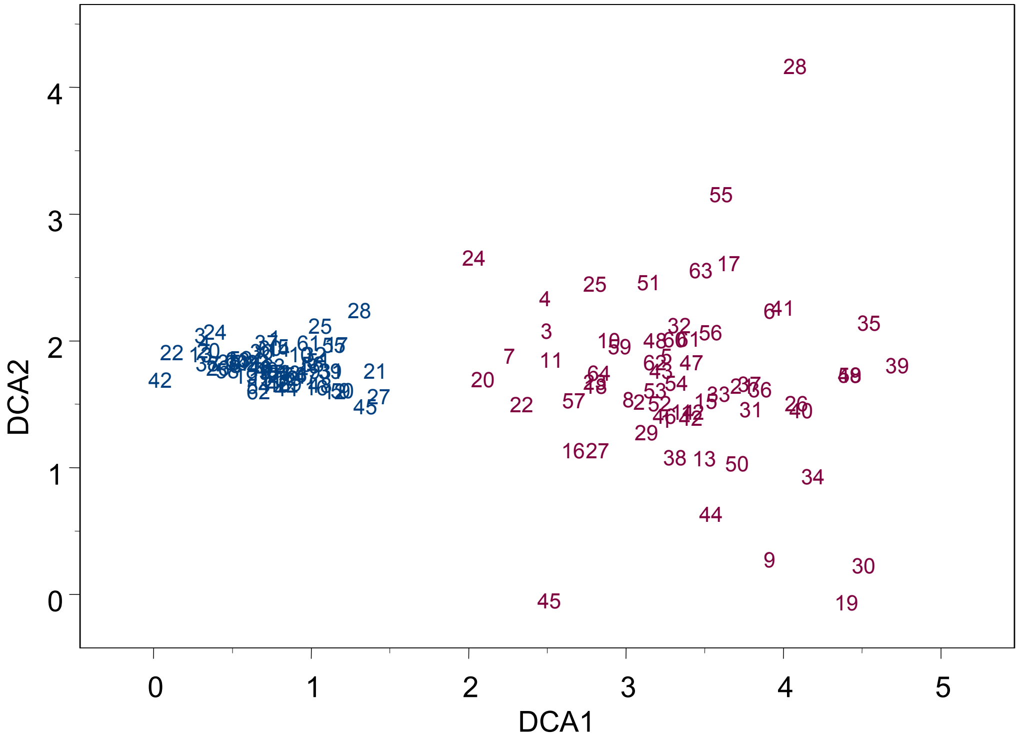

Figure 6. DCA ordination plot of full data set, 128 sample plots (indicated by their numbers), showing axes 1 and 2 in S.D. units. Ponds (1–64) in red to the right and pond margins (1–64) in blue to the left.

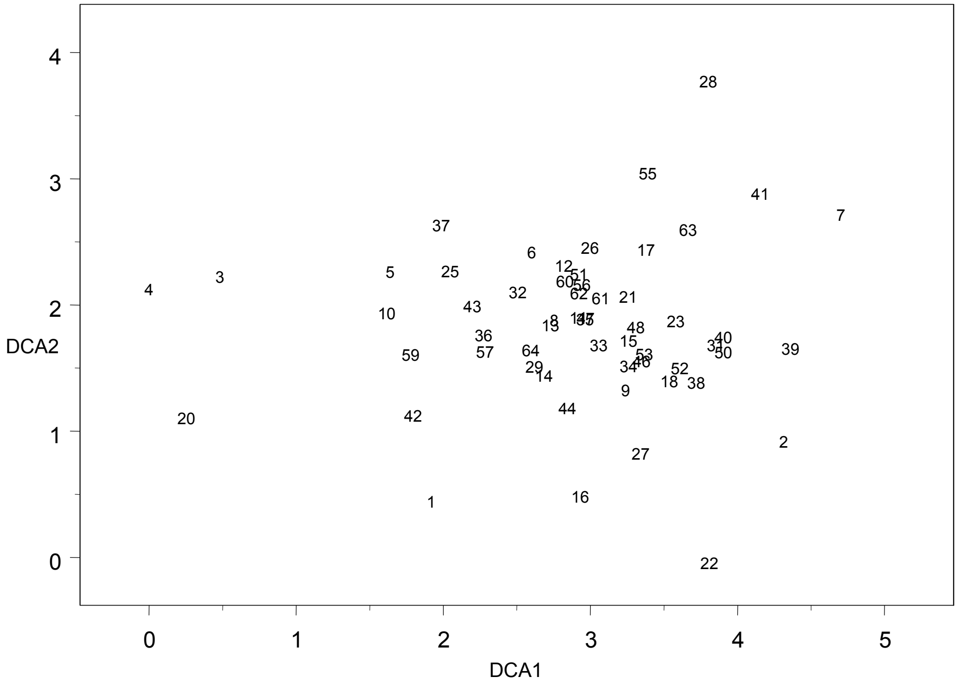

Figure 7. DCA ordination plot of 57 ponds, axes 1 and 2 in S.D. units.

The DCA axes 1–4 for 57 pond margin plots had eigenvalues of 0.319, 0.196, 0.164 and 0.139, respectively. Axes 1 and 2 had gradient lengths of 2.63 and 2.41, respectively (Tab. 3). The plot scores had a somewhat uniform trumpet-like distribution (Fig. 8).

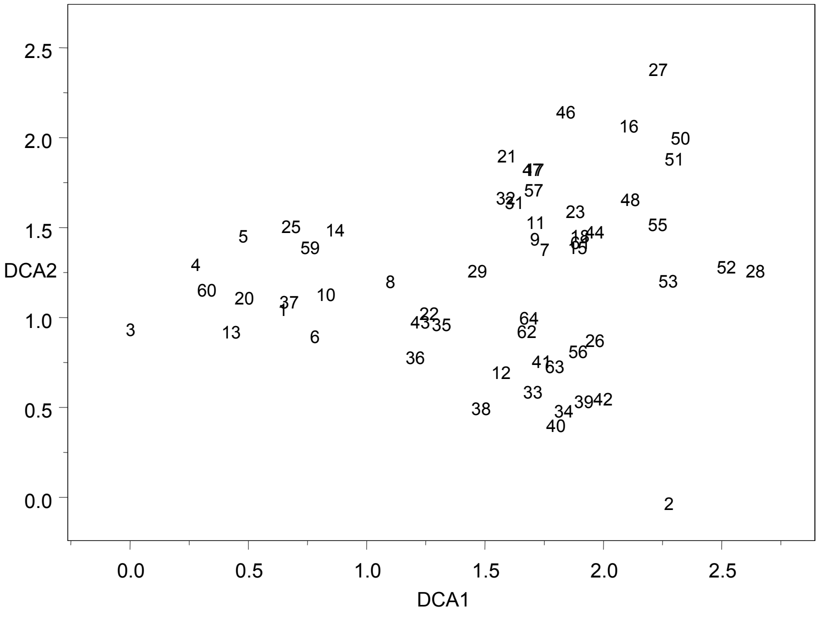

Figure 8. DCA ordination plot of 57 pond margins, axes 1 and 2 in S.D. units.

GNMDS

The gradient lengths of the rescaled first and second GNMDS axes based on 57 ponds were 3.69 and 4.99 S.D. units, respectively (Tab. 3). The scores were more or less uniformly distributed along the two first axes (Fig. 9).

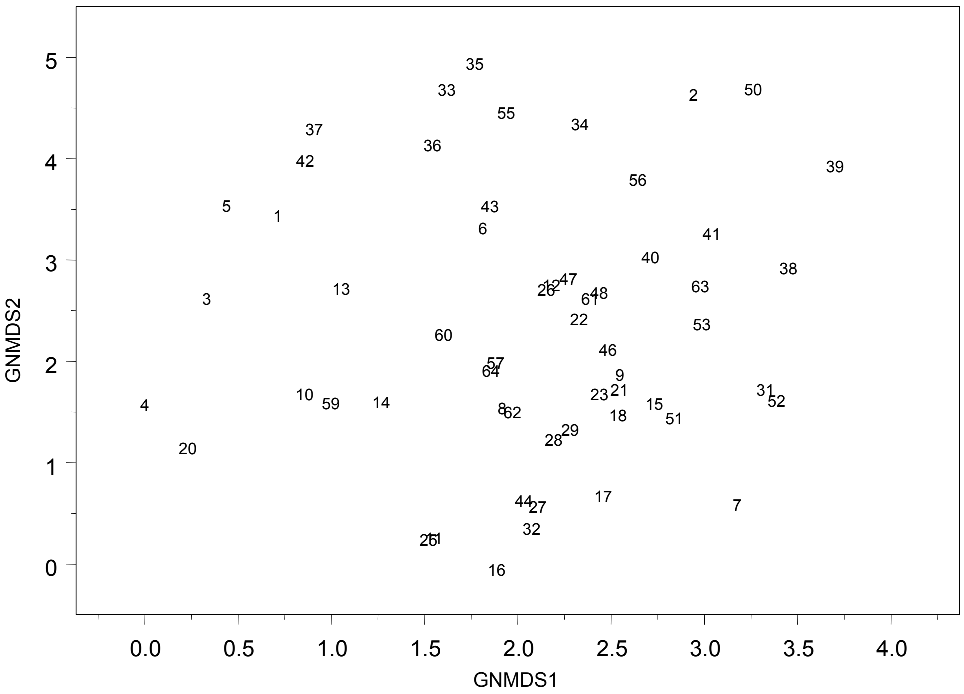

Figure 9. GNMDS ordination plot of 57 ponds, rescaled axes 1 and 2 in S.D. units.

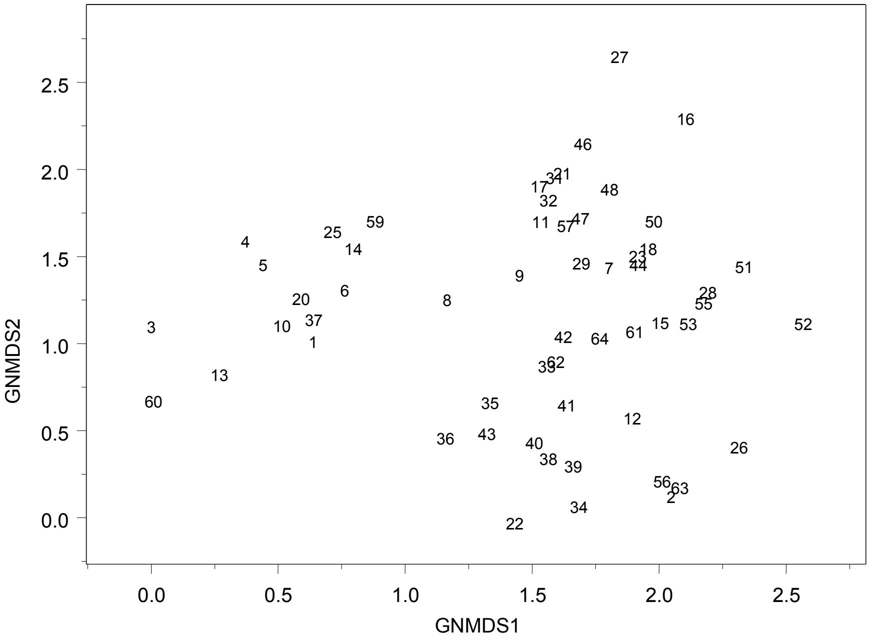

Figure 10. GNMDS ordination plot of 57 pond margins, rescaled axes 1 and 2 in S.D. units.

The first and second GNMDS axes for the pond margins had gradient lengths of 2.56 and 2.68 S.D. units, respectively (Tab. 3). The plots made up a trumpet-shaped cloud, although less strongly than for the DCA ordination (Fig. 10).

Ponds and adjacent pond margins located within the same 1 km^2 sample square

Locations within the same 1 km^2 sampling unit were compared with respect to species composition using DCA ordination. Of the 44 1 km^2 sampling units, one unit contained 8 ponds (and pond margins), one contained 3 ponds and six contained 2 ponds, outliers omitted.

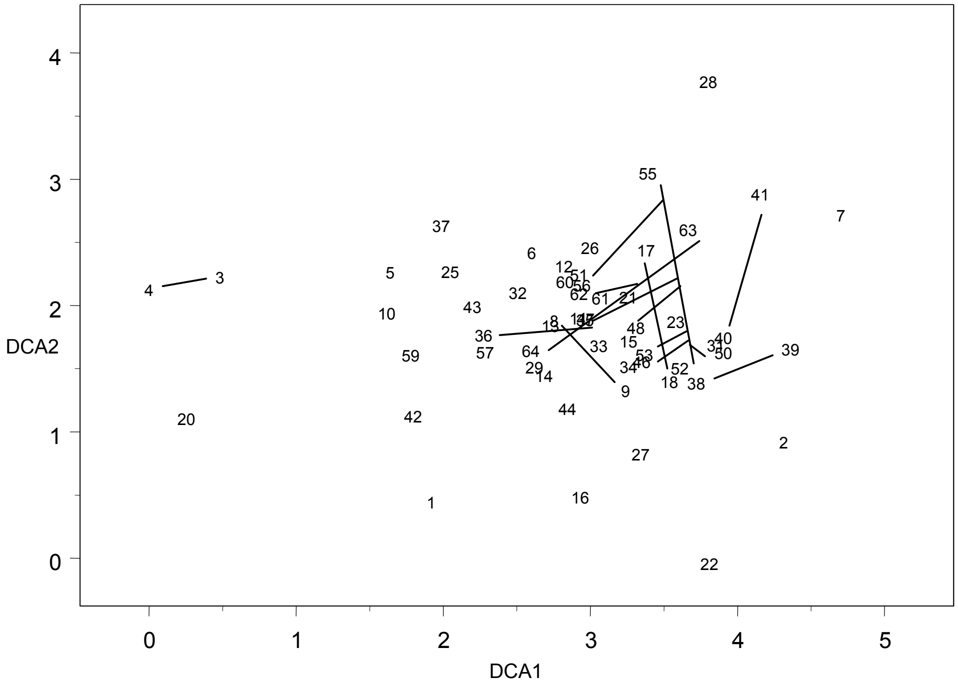

Figure 11. DCA ordination of 57 ponds, axes 1 and 2 in S.D. units. Ponds located within the same sampling unit are connected by a straight line.

Ponds Nos 46–48, 50–53 and 55 were located within the same square kilometre. Although they are confined to the same region of the ordination diagram, they are separated by more than 1 S.D. unit along DCA axis 2. (The same ponds made up a continuum along DCA axis 1). Ponds Nos 52 and 55 showed the largest difference in species composition being separated by 1.5 S.D. units, whereas the sample plots containing one pond pair mainly showed differences of 0.5 – 1 S.D. units along either axes (Fig. 11).

Figure 12 shows the relationship between pond margins. Pairs of pond margins showed a more similar species composition compared to the corresponding pond pairs (note the strong difference in gradient lengths, and hence, in scale used for the axes). The largest difference occurs between pond margins Nos 46 and 52 along DCA1 and Nos 46 and 53 along DCA 2. This may be due to large differences in number of species found in each site.

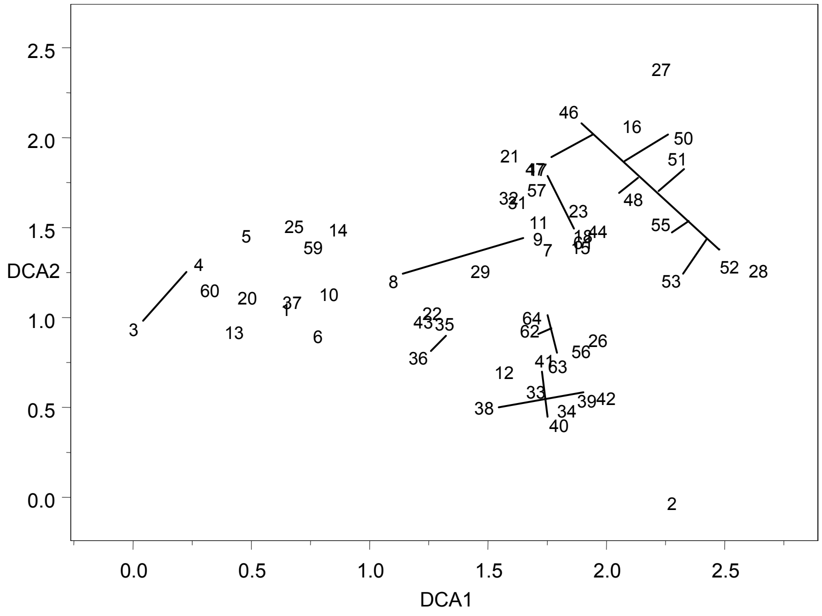

Figure 12. DCA ordination of 57 pond margins, axes 1 and 2 in S.D. units. Pond margins located within the same sampling unit are connected by a straight line.

Comparison of ordinations

Core lengths were calculated for both ponds and pond margins and for both ordination methods (Tab. 3). Core lengths were larger for pond margins than ponds, regardless of ordination method, but DCA in general had larger core lengths compared to GNMDS. Pairwise correlation coefficients and corresponding P-values between axes obtained by the two different ordination methods, DCA and GNMDS, for 57 sample plots, are given in Tabs 4 and 5 for ponds and pond margins, respectively. Correlations between DCA 1 and GNMDS 1 were strong in both data sets. This is also shown by the PCA ordinations of the ponds and the pond margins in Figures 13 and 14, respectively. For the pond data set DCA 2 was somehow strongly correlated with GNMDS 6 while DCA 3 was strongly correlated with GNMDS 2 (Tab. 4). For the pond margin data set the first three DCA axes were strongly correlated with the corresponding GNMDS axes, respectively (Tab. 5). Other correlations were less strong.

The PCA ordination plot of pond margins showed strong associations between the two first DCA axes and the corresponding GNMDS axes (Fig. 14).

The first ordination axes of DCA and GNMDS obtained for both ponds and pond margins, both DCA and GNMDS (Tabs 6 and 7, respectively), showed perfectly correlations. Pond and pond margin GNMDS 2 were also strongly correlated (Tab. 7), whereas pond and pond margin DCA 2 were not at all correlated. Other correlations were less strong.

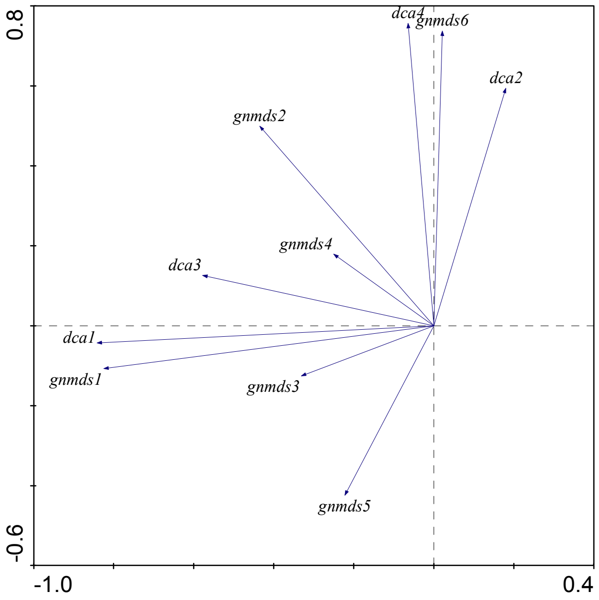

Figure 13. PCA ordination plot, axis 1 and 2, showing 4 DCA axes and 6 GNMDS axes for the pond data set.

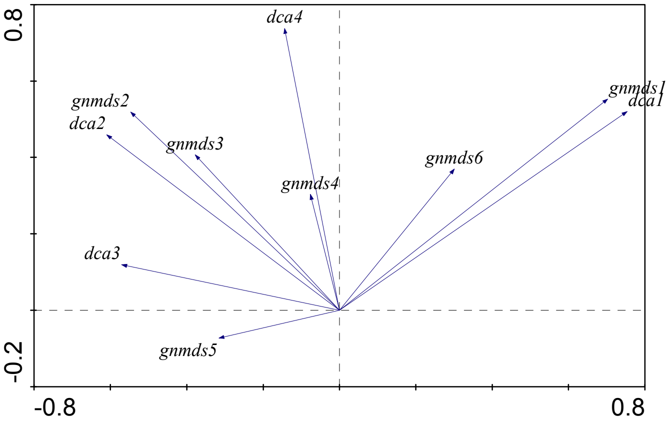

Figure 14. PCA ordination plot, axes 1 and 2, showing 4 DCA axes and 6 GNMDS axes for pond margin data set.

Table 4. Kendall’s correlation coefficients and corresponding P values between ordination axes for pond data set, significant (P<0.01) correlation between axes in bold.

Pond	DCA1		DCA2		DCA3		DCA4	
	τ	P	τ	P	τ	P	τ	P
GNMDS1	**.6929**	**<.0001**	.0300	.7411	.1553	.0878	-.0795	.3820
GNMDS2	.0739	.4166	-.0401	.6595	**.4711**	**<.0001**	.2850	.0017
GNMDS3	-.0100	.9123	.0438	.6299	.2393	.0085	-.1597	.0792
GNMDS4	.1992	.0286	-.0100	.9123	.0250	.7830	.1785	.0498
GNMDS5	.0939	.3018	-.2656	.0035	-.0375	.6796	.0181	.8418
GNMDS6	.0350	.6999	**.4223**	**<.0001**	-.1340	.1407	**.3477**	**<.0001**

Table 5. Kendall’s correlation coefficients and corresponding P values between ordination axes for pond margin data set, significant (P<0.01) correlation between axes in bold.

Pond margin	DCA1		DCA2		DCA3		DCA4	
	τ	P	τ	P	τ	P	τ	P
GNMDS1	**.7506**	**<.0001**	-.1002	.2707	-.1328	.1445	.1077	.2364
GNMDS2	-.0375	.6796	**.7330**	**<.0001**	.0989	.2768	.2619	.0040
GNMDS3	-.1328	.1445	.0338	.7101	**.3922**	**<.0001**	**.3596**	**<.0001**
GNMDS4	.0388	.6695	.0250	.7830	.0877	.3352	.1152	.2053
GNMDS5	-.0025	.9780	.0639	.4826	.1641	.0713	-.0939	.3018
GNMDS6	.2255	.0132	.0213	.8149	-.0363	.6897	.1666	.0671

Table 6. Kendall’s correlation coefficients with P values between DCA axes in both data sets, significant (P<0.01) correlation between axes in bold.

		Pond							
		DCA1		DCA2		DCA3		DCA4	
		τ	P	τ	P	τ	P	τ	P
Pond margin	DCA1	**.4849**	**<.0001**	.1077	.2364	.0701	.4407	-.0269	.7672
	DCA2	0	1	-.0288	.7515	.1967	.0307	.1510	.3857
	DCA3	-.2280	.0122	-.0037	.9671	.0789	.3857	-.0394	.6645
	DCA4	.0601	.5087	-.0488	.5913	**.2368**	**.0093**	.0958	.2922

Table 7. Kendall’s correlation coefficients with P values between GNMDS axes in both data sets, significant (P<0.01) correlation between axes in bold.

		Pond											
		GNMDS1		GNMDS2		GNMDS3		GNMDS4		GNMDS5		GNMDS6	
		τ	P	τ	P	τ	P	τ	P	τ	P	τ	P
Pond margin	GNMDS1	**.4974**	**<.0001**	-.0513	.5724	.0350	.6999	.0814	.3708	.1140	.2103	-.0300	.7411
	GNMDS2	.0451	.6202	**.4160**	**<.0001**	-.0238	.7936	-.0977	.2829	-.0902	.3216	-.0188	.8364
	GNMDS3	-.0751	.4088	-.1127	.2153	.1040	.2532	-.2406	.0082	-.0100	.9123	-.1917	.0352
	GNMDS4	.0037	.9671	-.1090	.2310	-.1052	.2475	**-.2418**	**.0079**	-.0413	.6496	.2080	.0223
	GNMDS5	-.0150	.8688	.1378	.1299	.2193	.0160	.0175	.8472	**-.3157**	**.0005**	.0588	.5176
	GNMDS6	.1378	.1299	-.0902	.3216	-.0187	.8364	.1177	.1956	-.1704	.0612	-.0112	.9014

Interpretation of ordinations

Correlations between ordination axes and explanatory variables

Comparison of DCA 1 and GNMDS 1 for ponds shows that these ordination axes had rather similar patterns of correlations with explanatory variables (Tab. 8). They were significantly negatively correlated with Maximum and Median water depth and positively correlated with Distance to forest and Pond age. Furthermore, most of the water chemistry variables were strongly positively correlated with DCA 1 and GNMDS 1. GNMDS 1 was correlated also with some more variables, e.g. UTM northing, Altitude and Secchi-depth. DCA 2 had only one significant correlation whereas its correlated component, GNMDS axis 6, had three significant correlations, with the same two water depth variables that were correlated with the first axes, and with NO_3-N. The subsequent axes were also correlated with some variables, but there were no indication of new groups of variables being correlated with gradients, except from Area which was correlated with all third and fourth axes in addition to UTM easting correlated with the third axes of both ordination methods.

DCA 1 and GNMDS 1 for pond margins were to a large extent correlated with the same variables as for pond DCA 1 and GNMDS 1 (Tab. 9). The water chemical variables, Pond age and Distance to forest were positively correlated and UTM northing and Altitude were negatively correlated. Renovation and some topographical variables were also correlated with the axes. DCA 2 and GNMDS 2 were both significantly correlated with several variables, many of the same that were correlated with the first axes but in addition some that were related to anthropological influence like Cutting and Pond used for watering, Average width, UTM easting and Distance to built-up area. The subsequent axes had various correlations related to all groups of variables, e.g. many water chemical and geographical variables for DCA axes 3 and 4 and GNMDS axis 3. The presence of Fish and Garbage were correlated to GNMDS 4, whereas Area, Maximum slope, Soil depth variables and Pond enlarging were correlated with GNMDS 5.

Although many of the correlations were significant, the Kendall’s correlation coefficients were generally low, indicating that the explanatory variables were relatively weak predictors of variation in species composition.

Multiple regression

GLM with ordination axes for 57 ponds as response variables and explanatory variables as predictors indicated that all groups of variables explained some variation in species composition along the ordination axes (Tab. 10). Water chemical variables like PO_4-P and Alkalinity, and

Table 8. Kendall's correlation coefficients and corresponding P values between ordination axes and explanatory variables related to pond data set. P<0.05 in bold

	DCA axes								GNMDS axes											
	1	P	2	P	3	P	4	P	1	P	2	P	3	P	4	P	5	P	6	P
PArea	-.0282	.7567	.0382	.6745	**.2312**	**.0111**	**.1917**	**.0351**	-.0683	.4530	.1497	.0999	**.1848**	**.0423**	**.2525**	**.0055**	-.1034	.2560	.0182	.8418
MaxDep	**-.2518**	**.0056**	-.0238	.7936	-.0338	.7101	-.1560	.0865	**-.2494**	**.0061**	-.0927	.3082	**.2406**	**.0082**	-.0050	.9561	**-.2055**	**.0239**	**-.1880**	**.0389**
MedDep	**-.2218**	**.0148**	-.0037	.9670	-.0175	.8471	**-.2424**	**.0077**	**-.2155**	**.0179**	-.1103	.2256	**.2531**	**.0054**	.0113	.9014	-.1566	.0852	**-.2356**	**.0096**
Fluct	-.0319	.6864	.0131	.8679	-.0883	.2643	.0187	.8123	-.1147	.1474	.0833	.2923	.0395	.6179	-.0721	.3626	-.1071	.1758	.0783	.3223
Drain	-.0125	.8274	.0137	.8105	.0651	.2569	.0620	.2805	-.0576	.3159	.0902	.1165	.0677	.2391	.0138	.8105	-.0940	.1020	-.0050	.9305
Well	-.0751	.2953	-.0112	.8753	.0025	.9722	-.0394	.5827	-.1090	.1291	-.0050	.9444	.0138	.8478	.0652	.3644	.1140	.1124	-.0652	.3644
Outl	-.0488	.5258	.0050	.9481	.0939	.2225	.1027	.1823	-.0576	.4543	.1316	.0877	-.0138	.8580	.1078	.1619	**-.2055**	**.0076**	-.0263	.7327
Inl	-.0751	.3364	.0200	.7977	.1228	.1164	**.1860**	**.0173**	-.0201	.7977	.1404	.0727	-.1115	.1539	.0777	.3205	-.1454	.0631	.0464	.5533
UTMn	-.1359	.1352	-.0720	.4286	-.0144	.8742	**.2681**	**.0032**	**-.1873**	**.0396**	**.2675**	**.0033**	-.1247	.1707	-.0633	.4869	.0457	.6153	.1598	.0792
UTMe	.0670	.4614	-.0131	.8851	**-.3615**	**.0001**	.1165	.2004	-.0019	.9835	**-.2600**	**.0043**	**-.3427**	**.0002**	.0984	.2798	.1272	.1623	.0545	.5492
Alt	-.1303	.1512	-.0250	.7825	-.1466	.1063	**.2286**	**.0118**	**-.2406**	**.0080**	.1178	.1945	**-.2732**	**.0026**	.0038	.9670	-.0564	.5345	.0902	.3203
DistWat	-.0426	.6392	.0576	.5259	-.0563	.5349	-.0219	.8093	-.0877	.3345	-.0088	.9231	-.0927	.3076	.0050	.9560	.1366	.1329	.0927	.3076
DistRoad	-.0238	.7931	.1190	.1897	.0802	.3769	.0507	.5761	-.0125	.8902	.1053	.2462	.0288	.7508	-.0451	.6192	-.1629	.0727	-.0238	.7931
DistAgr	-.1134	.2063	.0181	.8395	-.0795	.3752	.0902	.3147	**-.1773**	**.0482**	-.0633	.4807	-.1360	.1298	.0959	.2854	-.0934	.2982	-.0746	.4061
DistBui	-.0802	.3530	.0338	.6952	.0914	.2894	.1246	.1487	-.0990	.2516	**.2080**	**.0160**	.0977	.2577	**-.1717**	**.0468**	-.1479	.0868	.0977	.2577
DistFore	**.2744**	**.0024**	-.0989	.2733	-.1040	.2497	-.1284	.1552	**.2870**	**.0015**	-.1692	.0612	-.0388	.6673	.1178	.1924	.0714	.4293	-.0401	.6572
Age	**.1785**	**.0190**	-.0808	.2884	-.0870	.2526	-.0563	.4588	**.1811**	**.0174**	-.1096	.1498	-.0132	.8628	.0081	.9148	**.2513**	**.0010**	.0432	.5701
Fire	-.0426	.4918	-.0313	.6132	-.0238	.7008	-.0551	.3736	-.0238	.7008	.0088	.8874	.0639	.3024	-.0489	.4303	-.0163	.7926	-.0351	.5713
Water	-.0726	.3198	.0776	.2875	.1253	.0863	.0119	.8705	-.0890	.2232	.1328	.0690	.1078	.1401	.0376	.6068	**-.1805**	**.0135**	.0038	.9590
Drink	.0758	.3390	-.0156	.8434	**-.2161**	**.0064**	-.1134	.1526	.0683	.3891	-.1310	.0986	-.0558	.4819	-.1184	.1353	**.1949**	**.0140**	.0796	.3156
Laund	-.0137	.7749	.0188	.6965	-.0739	.1250	-.0877	.0687	.0088	.8556	-.0564	.2420	-.0702	.1454	**-.1128**	**.0193**	.0100	.8352	-.0025	.9585
Fence	.0213	.7806	.0852	.2651	**-.1641**	**.0318**	-.0563	.4608	.0063	.9347	-.0326	.6701	.0539	.4810	-.0376	.6230	.0689	.3674	.0940	.2190
Lime	-.0332	.4080	.0056	.8883	-.0369	.3570	.0144	.7196	-.0420	.2956	-.0244	.5427	**-.0959**	**.0169**	-.0407	.3103	-.0132	.7430	-.0721	.0726
Garb	.1159	.0163	.0244	.6125	.0043	.9276	.0319	.5077	**.1071**	**.0263**	.0044	.9276	-.0282	.5589	.0044	.9276	.0069	.8864	.0445	.3564
Renov	.0213	.7842	.0012	.9871	-.0827	.2877	-.0031	.9679	.0451	.5620	-.0940	.2270	-.1228	.1144	.0100	.8975	-.0201	.7966	.0714	.3585
Herbic	.0050	.9103	-.0614	.1675	-.0025	.9551	-.0451	.3106	-.0050	.9103	.0576	.1951	-.0451	.3106	-.0602	.1764	.0602	.1764	-.0401	.3674
StonyMa	-.0401	.3671	-.0200	.6520	**-.1127**	**.0112**	.0037	.9326	-.0388	.3822	-.0852	.0553	.0276	.5352	.0238	.5923	.0238	.5923	.0100	.8216
Cut	.0325	.6929	-.0739	.3701	-.1478	.0731	-.1340	.1041	.0664	.4208	-.1429	.0833	.0288	.7268	-.0263	.7497	**.1704**	**.0388**	.0451	.5845
Fell	.0081	.8817	**.1171**	**.0324**	**.1146**	**.0362**	.0463	.3971	-.0031	.9544	.0883	.1066	.0132	.8101	-.0232	.6720	-.0608	.2670	.0482	.3782
Graze	.0895	.1497	-.0231	.7094	-.0382	.5389	.0557	.3700	.0583	.3489	.0783	.2080	-.0056	.9278	.0006	.9920	.0896	.1497	.0695	.2635
Fish	.0607	.4493	-.0319	.6908	.1221	.1283	-.0338	.6736	.0533	.5073	.0746	.3533	.1297	.1064	**.1723**	**.0320**	-.1109	.1674	-.0921	.2516
Duck	.0144	.8332	-.0770	.2600	**-.1472**	**.0314**	.0607	.3744	.0006	.9927	-.0558	.4150	-.0959	.1612	-.0357	.6017	.1122	.1012	-.0069	.9198
Enlarge	-.1215	.0507	.0714	.2508	-.0889	.1526	-.0789	.2043	**-.1654**	**.0078**	-.1040	.0945	.1078	.0832	.0276	.6576	-.1128	.0698	.0263	.6722
Diminish	.0225	.6620	-.0062	.9034	-.0776	.1322	.0526	.3077	-.0263	.6101	-.0589	.2537	**-.1103**	**.0326**	**.1165**	**.0239**	.0664	.1981	.0113	.8270
Secchi	-.1109	.2227	.0469	.6054	.0507	.5769	**.1842**	**.0428**	**-.1999**	**.0280**	.0407	.6543	.0558	.5398	.1773	.0512	-.1548	.0889	.0044	.9615
Cnd	**.3395**	**.0002**	.1015	.2647	**.2694**	**.0031**	.0795	.3819	**.3459**	**.0001**	**.3208**	**.0004**	-.0150	.8688	.0902	.3215	-.1654	.0691	.1115	.2204
pH	**.2167**	**.0172**	.1365	.1334	**.2268**	**.0127**	.0858	.3455	**.2180**	**.0166**	**.2393**	**.0085**	.0576	.5264	.1341	.1406	**-.2130**	**.0192**	.0702	.4406
Alk	**.3740**	**<.0001**	.1008	.2677	**.2888**	**.0015**	.0112	.9014	**.3904**	**<.0001**	**.3127**	**.0006**	-.0320	.7255	.0846	.3527	-.1560	.0865	.0508	.5771
Ca	**.3439**	**.0002**	.1159	.2028	**.2700**	**.0030**	.0701	.4407	**.3402**	**.0002**	**.3503**	**.0001**	-.0432	.6348	.0570	.5310	-.1510	.0971	.1046	.2503
Clr	.1058	.2446	.0632	.4868	.0382	.6745	-.1566	.0852	**.1873**	**.0395**	-.1347	.1388	-.0182	.8417	-.0482	.5960	.0395	.6645	-.0420	.6446
Trb	.1428	.1165	.0701	.4406	-.0877	.3351	-.1184	.1931	**.2243**	**.0137**	-.1704	.0611	-.0451	.6201	-.0426	.6396	.1103	.2256	.1454	.1102
PO_4-P	**.4210**	**<.0001**	.0100	.9120	**.2481**	**.0062**	-.0507	.5757	**.4887**	**<.0001**	.0915	.3131	.0025	.9780	.0388	.6684	.0376	.6784	-.0376	.6784
Part-P	**.2249**	**.0134**	.0106	.9068	-.0156	.8633	**-.2280**	**.0122**	**.2813**	**.0020**	-.1297	.1541	.1034	.2560	-.0307	.7359	.0883	.3317	-.0658	.4697
Tot-P	**.3439**	**.0002**	.0094	.9177	.0845	.3524	-.1578	.0826	**.4242**	**<.0001**	-.0620	.4953	.0320	.7254	-.0207	.8202	.0721	.4283	-.0495	.5863
NH_4-N	.1516	.0955	-.0125	.8904	.0651	.4738	.0933	.3047	**.1930**	**.0339**	.0201	.8255	-.0551	.5444	.0188	.8363	-.0063	.9451	.0952	.2951
NO_3-N	-.0369	.6841	.0620	.4948	-.0307	.7354	**.2894**	**.0014**	-.1209	.1832	**.1936**	**.0331**	-.0570	.5303	.0207	.8200	-.0132	.8848	**.2099**	**.0209**
Part-N	**.3634**	**.0001**	.1466	.1072	.1441	.1134	.1008	.2677	**.2845**	**.0018**	**.2469**	**.0067**	.0301	.7411	.0664	.4656	-.1466	.1072	.0551	.5447
Tot-N	**.3258**	**.0003**	.0375	.6796	**.2180**	**.0166**	.1297	.1541	**.3246**	**.0004**	**.2807**	**.0020**	-.0201	.8256	.0852	.3491	-.1090	.2310	.0213	.8149

Table 9. Kendall's correlation coefficients and corresponding P values between ordination axes and explanatory variables related to pond margin data set. P<0.05 in bold

	DCA axes								GNMDS axes											
	1	P	2	P	3	P	4	P	1	P	2	P	3	P	4	P	5	P	6	P
MArea	-.0357	.6948	.1736	.0565	-.0357	.6948	.0658	.4698	-.1184	.1932	.1447	.1118	-.0708	.4366	.0495	.5865	**.2851**	**.0017**	-.0482	.5960
AvgWid	-.0238	.7931	**.2857**	**.0016**	-.0802	.3769	.1165	.1992	-.0714	.4313	**.2644**	**.0036**	-.0702	.4394	.1516	.0948	.1404	.1220	-.0840	.3550
MaxSlp	.1259	.1659	.1385	.1277	.0833	.3593	-.0520	.5672	.0783	.3889	.1472	.1053	-.0871	.3380	-.1535	.0913	**.3026**	**.0009**	.0495	.5861
MinSlp	.1153	.2038	.0288	.7507	.0852	.3476	-.1015	.2632	.0890	.3267	.0526	.5618	-.0251	.7823	-.0226	.8036	.0702	.4392	.1704	.0603
Soil	**-.1378**	**.0271**	.0125	.8407	.0927	.1369	.0363	.5600	-.1040	.0953	-.0063	.9200	.1115	.0737	-.0789	.2054	-.0363	.5600	-.0326	.6013
MaxSoil	**.1836**	**.0383**	.1009	.2549	.0294	.7396	.0595	.5017	.1510	.0883	**.1773**	**.0454**	-.0558	.5291	-.1548	.0807	**.2538**	**.0042**	.0420	.6357
MinSoil	**.2982**	**.0010**	.0038	.9670	.0125	.8904	.0902	.3211	**.2820**	**.0019**	.1065	.2415	.0276	.7618	-.0664	.4652	**.1805**	**.0472**	.1629	.0732
MedSoil	**.3791**	**<.0001**	-.0320	.7254	-.0558	.5399	.0169	.8525	**.3477**	**.0001**	.0821	.3670	-.0921	.3114	.0132	.8850	**.2600**	**.0043**	.1560	.0864
UTMn	**-.2751**	**.0025**	**.4455**	**<.0001**	-.0457	.6153	.0282	.7567	**-.3089**	**.0007**	**.3014**	**.0009**	-.1046	.2503	.0746	.4127	-.1585	.0816	-.1360	.1352
UTMe	-.0044	.9616	**-.1798**	**.0482**	-.0470	.6056	**-.3452**	**.0001**	-.0407	.6545	**-.2638**	**.0038**	**-.2588**	**.0045**	.1598	.0792	-.1723	.0583	-.0194	.8310
Alt	**-.3358**	**.0002**	**.2932**	**.0012**	-.0827	.3623	-.1090	.2298	**-.4023**	**.0001**	.1504	.0977	**-.1880**	**.0384**	.0965	.2879	-.1729	.0568	-.0476	.5999
DistWat	-.1504	.0980	.1454	.1097	.0175	.8469	.0063	.9450	-.1754	.0536	.1178	.1949	-.0752	.4081	**.2005**	**.0274**	-.0789	.3850	-.0075	.9341
DistRoad	-.0727	.4233	.0827	.3622	-.0539	.5528	.0426	.6388	-.0439	.6290	.0965	.2878	-.0301	.7404	-.0877	.3339	.0514	.5714	-.0050	.9560
DistAgr	-.1247	.1647	.0420	.6399	.0996	.2669	.0107	.9055	-.1523	.0898	.0182	.8395	.0119	.8945	-.0645	.4721	.0420	.6399	-.0044	.9610
DistBui	-.1053	.2228	**.2682**	**.0019**	.0564	.5137	**.2393**	**.0056**	-.1153	.1818	**.2506**	**.0037**	.0664	.4418	.1103	.2016	.0188	.8277	-.1140	.1866
DistFores	**.3997**	**<.0001**	**-.2155**	**.0171**	**-.2444**	**.0068**	-.1604	.0759	**.3484**	**.0001**	**-.2118**	**.0191**	-.0627	.4881	-.0789	.3823	-.0965	.2856	.1378	.1271
Age	.1485	.0511	**-.2650**	**.0005**	-.0520	.4945	-.0909	.2327	**.1949**	**.0105**	**-.2212**	**.0037**	-.0081	.9148	-.0269	.7234	-.0934	.2201	-.1422	.0617
Fire	-.0338	.5851	.0276	.6564	.0125	.8398	-.0150	.8083	-.0388	.5308	-.0113	.8556	.0414	.5046	.0614	.3218	.0251	.6859	.0138	.8240
Water	-.0589	.4201	**.2556**	**.0005**	.0125	.8638	.1103	.1312	-.1241	.0895	**.2393**	**.0011**	-.0213	.7706	.0363	.6189	.1090	.1356	**.2256**	**.0020**
Drink	-.0244	.7580	**-.1585**	**.0456**	.0482	.5429	-.0533	.5018	.0094	.9056	**-.1736**	**.0286**	-.0144	.8558	**.2212**	**.0053**	-.1096	.1667	**-.1598**	**.0439**
Laund	-.0376	.4353	-.0489	.3105	.0113	.8150	-.0589	.2217	.0013	.9793	**-.1015**	**.0352**	.0175	.7158	.0902	.0612	-.0138	.7749	.0100	.8352
Fence	-.0388	.6114	.0614	.4220	-.0376	.6230	-.0714	.3503	-.0439	.5663	.0025	.9739	-.0840	.2722	**.2130**	**.0053**	-.0138	.8569	-.0238	.7555
Lime	-.0721	.0726	.0157	.6963	.0420	.2956	-.0771	.0548	-.0583	.1466	.0282	.4824	.0056	.8883	-.0658	.1012	-.0244	.5427	**-.0796**	**.0474**
Garb	.0545	.2585	.0570	.2372	.0445	.3564	.0345	.4750	.0833	.0841	.0294	.5416	-.0132	.7850	**.1034**	**.0321**	-.0219	.6494	-.0558	.2477
Renov	**.1554**	**.0458**	-.0827	.2877	.0752	.3338	-.0865	.2664	**.1554**	**.0458**	-.1115	.1517	.0777	.3179	.0990	.2032	.0001	.9999	.1065	.1709
Herbic	-.0238	.5925	.0627	.1590	-.0414	.3526	.0088	.8437	-.0113	.7999	.0514	.2481	.0001	.9999	-.0088	.8437	-.0025	.9551	-.0100	.8217
StonyMa	-.0351	.4300	-.0238	.5923	.0564	.2047	-.0414	.3523	.0063	.8879	-.0627	.1587	.0564	.2047	-.0288	.5168	-.0050	.9102	-.0677	.1280
Cut	.1128	.1716	**-.2030**	**.0139**	-.1040	.2074	**-.1717**	**.0374**	.1554	.0596	**-.1805**	**.0287**	-.0576	.4847	-.0627	.4475	-.0201	.8080	-.0476	.5638
Fell	-.0445	.4165	**.1134**	**.0383**	.0269	.6227	.0157	.7748	-.0495	.3660	.1034	.0590	-.0620	.2572	-.0044	.9362	.0708	.1960	-.0232	.6720
Graze	-.0871	.1615	.0495	.4262	.0432	.4870	-.0670	.2811	-.0971	.1185	.0257	.6796	-.1159	.0624	-.0056	.9278	.0144	.8168	-.1184	.0569
Fish	.1410	.0793	-.0695	.3866	**-.1761**	**.0284**	.0533	.5073	.0959	.2327	-.0320	.6908	-.0244	.7610	**-.2487**	**.0020**	.0670	.4039	.0883	.2714
Duck	-.0006	.9927	.0107	.8763	-.0069	.9198	-.0808	.2375	-.0508	.4582	-.0345	.6145	-.0144	.8332	.0758	.2678	-.0883	.1966	**-.1848**	**.0069**
Enlarge	-.0890	.1526	.0313	.6145	.1078	.0832	-.0764	.2191	-.1103	.0762	-.0238	.7019	.0063	.9198	.0940	.1308	**.1867**	**.0027**	.0639	.3042
Diminish	.0326	.5278	-.0226	.6620	.0727	.1590	-.0564	.2745	.0238	.6445	-.0263	.6101	-.0251	.6272	-.0338	.5120	-.0376	.4663	-.0338	.5120
Cnd	**.3496**	**.0001**	**.2607**	**.0042**	-.1566	.0852	.0501	.5818	**.2970**	**.0011**	**.2857**	**.0017**	**-.2807**	**.0020**	-.0827	.3635	.1717	.0592	.1516	.0957
pH	**.2193**	**.0160**	.1742	.0556	-.1629	.0734	.0489	.5912	.1429	.1165	.1729	.0574	**-.2419**	**.0079**	-.0890	.3282	**.2231**	**.0142**	.1441	.1133
Alk	**.3427**	**.0002**	**.2450**	**.0071**	-.1711	.0602	.0758	.4049	**.2863**	**.0017**	**.2763**	**.0024**	**-.2462**	**.0068**	-.0746	.4127	.1610	.0769	.1585	.0816
Ca	**.3352**	**.0002**	**.2838**	**.0018**	-.1761	.0531	.0608	.5043	**.2838**	**.0018**	**.3152**	**.0005**	**-.2876**	**.0016**	-.0545	.5492	.1535	.0917	.1259	.1665
Clr	.0257	.7777	-.1372	.1316	**.2249**	**.0134**	.0482	.5960	.0808	.3745	-.1761	.0530	.1560	.0865	.1059	.2446	.0934	.3050	-.0232	.7989
Trb	.1316	.1482	**-.2018**	**.0266**	.0564	.5355	-.0426	.6396	**.1817**	**.0459**	**-.2306**	**.0113**	.0013	.9890	.0188	.8364	-.0664	.4655	-.0138	.8796
PO_4-P	**.3810**	**<.0001**	-.1115	.2187	-.0589	.5160	.1190	.1892	**.4198**	**<.0001**	-.0100	.9120	.0001	.9999	-.1353	.1356	.0301	.7401	.0150	.8683
Part-P	**.2976**	**.0011**	**-.3578**	**.0001**	-.0608	.5042	-.0370	.6846	**.3365**	**.0002**	**-.2563**	**.0049**	.0244	.7883	-.0946	.2985	-.0282	.7567	.0746	.4126
Tot-P	**.3427**	**.0002**	**-.2675**	**.0033**	-.0482	.5958	-.0107	.9068	**.4066**	**<.0001**	-.1523	.0942	-.0157	.8633	-.1247	.1705	.0144	.8741	.0019	.9835
NH_4-N	.0602	.5084	-.0025	.9780	-.0301	.7409	-.0877	.3349	.1353	.1368	-.0125	.8904	-.1115	.2202	.0050	.9561	-.1028	.2586	-.0777	.3930
NO_3-N	-.1523	.0938	**.3690**	**<.0001**	.0069	.9395	-.0695	.4440	**-.2036**	**.0250**	**.2600**	**.0042**	-.1573	.0834	.0144	.8740	.0282	.7563	-.1497	.0993
Part-N	**.2393**	**.0085**	**.2005**	**.0276**	-.1604	.0780	.0777	.3933	.1554	.0878	**.1892**	**.0376**	**-.1892**	**.0376**	-.1053	.2475	**.2218**	**.0148**	-.0238	.7936
Tot-N	**.2744**	**.0026**	**.2494**	**.0061**	-.1742	.0556	.0251	.7830	**.2632**	**.0038**	**.2406**	**.0082**	**-.2155**	**.0179**	-.1579	.0828	.0815	.3708	-.0113	.9014

Median water depth, were included in the model for the first ordination axes. DCA axis 2 showed no significant relationship to any of the variables whereas variation along GNMDS 2 was explained by UTM northing and easting as well as Calcium. GNMDS 3, DCA 3 and DCA 4 were also related to some of the geographical variables and PO_4-P as for the previous axes in addition to Enlarging, Liming, Stony margin and Pond used for drinking.

Generalised linear modelling of the ordination axes for pond margins also indicated relationships to many groups of explanatory variables (Tab. 10). Water chemical variables like PO_4-P, Conductivity, Colour and Calcium in addition to geographical variables like Distance to forest, UTM northing and easting, and Average pond margin width were included in various combinations in the modelling of all four DCA axes as well as GNMDS axes Nos 1, 2 and 3.

Variation partitioning

By forward selection of constraining variables prior to variation partitioning by CCA, all six groups of variables for ponds contained at least one significant variable, whereas none of the variables from the area group were significant for pond margins. The variation partitioning results (App. 6 for ponds and App. 7 for pond margins) were based on the following criteria for the two data sets; (1) The AVE-threshold limit for the pond and pond margin data set were 32.49 IU (inertia units) and 53 IU, respectively (Appendices 8 and 9, respectively). (2) The $\alpha = 0.05$ criterion specified a threshold VE of 183.69 IU for the pond data set and 102.22 IU for the pond margin data set (Appendices 10 and 11, respectively). The total variation explained was 23.9% of the total inertia for the ponds (TVE = 2047 IU; TI = 8579) and 34.8% for the pond margins (TVE = 1643; TI = 4727), respectively.

Seven unique components of variation in the pond data set were larger than AVE and thereby retained, six of which were the first-order components and the seventh was the second order intersection of geographical and anthropogenic impact variables. By using the $\alpha = 0.05$ criterion only the six first-order components from the pond data set were retained (Tab. 11). No more than six unique components from the pond margin data set were larger than AVE. By distribution six components were retained, all five first-order components in addition to the second-order intersection of geographical and water chemical variables. As for the pond data set only the five first-order components were retained by using the more strict $\alpha = 0.05$ criterion (Tab. 11).

Table 10. GLM of DCA and GNMDS ordination axes for both data sets showing significant ($P< 0.05$) models of explanatory variables.

Axis	Pond	F	P	Pond margin	F	P
DCA1	PO-P	31.35904	<.0001	DistForest	63.41802	<.0001
	+ Alk	8.95050	.0042	+ PO_4-P	28.43666	<.0001
				+ Cnd	13.98325	.0005
				+ DistForest: Cnd	10.53377	.0021
				+ PO-P: Cnd	5.01162	.0296
DCA2	None			UTMn	51.88782	<.0001
				+ Cnd	14.57182	.0004
				+ UTMe	7.42330	.0087
DCA3	UTMe	27.37298	<.0001	Clr	11.68726	.0012
	+ StonyMarg	9.11799	.0004	+ DistForest	5.24967	.0258
	+ PO_4-P	7.70776	.0076			
DCA4	UTMn	15.78737	.0002	UTMe	14.47283	.0004
	+ Enlarge	8.29814	.0008			
	+ Drink	4.54053	.0068			
GNMDS1	PO-P	59.68259	<.0001	PO_4-P	51.41958	<.0001
	+ Alk	12.83029	.0007	+ DistForest	20.49779	<.0001
	+ MedDep	5.11469	.0278	+ Cnd	12.48226	.0009
				+ Cnd: DistForest	11.61536	.0013
GNMDS2	Ca	22.93974	<.0001	Ca	19.55354	<.0001
	+ UTMe	7.58700	.0080	+ DistForest	15.39039	.0003
	+ UTMn	7.80403	.0072	+ AvgWid	4.91979	.0309
GNMDS3	UTMe	24.46130	<.0001	Ca	11.78041	.0012
	+ Lime	11.71481	<.0001	+ UTMe	10.76866	.0018
	+ Enlarge	5.22844	.0087			
	+ UTMn	5.31839	.0253			
GNMDS4	Laund	7.589080	.0080	Fish	7.655668	.0013
	+ Diminish	5.138382	.0091	+ Fence	6.309640	.0036
				+ Fish: Fence	3.605185	.0345
GNMDS5	Age	12.49058	.0008	MArea	20.75501	<.0001
				+ Alt	13.38697	.0006
				+ Enlarge	8.12509	.0009
				+ MaxSlp	5.27619	.0257
GNMDS6	MedDep	7.313945	.0092	Lime	6.769188	.0025
	+ Enlarge	3.705343	.0311	+ Drink	4.411008	.0079
				+Lime: Drink	5.752215	.0202

Table 11. Results showing simplification of variation partitioning using the $\alpha = 0.05$ criterion for both data sets.

Ponds		Pond margins	
Unique component	FTVE	Unique component	FTVE
Area	.0884	Year	.0626
Hydrological variables	.0884	Geographical variables	.2654
Year	.1006	Water chemical variables	.2015
Geographical variables	.1793	Topographical variables	.2033
Anthropological impacts	.2482	Anthropological impacts	.2696
Water chemical variables	.3004		

Spatial structure

The semi-variance increased as a function of lag distance for most continuous variables, at least in some distance intervals (Tab. 12). Nevertheless it was difficult to find distinct patterns of spatial structure of the explanatory variables.

Most variables were spatially structured in the first lag class; up to range 3000 m. This was an indication of self-similarity of variables for ponds and pond margins located in close proximity, e.g. which lie within the same 1 km^2 plot. A few variables, e.g. Altitude, Distance to built-up area and pH, showed spatial structure at all scales without range. Some variables were spatially structured up to the range 5-10(-20) km, as exemplified by Pond area, Distance to water, Soil depth variables, Secchi depth and some of the water chemical variables. This range indicates local differences between study sites at the scale of parishes or municipalities.

DCA 1 axes for both data sets had irregular patterns of variation in semivariance, but were strongly spatially structured at least in the two first lag classes. DCA 2 of the pond data set also showed strong spatial structuring up to about 10 km, whereas patterns of spatial structure were not apparent for subsequent axes. This is also shown for the pond margins where DCA axes 2–4 were possibly spatially structured within the first lag classes.

Relationships between species richness and environmental variables

Species richness

A total of 104 different species were found in the 64 ponds and 301 species were found in the adjacent pond margins. The maximum number of species found in one pond was 20, the minimum number was 1 and the median number was 9. For the pond margins the corresponding figures were 81, 13 and 44.5, respectively (Figs 15 and 16). Number of species in ponds and number of species in pond margins were correlated at the $P < 0.05$ level ($\tau = 0.1974$, $P = 0.0205$). This result indicated a relatively weak correlation. Two very different coenoclines could be seen in the data set and this may be a reason why species richness was not strongly correlated between ponds and pond margins.

Table 12. Standardised semivariance for the total set of continuant explanatory variables.

Variable	Lag class (No., upper bound (m) and no. of observation pairs.)							Comments on spatial dependence in lag classes
	1	2	3	4	5	6	7	
	3000	6000	12000	24000	48000	96000	192000	
	62	30	86	269	641	273	654	
PArea	0.489	0.656	1.047	0.865	1.016	0.809	1.177	Possible range 3
MArea	0.455	1.102	0.768	0.800	0.935	0.726	1.339	Strong to possible range 2
AvgWid	0.859	1.107	0.741	0.737	0.880	0.935	0.726	Possible range 2
MaxDep	0.567	1.192	1.498	1.081	0.919	0.771	1.108	Irregular, possible range 2
MedDep	0.750	0.773	1.488	1.157	0.967	0.769	1.034	Irregular
Altitude	0.006	0.112	0.118	0.230	0.809	0.835	1.816	All scales
DistWat	0.264	0.689	0.940	0.820	1.035	1.151	1.070	Range 3, maybe 6
DistRoad	1.109	0.886	1.063	0.903	0.887	0.943	1.158	None
DistAgr	0.303	1.118	0.926	1.172	0.923	1.236	0.977	Strong to range 2, irregular at broader scales
DistBui	0.578	0.820	0.841	0.916	0.994	1.073	1.077	Range 2, weaker to poss. range 7
DistForest	0.458	1.231	0.968	0.908	1.018	0.922	1.100	Strong to possible range 2
Age	0.260	0.923	0.732	0.806	0.664	0.922	1.552	Strong to range 2, possible weaker to range 5 or 7
MaxSlp	0.816	0.708	0.968	0.896	1.109	0.801	1.055	Irregular
MinSlp	1.330	1.247	0.806	0.915	0.959	0.796	1.144	Irregular, possible between 6 and 7
MaxSoil	0.125	0.730	0.929	0.824	1.172	1.342	0.865	Strong to range 2, possible range 6
MedSoil	0.210	0.540	0.825	0.889	0.974	1.353	1.040	Possible range 6
MinSoil	0.308	0.286	0.723	0.808	1.006	1.568	0.963	Possible range 6
Secchi	0.341	0.792	0.900	0.887	0.706	0.982	1.427	Possible range 2 or 3 and between 5 and 7
Cnd	0.181	0.922	0.825	0.861	0.973	0.777	1.282	Irregular, possible range 2 or 3
pH	0.341	0.649	0.685	0.732	0.881	1.187	1.270	Possible range 7
Alk	0.535	0.593	0.683	0.865	0.956	0.808	1.284	Range 5 or 7
Ca	0.173	0.770	0.759	0.822	0.874	0.734	1.430	Strong to range 2, weaker to range 5, maybe 7
Clr	0.496	0.581	0.858	0.816	0.813	1.151	1.282	Possible range 2 or 3
Trb	0.268	0.974	0.974	0.819	0.756	0.824	1.461	Irregular, possible range 2
PO$_4$-P	0.239	0.816	0.636	0.760	1.059	0.834	1.239	Irregular, possible range 2
Part-P	0.378	0.655	0.531	0.596	0.635	0.845	1.726	Range 2, possibly weaker to range 6, maybe 7
Tot-P	0.253	0.695	0.460	0.556	0.805	0.891	1.576	Possible range 2, possibly weaker to range 6, maybe 7
NH$_3$-N	2.029	0.593	0.735	0.938	1.233	0.800	0.833	No < 2, spatial dep. between 2 and 5
NO$_3$-N	0.394	0.452	0.478	0.547	0.493	1.581	1.593	Weak to range 4
Part-N	1.123	0.612	0.558	0.737	0.924	0.911	1.281	Irregular, possible between 3 and 5
Tot-N	0.346	0.665	0.593	0.877	1.113	0.948	1.093	Possible range 5
DCA1 (P)	0.427	3.071	1.311	1.341	1.172	0.648	0.758	Irregular, very strong to possible range 2
DCA2 (P)	0.177	0.734	0.860	0.697	0.830	1.167	1.330	Strong to range 2, maybe spatial dep. in subsequent lag classes
DCA3 (P)	0.695	0.898	0.708	0.763	0.848	1.662	1.043	Possible in the two first classes
DCA4 (P)	0.587	0.729	0.526	0.667	0.676	1.350	1.417	Possible in the two first classes
DCA1 (M)	0.218	1.379	0.819	1.022	1.072	0.806	1.079	Irregular, strong to possible range 2
DCA2 (M)	0.314	0.755	0.473	0.541	0.763	0.789	1.656	Range 2, possible spatial dep. in subsequent lag classes
DCA3 (M)	0.641	0.777	1.165	0.771	0.944	1.177	1.098	Range 2, maybe 3
DCA4 (M)	0.493	0.744	0.518	0.848	1.022	1.421	0.990	Range 2, possible between 3 and 6

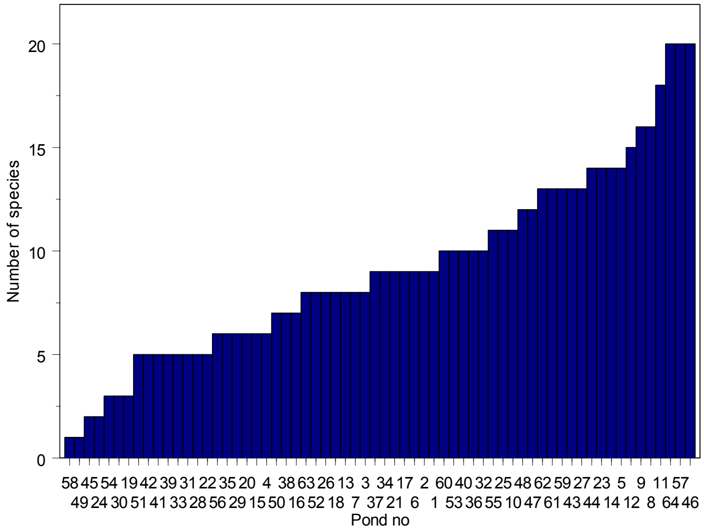

Figure 15. Number of species found in 64 ponds.

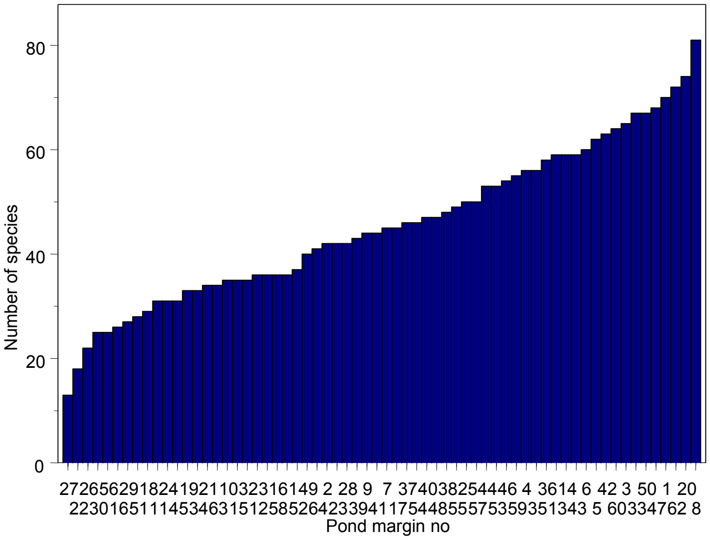

Figure 16. Number of species found in 64 pond margins.

Correlation

Correlations between species richness (species number) and explanatory variables are shown in Appendix 12. Only some water chemical variables, Periodically drained and Liming were significantly related to pond species number (Tab. 13). Area, Average width, UTM easting, Enlarging and some water chemical variables were correlated with the number of species in pond margins (Tab. 13).

Table 13. Kendall's correlation coefficient with P-values between number of species surveyed in each sampling unit (both ponds and pond margins) and significant ($P<0.05$) explanatory variables.

Ponds			Pond margins		
Exp. var.	τ	P	Exp. var.	τ	P
Tot-N	-.2485	.0036	MArea	.3933	<.0001
NH_3-N	-.2123	.0127	Part-P	-.2629	.0021
Alk	-.2004	.0188	Tot-P	-.2440	.0043
Drain	-.1295	.0249	AvgWid	.2197	.0100
Cnd	-.1786	.0362	Enlarge	.1383	.0167
Lime	-.0823	.0374	Trb	-.2008	.0189
pH	-.1677	.0492	UTMe	-.2004	.0192
			NO_3-N	.1889	.0269
			PO_4-P	-.1726	.0430

Multiple regression

The generalised linear modelling indicated four significant explanatory variables for the species abundance in the 64 ponds; all of them belonged to the water chemical variables (Tab. 14). No main effects or significant interactions could be combined among them. The best simplified model therefore only included one variable: Total-N (Tab. 15).

For the 64 pond margins ten individual significant variables were found; four of them in the water chemistry group, two from each of geography, anthropological impacts and the area group (Tab. 14). The best model found was MArea + Average width + Distance to forest + Enlarging (Tab. 15).

Table 14. Significant variables ($P<0.05$) in the generalised linear modelling of species abundance in ponds and pond margins.

Ponds			Pond margins		
Exp. var.	F	P	Exp. var.	F	P
Tot-N	8.111440	.0059	MArea	32.483700	<.0001
NH_3-N	7.372288	.0085	Part-P	9.595660	.0029
Alk	5.398005	.0234	Tot-P	7.986896	.0063
Cnd	3.998036	.0499	AvgWid	7.837792	.0068
			Enlarge	4.942926	.0102
			Trb	6.041321	.0167
			DistForest	5.579646	.0213
			UTMe	5.526427	.0219
			PO_4-P	4.488497	.0381
			Water	2.772936	.0491

Table 15. ANOVA-table showing simplified general linear models of numbers of species surveyed in each sample plot as a response to significant ($P < 0.05$) explanatory variables.

Ponds			Pond margins		
Exp. var.	F	P	Exp. var.	F	P
Tot-N	8.11144	.0059	MArea	43.45390	<.0001
			+ AvgWid	10.77911	.0017
			+ DistForest	6.92824	.0108
			+ Enlarge	3.56513	.0346

7 Discussion

Evaluation of ordination methods

Pairwise correlations between axes obtained by the two different ordination methods show that most of the corresponding DCA- and GNMDS-axes were strongly significantly related, but not all of them. None of these methods are considered optimal (R. Økland 1990a) and in this present study they were applied in parallel to ensure that true patterns of variation in vegetation were found. The conclusion that a consistent gradient structure has been identified does at least apply to the interpreted main gradient as well as the second gradient for pond margins, due to concordance of pairs of axes by the ordination methods used in parallel.

The plots' positions are considered to be more uncertain in (G)NMDS than in DCA because the relationship between floristic dissimilarity and ecological distance (which is the basis for NMDS ordination) is poor for small distances (R. Økland 1990a). In the present study DCA ordination axes have longer core lengths than GNMDS axes. This implies a stronger influence of outliers on the GNMDS ordination, indicating an inferior representation of gradient structure here. DCA has therefore been given more weight although the results obtained by both ordination methods have been reported throughout this study. Studies using DCA for ordination of field data often conclude that this method is well suited for extraction of ecologically interpretable axes (see R. Økland 1990a). Minchin (1987) and other authors (Peet *et al.* 1988) do, on the other hand, recommend NMDS. In the present study of SE Norwegian ponds GNMDS showed more correlations with external variables than did DCA, as also showed by e.g. Pitkänen (1997, 2000). Furthermore, in the present study no tendency for either DCA or GNMDS to show higher significance levels of correlations were found, which may indicate that environmental interpretability is not necessarily stronger for either ordination method.

The overall structure of DCA- and GNMDS-plots is more or less the same although a trumpet-shape (tongue-shape distortion by Minchin (1987)) could be seen in the pond margin data set when using DCA. This shape is due to the flattening of variation along the second axis. Sample plots have been well separated near the end of the major gradient whereas distinct aggregation of objects can be seen near the opposite end of this gradient. This tongue effect is one of the shortcomings of DCA (R. Økland 1990b). The distortion normally appears because in the detrending procedure the mean plot scores of all segments along the first axis are set equal to the general mean score along the second axis.

Interpretation of variation in vegetation

All ecosystems are dynamic and the rate of fluctuation or change varies through time, in accordance with natural and human-induced changes in the environmental conditions. Small ponds tend to constitute a less permanent environment than larger ones; they may show greater fluctuations in physical and chemical conditions and, in effect, represent several types of habitats over short time intervals (Friday 1987). It is expected that aquatic vascular plants will respond to the particular environmental conditions of a pond, both because they are rooted in the bottom sediments and because they are impacted by the water surrounding them.

The water chemical variables derived from pond water samples were also used for interpretations of variation in pond margin vegetation. This was based on the assumption that the soil chemistry in the pond margins would not differ much from that of the adjacent pond water. Moreover, nutrients in pond water are mainly determined by bedrock type, vegetation type, size and human activities in the catchment area (Brønmark & Hansson 1998).

The main gradient for ponds and pond margins

The ordination of the combined data set showing two distinct groups of plots, indicates that the species composition of ponds and pond margins are very distinctive, i.e. the existence of different major coenoclines for the ponds and the pond margins (see Fig. 6). Nevertheless, the strong pair-wise correlations between all first ordination axes (DCA and GNMDS) for both ponds and pond margins (see Tabs 6 and 7) shows that the main compositional gradients for ponds and pond margins are parallel in the sense that they are related to the same, consistently main, complex-gradient.

The main coenoclines for both pond and pond margin are related to a complex-gradient including UTM northing, altitude, distance to forest, pond age and water chemical variables. This is apparent from correlations between the first axis for both ordination methods and explanatory variables, regardless of data set. Most of these variables also make up one of the largest groups of strongly intercorrelated variables, although they did not segregate into separate groups in the PCA. Water depth variables were also correlated with the first ordination axes for the ponds whereas soil depth variables were correlated for the pond margins. These two variable groups were not included in both explanatory variable sets because they were only supposed to affect the species composition in either pond or pond margin.

GLM analyses revealed that water depth, alkalinity and PO_4-P contributed to explain DCA 1 and GNMDS 1, supporting the correlation results of both DCA and GNMDS axes for the ponds. Distance to forest, conductivity and PO_4-P were included when modelling pond margins. The similarity of selected variables with results of correlation analyses unequivocally supports that there is one strong complex gradient underlying the observed coenoclines.

Water chemical variables

A number of studies have stressed the importance of local environmental conditions like water chemistry in determining the species composition in (small) lakes (Arts *et al.* 1990; Rørslett 1991; Palmer *et al.* 1992, 1994; Srivastava *et al.* 1995; Toivonen & Huttunen 1995; Preston 1995; Vestergaard & Sand-Jensen 2000ab; Heegaard *et al.* 2001). In addition to the correlation analyses between explanatory variables and ordination axes, the variation partitioning results support this result showing that water chemical variables made the largest contributions to explained variation in the set of 64 ponds. This group of variables was also found to be important for the pond margins although the variation explained here was less.

Many of the water chemical variables were strongly intercorrelated. Water pH is important for plants because it determines the available form of nitrogen and phosphorus (Roelofs *et al.* 1984). It is shown that pH can promote phosphorus release into the water (Brønmark & Hansson 1998). Ponds are also expected to show regional differences in pH due to differences in geology and hydrology of the catchment area (Brønmark & Hansson 1998). This is shown e.g. by pond Nos 1, 40 and 42, with pH >7.8. These ponds lie in an area with lime-rich bedrock.

Vestergaard & Sand-Jensen (2000a) showed that alkalinity was a main determinant of the plant species distribution among Danish lakes, as also supported by the results presented in this study. Alkalinity is furthermore largely determined by the bicarbonate content which is an important source of inorganic carbon for the photosynthesis and growth of many submerged plants (Madsen & Sand-Jensen 1991) and is therefore likely to contribute to explain some of the variation in species composition. Srivastava *et al.* (1995) concluded that alkalinity and total amounts of nitrogen and phosphorus were strongly correlated with differences in vegetation in Nova Scotian ponds. Nutrient enrichment by nitrogen and phosphorus is also found to have induced changes in Dutch macrophyte vegetation (Arts *et al.* 1990). Nitrogen has been claimed generally not to be the main limiting nutrient for organisms in freshwaters because its concentration in water is less strongly correlated to trophic state than that of phosphorus (Brønmark & Hansson 1998), while Venterink *et al*. (2001) in a review found that nitrogen was the most frequent limiting nutrient in herbaceous wetlands. My results showed that both nitrogen and phosphorus were strongly correlated with the first ordination axes, although the variables including phosphorus did somewhat reveal higher correlation coefficients. The PO_4-P selected by GLM of axes 1 of both ordination methods and both data sets is the only inorganic fraction of phosphorus of importance for plants (Brønmark & Hansson 1998).

Water chemical variables can be related to eutrophication, and changes in vegetation caused by eutrophication are well documented (Arts *et al*. 1990; Arts 2002). Eutrophication in rural areas is often caused by fertilisers and animal stocking (cf. Friday 1987; Heegaard *et al*. 2001). For some reason, the presence of cattle (in addition to ducks and fish) and distance to agricultural area were overall not significantly correlated with water chemical variables in my study, indicating that the nutrient content of the studied ponds is not necessarily in general determined by fertiliser input by (domestic) animals.

Grazing and trampling by cattle could furthermore be expected to influence species composition, e.g. by creating open space for regeneration (Grubb 1977), but this variable did not seem to contribute to explain any variation in vegetation in my data. A possible reason for this lack of relationship might be relatively few ponds were influenced by cattle grazing in my material, a now typical situation in Norway (Bye *et al*. 2003).

Geographical variables

Altitude and UTM northing are strongly positively correlated and may influence species composition due to an indirect effect on temperature and longer growth season in lowland areas (Pedersen 1990; Dahl 1998). UTM northing and altitude were also strongly negatively correlated with many of the water chemical variables, indicating that pond trophy declined along the south-north and altitudinal gradients in the present study. These geographical variables should also be seen in context with geology, a factor that is not directly related to geographical gradients. Furthermore, lowland areas in SE Norway generally consist of silts and clays of marine origin, which are remains from the marine border past the last glacial period (Weichsel). The upper level of the post-Weichselian sea is at about 200 m in SE Norway (Undås 1952). Jeffries (1998) found that geographical variables like UTM northing and altitude were some of the most important variables linking pond types and environmental variables in ordination; also supported by my results. Furthermore Jeffries suggested that the geographical variables could act as surrogates for many of the chemical factors, as also proposed by Heegaard *et al*. (2001) who could not distinguish the effects of chemical and climatic (altitude) factors. This inter-relationship between variables is also seen in this present study. In variation partitioning water chemical variables did explain a larger part of variation compared to geographical variables for the pond data set, whereas the pond margins showed the opposite result, indicating that both groups of variables are important.

The variation partitioning showed a slight indication of covariance (shared variation) among groups of water chemistry and geographical variables for the pond margins (only present when using the less strict AVE criterion). When using the AVE threshold for distribution of variation among ponds, geographical variables were retained together with anthropological impact variables. They did anyhow explain a rather small amount of variation. Furthermore, this interaction did not appear when using the stricter $\alpha = 0.05$ criterion and should therefore not be given too much weight. This may indicate that geographic variables have a unique influence on species composition of ponds and pond margins, via climatic variables or other, unmeasured environmental factors.

Distance to forest was negatively correlated with altitude. This may simply be due to the fact that lowland areas support more arable land which normally will be used for agricultural purposes. Forests along a pond's edge may influence on the species composition because available light might be significantly reduced (Rea *et al*. 1998). Shading may reduce water temperatures so much that the habitat becomes suboptimal for several aquatic species (Anonymous 1994a; Heino 2002). Furthermore, the total amount of nitrogen has been shown to reach much higher levels in ponds exposed to sunlight than in shaded ponds (Vasey 1994). However, the total amount of nitrogen and distance to forest were not correlated in the study presented here and these variables are therefore more likely to vary independently along the main gradient. On the other hand, if a pond is (partly) surrounded by forest, new habitats will be added and species composition may change.

Historical features

Pond age was positively correlated with the first ordination axes although it did not contribute much to the variation explained according to variation partitioning results. Gee *et al*. (1997) found the aquatic vegetation biomass to increase with pond age. Natural succession should also be considered when the age of the ponds is discussed. The natural fate of all bodies of standing fresh water is to be filled and gradually to change into a terrestrial habitat (Gee *et al*. 1997). This natural succession can be reversed by pond restoration but all pond successional stages have their own distinctive species composition and thereby a distinctive conservation value (Biggs *et al*. 1994). Renovation of ponds causes an immediate change in vegetation both in the ponds and the adjacent pond margins and may therefore contribute to explain variation along the gradient, as seen by the correlations with DCA 1 and GNMDS 1 for pond margins, although not strong. The species composition in the ponds did anyhow not show any relationship with time since last renovation. This is in accordance with field observations; relatively small ponds were generally rather densely covered with plants (and algae) regardless of time since last pond renovation, indicating rapid successions.

Newly created ponds (low pond age) are usually large and used for watering purposes, as seen by the correlations in this study. Furthermore, watering implies fluctuating water levels. The possibility that pond age is an underlying factor that represents fluctuating water levels, should therefore be considered. However, only a negative relationship between pond age and pond used for watering was found, and neither of them were correlated with fluctuation, thus leading to a rejection of the hypothesis that the factor underlying relationships with pond age is water level fluctuations. Furthermore pond age was correlated with many of the water chemistry variables, but the variation partitioning showed no shared variation among these variable groups.

Hydrological variables

Studies in British ponds by Jeffries (1998), US ponds by Rea *et al*. (1998) and Norwegian lakes by Rørslett (1984) showed high importance of water depth on the distribution of aquatic macrophytes, supporting the results found in this study. As the area of deeper water increases, the range of suitable habitats may increase. A variety of pond bottom microtopographies might contribute to a varied species composition. However, Vestergaard & Sand-Jensen (2000a) found that mean and maximum water depth only explained a relatively small part of the variation in species composition. This is also the case for the variation partitioning in this present study where hydrological variables only contributed slightly to the variation explained. Own field observations accord with the proposal that maximum and median water depth as important factors contributing to explain variation in species composition should be rejected. Very few submerged species were found to grow in deeper waters, species were mostly observed along the margin (shallow water depth). This observation is most likely due to constrained light intensity (see below) and/or light quality, because except for shallow regions, the amount of light reaching the sediment is generally low (Brønmark & Hansson 1998). However, some ponds possessed high water transparency, and yet no vegetation could be observed on the bottom. This may be caused by unsuitable bottom sediments (Sculthorpe

1967), too short establishing time (indirectly caused by factors like low pond age, fluctuating water levels or pond renovation) or due to random change (see below).

Some plants rely on deeper water to grow, e.g. because of zonation and growth form. The importance of water depth should however be seen in relation to the influence of fluctuating water and Secchi-depth; the effect of differences in water transparency depends on lake morphometry like water depth. The vertical niche of certain species can be displaced towards deeper water due to water level changes (Rørslett 1984).

Water physical variables

A pond's macrovegetation may be restricted by light penetration as expressed by Secchi depth. Secchi depth was correlated with GNMDS1 for the ponds in addition to many of the water chemistry variables. The strong relationship between these physico-chemical variables can be explained by the fact that Secchi depth is assumed to be reduced in parallel with eutrophication (J. Økland 1975), as also shown by Vestergaard & Sand-Jensen (2000b). A strong correlation between Secchi depth and the concentration of phosphorus can be seen in the present study. High concentrations of phosphorus in pond water can result in increased densities of phytoplankton and epiphytes, which will further reduce available light (Roelofs *et al*. 1984).

A strong correlation between Secchi depth and turbidity was found in this study. Water table fluctuations can, in principle, alter turbidity and Secchi depth which furthermore changes the light quality and certain pond species may be favoured. However, correlation between fluctuating water level and Secchi depth and turbidity was not found in this present study.

Topographical variables

Soil depth was positively correlated with the first axis for pond margins. It was furthermore negatively correlated with UTM northing and altitude in addition to showing a positive relationship with many of the water chemical variables. Variation partitioning did anyhow not show any covariance between these groups. Species composition may shift due to variation in soil depth because plant species hold individual requirements. In my study of pond margins minimum and median soil depth should, however, be considered deep enough for plant species in general to be able to establish there, thus an explanation of why these explanatory variables were related to species composition is less obvious.

Anthropological impacts

Influence by human use and management may alter the species composition in many ways. Garbage was positively correlated with GNMDS 1 for the ponds. Garbage can act as pollutants or it can cover the bottom and thereby limit plant growth and alter the species composition. Moreover the pond's relatively low water volume can make the ponds highly susceptible to pollution (Williams *et al*. 1998).

A lake's plant species distribution may, in principle, be determined by competitive interactions involving fish (Spence 1967). The presence of fish stirring the hydrosoil may increase turbidity and thereby decrease light (Mitchell 1974). The presence of fish did anyhow not seem to contribute to the main gradient in my study. About half of the ponds still harbour or have harboured fish, according to information from the properties' owners. This observation could anyhow not be confirmed during field work. It is therefore likely that fish may have gone extinct in many ponds during the past year(s), and that my Fish variable does not adequately represent current presence of fish. Furthermore, fish population density, species, feeding habit, etc. should be taken into consideration, when relationships with plant species composition are discussed. This has, however, not been recorded in the present study.

From the results of this study we can conclude that geographical and water chemical variables are the most important predictors of variation in species composition along the main gradient in ponds and pond margins. This is supported by variation partitioning results, correlation analyses as well as generalised linear modelling.

The second gradient for ponds

Correlation analyses between DCA axis 2 and environmental variables showed only one significant correlation, whereas its correlated GNMDS axis 6 was significantly correlated with few variables. None of the explanatory variables were selected in the GLM of DCA 2. This indicates a very weak relationship between these ordination axes and species composition, and suggests that no strong second gradient existed in pond vegetation in the present study.

The second gradient for pond margins

Anthropological variables

Anthropological impact variables were the group with the highest variation explained in the variation partitioning of pond margins. Cutting, tree felling and pond used for watering were correlated with the second ordination axes. Cutting represents a kind of disturbance that may create a distinctive vegetation, e.g. by creating gaps which may be recolonised. This may also be the case for Ponds used for watering, a variable which was included in the GLM for the second gradient for pond margins. Water level changes and the effect of drying out may contribute to explanation of variation in species composition, as proposed by Jeffries (1998). Watering causes fluctuating water levels and thereby indirectly brings about stress and/or disturbance because the environment changes due to fluctuation. Fluctuating water levels may also create new habitats, as proposed by Spence (1967), and this will be further discussed in relation to species richness (see below). Fluctuation and Periodically drained were not included as variables in the pond margin data set because they were primarily considered to affect species composition in ponds. It is, however, obvious that watering and drying out imply fluctuating water levels, and fluctuation will thus be discussed in relation to species composition in pond margins as well.

Water chemical variables

Calcium, part-P and NO_3-N were strongly correlated with the second ordination axes. Plant compositional change is likely to occur when nutrients are added, by decreasing number of species (Kleijn & Snoeijing 1997). On the other hand Venterink *et al*. (2001) observed that wet meadows were found to be growth-(co-)limited by nutrients like nitrogen and phosphorus. Changes in species composition is likely to take place because plant species will be affected by increased productivity and hence by increased availability of limiting nutrients in different ways and at different intensities.

In addition to many of the water chemical variables, distance to built-up area was positively correlated with the second ordination axes for pond margins. Phosphorus did anyhow show a negatively correlation. An association between nutrients and distance to built-up area is also shown by studies of Finnish aquatic macrophytes where eutrophic ponds tended to be surrounded by settlements (Toivonen & Huttunen 1995).

Geographical variables

Variation partitioning show that geographical variables explained nearly as much of the variation in species composition as did anthropological impacts. Distance to forest, UTM northing and UTM easting were included in the GLM of the second ordination axes and found significant in correlation analyses. These variables were related to the main gradient as well, indicating complex relationships of both of the main coenoclines in pond margins to broad-scale regional factors.

Area

The average width of the ponds was positively correlated with both ordination axes. This variable is directly related to area, but area was somehow not selected in variation partitioning neither did it show any correlations with DCA 2 or GNMDS 2. However, in this study, area influences the number of species and will therefore be further discussed in relation to the species richness (see below).

Spatial structure

Most environmental variables were spatially structured on the local scale of communities or parishes (< 6 km). These variables may, however, be related to finer scales but this could not be detected in the present study, because pond pairs separated by 1–3 km were avoided due to the sampling strategy; 62 observation pairs between ponds were located within a distance of 3 km and furthermore only 30 observation pairs within a distance of 3 and 6 km.

Nevertheless, my results suggest that ponds are highly individualistic habitats where species composition and species richness even differ between ponds of relatively similar environments within a small geographical area, as seen when comparing sites located in the same 1 km^2 plot. The ponds seemed to differ more in species composition than did the pond margins. Thus, ponds Nos 47–55 located only a few meters apart, have more or less similar use and management histories and rather similar water chemistry, but nevertheless they have rather dissimilar species composition and species richness. This is also to some extent shown for the other pond pairs located within 1 km^2. This outcome suggests that plant distribution is decided not only by environmental variables like water quality, surrounding area, historical use, etc., but also by other factors such as species dispersal, plant life history traits related to colonisation and extinction and, perhaps also, interactions between individuals. On the other hand waterbodies such as ponds often have small catchment areas and can, as result, have individual physico-chemical characteristics that vary highly between ponds depending on e.g. local geology and land use (Williams *et al*. 2003). Chemical conditions in neighbouring ponds may thus differ considerably, and contribute to increase the distance between suitable habitats for the species and add to dispersal limitations. Thus, ponds Nos 17 and 18, located only a few hundred meters apart, showed a rather different species composition (see Fig. 11). These ponds also differed considerably in water chemistry (e.g. pH = 6.1 and 6.8, alkalinity = 635 and 3385 μeqv/L and total-N = 1.4 and 3.4 mg/L, respectively; App. 4).

The theory of island biogeography predicts that the number of species decreases with the degree of isolation (MacArthur & Wilson 1967). However, distance to the nearest stagnant water contributed neither to species composition nor to species richness in the present study, in accordance with Gee *et al*. (1997). An explanation for this might be that neighbouring ponds does not necessarily have the same origin or have undergone the same historical changes of use and management. Furthermore, Brose (2001) found that the longevity of seed banks of wetland species was high compared to other plant communities and might therefore counteract the effects of isolation. Linton & Goulder (2003) suggest that ponds contain both a baseline number of taxa representing long-distance migrations/introductions and a number of species which have come from neighbouring water bodies.

A more thorough analysis of species distribution due to their life history traits might clarify the extent to which factors other than the environmental variables already measured may contribute to explain variation in species composition in ponds in the agricultural landscape.

Relationships between species richness and environmental variables

The environmental factors influencing variation in species composition (coenocline) along a gradient will also to some extent influence species richness because the species composition indirectly contributes to the species richness.

The number of species observed in each pond or pond margin varied a lot. This may be due to several reasons. One explanation applicable for the ponds could be the inventorying strategy; species may have been overlooked while using the grapnel and the rake. Importance of these factors do, however, rest on the assumption that species were growing in deeper water, from the water's edge in large ponds, which could not be reached with the grapnel or rake, a proposal which has earlier been rejected. I therefore consider the recorded species richness figures to be reasonably accurate.

Ponds

Correlation analyses and multiple regression mainly showed the same results for ponds. Some water chemical variables in addition to Periodically drained and Liming of the ponds, were correlated with number of species, whereas the GLM only included variables related to water chemistry. The simplified GLM included only Total-N, a variable which had the largest τ with species richness of all included variables and explained the largest part of species richness although this amount was nevertheless rather small.

Water chemical variables

Results presented here support the hypothesis that pond trophy and conductivity are significant, although only some of the water chemistry variables and not phosphorus did explain variation in species richness. Vestergaard & Sand-Jensen (2000b) also showed that species richness declined with increasing concentrations of total nitrogen, thus supporting my results. On the other hand Jones *et al*. (2003) reported that species richness was correlated with neither total phosphorus nor with nitrogen. NH_3-N is selected in both correlation analyses as well as the multiple regression in this study of ponds. Nitrate is stated to be the dominant inorganic form of nitrogen in soft waters in European countries (Lükewille *et al*. 1997), making ammonium-nitrogen limiting. Somehow such an outcome was not very clear in this study of SE Norwegian ponds in the agricultural landscape. In general, the amount of NH_3-N was clearly higher than NO_3-N in this study, with only a few exceptions. Nevertheless nitrate has to be reduced to ammonium before it can be assimilated in the cell, making NH_3-N the most favourable nitrogen source (Brønmark & Hansson 1998).

pH is proposed to be one of the principal determinants of macrophyte richness in lakes (Iversen 1929; Rørslett 1991). Jeffries (1998) suggested that species richness increased with increasing pH, as opposed to the results found in this study and by Gee *et al*. (1997). Water pH is anyhow correlated with alkalinity in addition to other factors related to trophic status. Vestergaard & Sand-Jensen (2000b) and Jones *et al*. (2003) found that species richness increased with alkalinity, as opposed to the present study here which suggests a decline in species richness. Shimoda (1997) showed that species distribution was related to pond environment, especially to catchment area characteristics and water quality; species rich ponds were restricted to nutrient-poor waters with low conductivity.

A reason why a positive relationship between species richness and pond trophy has been recorded in some studies whereas a negative relationship is recorded in others, may be that the relationship, over a broad gradient of pond trophy, is hump-shaped; first increasing at low productivities while decreasing for high productivities (e.g. Grime 1973, 1979; Huston 1979; Tilman 1982). Mittelbach *et al*. (2001), in a review found that such hump-shaped relationships were particularly common in aquatic systems but that they occurred for terrestrial plants as well. This may be due the fact that ponds are relatively closed systems less subject to source-sink dynamics than other ecosystems.

The relationship between plant species richness and pond trophy found in this study may be explained as a part of a hump-shaped relationship over a broader pond trophy gradient. A species may respond positively to a given factor at relatively low levels of the factor. This may be due to e.g. nutrient constraints when the concentration of nutrients is limited. At high nutrient levels the concentrations may become supraoptimal and thereby make fewer locally available species succeed (Taylor *et al*. 1990). A toxic effect may arise and the species number starts to decline. This is likely to be the case in the present study.

Rørslett (1991), Toivonen & Huttunen (1995), Vestergaard & Sand-Jensen (2000b) observed that species richness was highest in meso-eutrophic and eutrophic lakes but declined in hypertrophic lakes. This can be seen as an expression of environmental stress (Grime 1979) that reduces the number of species. On the other hand Oksanen’s no-interaction model (1996) has shown that a humped diversity curve can be produced because of scaling artefacts without assuming environmental or biological stress factors. Furthermore, Waide *et al*. (1999) state that the hump-shaped model should not be overstated. Nevertheless, my results for SE Norwegian farm ponds are best explained by assuming a hump-shaped model for species richness.

Periodical draining causing water level changes will typically alter the inwash of allochthonous nutrients, e.g. caused by agricultural fertilising, tree felling, liming and pollution. Raised water levels may furthermore reduce N-availability (Berendse *et al*. 1994) but may also increase P-availability (Olila *et al*. 1997). Periodically drained was anyhow not correlated with any of the water chemistry or other explanatory variables in either data sets here.

Hydrological variables

Moderate intensities of stress and/or disturbance are supposed to lead to increased species richness, as proposed by Grime (1979). Riis & Hawes (2002) stated that species richness was highest in ponds with intra-annual (1 m monthly water level range) rather than inter-annual fluctuations of the water level. Rørslett (1991) also found that peak species richness occurred at moderate (1-3 m) changes in water levels, by which new habitats will be created. Water level changes can also minimise overgrowth because vegetation is reduced (Anonymous 1994a). A fluctuating water depth gradient can kill emergent wetland vegetation by flooding, at least over time, as shown by Seabloom *et al*. (2001). Jeffries (1998) stated that drying out was one of the most important variables contributing to increased species richness in British ponds. Fluctuation did, however, not contribute to explain variation in species richness in this study of 64 agricultural ponds but periodically drained did. Periodical drainage will have larger impacts on species richness because the pond species' local environment will be uninhabitable for shorter or longer periods of time. On the other hand, water level fluctuation may contribute positively by increasing number of species. By disturbance new habitats may become recolonised and new species can be introduced.

Anthropological impacts

Liming has been one of the most extensively used measures to counteract loss of biodiversity in Scandinavian ecosystems (Anonymous 1995). This has been done for acidic lakes etc., but the ponds in this present study cannot be considered overall acidic. Liming mobilises nitrogen and phosphorus in the sediment layers (Roelofs *et al*. 1994) and leads to an increase in calcium concentration (Brandrud 2002). Liming was anyhow not correlated with any of the nutrient variables given here. This may be due to the fact that the ponds originally held sufficient amounts of nutrients, or more probably due to the fact that only five ponds were reported to have been limed and a clear relationship was therefore unlikely to occur because of sparse material of limed ponds.

Since very few of the studies referred to in this study have been carried out on ponds located in the agricultural landscape, and since comparable SE Norwegian material for comparison is lacking, I will also briefly discuss my results with reference to the findings of other studies in which plant species richness in lakes and ponds have been related to other variables than the ones found important in my study:

Area

Møller & Rørdam (1985), Rørslett (1991) and Jones *et al*. (2003) found that pond area contributed most to explain variation in pond species richness. Area acts by enhancing the probability of new habitats being added (Williams 1964), but this is probably more relevant for larger oligotrophic lakes (Rørslett 1991) than for the smaller 64 ponds I have studied. Neither area nor geographical distribution of ponds was correlated with number of plant species in the present study, as also found by Friday (1987) and Linton & Goulder (2003). Gee *et al*. (1997) and Oertli *et al*. (2002) found only a slight relationship between plant species richness and area. They stated that two small ponds would together support more species than a single large pond because of the weak area effect and the fact that ponds in close proximity do not necessary hold the similar species composition. My results accord with this.

The biogeographic principle that larger areas support more species seems to have limited applicability for ponds, supporting the proposal of Haig *et al*. (2000) who pointed out that this positive relationship is not necessarily universal in nature. This implies that much space is not inhabited, thus interspecific interactions seem to play a less important role for the species richness of ponds. On the other hand biological (physical and morphological) constraints may limit the distribution of pond species, e.g. on deeper water (uninhabited space). Stress reduces the importance of competition for space (Grime).

Hydrological variables

Other hydrological variables, e.g. water depth and inlets and outlets, have been found in other studies to contribute to explain variation in species richness although no such relationship was found in this study. Vestergaard & Sand-Jensen (2000b) showed a significant, negative relationship between species richness and the mean water depth, as opposed to a study by Browne (1981) who found a positive relationship. As the area of deeper water increases, the variety of suitable habitats and varied pond microtopographies may enhance species richness, as proposed by Williams *et al*. (1998) and Jones *et al*. (2003).

As for the factors Area and Water depth not contributing to enhanced species richness in my study, increasing area most often implies larger area of deeper water. I have formerly argued (see above) that most species surveyed in this study of ponds in the SE Norwegian agricultural landscape, were found along the water's edge at shallow water depths. This may explain the lack of relationship.

The presence of inlets and outlets may contribute to species diversity in ponds (Gee *et al*. 1997; Jones *et al.* 2003), but such relationship was not found in the present study. Inlets and outlets may be unique environments where several species can find a suitable habitat. The ponds are also more likely to receive supply of colonist diaspores from upstream or downstream. On the other hand inlets and outlets may alter the gain and loss of allochthonous nutrient material. The presence of inlets (and outlets) was correlated with e.g. nitrogen, orthophosphate and turbidity and may therefore have influenced the water chemistry in some way although no direct relationship with species richness was observed in this study.

Geographical variables

Heino (2002) and Jones *et al*. (2003) reported a decline in species richness with altitude, a result which not could be found in this study. Altitude may contribute to species richness by influencing on the temperature-gradient and thereby the length of growth season (Pedersen 1990; Dahl 1998). Rørslett (1991) proposed that lakes in Norwegian lowland areas included more species because of calcareous bedrock and silts and clays of marine origin. The majority of the ponds in my study were located at altitudes < 200 m a.s.l., thus the potential influence of altitude on species number may therefore have been reduced by selection of study area (restriction to the boreo-nemoral and boreal vegetation zones).

Distance to nearest stagnant water was not included in GLM results or in any correlation analyses related to species richness. Similar results were found by Møller & Rørdam (1985) who were unable to show a correlation between species number and pond isolation. In the context of island biogeography by MacArthur & Wilson (1967), the increase in distance may be expected to lead to a decrease in immigration rate and hence lower equilibrium species number of pond, and thereby perhaps also pond margin, biotas. Aquatic habitats are well suited to such studies because of their relatively sharply delimited boundaries.

Historical features

Newly created ponds (low pond age) show a general increase in the number of macrophytes (Møller & Rørdam 1985) with time, while this number levels out within a few years (Barnes 1983). The number of plant species with weak dispersal capacity may, however, continue to rise over decades (Godwin 1923), although recently restored ponds or ponds with low age have been shown by Møller & Rørdam (1985) to display high species numbers. On the other hand, Grayson (1992) found no relationship between pond age and number of species, as observed in my study. Such lack of relationship was also shown by Gee *et al*. (1997) who found that there was no relationship between pond age and the number of species in ponds that were more than one year old. Grayson (1992) suggests that older ponds may have undergone “catastrophes”, natural or artificial, which furthermore may have halted or reversed the increase of species richness with time, thus weakening the correlation between species number and age. Such incidents are also likely to have happened in the ponds included in my study.

Anthropological impacts

Grazing by ducks or fish showed no influence on the species richness of pond species, a result also found by Anonymous (1994a) and Gee *et al*. (1997), however, separate assessments of fish and waterfowl stocks, individuals and taxa, might have produced different results. This is notably the case for the extent (temporal and spatial) of duck grazing which was also not measured. While observing the few ponds where ducks were fenced in, they clearly suggested very low number of pond species.

Pond margins

The pond margin can be seen as a marginal strip established between a pond and the surrounding matrix; e.g. crop, field, forest etc. (Marshall & Moonen 2002). Such margins are often associated with high species richness because they may harbour species from adjacent habitats. General biogeographic theory (e.g. Shmida & Wilson 1985) predicts high species richness in such transitional zones because of mass effects, i.e. establishment of species in sites where they cannot be self-maintaining. Nevertheless, ecotones (van der Maarel 1990) do not need to be more species rich than adjacent areas (Walker *et al*. 2003).

Correlation analyses and multiple regression for pond margins also showed mainly the same significant results; some water chemistry variables, area, UTM easting and enlargement of the ponds were correlated with the number of species in pond margins, in addition to Distance to forest and Pond used for watering which were also included in the GLM. Area explained a particularly large amount of the species richness and was also one of the variables included in the simplified GLM.

Area

Some studies (Hine 1995; Gee *et al*. 1997; Vestergaard & Sand-Jensen 2000b) conclude that the most significant relationship between species number and area occurs when the area of the vegetated margin is used rather than the surface area of the entire pond, and this might therefore be related to the relationship between pond margin area and number of species.

The species-area relationship (Arrhenius 1921; Preston 1960, 1962; MacArthur & Wilson 1967) is one of the most robust generalisations in ecology (Connor & McCoy 1979;

Rosenzweig 1995; Holt *et al*. 1999). My results accord with this generalisation. Species abundance and spatial distribution of environmental and biotic factors are considered by Crawley (1997) to be the two most important factors in interpreting species diversity (see He & Legendre 2002). A larger area will typically correspond to a wide range of habitats and contain a broader spectre of species characteristic for these habitats. Habitat heterogeneity has been shown to be the most important variable contributing to variation in the number of wetland species (Brose 2001). If the area of the landscape with patches of new habitat types is increased, each new habitat is assumed to contribute less to the total species number than the former, because of species overlap between habitats. On the other hand, in an agricultural landscape less species overlap among habitats should be expected because they may constitute fundamentally different habitats (Tjørve 2002).

Increased population sizes will also enhance the probability for survival of infrequent species and the chance of catching a propagule increases with increasing area (Shmida & Wilson 1985). My conclusion is that larger ponds have larger pond margins with higher habitat diversity and therefore also a higher species richness.

Water chemical variables

The variable Pond used for watering was included in the GLM although the F-value was low. Pond used for watering also reflects changes in water level which may reflect the number of new habitats created that furthermore may contribute to increasing species numbers and to alteration of the chemistry of pond water (as discussed above). In wetlands there is a consistent peak of species richness at low productivity, perhaps because of the absence of water shortage which makes nutrient availability be the primary control of species diversity here (Cornwell & Grubb 2003). Regressions between productivity and species richness by Venterink *et al*. (2003) for wetlands showed a wide unimodal curve for N-limited sites and a narrower unimodal curve for P-limited sites. The contribution of phosphorus and nitrogen to reduced species richness is likely to be mediated by increased dominance by competitive-ruderal species (Grime1979; Marrs 1993). The presence of nitrophilous plants in my material indicates that eutrophication is occurring, as demonstrated by the dominance of e.g. *Urtica dioica* and *Cirsium arvense* in several pond margins. Particularly *Urtica dioica* tended to dominate in pond margins with low species richness.

Geographical variables

Distance to nearest forest may alter species richness and this variable was included in the general linear modelling of number of species in pond margins as a response to significant explanatory variables. As for the contribution to explanation of some of the variation in species composition, it is possible that reduced species abundance may be due to shading by dense forest canopies, or, on the other hand, may increase species richness by adding new habitats.

Anthropological variables

Factors often contributing to disturbance is cutting and felling, which create distinctive vegetation patterns most often associated with increased species richness (Anonymous 1994a) because new space is laid open to for recolonising, a relationship that, however, not could be seen in this study. On the other hand disturbance may decrease the number of species because species are removed by the act of cutting and/or felling.

Structuring processes in species composition

Ponds represent a dynamic environment. In addition to the current environmental conditions the plant species distribution will reflect historical, often pond-specific (idiosyncratic) events. Many of the Kendall's τ correlation coefficients calculated in the correlation analyses and the F-values given in the GLM, showed relatively weak relationships. Even though a total of 56 environmental variables supposed to be of high importance was measured, one can never rule out that the lack of strong relationships between species richness and composition and explanatory variables is due to unmeasured factors. The results are relevant to a discussion of the relative importance of different structuring processes in vegetation (R. Økland 1990a):

(1) *Interspecific interactions*. Patterns of species distribution may be due to competitive interactions, even though not necessarily as a major determinant of pond biotic diversity (Wilson & Keddy 1985; Keddy & Constable 1986; Friday 1987; Shipley & Keddy 1994). A species' fundamental niche is determined by physiological processes. Because species coexist in communities, it is the realised niche that is of interest for applied ecology. Positive interactions may contribute to increased species diversity, whereas the opposite effect is brought about by interspecific competition (Tilman 1994). Aquatic plant communities can often be dominated by only a few species (Mitchell 1974), e.g. *Phragmites australis* in pond margins and *Lemna minor* in ponds as seen in this study. Such species may quickly establish

dominance over a suitable area preventing potential competitors from becoming established because of competition for space and resources like light, respectively. This study of pond species did, however, show that nutrients often are in excess. Neither did pond area contribute to enhanced richness, and it is therefore likely to conclude that interspecific competitive interactions are generally not important explaining variation in plant species composition or richness in ponds in agricultural landscapes.

(2) *Destabilising factors*. Huston (1979) predicted high species richness when mortality due to extrinsic factors is low, given relatively low intrinsic mortality as well. Many of the anthropological variables may have an impact on species distributions along gradients, although this study did not overall show any clear relationship between human use and management and species richness and composition. This may, however, be due to the land owner's subjective apprehension of historical use and management of the ponds (time span, etc.). Disturbance will vary under different external conditions and should always be seen in context with its three dimensions (van der Maarel 1993): (1) spatial extent, (2) temporal extent and (3) degree of intensity. Different vegetation patterns may result from the fact that the landscape is under different human influence and at different stages of recovering following disturbance in form of removal of biomass, e.g. by cutting, tree felling, grazing and pond renovation. On the other hand, anthropological disturbance may increase overall floristic diversity by increasing the number of colonisable patches, or it may achieve nothing more than a displacement of the landscape from its permanent state (Solon 1995). However, observations from the present study show that only a low proportion of these habitable sites are open for colonisation at any given time because of rapid recolonisation, and the observed gradient structure of vegetation should therefore being considered generally valid.

(3) *Stress*. Grime (1979) pointed out that species richness is lower in areas of high ecological stress. Stress promotes coexistence of species by reducing plant growth, and hence, competitive effects. Stress is often connected with end-points of environmental gradients (R. Økland 1990a; Økland & Eilertsen 1993). Constraints or overproduction may alter a species' response along a gradient involving nutrient supply, pH, light, water depth, soil depth, etc. These variables have been shown to contribute to explain some of the variation in vegetation in this study and they can be related to the main gradient of species composition as well as number of species in both ponds and pond margins.

(4) *Randomness*. The contribution of different processes to observed species richness is extremely difficult to quantify (van Groenendael *et al.* 2000). Random processes may be highly important affecting the species composition in ponds. Although interspecific

interactions, disturbance and stress may have contributed to explain the variation in vegetation in this study, the importance of chance is probably strongly underestimated, as also suggested in general forms by R. Økland (1990a).

A pond should be expected to have the potential of harbouring a larger species pool than observed in many of the ponds in this study. However area did not seem to contribute to neither species composition nor richness in the ponds. This can be due to establishment of plants (Nicol & Ganf 2000) (to some extent, also likely to have happened here because of inappropriate ecological conditions), unsuitable ecological conditions for seed production, maturation and germination, low reproductive success arising from hybridisation (Barett *et al.* 1993) or success of dispersal. Nevertheless, isolation did not seem to play an important role in the dispersal of aquatic macrophytes here, and aquatic plant species are considered having generally good dispersal abilities as their diaspores can be carried long distances by birds (Barett *et al.* 1993; Odland 1997; Brose 2001) in addition to high local dispersal of asexual clones (van Groenendael *et al.*1996; Santamaria 2002).

Intraspecific genetic variability may also contribute to randomness (R. Økland 1990a). This factor should be related to success of pollination and dispersal. Metapopulation theory predicts that both local and regional persistence of species depend critically on the existence of many populations within a region. Higher immigration rates of species will also reduce the extinction rate by supporting present populations with new genetic material. Because of relatively good dispersal abilities, new individuals and/or plant species are likely to be established or introduced in ponds. This assumption should anyhow be given further notice since the presence of ponds located in the agricultural landscape is rather low. Because of constant loss of such ponds during the past decades, ponds in close proximity to farms are becoming a relatively rare landscape element. If farm ponds are assumed to harbour a certain pond flora the importance of establishment and dispersal of plant species should be given further consideration. However, population dynamics of the pond species may reflect critical short-term incidents of the past, making it difficult to interpret ecological relationships based on the present-day situation (Rørslett & Johansen 1995).

It was hard to get a general impression of a “typical” farm pond due to the large variation not only in species composition and richness, but also in morphology, hydrology, use and management, etc. The distinctiveness of each such pond is maybe due to randomness in establishment in gaps, supporting suggestions of Økland *et al.* (2003) in a study of swamp forests as habitat islands in boreal forests. The results in my study show a combination of many important components determining species composition and number of species, supporting Tilman’s (1999) proposal that there exists a diversity of explanations for diversity, even within one ecosystem type such as farm ponds.

The effect of randomness can be demonstrated by the variation in species composition in apparently similar patches as seen in ponds within a small geographical area in this study, e.g. ponds Nos 47-55. The differences are particularly large when comparing species richness. This implies that neither anthropological impact variables (including age), dispersal, nutrient supply, hydrology, geography nor geology can always explain plant species composition and number of species in and adjacent to ponds located in the SE Norwegian landscape.

On this basis I believe that randomness is a major determinant of variation in species composition and species richness and that the results presented in this study therefore reflect properties of pond and pond margin communities that can be generalised.

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9 Appendices

Appendix 1. List showing 44 3Q- sample plots (given in Fig. 3) containing 64 study sites (farm/site, municipality and county).

No.	Farm/site	No. of 3Q-plot in map (Fig. 3)	Municipality	County
1	Helmen	1	Gran	Oppland
2	Rossum vestre	2	Gran	Oppland
3	Innleggen	3	Hurdal	Oppland
4	Innleggen	3	Hurdal	Oppland
5	Øvre Holt	4	Nord-Odal	Hedmark
6	Nokken	5	Nes	Akershus
7	Olstad nedre	6	Ullensaker	Akershus
8	Moer	7	Ås	Akershus
9	Sutterhol	7	Ås	Akershus
10	Mørksand	8	Ski	Akershus
11	Blikksland	9	Hobøl	Østfold
12	Sørby	10	Nesodden	Akershus
13	Torud søndre	11	Spydeberg	Østfold
14	Hyllibråten	12	Spydeberg	Østfold
15	Revhaug søndre	13	Spydeberg	Østfold
16	Solbergdalen	14	Skiptvedt	Østfold
17	Berg østre	15	Skiptvedt	Østfold
18	Berg nordre	15	Skiptvedt	Østfold
19	Mørk søndre	16	Spydeberg	Østfold
20	Ødemark	17	Våler	Østfold
21	Bjerketvedt	18	Våler	Østfold
22	Glenge	19	Rakkestad	Østfold
23	Dingtorp	20	Eidsberg	Østfold
24	Svenke Rånås	21	Eidsberg	Østfold
25	Svenke Rånås	21	Eidsberg	Østfold
26	Sørby	22	Eidsberg	Østfold
27	Krossby nordre	23	Eidsberg	Østfold
28	Nordre Mysen	24	Eidsberg	Østfold
29	Furulund	24	Eidsberg	Østfold
30	Øiestad søndre	25	Trøgstad	Østfold
31	Ringstad	26	Trøgstad	Østfold
32	Skjennum mellom	27	Trøgstad	Østfold
33	Aske	28	Ringsaker	Hedmark
34	Dalby lille	29	Ringsaker	Hedmark
35	Bjørke	30	Ringsaker	Hedmark
36	Bjørke	30	Ringsaker	Hedmark
37	Dalbystykket	31	Ringsaker	Hedmark
38	Opphus nordre	32	Hamar	Hedmark
39	Østre Hoel	32	Hamar	Hedmark
40	Skjelve lille	33	Stange	Hedmark
41	Skjelve lille	33	Stange	Hedmark
42	Dal vestre	34	Stange	Hedmark
43	Arnestad	35	Vestby	Akershus
44	Våk vestre	36	Våler	Østfold
45	Meum	37	Råde	Østfold
46	Elingård	38	Fredrikstad	Østfold
47	Elingård museum	38	Fredrikstad	Østfold
48	Elingård museum	38	Fredrikstad	Østfold
49	Elingård museum	38	Fredrikstad	Østfold
50	Elingård museum	38	Fredrikstad	Østfold
51	Elingård museum	38	Fredrikstad	Østfold
52	Elingård museum	38	Fredrikstad	Østfold
53	Elingård museum	38	Fredrikstad	Østfold
54	Elingård museum	38	Fredrikstad	Østfold

55	Elingård museum	38	Fredrikstad	Østfold
56	Sande vestre	39	Borre	Vestfold
57	Oddestad østre	40	Hobøl	Østfold
58	Oddestad vestre	40	Hobøl	Østfold
59	Ugjestrud søndre	41	Vestby	Akershus
60	Pålsrød vestre	42	Rygge	Østfold
61	Roksrud nordre	43	Frogn	Akershus
62	Klommestein nordre	44	Ås	Akershus
63	Ekeberg	44	Ås	Akershus
64	Skoftestad	44	Ås	Akershus

Appendix 2. Abundance values (0–1–2–3) for the pond data set. Species are listed in first column and ponds (1-64) are given in subsequent columns.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Equisetum fluviatile	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum pratense	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum sylvaticum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix petrandra	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix cinerea	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix aurita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Salix caprea	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alnus glutinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urtica dioica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex aquaticus	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex longifolius	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Rumex acetosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Stellaria alsine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Stellaria graminea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Cerastium fontanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Nymphaea alba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Nuphar lutea	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Caltha palustris	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus acris	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus repens	1	2	0	0	0	0	0	0	0	0	2	0	0	2	0	2	0	0	1	0	0	2	0	0	0	0	2	0	0	0	0	0
Ranunculus sceleratus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus aquatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus reptans	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus flammula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Filipendula ulmaria	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potentilla palustris	0	0	0	0	2	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Lupinus polyphyllus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium repens	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium hybridum	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola palustris	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lythrum salicaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium palustre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium watsonii	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Hippuris vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cicuta virosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia nummularia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia thyrsiflora	0	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium uliginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium palustre	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis laxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callitriche cophocarpa	0	0	0	0	2	2	0	0	2	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0	1	0	0
Callitriche palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Callitriche hamulata	0	0	0	0	0	0	0	0	2	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
Mentha arvensis	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Solanum dulcamara	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica beccabunga	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica scutellata	2	0	0	1	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0

Appendix 2 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Equisetum fluviatile	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0
Equisetum pratense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Equisetum sylvaticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Salix petrandra	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix cinerea	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix aurita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix caprea	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alnus glutinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urtica dioica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex aquaticus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex longifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Rumex acetosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stellaria media	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria alsine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria graminea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerastium fontanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nymphaea alba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuphar lutea	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caltha palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus acris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus sceleratus	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus aquatilis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus reptans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ranunculus flammula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filipendula ulmaria	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	2
Potentilla palustris	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Lupinus polyphyllus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium hybridum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lythrum salicaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0
Epilobium palustre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium watsonii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2
Hippuris vulgaris	0	0	3	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cicuta virosa	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia vulgaris	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0
Lysimachia nummularia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia thyrsiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0	0	2	0	0	0	0	2	0	0	0	0
Galium uliginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Galium palustre	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0
Myosotis laxa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callitriche cophocarpa	0	1	0	0	2	0	0	0	2	0	0	2	0	2	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Callitriche palustris	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callitriche hamulata	0	0	1	0	2	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mentha arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Solanum dulcamara	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	0
Veronica beccabunga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica scutellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Appendix 2 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Utricularia minor	2	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utricularia vulgaris	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bidens tripartita	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2	2	0	0	0	0	2	0	2	0	3	0	2	0	2	2
Bidens cernua	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tussilago farfara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisma plantago-aquatica	0	0	0	0	0	0	2	2	2	0	2	2	0	2	2	2	2	0	0	0	3	0	0	0	2	0	3	2	0	0	2	2
Potamogeton natans	2	3	0	0	0	1	0	2	0	0	0	1	2	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Potamogeton alpinus	0	0	0	0	2	0	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2
Potamogeton berchtoldii	0	0	0	0	0	3	2	2	2	0	2	2	0	2	3	0	0	1	0	0	2	0	2	0	0	3	0	0	0	0	2	2
Potamogeton pusillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0
Potamogeton perfoliatus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha latifolia	0	0	0	0	0	2	0	0	0	3	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha angustifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium erectum	0	3	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Sparganium emersum	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sparganium glomeratum	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium natans	0	0	2	2	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0
Lemna minor	0	2	0	0	0	2	1	2	3	0	1	2	0	0	3	0	3	3	1	0	3	3	3	0	0	2	2	1	2	1	3	2
Spirodela polyrhiza	0	0	0	0	0	0	0	2	3	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0
Lemna trisulca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acorus calamus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calla palustris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris pseudacorus	0	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0
Juncus filiformis	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Juncus effusus	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Juncus conglomeratus	0	0	0	0	0	0	0	2	0	1	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Juncus supinus	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Juncus articulatus	0	0	2	2	1	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Juncus bufonius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Festuca pratensis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa trivialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Poa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyceria fluitans	2	0	2	0	2	2	0	2	2	2	3	2	2	2	2	0	2	2	0	2	2	3	2	0	2	0	2	0	0	0	0	2
Elymus repens	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia cespitosa	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Agrostis capillaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agrostis stolonifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Phleum pratense	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Alopecurus geniculatus	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alopecurus aequalis	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phalaris arundinacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Phragmites australis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirpus sylvaticus	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	0	0	0	0	0	0	0
Eleocharis mamillata	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0
Eleocharis palustris	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	2
Schoenoplectus lacustris	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex panicea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Carex ovalis	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex canescens	0	0	0	0	0	0	0	2	0	2	3	0	2	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	2	0	0	3
Carex vesicaria	0	0	0	0	0	0	0	2	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0

Appendix 2 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Utricularia minor	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utricularia vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bidens tripartita	0	0	0	0	0	1	0	0	0	0	0	2	0	2	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0
Bidens cernua	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0
Tussilago farfara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Alisma plantago-aquatica	0	0	0	0	0	0	0	2	0	0	0	2	0	2	2	2	0	0	3	2	2	0	0	0	1	0	2	2	2	3	0	2
Potamogeton natans	3	1	3	3	3	0	0	2	0	1	3	0	0	2	2	2	0	1	0	0	0	0	3	2	3	0	2	2	3	3	0	3
Potamogeton alpinus	0	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Potamogeton berchtoldii	1	0	0	1	0	0	1	0	0	0	2	2	0	2	1	0	0	1	0	0	2	0	1	2	2	0	0	0	2	0	2	2
Potamogeton pusillus	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Potamogeton perfoliatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	3	0	3
Typha angustifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium erectum	1	3	0	0	0	3	3	2	0	0	0	0	0	2	2	2	0	2	0	2	2	0	1	0	1	0	0	0	2	0	0	0
Sparganium emersum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Sparganium glomeratum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium natans	0	0	2	0	2	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Lemna minor	0	2	2	1	0	3	3	1	3	0	3	2	0	3	2	2	1	1	2	3	2	2	1	3	2	1	1	1	3	2	3	3
Spirodela polyrhiza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Lemna trisulca	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acorus calamus	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Calla palustris	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris pseudacorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	3	0
Juncus filiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0
Juncus effusus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	2
Juncus conglomeratus	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	2
Juncus supinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus articulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Juncus bufonius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca pratensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa trivialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Glyceria fluitans	2	2	0	2	0	0	0	0	0	1	0	2	0	2	2	2	0	0	0	0	2	2	0	0	2	0	2	2	2	2	0	2
Elymus repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia cespitosa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Agrostis capillaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Agrostis stolonifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phleum pratense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alopecurus geniculatus	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alopecurus aequalis	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phalaris arundinacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	0	0	0
Scirpus sylvaticus	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	2	0	0	2	2	2	0	0	3	0	0	0	0	2	0	2	0
Eleocharis mamillata	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	0	2
Eleocharis palustris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Schoenoplectus lacustris	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex panicea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex ovalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Carex canescens	0	0	0	0	0	2	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	2	0	0	0
Carex vesicaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0

83

Appendix 2 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Carex rostrata	0	0	3	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex pseudocyperus	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex nigra	0	0	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	2	0	2	0	0	2	0	0	0	0	0	0
Carex acuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Carex rostrata	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex pseudocyperus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex nigra	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	2	0	0	0
Carex acuta	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3. Abundance values (0-1-2-3) for the pond margin data set. Species are listed in first column and ponds (1-64) are given in subsequent columns.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Equisetum fluviatile	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum palustre	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum arvense	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
Equisetum pratense	0	0	0	0	2	0	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	1	0
Equisetum sylvaticum	0	0	2	2	0	2	0	0	0	2	0	0	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
Pteridium aquilinum	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0
Athyrium filix-femina	0	0	2	2	0	0	0	2	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0
Phegopteris connectilis	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
Dryopteris filix-mas	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris carthusiana	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris expansa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnocarpium dryopteris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Picea abies	2	0	2	0	0	0	0	0	2	2	0	0	2	2	0	0	1	0	0	2	0	0	0	1	0	1	0	0	0	0	0	1
Juniperus communis	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
Pinus sylvestris	2	0	2	0	2	0	0	0	0	1	0	0	2	1	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Salix petrandra	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix alba x fragilis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix lapponum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix myrsinifolia	2	2	2	0	2	2	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Salix cinerea	2	2	0	0	0	0	0	1	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Salix aurita	0	0	2	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	3	2	0	0	0	0	0	0	0
Salix caprea	2	2	2	0	2	2	0	2	2	2	0	0	2	1	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Populus tremula	0	0	0	0	0	0	0	2	0	0	0	0	2	0	2	0	0	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0
Betula pendula	2	1	0	0	2	2	0	2	0	2	0	0	2	2	0	0	0	0	0	2	0	1	1	2	2	0	0	0	0	0	0	0
Betula pubescens	2	0	2	2	2	2	0	0	0	2	0	0	2	2	0	0	1	0	0	3	0	2	0	0	1	0	0	2	0	0	0	0
Alnus glutinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alnus incana	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	3	2	0	0	0	0	0	0	0
Corylus avellana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus robur	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urtica dioica	0	3	0	0	1	2	2	2	2	0	1	2	0	0	2	2	2	2	2	0	2	0	3	0	0	2	1	2	2	1	2	2
Polygonum aviculare	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bistorta vivipara	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria maculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria amphibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Fallopia convolvulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex aquaticus	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Rumex longifolius	0	1	0	0	0	0	2	0	2	0	3	0	1	0	1	2	1	2	1	2	0	2	0	0	0	0	0	1	2	1	0	2
Rumex acetosa	0	0	2	2	2	0	2	2	2	0	0	0	2	2	0	0	1	0	1	0	2	0	2	0	1	0	0	2	1	1	2	3
Rumex acetosella	0	0	0	2	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Chenopodium album	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atriplex patula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Montia fontana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria nemorum	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Stellaria media	0	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0	2	0
Stellaria alsine	0	0	0	0	0	0	2	0	2	2	0	0	0	0	2	0	0	0	0	1	0	0	2	0	0	0	0	2	0	0	1	0
Stellaria graminea	0	0	0	0	0	2	2	2	2	2	0	2	1	1	2	2	2	2	2	2	2	0	2	0	2	0	0	2	2	2	2	2
Cerastium fontanum	1	0	0	0	0	2	0	2	0	2	1	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	1	0	0	0	0	0
Sagina procumbens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Spergula arvensis	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lychnis flos-cuculi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Silene latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

86

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Equisetum fluviatile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0
Equisetum palustre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum arvense	0	0	2	1	0	2	0	0	0	0	0	2	0	2	1	0	0	0	0	0	0	0	1	2	2	0	0	1	2	2	2	0
Equisetum pratense	2	0	2	2	2	2	2	0	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0	0
Equisetum sylvaticum	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0	2	0	2
Pteridium aquilinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Athyrium filix-femina	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	2	2	0
Phegopteris connectilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dryopteris filix-mas	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	1
Dryopteris carthusiana	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0
Dryopteris expansa	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnocarpium dryopteris	0	0	0	0	2	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Picea abies	0	2	0	2	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0	0	0
Juniperus communis	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinus sylvestris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Salix petrandra	0	0	0	1	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix alba x fragilis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Salix lapponum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix myrsinifolia	2	0	3	2	2	0	2	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	1	2	0
Salix cinerea	1	0	2	0	0	2	0	2	2	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0
Salix aurita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	2	0	0
Salix caprea	2	2	2	2	1	2	2	2	2	2	2	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	2	2	2	0	0
Populus tremula	2	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	0	1	0	3
Betula pendula	2	2	2	2	2	2	2	3	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Betula pubescens	0	0	2	2	2	3	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Alnus glutinosa	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	0	0	0	0	0	2	0	0	0	0
Alnus incana	2	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Corylus avellana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Quercus robur	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Urtica dioica	2	3	2	3	2	3	2	2	2	0	2	2	2	0	2	2	2	2	3	3	3	2	2	3	2	2	0	0	2	3	2	2
Polygonum aviculare	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Bistorta vivipara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria maculosa	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Persicaria amphibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persicaria hydropiper	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fallopia convolvulus	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex aquaticus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex longifolius	2	2	2	2	2	0	0	1	0	1	0	0	0	2	2	2	2	1	2	1	2	2	0	0	0	0	0	0	0	2	0	2
Rumex acetosa	0	0	2	2	2	2	2	0	0	2	0	2	1	2	2	2	0	1	0	0	1	2	2	0	2	2	2	0	2	2	0	2
Rumex acetosella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chenopodium album	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Atriplex patula	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Montia fontana	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria nemorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria media	0	0	0	0	0	0	0	0	1	2	0	0	0	0	2	0	2	0	0	0	2	2	2	0	2	2	0	0	0	0	0	0
Stellaria alsine	0	0	0	0	0	0	0	0	0	2	0	2	0	2	0	1	0	1	0	0	0	0	0	0	2	0	0	0	2	0	0	0
Stellaria graminea	2	0	2	2	0	1	1	0	2	2	2	2	0	2	2	1	1	2	0	2	2	1	2	0	2	2	2	0	2	0	0	0
Cerastium fontanum	2	0	1	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	1	0	1	0	2	2	1	2	0	0	0	0
Sagina procumbens	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spergula arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lychnis flos-cuculi	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silene latifolia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Aquilegia vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aconitum septentrionale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemone nemorosa	1	0	2	0	1	2	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Caltha palustris	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus acris	2	2	2	2	2	2	2	2	0	0	2	0	2	2	1	0	2	2	0	0	2	0	2	0	0	0	0	0	0	2	2	2
Ranunculus repens	2	2	2	2	2	2	2	2	2	2	2	0	0	2	2	0	2	2	3	2	0	0	2	0	2	2	2	2	2	2	3	2
Ranunculus sceleratus	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus reptans	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus flammula	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Fumaria officinalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erysimum cheiranthoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cardamine amara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rorippa palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barbarea vulgaris	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cardamine pratensis	0	0	0	0	2	0	0	2	2	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capsella bursa-pastoris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thlaspi arvense	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum telephium	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum spurium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysosplenium alternifolium	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribes spicatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribes rubrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribes nigrum	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aruncus dioicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus saxatilis	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Filipendula ulmaria	0	3	2	2	2	0	2	2	2	0	2	3	0	2	3	0	2	0	0	0	2	0	0	0	0	3	0	0	0	1	1	2
Rubus ideaus	2	2	2	1	0	0	2	2	0	0	0	2	2	2	2	0	0	0	0	1	0	2	0	2	2	2	0	1	2	0	0	0
Rubus spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Rubus villosa	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa subcollina	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agrimonia eupatoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geum rivale	2	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Geum urbanum	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potentilla erecta	2	0	2	3	2	2	0	2	0	2	0	0	2	2	0	0	0	0	0	2	0	0	0	2	2	0	0	0	0	0	2	0
Potentilla anserina	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Potentilla palustris	0	0	0	0	2	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Fragaria vesca	2	0	0	0	0	2	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla monticola	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Alchemilla glabra	1	0	0	0	0	2	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla subcrenata	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Alchemilla gracilis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla filicaulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla wichurae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorbus aucuparia	1	0	2	0	2	2	0	2	0	0	0	0	2	0	0	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0
Sorbus intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cotoneaster lucidus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus avium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus cerasus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Amelanchier spicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Prunus padus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lupinus polyphyllus	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vicia cracca	2	2	0	2	2	2	2	2	2	2	0	2	1	2	2	0	2	2	2	2	2	0	2	0	1	1	1	2	2	1	2	2

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Aquilegia vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Aconitum septentrionale	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemone nemorosa	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Caltha palustris	1	2	2	1	2	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus acris	2	0	2	2	2	2	0	0	0	0	0	2	0	2	2	2	0	1	0	0	0	2	1	0	2	2	2	0	2	0	0	0
Ranunculus repens	2	0	2	0	2	3	2	2	2	2	2	2	2	3	3	2	2	2	3	3	3	3	3	0	2	2	2	0	2	2	0	2
Ranunculus sceleratus	0	0	0	0	1	0	2	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Ranunculus reptans	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Ranunculus flammula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Fumaria officinalis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Erysimum cheiranthoides	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Cardamine amara	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rorippa palustris	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barbarea vulgaris	2	0	0	0	0	0	0	1	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cardamine pratensis	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2	0
Capsella bursa-pastoris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Thlaspi arvense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum telephium	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum spurium	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysosplenium alternifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribes spicatum	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ribes rubrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Ribes nigrum	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aruncus dioicus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus saxatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filipendula ulmaria	2	3	2	2	2	3	0	0	2	0	3	2	0	0	2	2	2	2	2	2	2	2	2	2	2	0	2	0	3	0	3	2
Rubus ideaus	2	2	2	2	0	2	2	2	2	2	2	2	0	1	1	0	0	0	0	0	2	0	0	2	0	0	0	2	0	2	3	2
Rubus spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus villosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa subcollina	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Agrimonia eupatoria	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geum rivale	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geum urbanum	2	0	0	1	0	0	0	0	1	0	0	0	2	1	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Potentilla erecta	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
Potentilla anserina	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Potentilla palustris	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Fragaria vesca	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Alchemilla monticola	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Alchemilla glabra	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla subcrenata	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Alchemilla filicaulis	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alchemilla wichurae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorbus aucuparia	0	0	2	1	2	2	1	0	1	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Sorbus intermedia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotoneaster lucidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus avium	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus cerasus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amelanchier spicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus padus	2	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Lupinus polyphyllus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Vicia cracca	2	2	0	2	2	2	2	1	2	2	2	2	0	1	1	2	0	2	2	2	2	0	2	2	2	0	2	0	2	2	2	2

Appendix 3 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Vicia sylvatica	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vicia sepium	0	0	0	1	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lathyrus linifolius	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Lathyrus pratensis	0	2	0	0	1	2	2	2	2	2	0	0	1	0	0	0	2	0	0	1	0	0	2	0	0	0	0	0	0	1	0	2
Trifolium repens	2	0	2	1	2	2	2	2	2	0	3	0	0	2	2	2	2	0	2	0	1	0	0	0	2	0	3	0	2	2	2	2
Trifolium hybridum	0	0	0	0	0	2	2	2	0	0	0	0	0	0	2	2	0	0	0	2	0	0	0	0	1	0	0	0	0	0	2	0
Trifolium medium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium pratense	2	0	0	0	2	2	2	2	2	0	0	0	2	2	1	2	2	2	2	2	0	0	0	0	2	2	0	0	0	1	3	2
Lotus corniculatus	2	0	0	0	0	2	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	2	0
Medicago lupulina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthyllis vulneraria	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxalis acetosella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Geranium sylvaticum	0	0	2	2	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Geranium robertianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erodium cicutarium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linum catharticum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygala amarella	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acer platanoides	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Acer pseudoplatanus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impatiens noli-tangere	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impatiens glandulifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frangula alnus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0
Hypericum maculatum	0	0	2	1	0	0	2	2	0	0	1	0	2	2	0	0	0	0	1	2	2	0	0	0	0	0	0	0	2	0	0	0
Viola palustris	0	0	2	2	2	0	0	0	0	2	0	0	2	1	0	0	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0
Viola riviniana	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola canina	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola mirabilis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola tricolor	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Viola arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lythrum salicaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium montanum	2	0	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Epilobium palustre	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Epilobium angustifolium	0	2	2	1	0	2	0	2	2	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0	1	0	0	0
Epilobium watsonii	2	2	0	0	2	2	2	2	2	2	0	0	0	2	2	2	2	2	2	2	2	0	2	0	2	0	0	2	2	1	3	2
Hippuris vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cornus sanguinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthriscus sylvestris	0	0	0	2	0	0	2	2	2	0	2	2	2	2	2	0	1	1	2	0	2	0	2	0	1	1	0	2	0	1	0	2
Aegopodium podagraria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heracleum sibiricum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carum carvi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peucedanum palustre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Angelica sylvestris	0	0	0	0	0	0	0	2	2	2	0	0	2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2	0	0	0
Monotropa hypopitys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calluna vulgaris	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Vaccinium vitis-idaea	0	0	2	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Vaccinium myrtillus	0	0	2	1	2	0	0	2	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Vaccinium uliginosum	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia vulgaris	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Lysimachia nummularia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia thyrsiflora	0	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trientalis europaea	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Menyanthes trifoliata	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Vicia sylvatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Vicia sepium	2	0	0	0	2	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lathyrus linifolius	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lathyrus pratensis	2	0	2	2	0	2	2	0	0	0	2	2	0	0	1	2	0	2	0	0	0	0	2	0	2	1	0	0	2	2	0	1
Trifolium repens	0	1	2	0	2	0	0	0	2	1	0	2	0	3	2	2	0	2	2	0	0	2	2	0	2	2	2	0	0	0	0	0
Trifolium hybridum	0	0	0	0	0	0	0	2	1	2	0	2	0	0	0	2	0	1	2	1	0	0	0	0	2	2	2	0	1	0	0	0
Trifolium medium	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
Trifolium pratense	2	0	2	0	0	0	0	2	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	2
Lotus corniculatus	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicago lupulina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthyllis vulneraria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxalis acetosella	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Geranium sylvaticum	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geranium robertianum	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erodium cicutarium	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linum catharticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygala amarella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acer platanoides	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	2	1	0	0	2	0	2	0	0	0	0	0	0	0	0	0
Acer pseudoplatanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impatiens noli-tangere	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impatiens glandulifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Frangula alnus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Hypericum maculatum	1	0	0	1	0	0	0	2	0	2	2	0	2	0	0	2	1	2	0	1	0	2	0	0	2	2	2	1	0	2	2	0
Viola palustris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
Viola riviniana	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0
Viola canina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola tricolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Lythrum salicaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	2	2	0	0	0	0	2	0	0	0
Epilobium montanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
Epilobium palustre	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epilobium angustifolium	0	2	2	2	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	2	0	2
Epilobium watsonii	2	2	2	2	2	0	0	0	2	0	2	2	2	0	0	2	2	2	0	0	2	2	0	2	2	0	0	0	2	3	3	2
Hippuris vulgaris	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cornus sanguinea	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthriscus sylvestris	2	2	2	2	2	2	2	0	0	2	2	0	0	1	1	0	1	1	2	2	2	2	2	0	0	2	2	0	2	2	2	2
Aegopodium podagraria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	3	3	0	2	1	0	0	0	0	0	0	0	0	0
Heracleum sibiricum	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Carum carvi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Peucedanum palustre	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Angelica sylvestris	0	2	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	2	0	2
Monotropa hypopitys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Calluna vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vaccinium vitis-idaea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Vaccinium myrtillus	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Vaccinium uliginosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysimachia vulgaris	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2	2	2
Lysimachia nummularia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Lysimachia thyrsiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	0	0	0	2	0	0	0	0	2	0	0	0	0
Trientalis europaea	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Menyanthes trifoliata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

91

Appendix 3 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Galium boreale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium uliginosum	2	0	2	2	1	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0
Galium palustre	0	0	0	0	1	0	0	2	1	0	0	0	0	0	2	0	2	0	0	0	3	0	0	1	2	0	0	0	1	0	2	0
Galium album	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Fraxinus excelsior	0	0	0	0	0	0	0	2	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Convolvolus arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis laxa	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis scorpioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis arvensis	0	0	0	0	0	0	2	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0
Callitriche palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeopsis speciosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeopsis tetrahit	0	2	0	0	0	0	0	2	2	0	0	0	0	0	2	2	2	2	3	0	2	2	3	0	2	0	0	2	2	0	1	0
Galeopsis bifida	2	0	0	0	0	2	2	0	2	2	1	0	0	0	0	0	2	0	2	2	0	2	0	0	0	0	0	0	1	0	0	0
Stachys palustris	0	0	0	0	0	0	0	2	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Stachys sylvatica	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glechoma hederacea	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunella vulgaris	2	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ajuga pyramidalis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mentha arvensis	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Origanum vulgare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum dulcamara	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Scrophularia nodosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linaria vulgaris	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica chamaedrys	0	0	0	0	1	0	0	2	2	0	1	0	2	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Veronica serpyllifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0
Veronica beccabunga	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica scutellata	2	0	0	1	2	0	0	2	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Veronica officinalis	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melampyrum pratense	0	0	2	0	2	2	0	2	0	2	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melampyrum sylvaticum	0	0	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphrasia nemorosa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago major	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	2	2	2	0	2	0	0	0	0	0	0	0	2	0	0
Sambucus racemosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum opulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valeriana sambucifolia	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knautia arvensis	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula patula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula rotundifolia	0	0	2	2	0	1	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula persicifolia	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula rapunculoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago virgaurea	0	0	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Omalotheca sylvatica	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Filaginella uliginosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0
Bidens tripartita	0	2	0	0	0	0	0	2	3	0	0	0	0	0	0	2	2	2	2	0	2	0	3	0	2	0	2	2	3	0	2	2
Bidens cernua	0	0	0	0	0	0	0	2	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Achillea ptarmica	0	0	2	2	2	2	2	2	0	2	2	2	1	2	2	1	2	0	2	2	2	0	2	0	0	0	0	2	2	0	1	1
Achillea millefolium	2	0	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	0	2	2	2	2	3	0	2	0	0	2	2	2	2	2
Matricaria perforata	0	2	0	0	0	2	1	2	0	0	0	0	0	1	0	2	0	2	3	1	0	0	0	0	0	0	0	0	0	0	2	2
Chamomilla suaveolens	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0
Leucanthemum vulgare	2	0	2	2	0	1	0	2	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Tanacetum vulgare	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Galium boreale	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Galium uliginosum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	3	0
Galium palustre	0	0	2	1	2	2	0	0	0	0	3	2	3	1	2	2	2	2	0	0	2	0	2	0	2	0	2	0	0	2	0	2
Galium album	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	2	2	0	2	0	2	0	0	0	0	3	0	0
Fraxinus excelsior	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	0	0	0	0	0	0	1	1	2
Convolvolus arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis laxa	0	0	1	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Myosotis scorpioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis arvensis	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	1	0	1	0	0	2	1	0	0	2	1	0	0	0	3	1	0
Callitriche palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeopsis speciosa	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeopsis tetrahit	2	2	2	2	0	2	1	2	0	2	2	2	1	0	2	0	1	1	0	2	2	2	2	2	2	0	2	1	2	3	2	2
Galeopsis bifida	2	2	2	0	0	0	2	2	2	0	0	0	0	0	2	0	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0
Stachys palustris	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Stachys sylvatica	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glechoma hederacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0
Prunella vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Ajuga pyramidalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mentha arvensis	2	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1
Origanum vulgare	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum dulcamara	0	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	1	0	0	2	2	0	2	0	0	0	0	0	0	0	2	3
Scrophularia nodosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linaria vulgaris	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	2	0	1
Veronica chamaedrys	0	0	0	0	0	0	0	1	0	0	2	0	1	2	2	2	0	2	0	2	2	3	2	0	2	2	0	1	0	0	0	1
Veronica serpyllifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica beccabunga	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica scutellata	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0
Veronica officinalis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Melampyrum pratense	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Melampyrum sylvaticum	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphrasia nemorosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago major	0	0	1	0	2	2	0	0	0	0	0	0	0	2	2	0	2	2	0	0	0	0	0	0	2	0	0	1	0	0	0	0
Sambucus racemosa	0	0	0	0	0	3	0	1	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0
Viburnum opulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Valeriana sambucifolia	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knautia arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula patula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Campanula rotundifolia	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	1	0	1	1	2	0	0	0	0	0	0	0	0	0	0
Campanula persicifolia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanula rapunculoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Solidago virgaurea	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Omalotheca sylvatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaginella uliginosa	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Bidens tripartita	2	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	0	2	2	2	2	0	2	0	2	0	0	2	0	1
Bidens cernua	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0
Achillea ptarmica	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	2	0	0	2	1	0	2	2	1	2	0	2	2	1	2
Achillea millefolium	2	0	0	1	2	2	0	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2	2	0	2	2	2	0	2	2	1	2
Matricaria perforata	2	0	0	0	0	2	2	2	0	2	2	2	2	2	0	1	1	2	0	1	0	2	0	0	2	2	0	0	0	2	0	0
Chamomilla suaveolens	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leucanthemum vulgare	2	0	1	2	0	2	0	0	0	2	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	2	0	0	2	0	0
Tanacetum vulgare	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Artemisia vulgaris	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	0	0	1	0	2	0	0	0	0
Tussilago farfara	2	2	0	1	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Senecio viscosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctium spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirsium arvense	2	2	0	0	0	0	2	2	0	0	0	0	0	0	2	2	0	0	0	2	2	0	3	0	0	2	0	2	2	0	2	0
Cirsium vulgare	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Carduus crispus	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Cirsium palustre	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirsium helenioides	1	0	2	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centaurea jacea	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leontodon autumnalis	2	0	0	0	2	0	1	0	0	0	0	0	2	2	0	0	0	2	2	2	0	0	1	0	0	0	0	0	0	1	0	2
Tragopogon pratensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus arvensis	2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus oleraceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus asper	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraxacum spp.	2	0	0	0	0	2	2	2	0	0	2	2	0	2	2	0	2	2	2	2	0	1	1	0	0	1	0	2	0	2	2	2
Mycelis muralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lapsana communis	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Crepis paludosa	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium foliosa	0	0	0	2	0	2	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium vulgata	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium rigida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Senecio jacobaea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Alisma plantago-aquatica	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	2	0	0	0	2	0	1	0	0	0	2	2	0	0	2	2
Typha latifolia	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium erectum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Sparganium glomeratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Acorus calmus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calla palustris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paris quadrifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris pseudacorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Hosta spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Convallaria majalis	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maianthemum bifolium	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Dactylorhiza fuchsii	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus filiformis	0	0	2	2	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	0	2	0	2	0	0	0	0	0	2	2
Juncus effusus	0	0	0	0	0	2	0	0	0	2	0	2	0	0	0	2	2	0	0	2	2	0	0	0	2	0	0	0	0	0	0	0
Juncus conglomeratus	0	0	0	0	0	0	0	2	2	3	0	0	2	2	0	0	2	0	0	3	2	0	0	0	2	0	0	0	2	0	2	1
Juncus supinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Juncus articulatus	0	0	2	2	1	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0
Juncus bufonius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0
Juncus alpinoarticulatus	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Luzula multiflora	2	0	2	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Luzula pilosa	0	0	2	0	0	2	0	2	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Festuca rubra	2	0	2	2	2	0	0	0	0	0	0	0	0	2	1	0	1	0	2	0	0	0	2	0	2	0	2	0	2	0	0	0
Festuca pratensis	2	0	0	0	2	0	2	2	2	0	0	0	0	2	1	2	0	2	0	0	2	0	3	0	0	0	0	2	0	0	2	3
Lolium perenne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Lolium multiflorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa annua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Poa trivialis	2	2	0	0	2	2	2	2	2	0	0	2	1	2	2	0	1	2	0	0	0	2	2	0	2	2	0	2	0	2	3	2
Poa palustris	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Artemisia vulgaris	2	2	0	0	0	0	1	2	0	2	0	2	2	0	0	0	0	1	0	2	0	0	0	2	0	0	0	0	0	2	0	2
Tussilago farfara	1	0	2	2	0	2	2	2	2	1	0	0	0	0	0	2	0	2	0	0	2	0	0	0	0	0	0	1	0	1	0	0
Senecio viscosus	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Senecio vulgaris	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Arctium spp.	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirsium arvense	2	0	2	0	0	2	2	2	2	2	2	2	0	0	0	0	2	2	2	3	2	0	2	3	2	2	2	0	2	3	0	2
Cirsium vulgare	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Carduus crispus	1	1	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirsium palustre	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Cirsium helenioides	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Centaurea jacea	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
Leontodon autumnalis	2	0	0	0	0	0	0	0	2	2	0	2	0	2	0	0	0	2	1	0	0	3	2	0	0	0	2	2	0	0	0	0
Tragopogon pratensis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus arvensis	1	2	0	0	0	0	1	2	2	2	0	0	0	0	0	0	0	2	0	0	0	0	2	0	2	0	0	0	1	1	0	0
Sonchus oleraceus	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sonchus asper	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Taraxacum spp.	2	2	2	2	0	2	0	2	2	3	0	2	0	1	2	0	2	2	2	1	0	2	2	0	0	2	0	0	2	0	0	2
Mycelis muralis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lapsana communis	2	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	1	2	0
Crepis paludosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium foliosa	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Hieracium vulgata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hieracium rigida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Senecio jacobaea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alisma plantago-aquatica	2	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	2	1	0	2	0	0	0	0	0	0	1	0	0	0	0
Typha latifolia	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Sparganium erectum	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparganium glomeratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acorus calmus	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Calla palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paris quadrifolia	0	0	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris pseudacorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Hosta spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Convallaria majalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maianthemum bifolium	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Dactylorhiza fuchsii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus filiformis	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Juncus effusus	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	1	0	2	1	2	2	0	2	2	0	0	0	2	2	2	0	2
Juncus conglomeratus	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	0	0	0	0	0	1	1	0	2	2	0	2	0	2
Juncus supinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus articulatus	2	0	0	2	1	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus bufonius	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus alpinoarticulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luzula multiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Luzula pilosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0
Festuca rubra	0	0	0	0	2	2	0	0	1	3	2	0	0	0	1	0	0	0	0	0	0	2	0	0	2	2	0	0	0	0	0	0
Festuca pratensis	2	0	0	0	0	0	1	0	0	2	2	2	2	2	2	0	0	0	0	0	0	1	0	0	2	3	0	0	1	0	1	2
Lolium perenne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0
Lolium multiflorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Poa annua	0	0	1	0	0	0	0	0	1	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0
Poa trivialis	2	2	2	2	0	2	2	2	2	2	2	0	0	3	2	0	2	2	0	0	2	2	2	1	2	2	2	0	2	3	2	2
Poa palustris	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2	0	2	1	0	0	1	0	0	0	2	0	0	0	0	0	0	1

Appendix 3 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Poa pratensis	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	0
Poa nemoralis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dactylis glomerata	2	1	2	2	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Melica nutans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyceria fluitans	1	0	2	0	0	2	0	2	2	2	0	1	0	2	0	0	2	2	2	0	0	0	0	0	2	0	0	1	0	0	1	2
Bromus inermis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Elymus repens	0	1	0	1	0	2	2	0	0	1	1	0	0	0	2	1	0	2	2	2	0	0	2	0	0	1	0	0	0	2	0	0
Avena sativa	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia cespitosa	2	0	2	2	2	2	0	2	2	2	0	0	2	2	1	2	1	0	0	2	2	0	2	2	0	0	0	0	2	2	2	3
Deschampsia flexuosa	2	0	2	2	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	2	0	2	0	0	0	0	0	0	0	0
Agrostis capillaris	2	0	2	2	0	2	2	2	2	2	2	0	2	2	0	0	2	0	2	2	2	0	2	0	2	0	1	0	0	0	0	2
Agrostis stolonifera	0	0	0	2	2	2	0	0	0	0	2	0	0	2	0	2	0	2	0	0	3	0	2	0	0	0	0	0	0	0	0	0
Agrostis gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis arundinacea	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis purpurea	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis canescens	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phleum pratense	2	0	0	0	0	2	2	2	2	0	0	0	1	2	2	2	0	3	0	2	2	0	3	0	0	2	2	3	0	2	2	2
Alopecurus pratensis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	2	0	0
Alopecurus geniculatus	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alopecurus aequalis	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phalaris arundinacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Anthoxanthum odoratum	0	0	2	2	1	2	0	0	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	2
Phragmites australis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirpus sylvaticus	2	2	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	2	2	0	0	0	0	0	0	0
Eleocharis mamillata	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
Eleocharis palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	2
Schoenoplectus lacustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Carex panicea	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Carex echinata	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0
Carex ovalis	0	0	2	2	2	0	2	2	0	2	0	0	1	2	0	2	2	0	0	2	2	0	2	0	2	0	0	0	0	0	2	0
Carex canescens	0	0	2	2	2	2	0	2	2	3	2	1	2	2	0	0	0	2	0	0	3	0	0	2	1	0	0	3	0	0	3	0
Carex vesicaria	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex rostrata	2	0	3	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Carex pseudocyperus	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex flava	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex pallescens	0	0	2	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex nigra	2	0	2	2	2	2	0	2	2	0	0	0	0	2	0	0	1	0	0	0	3	0	0	2	2	0	0	0	0	0	0	0
Carex aquatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Carex acuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex elongata	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex diandra	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

96

Appendix 3 cont.

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Poa pratensis	0	0	1	1	0	0	0	0	0	1	0	0	0	2	0	0	2	0	2	1	1	1	0	0	0	0	1	0	0	2	0	0
Poa nemoralis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dactylis glomerata	0	0	2	2	0	0	0	0	2	2	0	0	0	0	2	2	3	2	0	3	2	3	2	0	0	0	0	2	2	2	2	2
Melica nutans	1	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyceria fluitans	2	0	1	0	0	0	0	1	0	0	0	2	2	0	0	2	0	0	0	0	2	2	0	0	0	0	2	1	0	2	0	0
Bromus inermis	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Elymus repens	2	2	0	2	0	2	2	2	2	2	2	2	0	0	2	0	2	2	2	3	0	1	2	2	2	3	2	0	0	2	1	0
Avena sativa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia cespitosa	2	2	2	3	2	2	2	2	0	2	0	0	2	0	2	1	2	1	0	0	0	3	0	0	2	1	2	1	0	0	0	2
Deschampsia flexuosa	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Agrostis capillaris	0	2	0	1	2	0	0	2	2	0	2	0	2	2	1	2	1	0	0	0	2	2	1	0	2	2	2	2	2	2	0	2
Agrostis stolonifera	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Agrostis gigantea	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis arundinacea	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis purpurea	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calamagrostis canescens	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	1	0	3	0	1
Phleum pratense	2	0	2	0	0	0	2	2	2	2	0	2	0	1	2	0	2	2	2	2	2	0	0	0	2	2	2	0	2	0	1	0
Alopecurus pratensis	2	0	0	0	0	1	2	2	2	0	3	0	0	0	2	2	2	0	0	2	2	0	2	0	0	0	0	0	0	0	2	0
Alopecurus geniculatus	0	0	0	0	0	0	1	0	1	1	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Alopecurus aequalis	0	0	0	1	0	0	0	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Phalaris arundinacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0
Anthoxanthum odoratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Phragmites australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Scirpus sylvaticus	0	2	1	2	0	0	3	2	0	0	2	0	0	1	2	2	0	1	2	3	2	0	2	2	0	0	0	0	2	0	2	0
Eleocharis mamillata	2	0	0	0	0	0	2	0	0	0	0	1	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Eleocharis palustris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Schoenoplectus lacustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex panicea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex echinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex ovalis	0	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	2	2	2	1	0	0	0	0
Carex canescens	0	0	0	2	2	0	2	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	2	0
Carex vesicaria	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex rostrata	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Carex pseudocyperus	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex flava	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex pallescens	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
Carex nigra	2	0	0	2	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	0	0	2	2	0	0	0
Carex aquatilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex acuta	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex elongata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex diandra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4. Untransformed values for the 56 explanatory variables for both pond and pond margin data sets.

	PArea	MArea	AvgWid	MaxDep	MedDep	Fluct	Drain	Well	Outl	Inl	UTMn	UTMe	Alt	DistWat	DistRoad
1	2602	570	3	229	200	0	0	3	3	0	6691499	583984	390	450	116
2	247	195	3	102	100.5	0	0	0	3	3	6700879	581205	170	350	26
3	280	147	2.3	82	65	0	0	0	3	3	6708049	610416	395	15	84
4	704	98	1	181	150	0	0	0	3	3	6708100	610438	395	15	74
5	328	175	2.5	74	51.5	0	0	3	3	3	6702849	638481	185	930	3
6	300	88	1.3	147	115.5	1	0	3	0	0	6660827	633264	140	2850	5
7	199	111	1.9	151	125	0	0	3	3	0	6663173	618121	160	500	52
8	462	200	2.4	237	198	1	0	3	0	0	6611595	604177	105	60	3
9	460	114	1.4	168	148	0	0	3	0	0	6611755	604011	100	300	89
10	61	45	1.4	219	156.5	0	0	0	3	3	6615017	610600	165	450	110
11	118	134	2.9	61	55.5	0	0	0	3	3	6614757	613671	115	350	16
12	142	114	2.3	110	98.5	0	0	0	3	3	6632284	594766	75	300	63
13	48	63	2	116	58.5	1	1	0	3	0	6614689	616244	170	100	37
14	145	119	2.3	196	156.5	1	0	3	0	0	6612094	616257	155	1300	47
15	170	43	0.8	220	138.5	0	0	3	0	0	6602730	619947	110	200	3
16	20	22	1.1	66	54.5	0	1	0	0	3	6591508	623022	60	30	26
17	61	21	0.7	81	75.5	1	0	0	0	0	6593664	620245	140	750	5
18	54	70	2.2	141	121.5	2	0	0	0	0	6594313	619728	145	100	26
19	256	43	0.8	148	236.5	0	0	3	0	0	6600264	613344	115	1700	2
20	653	250	2.6	287	252.5	0	0	3	3	3	6596638	613447	125	650	130
21	128	122	2.5	148	128.5	0	0	0	0	0	6591167	619514	110	175	63
22	19	5	0.4	80	64.5	1	1	0	3	0	6585675	635123	110	750	32
23	94	115	2.7	142	122.5	2	0	0	0	0	6594792	629102	105	185	74
24	163	75	1.5	165	161	0	0	0	0	0	6597756	632113	160	70	21
25	474	149	1.8	295	125	2	0	0	3	0	6597756	632209	160	70	3
26	33	48	1.9	79	65	1	1	0	0	0	6594607	634831	110	440	26
27	183	11	0.2	109	102	0	0	3	3	0	6599990	634803	135	340	3
28	700	279	2.8	225	218.5	0	0	3	0	0	6603789	631643	110	890	5
29	137	60	1.3	129	98.5	0	0	0	3	3	6603015	631145	125	890	74
30	300	157	2.3	27	21.5	0	1	0	0	0	6612540	628413	110	800	268
31	463	200	2.4	107	89.5	0	0	0	3	0	6618857	630909	160	520	42
32	147	143	2.8	183	108.5	0	0	0	0	0	6621095	628296	130	220	10
33	975	370	3	162	108	2	3	0	3	0	6740246	600599	290	300	21
34	232	176	2.8	98	66.5	3	0	0	3	3	6746060	595405	200	550	52
35	168	123	2.3	149	90	0	0	3	3	3	6755447	600188	325	30	358
36	1707	466	3	310	229	4	2	0	3	3	6755496	600188	330	30	373
37	171	135	2.5	109	103	0	0	0	3	3	6761365	606365	440	100	4
38	241	423	3	87	64.5	0	0	0	0	3	6741029	619042	150	500	126
39	1190	394	3	44	35	0	0	0	0	0	6741055	619285	160	500	37
40	1370	383	2.72	232	150	4	0	0	3	3	6735532	619048	205	230	16
41	103	35	0.9	82	76.5	1	0	0	3	3	6735435	619296	215	230	10
42	2219	529	3	350	205	4	0	3	3	3	6735377	622459	180	2200	47
43	144	126	2.5	127	110	2	0	3	0	0	6602683	595222	45	600	10
44	304	155	2.3	134	104	0	0	0	0	0	6593486	602006	30	450	26
45	66	90	2.4	27	16	1	0	0	0	0	6578508	601873	30	1200	105
46	357	171	2.3	75	70	1	0	0	0	0	6569790	602946	20	170	121
47	481	144	1.7	160	107	0	1	0	3	3	6569634	602813	20	10	3
48	420	116	0.5	166	162	0	0	0	3	3	6569573	602815	20	10	70
49	263	195	3	92	70.5	0	1	0	3	3	6569507	602835	20	10	105
50	546	242	2.6	117	68	0	0	0	3	3	6569496	602743	20	10	58
51	181	68	1.3	173	151	0	0	0	3	3	6569535	602752	20	10	74
52	286	142	2.2	145	136.5	0	0	0	3	3	6569573	602749	20	10	58
53	171	133	2.4	104	91	0	0	0	3	3	6569618	602732	20	10	3
54	484	161	2	165	125.5	0	0	0	3	3	6569629	602774	25	10	3
55	806	151	1.5	248	225.5	1	0	0	0	0	6569368	602793	20	120	100
56	101	126	2.8	124	93.5	0	2	0	3	3	6583937	581012	30	100	47
57	155	99	2	147	141.5	0	0	0	0	0	6602634	601799	50	400	5
58	29	34	1.5	42	41	0	1	3	3	0	6602685	601371	50	400	32
59	69	34	1	263	207	3	0	0	0	0	6608253	595353	100	500	47
60	2283	500	2.9	352	244	0	1	3	0	0	6581903	595813	25	1110	52
61	158	113	2.2	106	88.5	0	0	3	0	0	6617507	595086	80	950	26
62	3010	600	2.9	208	193	4	0	0	3	3	6614741	594773	85	250	42
63	52	74	2.2	121	97.5	0	0	3	3	0	6614798	595055	100	250	32
64	118	82	1.9	208	196.5	1	0	0	3	0	6614165	595558	100	150	16

Appendix 4 cont.

	DistAgr	DistBui	DistForest	Age	Fire	Water	Drink	Laund	Fence	Lime	Garb	Renov	Herbic	StonyMarg	Cut	Fell	Graze
1	5	74	4	14	0	3	0	0	3	0	0	0	0	0	0	0	0
2	6	5	1	50	3	1	0	0	0	0	1	1	0	0	0	2	0
3	126	2	1	51	0	0	0	0	0	3	0	0	2	0	2	0	0
4	153	1	6	51	3	0	0	0	0	3	0	1	0	1	0	0	0
5	2	1	2	100	0	0	0	0	0	0	0	1	0	0	3	0	0
6	10	1	10	100	3	0	1	1	0	0	0	2	0	0	0	0	1
7	2	1	405	100	3	0	1	0	3	0	0	1	0	1	3	0	1
8	10	32	1	100	0	0	0	0	0	0	0	1	0	0	2	2	0
9	11	1	1	100	3	3	1	0	3	0	0	1	0	0	1	0	1
10	2	84	5	31	0	1	0	0	0	0	0	1	0	0	0	0	0
11	16	1	137	100	0	0	0	0	0	0	0	1	0	0	3	0	0
12	9	16	1	100	0	0	0	0	1	0	1	1	0	1	0	0	0
13	4	10	1	100	0	0	1	0	3	0	0	0	0	0	2	0	1
14	21	1	6	100	0	0	1	0	3	0	0	1	0	0	0	0	0
15	3	1	52	100	0	0	1	0	3	1	0	1	0	0	0	0	0
16	25	1	16	100	0	0	1	0	0	0	0	3	0	2	3	0	0
17	5	1	52	100	0	0	1	0	0	0	0	1	0	0	0	0	0
18	39	1	26	100	0	0	1	1	1	0	3	2	0	0	1	0	0
19	2	1	63	43	3	0	0	0	3	0	0	1	0	0	0	0	0
20	63	1	1	33	0	3	0	0	3	0	0	0	0	0	0	3	0
21	4	2	47	100	0	0	1	1	1	0	0	1	0	0	0	0	1
22	32	1	1	100	0	0	1	0	0	3	0	1	0	0	0	0	1
23	5	3	360	100	0	0	1	1	1	0	0	1	0	0	1	0	0
24	21	42	1	100	0	0	0	0	0	0	0	0	0	0	0	1	0
25	63	2	2	50	3	1	0	0	0	0	0	3	0	0	0	0	0
26	3	1	26	100	0	0	0	0	0	0	0	1	0	0	2	0	0
27	5	37	179	100	0	0	0	0	0	0	0	1	0	0	0	0	0
28	11	5	242	100	0	0	1	0	3	0	1	1	0	0	0	0	0
29	5	1	84	100	0	0	1	1	3	0	0	1	0	0	3	0	0
30	3	231	53	100	0	0	3	0	0	0	0	1	0	0	0	0	3
31	5	1	26	100	0	0	1	0	1	0	1	1	0	0	0	0	0
32	5	5	110	50	0	0	1	0	0	0	0	0	0	0	1	0	0
33	6	25	2	100	3	3	1	0	3	0	0	1	1	0	0	0	1
34	4	5	158	38	0	3	0	0	0	0	0	2	0	0	0	3	0
35	5	310	1	28	0	0	0	0	0	0	0	0	0	0	0	1	0
36	16	347	1	12	0	2	0	0	0	0	0	0	0	0	0	2	0
37	32	21	5	100	0	0	2	0	0	0	0	1	0	0	0	0	2
38	10	58	1	100	0	0	0	0	0	0	1	1	0	0	0	1	1
39	10	47	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0
40	5	79	147	20	0	3	0	0	3	0	0	0	0	0	0	0	0
41	10	1	226	100	0	3	1	0	3	0	0	1	3	0	3	0	1
42	7	5	189	33	0	3	0	0	3	0	0	2	0	0	0	0	0
43	5	53	2	100	0	0	1	0	1	0	0	1	0	0	0	0	0
44	10	1	2	100	0	0	1	0	0	0	0	1	0	0	1	0	0
45	3	26	10	100	0	0	1	0	1	0	0	1	0	1	0	0	1
46	3	105	21	100	0	0	3	0	0	0	0	0	0	0	1	1	3
47	8	1	158	100	0	0	0	0	0	0	0	1	0	0	1	0	0
48	8	1	184	100	0	0	0	0	0	0	0	1	0	0	1	0	0
49	8	1	189	100	0	0	0	0	0	0	0	1	0	0	1	0	0
50	5	1	132	100	0	0	0	0	0	0	0	1	0	0	1	0	0
51	8	1	179	100	0	0	0	0	0	0	0	1	0	0	1	0	0
52	5	1	200	100	0	0	0	0	0	0	0	1	0	0	1	0	0
53	5	1	189	100	0	0	0	0	0	0	0	1	0	0	1	0	0
54	5	1	184	100	0	0	0	0	0	0	0	1	0	0	1	0	0
55	10	1	5	100	0	0	0	0	0	0	0	1	0	0	1	0	0
56	15	42	16	33	3	2	0	0	0	0	0	2	0	0	0	0	0
57	2	10	85	100	3	0	1	0	3	0	0	1	3	0	1	0	0
58	26	1	37	97	0	0	1	0	3	1	0	1	0	1	3	0	1
59	5	5	10	77	3	0	1	1	0	0	0	1	0	1	1	0	0
60	47	1	1	44	0	3	0	0	0	0	0	0	0	0	0	0	0
61	10	5	132	100	3	1	1	0	0	0	0	1	0	0	1	0	0
62	5	84	205	50	0	3	0	0	0	0	0	2	0	0	0	0	0
63	3	37	37	100	0	0	1	0	0	0	0	0	1	0	1	0	0
64	5	147	1	15	0	1	0	0	0	0	0	0	0	0	0	0	0

Appendix 4 cont.

	Fish	Duck	Enlarge	Diminish	Secchi	MaxSlp	MinSlp	Soil	MaxSoil	MinSoil	MedSoil	Cnd	pH	Alk
1	3	0	0	0	150	24	6	2	86	7	31	184	7.9	1458
2	0	0	0	0	75	37	7	0	100	88	100	751	7.5	5562
3	0	2	0	0	360	21	5	0	88	3	23.5	46	6.5	132
4	1	2	0	0	360	26	6	2	74	9	24	43	6.9	267
5	0	0	0	0	66	24	12	1	82	34	71	31	6.1	174
6	0	0	0	1	60	31	12	0	100	20	42.5	81	6.8	826
7	1	2	1	0	51	27	10	0	40	6	15.5	222	8.1	1938
8	1	3	1	0	84	34	8	0	59	19	29	48	6.5	285
9	3	1	0	0	60	12	10	0	60	37	39.5	51	6.5	374
10	0	0	1	0	72	26	15	0	47	21	35	81	6.7	464
11	1	1	0	1	250	25	2	0	44	23	30	42	6.1	224
12	0	0	0	0	70	28	6	2	70	7	9.5	175	6.7	732
13	0	0	0	0	52	33	10	0	50	3	19	18	6.0	32
14	0	0	1	0	68	27	18	0	53	4	29.5	20	6.1	50
15	0	1	0	0	59	24	13	0	100	3	60.5	97	6.8	755
16	0	0	2	2	200	28	17	2	72	6	50.5	148	7.0	524
17	1	0	0	0	41	31	11	0	54	8	29	76	6.1	635
18	0	0	0	0	43	41	6	0	50	3	14	481	6.8	3385
19	1	3	0	0	25	18	9	0	52	30	49.5	197	6.8	1161
20	0	0	1	0	40	33	10	0	100	37	69.5	26	5.9	50
21	0	0	0	0	66	15	7	0	45	20	31	37	6.4	305
22	0	0	0	1	43	36	24	0	100	65	89	177	6.9	1580
23	0	1	0	0	74	32	11	0	60	38	51	142	7.0	1037
24	0	0	0	0	123	30	11	1	88	35	63	46	5.8	55
25	0	0	0	0	57	30	3	1	60	14	35	37	6.6	60
26	0	0	0	0	20	28	15	0	75	38	65.5	911	6.1	784
27	0	0	0	0	91	25	17	0	58	26	49	108	6.9	908
28	1	1	0	1	97	33	3	0	100	37	91.5	39	6.0	212
29	3	0	0	0	26	20	13	0	80	49	56.5	29	5.8	110
30	0	0	0	0	1	22	3	0	25	1	5.5	477	7.4	3883
31	0	2	0	0	48	22	15	0	52	40	45	153	6.7	1303
32	0	0	0	0	127	19	6	0	49	33	39	60	6.8	560
33	3	0	1	0	99	38	7	0	57	15	38.5	344	7.6	2930
34	0	0	0	0	360	42	35	2	100	41	61	243	7.7	1421
35	1	0	0	0	360	45	4	0	42	8	21	278	6.7	1314
36	1	0	0	0	360	25	8	0	84	7	27	239	7.3	991
37	0	3	0	1	28	30	7	1	69	12	17	112	6.6	906
38	0	0	0	0	25	32	19	0	100	26	69.5	830	7.4	5757
39	0	2	0	0	200	16	4	0	100	38	70	498	7.5	4892
40	0	0	0	0	119	39	22	0	74	40	53	760	7.9	3662
41	3	0	0	0	35	30	7	0	63	9	51.5	725	7.4	4850
42	3	3	2	0	140	40	22	0	100	34	54.5	781	8.0	3520
43	0	0	0	0	60	31	9	0	100	59	71	265	7.4	2279
44	0	0	0	0	90	17	7	0	88	24	56.5	101	6.8	717
45	1	1	0	0	18	35	10	1	65	33	47	44	6.3	205
46	0	0	0	0	42	29	2	0	100	32	100	143	6.5	54
47	3	0	0	0	75.5	38	16	0	100	55	59.5	272	7.2	1908
48	3	0	0	0	77	37	8	0	100	42	63	263	7.3	2038
49	3	0	0	0	47	38	18	0	100	48	69	297	7.4	2272
50	3	0	0	0	63	38	15	0	100	48	100	353	7.4	2703
51	3	0	0	0	83	38	14	0	100	59	73.5	367	7.5	2949
52	3	0	0	1	112	39	13	1	100	49	89.5	322	6.9	2474
53	3	0	0	0	64	54	27	0	100	63	92	302	6.9	2331
54	3	0	0	0	95	44	14	0	100	45	76.5	255	7.2	1594
55	3	0	0	0	97	26	4	0	100	58	100	145	7.0	1227
56	0	0	0	0	200	29	8	0	96	54	69.5	266	7.2	2212
57	0	0	0	0	44	12	7	0	67	47	61.5	69	6.4	562
58	0	3	1	0	17	24	21	1	69	38	62	173	7.6	1221
59	0	0	1	0	96	44	13	1	71	5	45	63	6.6	471
60	3	0	1	0	142.5	35	7	1	100	35	47.5	57	6.4	226
61	3	1	0	0	25	34	11	0	100	20	50	47	6.3	402
62	0	0	1	0	187.5	31	22	0	83	47	63.5	390	7.2	2095
63	0	0	0	0	41	24	12	0	52	30	36.5	143	6.3	1177
64	1	0	0	0	55	30	12	0	51	37	46.5	175	6.6	1283

Appendix 4 cont.

	Ca	Clr	Trb	PO_4-P	Part-P	Tot-P	NH_4-N	NO_3-N	Part-N	Tot-N
1	26	0.006	10	0	3	3	189	5	0.3	0.5
2	118	0.092	13	8	5	12	45	1287	1.1	2.4
3	3	0.024	1	0	3	3	59	362	0.4	0.8
4	5	0.011	1	0	3	3	84	18	0.1	0.2
5	2	0.145	5	10	8	18	161	7	0.0	0.2
6	7	0.150	18	10	57	67	206	3	0.1	0.3
7	24	0.047	6	5	44	49	115	150	1.3	1.5
8	4	0.289	9	18	77	95	24	10	0.2	0.3
9	5	0.160	28	10	45	55	224	3	0.0	0.2
10	7	0.153	6	5	44	49	150	3	0.2	0.3
11	3	0.059	50	3	61	64	157	6	0.2	0.4
12	17	0.092	17	33	34	67	437	1656	1.4	3.5
13	1	0.087	8	3	68	70	245	30	0.1	0.4
14	1	0.088	5	0	34	34	91	3	0.0	0.1
15	12	0.097	3	10	33	43	101	3	0.1	0.2
16	12	0.101	6	3	28	30	140	5	0.0	0.2
17	6	0.161	60	8	87	95	245	4	1.1	1.4
18	62	0.183	24	94	125	220	1619	5	1.7	3.4
19	19	0.222	500	20	260	280	66	3	0.7	0.8
20	1	0.229	11	5	28	34	147	5	0.2	0.4
21	4	0.224	15	13	85	98	31	1	0.2	0.3
22	28	0.145	18	69	102	171	136	3	1.1	1.3
23	15	0.108	17	43	94	137	224	1	0.3	0.5
24	1	0.156	15	5	19	24	462	4	0.0	0.5
25	2	0.149	13	0	18	18	150	0	0.0	0.2
26	40	0.043	80	3	269	271	1476	2	0.0	1.5
27	9	0.081	11	53	93	146	84	1	0.2	0.3
28	2	0.156	7.7	92	33	125	238	4	0.3	0.5
29	0	0.186	65	23	139	162	280	2	0.1	0.4
30	27	0.176	10	74	627	701	3290	20	0.3	3.6
31	18	0.119	100	18	89	107	402	2	0.4	0.8
32	4	0.072	8.6	5	31	37	52	1	0.2	0.2
33	41	0.072	3.3	5	10	15	388	10	1.1	1.5
34	26	0.052	1.9	18	4	21	31	417	0.9	1.4
35	34	0.027	2	15	18	34	206	1538	1.6	3.3
36	25	0.058	1.2	3	7	9	157	1334	1.4	2.8
37	11	0.219	91	10	20	30	234	9	0.0	0.3
38	116	0.184	15.5	906	3	909	1955	11	1.6	3.6
39	103	0.129	14.3	25	69	95	220	4	1.4	1.6
40	139	0.075	2.8	8	8	15	143	484	2.3	2.9
41	127	0.098	7.2	69	29	98	87	7	0.7	0.8
42	161	0.066	3.6	0	9	9	56	389	1.6	2.0
43	38	0.074	1.8	5	7	12	0	6	0.7	0.7
44	10	0.125	16	8	78	85	0	4	0.4	0.4
45	2	0.136	32	10	231	241	126	2	0.6	0.7
46	8	0.262	34	216	226	442	423	6	0.9	1.4
47	22	0.150	6	331	53	384	2794	3	0.6	3.4
48	27	0.114	14.3	354	265	619	0	0	1.1	1.1
49	24	0.174	14.7	1300	377	1677	4287	2	0.0	4.3
50	34	0.158	20	438	309	747	1392	2	1.4	2.7
51	36	0.104	11.6	542	278	820	4024	1	0.0	4.1
52	33	0.171	23	377	108	485	720	1	1.5	2.2
53	30	0.231	28	112	120	232	374	4	1.0	1.4
54	19	0.197	3.3	702	57	759	2570	9	0.0	2.6
55	13	0.115	8.7	76	94	171	0	0	1.3	1.3
56	40	0.024	3.8	25	17	43	108	1	0.2	0.4
57	6	0.087	24	5	114	119	115	1	0.1	0.3
58	14	0.358	144	422	718	1140	94	4	0.5	0.6
59	4	0.223	1070	8	78	85	115	1	0.1	0.3
60	2	0.122	4	5	80	85	14	0	0.1	0.2
61	6	0.093	11	25	130	155	0	0	0.2	0.2
62	32	0.081	14	15	24	40	182	5	0.7	0.8
63	12	0.238	16	25	118	143	1556	1	0.1	1.7
64	15	0.167	14	20	99	119	77	2	0.2	0.2

Appendix 5. Transformed values for the 56 explanatory variables for both pond and pond margin data sets.

	PArea	MArea	AvgWid	MaxDep	MedDep	Fluct	Drain	Well	Outl	Inl	UTMn	UTMe	Alt	DistWat	DistRoad
1	0.9732	0.9841	1.0000	0.7575	0.8537	0	0	3	3	0	0.8456	0.0593	0.9466	0.5334	0.7162
2	0.5365	0.6621	1.0000	0.3770	0.4895	0	0	0	3	3	0.8705	0.0039	0.5997	0.4749	0.3761
3	0.5601	0.5820	0.5609	0.2939	0.3144	0	0	0	3	3	0.8884	0.5470	0.9522	0.0186	0.6396
4	0.7319	0.4725	0.1301	0.6358	0.6886	0	0	0	3	3	0.8885	0.5474	0.9522	0.0186	0.6099
5	0.5897	0.6311	0.6664	0.2578	0.2380	0	0	3	3	3	0.8755	1.0000	0.6330	0.7112	0.0342
6	0.5730	0.4447	0.1995	0.5354	0.5545	1	0	3	0	0	0.7505	0.9201	0.5253	1.0000	0.0910
7	0.4957	0.5054	0.3873	0.5479	0.5934	0	0	3	3	0	0.7587	0.6773	0.5761	0.5585	0.5284
8	0.6537	0.6694	0.6119	0.7760	0.8476	1	0	3	0	0	0.5163	0.4378	0.4211	0.1451	0.0342
9	0.6529	0.5125	0.2259	0.5990	0.6813	0	0	3	0	0	0.5174	0.4349	0.4043	0.4401	0.6533
10	0.2651	0.2867	0.2259	0.7338	0.7118	0	0	0	3	3	0.5383	0.5501	0.5880	0.5334	0.7035
11	0.3957	0.5564	0.9242	0.1951	0.2613	0	0	0	3	3	0.5367	0.6026	0.4532	0.4749	0.2784
12	0.4314	0.5125	0.5609	0.4078	0.4805	0	0	0	3	3	0.6330	0.2665	0.3098	0.4401	0.5725
13	0.2155	0.3625	0.4265	0.4300	0.2784	1	1	0	3	0	0.5363	0.6460	0.5997	0.2224	0.4521
14	0.4354	0.5241	0.5609	0.6760	0.7118	1	0	3	0	0	0.5196	0.6462	0.5639	0.7963	0.5055
15	0.4658	0.2771	0.0909	0.7362	0.6460	0	0	3	0	0	0.4525	0.7075	0.4374	0.3528	0.0342
16	0.0136	0.1535	0.1517	0.2198	0.2555	0	1	0	0	3	0.3519	0.7577	0.2429	0.0677	0.3761
17	0.2651	0.1462	0.0731	0.2895	0.3698	1	0	0	0	0	0.3734	0.7124	0.5253	0.6574	0.0910
18	0.2401	0.3877	0.5131	0.5161	0.5793	2	0	0	0	0	0.3797	0.7038	0.5385	0.2224	0.3761
19	0.5432	0.2771	0.0909	0.5385	0.9578	0	0	3	0	0	0.4326	0.5971	0.4532	0.8653	0.0000
20	0.7179	0.7345	0.7246	0.8819	1.0000	0	0	3	3	3	0.4012	0.5988	0.4833	0.6221	0.7435
21	0.4114	0.5308	0.6664	0.5385	0.6074	0	0	0	0	0	0.3484	0.7003	0.4374	0.3257	0.5725
22	0.0000	0.0000	0.0264	0.2850	0.3117	1	1	0	3	0	0.2865	0.9488	0.4374	0.6574	0.4204
23	0.3514	0.5149	0.7868	0.5194	0.5834	2	0	0	0	0	0.3842	0.8550	0.4211	0.3368	0.6099
24	0.4578	0.4046	0.2541	0.5902	0.7275	0	0	0	0	0	0.4112	0.9022	0.5761	0.1667	0.3320
25	0.6584	0.5858	0.3507	0.8975	0.5934	2	0	0	3	0	0.4112	0.9037	0.5761	0.1667	0.0342
26	0.1343	0.3007	0.3873	0.2806	0.3144	1	1	0	0	0	0.3825	0.9443	0.4374	0.5281	0.3761
27	0.4798	0.0629	0.0000	0.4040	0.4962	0	0	3	3	0	0.4303	0.9438	0.5117	0.4683	0.0342
28	0.7308	0.7670	0.8532	0.7481	0.9079	0	0	3	0	0	0.4607	0.8949	0.4374	0.7001	0.0910
29	0.4245	0.3510	0.1995	0.4761	0.4805	0	0	0	3	3	0.4547	0.8871	0.4833	0.7001	0.6099
30	0.5730	0.6004	0.5609	0.0000	0.0411	0	1	0	0	0	0.5225	0.8441	0.4374	0.6735	0.9190
31	0.6541	0.6694	0.6119	0.3964	0.4387	0	0	0	3	0	0.5615	0.8834	0.5761	0.5679	0.4802
32	0.4380	0.5743	0.8532	0.6413	0.5248	0	0	0	0	0	0.5744	0.8423	0.4977	0.3727	0.1936
33	0.7921	0.8518	1.0000	0.5814	0.5226	2	3	0	3	0	0.9597	0.3736	0.8183	0.4401	0.3320
34	0.5247	0.6327	0.8532	0.3611	0.3225	3	0	0	3	3	0.9712	0.2784	0.6642	0.5814	0.5284
35	0.4635	0.5330	0.5609	0.5417	0.4411	0	0	3	3	3	0.9891	0.3662	0.8672	0.0677	0.9899
36	0.8955	0.9221	1.0000	0.9259	0.9374	4	2	0	3	3	0.9892	0.3662	0.8737	0.0677	1.0000
37	0.4669	0.5584	0.6664	0.4040	0.5007	0	0	0	3	3	1.0000	0.4765	1.0000	0.2224	0.0642
38	0.5319	0.8925	1.0000	0.3156	0.3117	0	0	0	0	3	0.9613	0.6925	0.5513	0.5585	0.7360
39	0.8290	0.8708	1.0000	0.1040	0.1350	0	0	0	0	0	0.9613	0.6965	0.5761	0.5585	0.4521
40	0.8550	0.8622	0.7997	0.7645	0.6886	4	0	0	3	3	0.9501	0.6926	0.6741	0.3821	0.2784
41	0.3693	0.2354	0.1098	0.2939	0.3749	1	0	0	3	3	0.9499	0.6967	0.6935	0.3821	0.1936
42	0.9439	0.9611	1.0000	0.9966	0.8686	4	0	3	3	3	0.9497	0.7486	0.6221	0.9323	0.5055
43	0.4341	0.5396	0.6664	0.4692	0.5312	2	0	3	0	0	0.4521	0.2750	0.1653	0.6025	0.1936
44	0.5755	0.5968	0.5609	0.4930	0.5051	0	0	0	0	0	0.3717	0.3990	0.0730	0.5334	0.3761
45	0.2811	0.4505	0.6119	0.0000	0.0000	1	0	0	0	0	0.1863	0.3966	0.0730	0.7758	0.6925
46	0.6056	0.6245	0.5609	0.2624	0.3412	1	0	0	0	0	0.0110	0.4159	0.0000	0.3199	0.7263
47	0.6612	0.5763	0.3163	0.5754	0.5183	0	1	0	3	3	0.0070	0.4135	0.0000	0.0000	0.0342
48	0.6359	0.5172	0.0410	0.5932	0.7310	0	0	0	3	3	0.0054	0.4135	0.0000	0.0000	0.5969
49	0.5483	0.6621	1.0000	0.3366	0.3438	0	1	0	3	3	0.0037	0.4139	0.0000	0.0000	0.6925
50	0.6847	0.7249	0.7246	0.4337	0.3306	0	0	0	3	3	0.0034	0.4122	0.0000	0.0000	0.5534
51	0.4777	0.3807	0.1995	0.6134	0.6922	0	0	0	3	3	0.0044	0.4124	0.0000	0.0000	0.6099
52	0.5641	0.5724	0.5131	0.5290	0.6384	0	0	0	3	3	0.0054	0.4123	0.0000	0.0000	0.5534
53	0.4669	0.5543	0.6119	0.3848	0.4458	0	0	0	3	3	0.0066	0.4120	0.0000	0.0000	0.0342
54	0.6623	0.6075	0.4265	0.5902	0.5954	0	0	0	3	3	0.0068	0.4128	0.0379	0.0000	0.0342
55	0.7569	0.5895	0.2541	0.8006	0.9277	1	0	0	0	0	0.0000	0.4131	0.0000	0.2541	0.6809
56	0.3655	0.5396	0.8532	0.4587	0.4575	0	2	0	3	3	0.2645	0.0000	0.0730	0.2224	0.5055
57	0.4482	0.4752	0.4265	0.5354	0.6573	0	0	0	0	0	0.4517	0.3953	0.1926	0.5058	0.0910
58	0.1049	0.2298	0.2541	0.0925	0.1738	0	1	3	3	0	0.4521	0.3876	0.1926	0.5058	0.4204
59	0.2900	0.2298	0.1301	0.8330	0.8746	3	0	0	0	0	0.4935	0.2774	0.4043	0.5585	0.5055
60	0.9491	0.9437	0.9242	1.0000	0.9778	0	1	3	0	0	0.2371	0.2859	0.0379	0.7559	0.5284
61	0.4518	0.5101	0.5131	0.3926	0.4340	0	0	3	0	0	0.5535	0.2724	0.3302	0.7165	0.3761
62	1.0000	1.0000	0.9242	0.7067	0.8323	4	0	0	3	3	0.5366	0.2666	0.3498	0.4000	0.4802
63	0.2322	0.4013	0.5131	0.4481	0.4759	0	0	3	3	0	0.5369	0.2719	0.4043	0.4000	0.4204
64	0.3957	0.4268	0.3873	0.7067	0.8430	1	0	0	3	0	0.5330	0.2812	0.4043	0.2955	0.2784

Appendix 5 cont.

	DistAgr	DistBui	DistForest	Age	Fire	Water	Drink	Laund	Fence	Lime	Garb	Renov	Herbic	StonyMarg	Cut	Fell
1	0.3910	0.8902	0.1706	0.0947	0	3	0	0	3	0	0	0	0	0	0	0
2	0.4333	0.6853	0.0000	0.4737	3	1	0	0	0	0	1	1	0	0	0	2
3	0.9688	0.5875	0.0000	0.4842	0	0	0	0	0	3	0	0	2	0	2	0
4	1.0000	0.0000	0.2337	0.4842	3	0	0	0	0	3	0	1	0	1	0	0
5	0.0000	0.0000	0.0752	1.0000	0	0	0	0	0	0	0	1	0	0	3	0
6	0.5382	0.0000	0.3187	1.0000	3	0	1	1	0	0	0	2	0	0	0	0
7	0.0000	0.0000	1.0000	1.0000	3	0	1	0	3	0	0	1	0	1	3	0
8	0.5382	0.8298	0.0000	1.0000	0	0	0	0	0	0	0	1	0	0	2	2
9	0.5563	0.0000	0.0000	1.0000	3	3	1	0	3	0	0	1	0	0	1	0
10	0.0000	0.8993	0.2048	0.2737	0	1	0	0	0	0	0	1	0	0	0	0
11	0.6248	0.0000	0.7961	1.0000	0	0	0	0	0	0	0	1	0	0	3	0
12	0.5178	0.7786	0.0000	1.0000	0	0	0	0	1	0	1	1	0	1	0	0
13	0.3332	0.7425	0.0000	1.0000	0	0	1	0	3	0	0	0	0	0	2	0
14	0.6726	0.0000	0.2337	1.0000	0	0	1	0	3	0	0	1	0	0	0	0
15	0.2415	0.0000	0.6153	1.0000	0	0	1	0	3	1	0	1	0	0	0	0
16	0.7025	0.0000	0.4007	1.0000	0	0	1	0	0	0	0	3	0	2	3	0
17	0.3910	0.0000	0.6153	1.0000	0	0	1	0	0	0	0	1	0	0	0	0
18	0.7774	0.0000	0.4879	1.0000	0	0	1	1	1	0	3	2	0	0	1	0
19	0.0000	0.0000	0.6509	0.4000	3	0	0	0	3	0	0	1	0	0	0	0
20	0.8564	0.0000	0.0000	0.2947	0	3	0	0	3	0	0	0	0	0	0	3
21	0.3332	0.5875	0.5965	1.0000	0	0	1	1	1	0	0	1	0	0	0	0
22	0.7443	0.0000	0.0000	1.0000	0	0	1	0	0	3	0	1	0	0	0	0
23	0.3910	0.6364	0.9778	1.0000	0	0	1	1	1	0	0	1	0	0	1	0
24	0.6726	0.8495	0.0000	1.0000	0	0	0	0	0	0	0	0	0	0	0	1
25	0.8564	0.5875	0.0752	0.4737	3	1	0	0	0	0	0	3	0	0	0	0
26	0.2415	0.0000	0.4879	1.0000	0	0	0	0	0	0	0	1	0	0	2	0
27	0.3910	0.8403	0.8463	1.0000	0	0	0	0	0	0	0	1	0	0	0	0
28	0.5563	0.6853	0.9030	1.0000	0	0	1	0	3	0	1	1	0	0	0	0
29	0.3910	0.0000	0.7045	1.0000	0	0	1	1	3	0	0	1	0	0	3	0
30	0.2415	0.9712	0.6188	1.0000	0	0	3	0	0	0	0	1	0	0	0	0
31	0.3910	0.0000	0.4879	1.0000	0	0	1	0	1	0	1	1	0	0	0	0
32	0.3910	0.6853	0.7549	0.4737	0	0	1	0	0	0	0	0	0	0	1	0
33	0.4333	0.8117	0.0752	1.0000	3	3	1	0	3	0	0	1	1	0	0	0
34	0.3332	0.6853	0.8228	0.3474	0	3	0	0	0	0	0	2	0	0	0	3
35	0.3910	0.9920	0.0000	0.2421	0	0	0	0	0	0	0	0	0	0	0	1
36	0.6248	1.0000	0.0000	0.0737	0	2	0	0	0	0	0	0	0	0	0	2
37	0.7443	0.7989	0.2048	1.0000	0	0	2	0	0	0	0	1	0	0	0	0
38	0.5382	0.8728	0.0000	1.0000	0	0	0	0	0	0	1	1	0	0	0	1
39	0.5382	0.8576	0.3187	0.0000	0	0	0	0	0	0	0	0	0	0	0	0
40	0.3910	0.8949	0.8093	0.1579	0	3	0	0	3	0	0	0	0	0	0	0
41	0.5382	0.0000	0.8901	1.0000	0	3	1	0	3	0	0	1	3	0	3	0
42	0.4667	0.6853	0.8565	0.2947	0	3	0	0	3	0	0	2	0	0	0	0
43	0.3910	0.8663	0.0752	1.0000	0	0	1	0	1	0	0	1	0	0	0	0
44	0.5382	0.0000	0.0752	1.0000	0	0	1	0	0	0	0	1	0	0	1	0
45	0.2415	0.8146	0.3187	1.0000	0	0	1	0	1	0	0	1	0	1	0	0
46	0.2415	0.9152	0.4493	1.0000	0	0	3	0	0	0	0	0	0	0	1	1
47	0.4943	0.0000	0.8228	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
48	0.4943	0.0000	0.8514	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
49	0.4943	0.0000	0.8565	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
50	0.3910	0.0000	0.7891	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
51	0.4943	0.0000	0.8463	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
52	0.3910	0.0000	0.8671	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
53	0.3910	0.0000	0.8565	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
54	0.3910	0.0000	0.8514	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
55	0.5382	0.0000	0.2048	1.0000	0	0	0	0	0	0	0	1	0	0	1	0
56	0.6133	0.8495	0.4007	0.2947	3	2	0	0	0	0	0	2	0	0	0	0
57	0.0000	0.7425	0.7067	1.0000	3	0	1	0	3	0	0	1	3	0	1	0
58	0.7092	0.0000	0.5524	0.9684	0	0	1	0	3	1	0	1	0	1	3	0
59	0.3910	0.6853	0.3187	0.7579	3	0	1	1	0	0	0	1	0	1	1	0
60	0.8083	0.0000	0.0000	0.4105	0	3	0	0	0	0	0	0	0	0	0	0
61	0.5382	0.6853	0.7891	1.0000	3	1	1	0	0	0	0	1	0	0	1	0
62	0.3910	0.8993	0.8718	0.4737	0	3	0	0	0	0	0	2	0	0	0	0
63	0.2415	0.8403	0.5524	1.0000	0	0	1	0	0	0	0	0	1	0	1	0
64	0.3910	0.9391	0.0000	0.1053	0	1	0	0	0	0	0	0	0	0	0	0

Appendix 5 cont.

	Graze	Fish	Duck	Enlarge	Diminish	MaxSlp	MinSlp	Soil	MaxSoil	MinSoil	MedSoil	Secchi	Cnd	pH
1	0	3	0	0	0	0.3014	0.2760	2	0.6989	0.0988	0.3161	0.7805	0.5754	0.9291
2	0	0	0	0	0	0.6132	0.3271	0	1.0000	1.0000	1.0000	0.6123	0.9484	0.7667
3	0	0	2	0	0	0.2273	0.2193	0	0.7374	0.0337	0.2276	1.0000	0.2201	0.3587
4	0	1	2	0	0	0.3503	0.2760	2	0.4949	0.1302	0.2336	1.0000	0.2035	0.5202
5	0	0	0	0	0	0.3014	0.5273	1	0.6259	0.4706	0.7372	0.5822	0.1244	0.1510
6	1	0	0	0	1	0.4711	0.5273	0	1.0000	0.2907	0.4454	0.5599	0.3624	0.4817
7	1	1	2	1	0	0.3747	0.4561	0	0.1082	0.0828	0.1293	0.5224	0.6248	1.0000
8	0	1	3	1	0	0.5425	0.3737	0	0.2949	0.2769	0.2928	0.6393	0.2306	0.3676
9	1	3	1	0	0	0.0000	0.4561	0	0.3066	0.5062	0.4124	0.5599	0.2456	0.3452
10	0	0	0	1	0	0.3503	0.6187	0	0.1697	0.3044	0.3619	0.6026	0.3624	0.4339
11	0	1	1	0	1	0.3259	0.0000	0	0.1424	0.3313	0.3045	0.9079	0.1977	0.1605
12	0	0	0	0	0	0.3989	0.2760	2	0.4362	0.0988	0.0526	0.5960	0.5622	0.4513
13	1	0	0	0	0	0.5188	0.4561	0	0.1985	0.0337	0.1728	0.5269	0.0000	0.1030
14	0	0	0	1	0	0.3747	0.6967	0	0.2289	0.0503	0.2987	0.5892	0.0233	0.1652
15	0	0	1	0	0	0.3014	0.5596	0	1.0000	0.0337	0.6340	0.5560	0.4087	0.4687
16	0	0	0	2	2	0.3989	0.6719	2	0.4650	0.0828	0.5312	0.8520	0.5183	0.5584
17	0	1	0	0	0	0.4711	0.4929	0	0.2394	0.1146	0.2928	0.4732	0.3461	0.1888
18	0	0	0	0	0	0.7063	0.2760	0	0.1985	0.0337	0.1103	0.4839	0.8297	0.4817
19	0	1	3	0	0	0.1524	0.4165	0	0.2186	0.4216	0.5206	0.3675	0.5933	0.4730
20	0	0	0	1	0	0.5188	0.4561	0	1.0000	0.5062	0.7228	0.4678	0.0831	0.0836
21	1	0	0	0	0	0.0766	0.3271	0	0.1513	0.2907	0.3161	0.5822	0.1669	0.2954
22	1	0	0	0	1	0.5897	0.8246	0	1.0000	0.7994	0.9039	0.4839	0.5652	0.5074
23	0	0	1	0	0	0.4950	0.4929	0	0.3066	0.5178	0.5364	0.6091	0.5075	0.5500
24	0	0	0	0	0	0.4471	0.4929	1	0.7374	0.4825	0.6590	0.7317	0.2201	0.0199
25	0	0	0	0	0	0.4471	0.0837	1	0.3066	0.2055	0.3619	0.5480	0.1669	0.3943
26	0	0	0	0	0	0.3989	0.6187	0	0.5103	0.5178	0.6838	0.3231	1.0000	0.1794
27	0	0	0	0	0	0.3259	0.6719	0	0.2834	0.3708	0.5153	0.6585	0.4364	0.5373
28	0	1	1	0	1	0.5188	0.0837	0	1.0000	0.5062	0.9261	0.6739	0.1796	0.1367
29	0	3	0	0	0	0.2025	0.5596	0	0.5914	0.6398	0.5935	0.3756	0.1087	0.0000
30	3	0	0	0	0	0.2521	0.0837	0	0.0000	0.0000	0.0000	0.0000	0.8274	0.7469
31	0	0	2	0	0	0.2521	0.6187	0	0.2186	0.5408	0.4726	0.5086	0.5270	0.4513
32	0	0	0	0	0	0.1775	0.2760	0	0.1887	0.4585	0.4068	0.7395	0.2863	0.4989
33	1	3	0	1	0	0.6366	0.3271	0	0.2721	0.2201	0.4013	0.6788	0.7406	0.8139
34	0	0	0	0	0	0.7293	1.0000	2	1.0000	0.5522	0.6391	1.0000	0.6486	0.8528
35	0	1	0	0	0	0.7980	0.1559	0	0.1250	0.1146	0.1973	1.0000	0.6842	0.4557
36	0	1	0	0	0	0.3259	0.3737	0	0.6617	0.0988	0.2693	1.0000	0.6442	0.6785
37	2	0	3	0	1	0.4471	0.3271	1	0.4221	0.1759	0.1480	0.3909	0.4458	0.4075
38	1	0	0	0	0	0.4950	0.7202	0	1.0000	0.3708	0.7228	0.3675	0.9751	0.7509
39	0	0	2	0	0	0.1020	0.1559	0	1.0000	0.5178	0.7276	0.8520	0.8389	0.7628
40	0	0	0	0	0	0.6599	0.7853	0	0.4949	0.5408	0.5573	0.7236	0.9516	0.9177
41	1	3	0	0	0	0.4471	0.3271	0	0.3431	0.1302	0.5417	0.4385	0.9390	0.7469
42	0	3	3	2	0	0.6831	0.7853	0	1.0000	0.4706	0.5729	0.7635	0.9589	0.9740
43	0	0	0	0	0	0.4711	0.4165	0	1.0000	0.7418	0.7372	0.5599	0.6715	0.7469
44	0	0	0	0	0	0.1273	0.3271	0	0.7374	0.3446	0.5935	0.6559	0.4191	0.4817
45	1	1	1	0	0	0.5662	0.4561	1	0.3685	0.4585	0.4941	0.3029	0.2091	0.2495
46	3	0	0	0	0	0.4231	0.0000	0	1.0000	0.4463	1.0000	0.4786	0.5094	0.3407
47	0	3	0	0	0	0.6366	0.6460	0	1.0000	0.7019	0.6240	0.6139	0.6784	0.6703
48	0	3	0	0	0	0.6132	0.3737	0	1.0000	0.5635	0.6590	0.6186	0.6695	0.6987
49	0	3	0	0	0	0.6366	0.6967	0	1.0000	0.6291	0.7179	0.5039	0.7017	0.7469
50	0	3	0	0	0	0.6366	0.6187	0	1.0000	0.6291	1.0000	0.5713	0.7474	0.7189
51	0	3	0	0	0	0.6366	0.5900	0	1.0000	0.7418	0.7611	0.6364	0.7578	0.7588
52	0	3	0	0	1	0.6599	0.5596	1	1.0000	0.6398	0.9083	0.7088	0.7231	0.5160
53	0	3	0	0	0	1.0000	0.8785	0	1.0000	0.7805	0.9305	0.5749	0.7061	0.5202
54	0	3	0	0	0	0.7752	0.5900	0	1.0000	0.5967	0.7895	0.6689	0.6613	0.6622
55	0	3	0	0	0	0.3503	0.1559	0	1.0000	0.7319	1.0000	0.6739	0.5130	0.5584
56	0	0	0	0	0	0.4231	0.3737	0	0.9061	0.6918	0.7228	0.8520	0.6725	0.6662
57	0	0	0	0	0	0.0000	0.3271	0	0.3948	0.6184	0.6441	0.4890	0.3216	0.3045
58	1	0	3	1	0	0.3014	0.7645	1	0.4221	0.5178	0.6491	0.2922	0.5592	0.7944
59	0	0	0	1	0	0.7752	0.5596	1	0.4505	0.0667	0.4726	0.6714	0.2986	0.3898
60	0	3	0	1	0	0.5662	0.3271	1	1.0000	0.4825	0.4994	0.7679	0.2734	0.2954
61	0	3	1	0	0	0.5425	0.4929	0	1.0000	0.2907	0.5259	0.3675	0.2254	0.2402
62	0	0	0	1	0	0.4711	0.7853	0	0.6437	0.6184	0.6640	0.8359	0.7739	0.6334
63	0	0	0	0	0	0.3014	0.5273	0	0.2186	0.4216	0.3789	0.4732	0.5094	0.2449
64	0	1	0	0	0	0.4471	0.5273	0	0.2084	0.5062	0.4887	0.5398	0.5622	0.3809

Appendix 5 cont.

	Alk	Ca	Clr	Trb	PO_4-P	Part-P	Tot-P	NH_4-N	NO_3-N	Part-N	Tot-N
1	0.5851	0.6302	0.0000	0.4768	0.0000	0.0102	0.0000	0.5136	0.6174	0.3951	0.4353
2	0.9891	0.9376	0.3578	0.5062	0.3929	0.0481	0.1825	0.3071	0.9831	0.7648	0.8546
3	0.0970	0.2568	0.0870	0.0000	0.0000	0.0102	0.0000	0.3441	0.8983	0.4946	0.5855
4	0.1946	0.3313	0.0250	0.1149	0.0000	0.0102	0.0000	0.3932	0.7003	0.1632	0.1725
5	0.1305	0.2091	0.5254	0.3757	0.4260	0.1177	0.2445	0.4894	0.6424	0.0000	0.1624
6	0.4334	0.3833	0.5398	0.5459	0.4260	0.4592	0.4551	0.5271	0.5871	0.2035	0.3290
7	0.6666	0.6183	0.1876	0.4178	0.3468	0.4064	0.4024	0.4398	0.8395	0.8187	0.7443
8	0.2056	0.2791	0.8708	0.4600	0.4912	0.5203	0.5124	0.2277	0.6637	0.3789	0.3046
9	0.2556	0.3346	0.5679	0.5964	0.4260	0.4109	0.4218	0.5394	0.5961	0.0030	0.2493
10	0.2994	0.3933	0.5483	0.4047	0.3468	0.4064	0.4024	0.4792	0.5871	0.2906	0.3356
11	0.1665	0.2421	0.2361	0.6616	0.2706	0.4749	0.4474	0.4861	0.6285	0.3458	0.3825
12	0.4035	0.5493	0.3578	0.5379	0.5640	0.3575	0.4551	0.6425	1.0000	0.8423	0.9469
13	0.0000	0.0443	0.3404	0.4434	0.2706	0.4942	0.4625	0.5531	0.7320	0.1717	0.3665
14	0.0197	0.0808	0.3439	0.3950	0.0000	0.3549	0.3411	0.4048	0.5961	0.0159	0.0000
15	0.4111	0.4763	0.3750	0.3120	0.4260	0.3490	0.3804	0.4207	0.5871	0.2557	0.2592
16	0.3257	0.4779	0.3885	0.4218	0.2706	0.3204	0.3257	0.4684	0.6232	0.0232	0.1352
17	0.3695	0.3561	0.5707	0.6820	0.3929	0.5461	0.5124	0.5531	0.6039	0.7788	0.7136
18	0.8341	0.8075	0.6296	0.5789	0.6878	0.6231	0.6543	0.8469	0.6174	0.9119	0.9387
19	0.5223	0.5658	0.7256	0.9163	0.5068	0.7793	0.6959	0.3597	0.5961	0.6519	0.5748
20	0.0197	0.0916	0.7419	0.4882	0.3468	0.3238	0.3411	0.4757	0.6174	0.3328	0.3648
21	0.2175	0.2660	0.7303	0.5216	0.4519	0.5412	0.5177	0.2589	0.5497	0.3643	0.2870
22	0.6078	0.6450	0.5254	0.5459	0.6504	0.5797	0.6119	0.4646	0.5871	0.7794	0.6930
23	0.4921	0.5252	0.4116	0.5413	0.5957	0.5624	0.5750	0.5394	0.5304	0.4432	0.4824
24	0.0249	0.1019	0.5568	0.5248	0.3468	0.2535	0.2899	0.6509	0.6039	0.0081	0.4421
25	0.0301	0.1624	0.5370	0.5116	0.0000	0.2441	0.2445	0.4792	0.5033	0.0212	0.1443
26	0.4204	0.7157	0.1708	0.7140	0.2706	0.7864	0.6902	0.8324	0.5768	0.0549	0.7381
27	0.4575	0.4330	0.3190	0.4882	0.6207	0.5601	0.5858	0.3932	0.5304	0.3564	0.3290
28	0.1582	0.1624	0.5568	0.4450	0.6846	0.3541	0.5593	0.5487	0.6110	0.4059	0.4681
29	0.0779	0.0000	0.6373	0.6909	0.5207	0.6445	0.6026	0.5736	0.5768	0.2319	0.3990
30	0.8764	0.6363	0.6112	0.4768	0.6589	0.9706	0.8515	0.9584	0.7054	0.4357	0.9577
31	0.5538	0.5647	0.4469	0.7387	0.4912	0.5509	0.5327	0.6295	0.5646	0.4622	0.5643
32	0.3406	0.3031	0.2859	0.4586	0.3468	0.3430	0.3552	0.3267	0.5497	0.2771	0.2158
33	0.7899	0.7207	0.2859	0.3317	0.3468	0.1495	0.2163	0.6241	0.6606	0.7710	0.7349
34	0.5779	0.6348	0.2081	0.2380	0.4912	0.0230	0.2687	0.2589	0.9077	0.7289	0.7182
35	0.5561	0.6828	0.1007	0.2481	0.4732	0.2439	0.3411	0.5271	0.9950	0.8782	0.9341
36	0.4802	0.6255	0.2321	0.1149	0.2706	0.0907	0.1404	0.4861	0.9855	0.8380	0.8979
37	0.4569	0.4646	0.7186	0.7283	0.4260	0.2624	0.3257	0.5464	0.6574	0.0133	0.2726
38	1.0000	0.9330	0.6321	0.5286	0.9570	0.0000	0.8956	0.8765	0.6667	0.8906	0.9547
39	0.9486	0.9087	0.4779	0.5192	0.5331	0.4987	0.5124	0.5370	0.6110	0.8465	0.7575
40	0.8583	0.9704	0.2971	0.3065	0.3929	0.1091	0.2163	0.4721	0.9177	1.0000	0.9056
41	0.9459	0.9526	0.3784	0.4366	0.6504	0.3265	0.5177	0.3991	0.6424	0.6613	0.5902
42	0.8461	1.0000	0.2632	0.3444	0.0000	0.1344	0.1404	0.3356	0.9031	0.8842	0.8133
43	0.7144	0.7085	0.2934	0.2268	0.3468	0.1001	0.1825	0.0000	0.6335	0.6446	0.5466
44	0.3984	0.4466	0.4656	0.5323	0.3929	0.5231	0.4953	0.0000	0.6039	0.4959	0.4026
45	0.1533	0.1548	0.4990	0.6115	0.4260	0.7534	0.6700	0.4527	0.5646	0.5959	0.5498
46	0.0239	0.4028	0.8149	0.6183	0.7866	0.7488	0.7731	0.6374	0.6335	0.7276	0.7140
47	0.6621	0.5996	0.5398	0.4136	0.8371	0.4463	0.7492	0.9326	0.5871	0.5818	0.9383
48	0.6814	0.6363	0.4311	0.5192	0.8451	0.7835	0.8303	0.0000	0.4569	0.7702	0.6554
49	0.7135	0.6167	0.6059	0.5224	1.0000	0.8594	1.0000	1.0000	0.5768	0.0257	1.0000
50	0.7655	0.6846	0.5624	0.5580	0.8704	0.8167	0.8623	0.8232	0.5768	0.8374	0.8891
51	0.7919	0.6972	0.3985	0.4945	0.8959	0.7938	0.8782	0.9901	0.5497	0.0599	0.9852
52	0.7389	0.6822	0.5979	0.5740	0.8526	0.5920	0.7887	0.7202	0.5497	0.8592	0.8312
53	0.7211	0.6622	0.7465	0.5964	0.7084	0.6134	0.6635	0.6184	0.6039	0.7432	0.7140
54	0.6103	0.5720	0.6652	0.3317	0.9267	0.4591	0.8650	0.9195	0.6539	0.0267	0.8743
55	0.5373	0.4978	0.4343	0.4600	0.6629	0.5634	0.6119	0.0000	0.5033	0.8206	0.6984
56	0.7055	0.7197	0.0870	0.3522	0.5331	0.2339	0.3804	0.4305	0.5304	0.3817	0.3706
57	0.3414	0.3674	0.3404	0.5789	0.3468	0.6027	0.5509	0.4398	0.5304	0.2615	0.2777
58	0.5360	0.5160	1.0000	0.7791	0.8662	1.0000	0.9343	0.4103	0.6110	0.5532	0.5046
59	0.3026	0.2915	0.7280	1.0000	0.3929	0.5231	0.4953	0.4398	0.5497	0.2623	0.2789
60	0.1678	0.2030	0.4563	0.3629	0.3468	0.5297	0.4953	0.1652	0.5033	0.2731	0.1476
61	0.2698	0.3441	0.3613	0.4849	0.5331	0.6309	0.5961	0.0000	0.0000	0.3006	0.1613
62	0.6895	0.6761	0.3190	0.5175	0.4732	0.2951	0.3683	0.5079	0.6232	0.6277	0.5929
63	0.5260	0.4842	0.7624	0.5323	0.5331	0.6100	0.5823	0.8407	0.5497	0.1952	0.7619
64	0.5496	0.5213	0.5871	0.5124	0.5068	0.5724	0.5509	0.3806	0.5768	0.2941	0.2655

Appendix 6. Variation partitioning on six sets of environmental explanatory variables for the pond data set.

Step/ order	pCCA run	Constr. var.	Covariables		Union VE	Intersection VE
1	1	A	HGYIW	A|(H∪G∪Y∪I∪W)	169	169
1	2	H	AGYIW	H|(A∪G∪Y∪I∪W)	176	176
1	3	G	AHYIW	G|(A∪H∪Y∪I∪W)	327	327
1	4	Y	AHGIW	Y|(A∪H∪G∪I∪W)	189	189
1	5	I	AHGYW	I|(A∪H∪G∪Y∪W)	476	476
1	6	W	AHGYI	W|(A∪H∪G∪Y∪I)	595	595
2	7	AH	GYIW	(A∩H)|(G∪Y∪I∪W)	346	1
2	8	AG	HYIW	(A∩G)|(H∪Y∪I∪W)	503	7
2	9	AY	HGIW	(A∩Y)|(H∪G∪I∪W)	360	2
2	10	AI	HGYW	(A∩I|)(H∪G∪Y∪W)	645	0
2	11	AW	HGYI	(A∩W)|(H∪G∪Y∪I)	768	4
2	12	HG	AYIW	(H∩G)|(A∪Y∪I∪W)	504	1
2	13	HY	AGIW	(H∩Y)|(A∪G∪I∪W)	367	2
2	14	HI	AGYW	(H∩I)|(A∪G∪Y∪W)	646	-6
2	15	HW	AGYI	(H∩W)|(A∪G∪Y∪I)	766	-5
2	16	GY	AHIW	(G∩Y)|(A∪H∪I∪W)	519	3
2	17	GI	AHYW	(G∩I)|(A∪H∪Y∪W)	839	36
2	18	GW	AHYI	(G∩W)|(A∪H∪Y∪I)	930	8
2	19	YI	AHGW	(Y∩I)|(A∪H∪G∪W)	677	12
2	20	YW	AHGI	(Y∩W)|(A∪H∪G∪I)	781	-3
2	21	IW	AHGY	(I∩W)|(A∪H∪G∪Y)	1080	9
3	22	AHG	YIW	(A∩H∩G)|(Y∪I∪W)	682	1
3	23	AHY	GIW	(A∩H∩Y)|(G∪I∪W)	539	0
3	24	AHI	GYW	(A∩H∩I)|(G∪Y∪W)	816	0
3	25	AHW	GYI	(A∩H∩W)|(G∪Y∪I)	941	1
3	26	AGY	HIW	(A∩G∩Y)|(H∪I∪W)	698	1
3	27	AGI	HYW	(A∩G∩I)|(H∪Y∪W)	1017	2
3	28	AGW	HYI	(A∩G∩W)|(H∪Y∪I)	1112	2
3	29	AYI	HGW	(A∩Y∩I)|(H∪G∪W)	849	1
3	30	AYW	HGI	(A∩Y∩W)|(H∪G∪I)	955	-1
3	31	AIW	HGY	(A∩I∩W)|(H∪G∪Y)	1252	-1
3	32	HGY	AIW	(H∩G∩Y)|(A∪I∪W)	699	1
3	33	HGI	AYW	(H∩G∩I)|(A∪Y∪W)	1010	0
3	34	HGW	AYI	(H∩G∩W)|(A∪Y∪I)	1110	8
3	35	HYI	AGW	(H∩Y∩I)|(A∪G∪W)	849	0
3	36	HYW	AGI	(H∩Y∩W)|(A∪G∪I)	956	2
3	37	HIW	AGY	(H∩I∩W)|(A∪G∪Y)	1247	2
3	38	GYI	AHW	(G∩Y∩I)|(A∪H∪W)	1044	1
3	39	GYW	AHI	(G∩Y∩W)|(A∪H∪I)	1126	7
3	40	GIW	AHY	(G∩I∩W)|(A∪H∪Y)	1457	6
3	41	YIW	AHG	(Y∩I∩W)|(A∪H∪G)	1275	-3
4	42	AHGY	IW	(A∩H∩G∩Y)|(I∪W)	880	-12
4	43	AHGI	YW	(A∩H∩G∩I)|(Y∪W)	1189	-1
4	44	AHGW	YI	(A∩H∩G∩W)|(Y∪I)	1296	1
4	45	AHYI	GW	(A∩H∩Y∩I)|(G∪W)	1022	0
4	46	AHYW	GI	(A∩H∩Y∩W)|(G∪I)	1132	0
4	47	AHIW	GY	(A∩H∩I∩W)|(G∪Y)	1421	0
4	48	AGYI	HW	(A∩G∩Y∩I)|(H∪W)	1228	2
4	49	AGYW	HI	(A∩G∩Y∩W)|(H∪I)	1311	1
4	50	AGIW	HY	(A∩G∩I∩W)|(H∪Y)	1641	1
4	51	AYIW	HG	(A∩Y∩I∩W)|(H∪G)	1448	-1

4	52	HGYI	AW	(H∩G∩Y∩I)|(A∪W)	1217	-1
4	53	HGYW	AI	(H∩G∩Y∩W)|(A∪I)	1316	5
4	54	HGIW	AY	(H∩G∩I∩W)|(A∪Y)	1629	-4
4	55	HYIW	AG	(H∩Y∩I∩W)|(A∪G)	1449	3
4	56	GYIW	AH	(G∩Y∩I∩W)|(A∪H)	1664	1
5	57	AHGYI	W	(A∩H∩G∩Y∩I)|W	1403	13
5	58	AHGYW	I	(A∩H∩G∩Y∩W)|I	1511	18
5	59	AHGIW	Y	(A∩H∩G∩I∩W)|Y	1816	0
5	60	AHYIW	G	(A∩H∩Y∩I∩W)|G	1625	1
5	61	AGYIW	H	(A∩G∩Y∩I∩W)|H	1854	1
5	62	HGYIW	A	(H∩G∩Y∩I∩W)|A	1849	1
6	0	AHGYIW		A∩H∩G∩Y∩I∩W	2047	-15

Appendix 7. Variation partitioning on five sets of environmental explanatory variables for the pond margin data set.

Step/ order	pCCA run	Constr. var.	Covariables		Union VE	Intersection VE
1	1	T	GYIW	$T\mid(G\cup Y\cup I\cup W)$	299	299
1	2	G	TYIW	$G\mid(T\cup Y\cup I\cup W)$	384	384
1	3	Y	TGIW	$Y\mid(T\cup G\cup I\cup W)$	86	86
1	4	I	TGYW	$I\mid(T\cup G\cup Y\cup W)$	383	383
1	5	W	TGYI	$W\mid(T\cup G\cup Y\cup I)$	257	257
2	6	TG	YIW	$(T\cap G)\mid(Y\cup I\cup W)$	688	5
2	7	TY	GIW	$(T\cap Y)\mid(G\cup I\cup W)$	385	0
2	8	TI	GYW	$(T\cap I)\mid(G\cup Y\cup W)$	696	14
2	9	TW	GYI	$(T\cap W)\mid(G\cup Y\cup I)$	585	29
2	10	GY	TIW	$(G\cap Y)\mid(T\cup I\cup W)$	464	-6
2	11	GI	TYW	$(G\cap I)\mid(T\cup Y\cup W)$	790	23
2	12	GW	TYI	$(G\cap W)\mid(T\cup Y\cup I)$	689	48
2	13	YI	TGW	$(Y\cap I)\mid(T\cup G\cup W)$	488	19
2	14	YW	TGI	$(Y\cap W)\mid(T\cup G\cup I)$	339	-4
2	15	IW	TGY	$(I\cap W)\mid(T\cup G\cup Y)$	667	27
3	16	TGY	IW	$(T\cap G\cap Y)\mid(I\cup W)$	769	1
3	17	TGI	YW	$(T\cap G\cap I)\mid(Y\cup W)$	1109	1
3	18	TGW	YI	$(T\cap G\cap W)\mid(Y\cup I)$	1033	11
3	19	TYI	GW	$(T\cap Y\cap I)\mid(G\cup W)$	805	4
3	20	TYW	GI	$(T\cap Y\cap W)\mid(G\cup I)$	668	1
3	21	TIW	GY	$(T\cap I\cap W)\mid(G\cup Y)$	1004	-5
3	22	GYI	TW	$(G\cap Y\cap I)\mid(T\cup W)$	893	4
3	23	GYW	TI	$(G\cap Y\cap W)\mid(T\cup I)$	767	2
3	24	GIW	TY	$(G\cap I\cap W)\mid(T\cup Y)$	1137	15
3	25	YIW	TG	$(Y\cap I\cap W)\mid(T\cup G)$	781	13
4	26	TGYI	W	$(T\cap G\cap Y\cap I)\mid W$	1214	-3
4	27	TGYW	I	$(T\cap G\cap Y\cap W)\mid I$	1112	-1
4	28	TGIW	Y	$(T\cap G\cap I\cap W)\mid Y$	1502	11
4	29	TYIW	G	$(T\cap Y\cap I\cap W)\mid G$	1123	0
4	30	GYIW	T	$(G\cap Y\cap I\cap W)\mid T$	1268	17
5	0	TGYIW		$T\cap G\cap Y\cap I\cap W$	1643	8

Appendix 8. Simplification of variation partitioning results for the pond data set. The threshold for distribution of variation is AVE = 32.49.

Order of partial component	Unique component	Original VE	VE added by distribution from components of lower order					VE after distribution
			Order 5	Order 4	Order 3	Order 2	Order 1	
6	A∩H∩G∩Y∩I∩W	-15					-15 distributed	0
5	(A∩H∩G∩Y∩I)|W	13	-3				10 distributed	0
5	(A∩H∩G∩Y∩W)|I	18	-3				15 distributed	0
5	(A∩H∩G∩I∩W)|Y	0	-3				-3 distributed	0
5	(A∩H∩Y∩I∩W)|G	1	-3				-2 distributed	0
5	(A∩G∩Y∩I∩W)|H	1	-3				-2 distributed	0
5	(H∩G∩Y∩I∩W)|A	1	-3				-2 distributed	0
4	(A∩H∩G∩Y)|(I∪W)	-12		+3+2			-7 distributed	0
4	(A∩H∩G∩I)|(Y∪W)	-1					0 distributed	0
4	(A∩H∩G∩W)|(Y∪I)	1					3 distributed	0
4	(A∩H∩Y∩I)|(G∪W)	0		+0+2			2 distributed	0
4	(A∩H∩Y∩W)|(G∪I)	0		+0+3			3 distributed	0
4	(A∩H∩I∩W)|(G∪Y)	0		+0-1			-1 distributed	0
4	(A∩G∩Y∩I)|(H∪W)	2		+0+2			4 distributed	0
4	(A∩G∩Y∩W)|(H∪I)	1		+0+3			4 distributed	0
4	(A∩G∩I∩W)|(H∪Y)	1		+0-1			0 distributed	0
4	(A∩Y∩I∩W)|(H∪G)	-1		+0+0			-1 distributed	0
4	(H∩G∩Y∩I)|(A∪W)	-1		+0+2			1 distributed	0
4	(H∩G∩Y∩W)|(A∪I)	5		+0+3			8 distributed	0
4	(H∩G∩I∩W)|(A∪Y)	-4		+0-1			-5 distributed	0
4	(H∩Y∩I∩W)|(A∪G)	3		+0+0			3 distributed	0
4	(G∩Y∩I∩W)|(A∪H)	1		+0+0			1 distributed	0
3	(A∩H∩G)|(Y∪I∪W)	1			+1+0-2		0 distributed	0
3	(A∩H∩Y)|(G∪I∪W)	0			+1+1-2		0 distributed	0
3	(A∩H∩I)|(G∪Y∪W)	0			+0+1+0		1 distributed	0
3	(A∩H∩W)|(G∪Y∪I)	1			+0+1+1		3 distributed	0
3	(A∩G∩Y)|(H∪I∪W)	1			+1+1-2		1 distributed	0
3	(A∩G∩I)|(H∪Y∪W)	2			+0+1+0		3 distributed	0
3	(A∩G∩W)|(H∪Y∪I)	2			+0+1+1		4 distributed	0
3	(A∩Y∩I)|(H∪G∪W)	1			+0+1+1		3 distributed	0
3	(A∩Y∩W)|(H∪G∪I)	-1			+0+1+1		1 distributed	0
3	(A∩I∩W)|(H∪G∪Y)	-1			+0+0+0		-1 distributed	0
3	(H∩G∩Y)|(A∪I∪W)	1			+2+0-2		1 distributed	0
3	(H∩G∩I)|(A∪Y∪W)	0			+0-1+0		-1 distributed	0
3	(H∩G∩W)|(A∪Y∪I)	8			+2-1+1		10 distributed	0
3	(H∩Y∩I)|(A∪G∪W)	0			+1+0+1		2 distributed	0
3	(H∩Y∩W)|(A∪G∪I)	2			+1+2+1		6 distributed	0
3	(H∩I∩W)|(A∪G∪Y)	2			+1-1+0		2 distributed	0
3	(G∩Y∩I)|(A∪H∪W)	1			+0+0+1		2 distributed	0
3	(G∩Y∩W)|(A∪H∪I)	7			+0+2+1		10 distributed	0
3	(G∩I∩W)|(A∪H∪Y)	6			+0-1+0		5 distributed	0
3	(Y∩I∩W)|(A∪H∪G)	-3			+0+1+0		-2 distributed	0
2	(A∩H)|(G∪Y∪I∪W)	1				+1+0+0+0	2 distributed	0

2	(A∩G)|(H∪Y∪I∪W)	7	+1+1+0+0	9 distributed	0
2	(A∩Y)|(H∪G∪I∪W)	2	+0+1+0+0	3 distributed	0
2	(A∩I|)(H∪G∪Y∪W)	0	+0+1+1+0	2 distributed	0
2	(A∩W)|(H∪G∪Y∪I)	4	+0+0+1+1	6 distributed	0
2	(H∩G)|(A∪Y∪I∪W)	1	+3+0+0+0	4 distributed	0
2	(H∩Y)|(A∪G∪I∪W)	2	+2+1+0+0	5 distributed	0
2	(H∩I)|(A∪G∪Y∪W)	-6	+1+1+0+0	-4 distributed	0
2	(H∩W)|(A∪G∪Y∪I)	-5	+1+2+3+1	2 distributed	0
2	(G∩Y)|(A∪H∪I∪W)	3	+3+1+0+0	7 distributed	0
2	(G∩I)|(A∪H∪Y∪W)	36	+2+1+0+1		40
2	(G∩W)|(A∪H∪Y∪I)	8	+2+3+3+1	17 distributed	0
2	(Y∩I)|(A∪H∪G∪W)	12	+1-1+1+1	14 distributed	0
2	(Y∩W)|(A∪H∪G∪I)	-3	+3-1+2+0	1 distributed	0
2	(I∩W)|(A∪H∪G∪Y)	9	+2-1+1+0	11 distributed	0
1	A|(H∪G∪Y∪I∪W)	169	+1+5+2+1+3		181
1	H|(A∪G∪Y∪I∪W)	176	+1+2+3-2+1		181
1	G|(A∪H∪Y∪I∪W)	327	+5+2+4+9		347
1	Y|(A∪H∪G∪I∪W)	189	+2+3+4+7+1		206
1	I|(A∪H∪G∪Y∪W)	476	+1-2+7+6		488
1	W|(A∪H∪G∪Y∪I)	595	+3+1+9+1+6		615

Appendix 9. Simplification of variation partitioning results for the pond margin data set. The threshold for distribution of variation is AVE = 53.

Order of partial component	Unique component	Original VE	VE added by distribution from components of lower order				VE after distribution
			Order 4	Order 3	Order 2	Order 1	
5	T∩G∩Y∩I∩W	8				8 distributed	0
4	(T∩G∩Y∩I)| W	-3	+2			-1 distributed	0
4	(T∩G∩Y∩W)|I	-1	+2			1distributed	0
4	(T∩G∩I∩W)|Y	11	+2			13 distributed	0
4	(T∩Y∩I∩W)|G	0	+2			2 distributed	0
4	(G∩Y∩I∩W)|T	17	+2			19 distributed	0
3	(T∩G∩Y)|(I∪W)	1		+0+0		1 distributed	0
3	(T∩G∩I)|(Y∪W)	1		+3+0		4 distributed	0
3	(T∩G∩W)|(Y∪I)	11		+3+0		14 distributed	0
3	(T∩Y∩I)|(G∪W)	4		+1+0		5 distributed	0
3	(T∩Y∩W)|(G∪I)	1		+1+0		2 distributed	0
3	(T∩I∩W)|(G∪Y)	-5		+1+3		-1 distributed	0
3	(G∩Y∩I)|(T∪W)	4		+5+0		1 distributed	0
3	(G∩Y∩W)|(T∪I)	2		+5+0		7 distributed	0
3	(G∩I∩W)|(T∪Y)	15		+5+3		23 distributed	0
3	(Y∩I∩W)|(T∪G)	13		+5+1		19 distributed	0
2	(T∩G)|(Y∪I∪W)	5		5+1+0		11 distributed	0
2	(T∩Y)|(G∪I∪W)	0		1+2+0		3 distributed	0
2	(T∩I)|(G∪Y∪W)	14		0+2+1		17 distributed	0
2	(T∩W)|(G∪Y∪I)	29		0+1+5		35 distributed	0
2	(G∩Y)|(T∪I∪W)	-6		2+0+0		-4 distributed	0
2	(G∩I)|(T∪Y∪W)	23		8+0+1		32 distributed	0
2	(G∩W)|(T∪Y∪I)	48		8+2+5			63
2	(Y∩I)|(T∪G∪W)	19		6+0+2		27 distributed	0
2	(Y∩W)|(T∪G∪I)	-4		6+2+1		5 distributed	0
2	(I∩W)|(T∪G∪Y)	27		6+8+0		41 distributed	0
1	T|(G∪Y∪I∪W)	299			+18+9+2+6		334
1	G|(T∪Y∪I∪W)	384			+16+(-2)+6		404
1	Y|(T∪G∪I∪W)	86			+3+14+(-2)+2		103
1	I|(T∪G∪Y∪W)	383			+21+14+16+9		443
1	W|(T∪G∪Y∪I)	257			+21+3+18		299

Appendix 10. Simplification of variation partitioning results for the pond data set. The threshold for distribution of variation is VE = 184.

Order of partial component	Unique component	Original VE	VE added by distribution from components of lower order					VE after distribution
			Order 5	Order 4	Order 3	Order 2	Order 1	
6	A∩H∩G∩Y∩I∩W	-15					-15 distributed	0
5	(A∩H∩G∩Y∩I)|W	13	-3				10 distributed	0
5	(A∩H∩G∩Y∩W)|I	18	-3				15 distributed	0
5	(A∩H∩G∩I∩W)|Y	0	-3				-3 distributed	0
5	(A∩H∩Y∩I∩W)|G	1	-3				-2 distributed	0
5	(A∩G∩Y∩I∩W)|H	1	-3				-2 distributed	0
5	(H∩G∩Y∩I∩W)|A	1	-3				-2 distributed	0
4	(A∩H∩G∩Y)|(I∪W)	-12	+3+2				-7 distributed	0
4	(A∩H∩G∩I)|(Y∪W)	-1					0 distributed	0
4	(A∩H∩G∩W)|(Y∪I)	1					3 distributed	0
4	(A∩H∩Y∩I)|(G∪W)	0	+0+2				2 distributed	0
4	(A∩H∩Y∩W)|(G∪I)	0	+0+3				3 distributed	0
4	(A∩H∩I∩W)|(G∪Y)	0	+0-1				-1 distributed	0
4	(A∩G∩Y∩I)|(H∪W)	2	+0+2				4 distributed	0
4	(A∩G∩Y∩W)|(H∪I)	1	+0+3				4 distributed	0
4	(A∩G∩I∩W)|(H∪Y)	1	+0-1				0 distributed	0
4	(A∩Y∩I∩W)|(H∪G)	-1	+0+0				-1 distributed	0
4	(H∩G∩Y∩I)|(A∪W)	-1	+0+2				1 distributed	0
4	(H∩G∩Y∩W)|(A∪I)	5	+0+3				8 distributed	0
4	(H∩G∩I∩W)|(A∪Y)	-4	+0-1				-5 distributed	0
4	(H∩Y∩I∩W)|(A∪G)	3	+0+0				3 distributed	0
4	(G∩Y∩I∩W)|(A∪H)	1	+0+0				1 distributed	0
3	(A∩H∩G)|(Y∪I∪W)	1		+1+0-2			0 distributed	0
3	(A∩H∩Y)|(G∪I∪W)	0		+1+1-2			0 distributed	0
3	(A∩H∩I)|(G∪Y∪W)	0		+0+1+0			1 distributed	0
3	(A∩H∩W)|(G∪Y∪I)	1		+0+1+1			3 distributed	0
3	(A∩G∩Y)|(H∪I∪W)	1		+1+1-2			1 distributed	0
3	(A∩G∩I)|(H∪Y∪W)	2		+0+1+0			3 distributed	0
3	(A∩G∩W)|(H∪Y∪I)	2		+0+1+1			4 distributed	0
3	(A∩Y∩I)|(H∪G∪W)	1		+0+1+1			3 distributed	0
3	(A∩Y∩W)|(H∪G∪I)	-1		+0+1+1			1 distributed	0
3	(A∩I∩W)|(H∪G∪Y)	-1		+0+0+0			-1 distributed	0
3	(H∩G∩Y)|(A∪I∪W)	1		+2+0-2			1 distributed	0
3	(H∩G∩I)|(A∪Y∪W)	0		+0-1+0			-1 distributed	0
3	(H∩G∩W)|(A∪Y∪I)	8		+2-1+1			10 distributed	0
3	(H∩Y∩I)|(A∪G∪W)	0		+1+0+1			2 distributed	0
3	(H∩Y∩W)|(A∪G∪I)	2		+1+2+1			6 distributed	0
3	(H∩I∩W)|(A∪G∪Y)	2		+1-1+0			2 distributed	0
3	(G∩Y∩I)|(A∪H∪W)	1		+0+0+1			2 distributed	0
3	(G∩Y∩W)|(A∪H∪I)	7		+0+2+1			10 distributed	0
3	(G∩I∩W)|(A∪H∪Y)	6		+0-1+0			5 distributed	0
3	(Y∩I∩W)|(A∪H∪G)	-3		+0+1+0			-2 distributed	0
2	(A∩H)|(G∪Y∪I∪W)	1			1+0+0+0		2 distributed	0

2	(A∩G)|(H∪Y∪I∪W)	7	1+1+0+0	9 distributed	0
2	(A∩Y)|(H∪G∪I∪W)	2	0+1+0+0	3 distributed	0
2	(A∩I|)(H∪G∪Y∪W)	0	0+1+1+0	2 distributed	0
2	(A∩W)|(H∪G∪Y∪I)	4	0+0+1+1	6 distributed	0
2	(H∩G)|(A∪Y∪I∪W)	1	3+0+0+0	4 distributed	0
2	(H∩Y)|(A∪G∪I∪W)	2	2+1+0+0	5 distributed	0
2	(H∩I)|(A∪G∪Y∪W)	-6	1+1+0+0	-4 distributed	0
2	(H∩W)|(A∪G∪Y∪I)	-5	1+2+3+1	2 distributed	0
2	(G∩Y)|(A∪H∪I∪W)	3	3+1+0+0	7 distributed	0
2	(G∩I)|(A∪H∪Y∪W)	36	2+1+0+1	40 distributed	0
2	(G∩W)|(A∪H∪Y∪I)	8	2+3+3+1	17 distributed	0
2	(Y∩I)|(A∪H∪G∪W)	12	1-1+1+1	14 distributed	0
2	(Y∩W)|(A∪H∪G∪I)	-3	3-1+2+0	1 distributed	0
2	(I∩W)|(A∪H∪G∪Y)	9	2-1+1+0	11 distributed	0
1	A|(H∪G∪Y∪I∪W)	169	1+5+2+1+3		181
1	H|(A∪G∪Y∪I∪W)	176	1+2+3-2+1		181
1	G|(A∪H∪Y∪I∪W)	327	5+2+4+9+20		367
1	Y|(A∪H∪G∪I∪W)	189	2+3+4+7+1		206
1	I|(A∪H∪G∪Y∪W)	476	1-2+7+6+20		508
1	W|(A∪H∪G∪Y∪I)	595	3+1+9+1+6		615

Appendix 11. Simplification of variation partitioning results for the pond margin data set. The threshold for distribution of variation is VE = 102.

Order of partial component	Unique component	Original VE	VE added by distribution from components of lower order				VE after distribution
			Order 4	Order 3	Order 2	Order 1	
5	T∩G∩Y∩I∩W	8				8 distributed	0
4	(T∩G∩Y∩I)| W	-3	+2			-1 distributed	0
4	(T∩G∩Y∩W)|I	-1	+2			1distributed	0
4	(T∩G∩I∩W)|Y	11	+2			13 distributed	0
4	(T∩Y∩I∩W)|G	0	+2			2 distributed	0
4	(G∩Y∩I∩W)|T	17	+2			19 distributed	0
3	(T∩G∩Y)|(I∪W)	1		+0+0		1 distributed	0
3	(T∩G∩I)|(Y∪W)	1		+3+0		4 distributed	0
3	(T∩G∩W)|(Y∪I)	11		+3+0		14 distributed	0
3	(T∩Y∩I)|(G∪W)	4		+1+0		5 distributed	0
3	(T∩Y∩W)|(G∪I)	1		+1+0		2 distributed	0
3	(T∩I∩W)|(G∪Y)	-5		+1+3		-1 distributed	0
3	(G∩Y∩I)|(T∪W)	4		+5+0		1 distributed	0
3	(G∩Y∩W)|(T∪I)	2		+5+0		7 distributed	0
3	(G∩I∩W)|(T∪Y)	15		+5+3		23 distributed	0
3	(Y∩I∩W)|(T∪G)	13		+5+1		19 distributed	0
2	(T∩G)|(Y∪I∪W)	5		5+1+0		11 distributed	0
2	(T∩Y)|(G∪I∪W)	0		1+2+0		3 distributed	0
2	(T∩I)|(G∪Y∪W)	14		0+2+1		17 distributed	0
2	(T∩W)|(G∪Y∪I)	29		0+1+5		35 distributed	0
2	(G∩Y)|(T∪I∪W)	-6		2+0+0		-4 distributed	0
2	(G∩I)|(T∪Y∪W)	23		8+0+1		32 distributed	0
2	(G∩W)|(T∪Y∪I)	48		8+2+5		63 distributed	0
2	(Y∩I)|(T∪G∪W)	19		6+0+2		27 distributed	0
2	(Y∩W)|(T∪G∪I)	-4		6+2+1		5 distributed	0
2	(I∩W)|(T∪G∪Y)	27		6+8+0		41 distributed	0
1	T|(G∪Y∪I∪W)	299			18+9+2+6		334
1	G|(T∪Y∪I∪W)	384			32+16+(-2)+6		436
1	Y|(T∪G∪I∪W)	86			3+14+(-2)+2		103
1	I|(T∪G∪Y∪W)	383			21+14+16+9		443
1	W|(T∪G∪Y∪I)	257			21+3+32+18		331

Appendix 12. Kendall’s correlation coefficient and adjacent significance level between number of species surveyed in each sampling unit (both ponds and pond margins) and explanatory variables, P < 0.05 given in bold.

Pond			Pond margin		
Exp. var.	Kendall’s τ	P	Exp. var.	Kendall’s τ	P
PArea	.0114	.8936	MArea	**.3933**	**<.0001**
MaxDep	.1319	.1217	AvgWid	**.2197**	**.0100**
MedDep	.1517	.0750	MaxSlp	.1359	.1117
Fluct	.1116	.1247	MinSlp	-.0719	.3994
Drain	-.1294	.0249	Soil	-.0069	.9101
Well	.0183	.7850	MaxSoil	.1532	.0663
Outl	-.0808	.2662	MinSoil	-.0634	.4577
Inl	-.0565	.4389	MedSoil	-.0064	.9399
UTMn	.0114	.8936	UTMn	.1463	.0872
UTMe	-.1418	.0962	UTMe	**-.2004**	**.0192**
Alt	-.0882	.2992	Alt	.0848	.3203
DistWat	-.0148	.8612	DistWat	-.0466	.5852
DistRoad	-.0858	.3131	DistRoad	.0158	.8525
DistAgr	-.0396	.6376	DistAgr	.0987	.2429
DistBui	.1031	.2005	DistBui	.0431	.5935
DistForest	-.0912	.2814	DistForest	-.1562	.0661
Age	.0252	.7217	Age	-.1121	.1156
Fire	.0317	.5807	Fire	.0302	.5997
Water	.0421	.5221	Water	.1274	.0537
Drink	-.0119	.8732	Drink	-.1086	.1466
Laund	.0277	.5175	Laund	-.0362	.4003
Fence	-.0962	.1825	Fence	.0421	.5604
Lime	**-.0823**	**.0374**	Lime	-.0153	.6983
Garb	-.0272	.5254	Garb	-.0501	.2449
Renov	-.0148	.8351	Renov	-.1131	.1147
Herbic	-.0193	.6249	Herbic	.0401	.3113
StonyMarg	-.0436	.3427	StonyMarg	-.0431	.3497
Cut	.0833	.2801	Cut	-.0203	.7927
Fell	.0054	.9154	Fell	.0699	.1747
Graze	-.0967	.1140	Graze	-.0223	.7162
Fish	-.0788	.2994	Fish	.1210	.1124
Duck	-.0942	.1532	Duck	-.0024	.9701
Enlarge	.0014	.9794	Enlarge	**.1383**	**.0167**
Diminish	-.0233	.6123	Diminish	-.0694	.1323
Secchi	.0907	.2868	Cnd	-.0396	.6428
Cnd	**-.1785**	**.0362**	pH	.0451	.5977

pH	**-.1676**	**.0492**	Alk	-.0406	.6345
Alk	**-.2004**	**.0188**	Ca	-.0312	.7149
Ca	-.1602	.0602	Clr	-.0461	.5898
Clr	-.0565	.5072	Trb	**-.2008**	**.0189**
Trb	.0282	.7402	PO_4-P	**-.1726**	**.0430**
PO_4-P	-.1289	.1292	Part-P	**-.2629**	**.0021**
Part-P	-.0416	.6251	Tot-P	**-.2440**	**.0043**
Tot-P	-.1235	.1473	NH_3-N	-.0838	.3270
NH_3-N	**-.2123**	**.0127**	NO_3-N	**.1889**	**.0269**
NO_3-N	-.0768	.3665	Part-N	.0798	.3507
Part-N	-.0530	.5336	Tot-N	-.0342	.6892
Tot-N	**-.2485**	**.0036**			