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Macrophytes and benthic fauna as biological elements following the EU Water Framework Directive

Status classification of the river Skattmansöån in mid-Sweden

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ABSTRACT

The water framework directive (WFD) was implemented in December 2000, with the goal to improve all the water bodies in Europe to "good status" by 2015. To assess the water status of rivers, biological elements such as macroinvertebrates, aquatic flora (macrophytes, benthic algae, and diatoms) and fish is used. The aims of this study were to investigate whether (1) it is suitable to use macrophytes to determine the status of a river; and (2) whether the ecological status determined by macrophytes corresponds with the ecological status derived from benthic fauna. Two different sites along the river Skattmansöån was chosen. The first site is surrounded by farming landscape, the second site lies within a nature reserve. Both sites had a macrophyte inventory performed. Benthic fauna was, at the farm site, sampled for the national survey program and the nature reserve site was sampled for this study. For macrophytes, indices were used to calculate species diversity differences and dissimilarity of the sites and between transects. Ellenberg Nitrogen index and Trophic macrophyte index (TMI) were used to estimate the nutrient status. Ecological quality ratios (EQR) to classify the status of the river was done for both benthic fauna and macrophytes. The sites were clearly different when looking at macrophyte species community set up. However the results changed when looking at the Ellenberg index, TMI and EQR for macrophytes, which showed that both sites had nearly the same values for all of these indices, hence should have the same status. At this time, it is doubtful as to whether it is possible to use macrophytes to make a status classification of the river Skattmanöån according to the WFD. In addition the benthic fauna and the macrophyte results did not concur. Therefore, depending on what kind of biological element is investigated, the results can differ, and hence it is important to sample several biological elements to get a reliable status classification.

INTRODUCTION

European Union Water Framework Directive

High demand for clean rivers and lakes has been evident for a long time in many European countries (European Commission, 2008). A poll in 2007 in 27 European Union member states showed that 42% of the citizens were worried about the water pollution issues (European Commission, 2008). Already in 1988 the need for a European water legislation that would protect EU waters was identified, but it took 10 more years before the European Commission came out with a proposal in 1997/98. Two years later, on 23d October 2000, the new European Union water framework directive (WFD) was implemented (WISE, 2007).

The goals of the WFD were to:

(1) Protect and improve all water bodies including rivers, lakes, coastal waters and groundwater;
(2) Prevent a further degradation in status of aquatic systems and wetlands;
(3) Secure the water supply for the future;
(4) Prevent and reduce the pollution of groundwater;
(5) Ease the effects of floods and droughts (Directive 2000/60/EC, 2000).

It also had an ambitious goal that all waters should have achieved "good status" by 2015. "Good status" means that the parameters for the biological quality elements should only show low levels of disturbance, as a result of human activity. Measurements should be taken to amend and plan improvements for all the water bodies that are not considered to have this status. Because of this goal, environmental quality achievement levels have been suggested to describe the quality of EU water bodies. It is up to each EU member to decide upon national laws and rules, which need to apply the new directive (Naturvårdsverket, 2007a). One of the biggest challenges, when compared with previous water management, is that the management should be based on natural river basins, which requires a combined effort across jurisdictions and between many different organisations within the catchment (WISE, 2007).

The WFD has been incorporated into Swedish national law. Three legislations and ordinances oversee the workings of The Swedish Water Administration, and they include: (1) The Environmental Code (Miljöbalken); (2) Ordinance 2004:660 (Förordning om förvaltning av kvaliteten på vattenmiljön); (3) Ordinance 2002:864 (Förordning med länstyrelseinstruktion). Since 2004 Sweden has been divided into 5 water districts (Figure 1). These districts each contain several catchments. One county administrative board within each water district has been appointed to the water authority and they are responsible for the environmental quality of the water bodies within each district. The water authority is also responsible for constructing an action program with reference to what is needed to be fulfilled and to ensure the environmental standards are met within the water districts (Hägerhäll-Aniansson *et al.* 2005).

The quality demand

Surface water status is assessed using two components. They include the biological status and chemical status of the water bodies. In rivers there are three biological elements. These include (1) aquatic flora (macrophytes, benthic algae, and diatoms), (2) macroinvertebrates, and (3) fish. There are also hydromorphological and chemical elements used to support the biological elements (Directive 2000/60/EC, 2000). Classification of the water body is determined in view of these biological elements and falls into five status classes, including high, good, moderate, unsatisfactory or poor, in order of descending quality. Chemical status is only divided into "good" and "does not achieve good status" (Directive 2000/60/EC, 2000). The WFD states that the chemical elements and the poorer of the biological elements should determine the status of the water body, meaning that the worst factors will drive the final status classification of the water body.

Figure 1. Sweden's five water districts. (County administrative board, 2008).

In Sweden, baselines for river quality parameters have been agreed upon for all the biological parameters except macrophytes, due to inadequate data (Naturvårdsverket, 2003). Macrophytes are defined as large aquatic plants. According to the WFD all member states have to define quality elements for all the biological parameters, or have an expert assessment conducted on that biological element.

Macrophytes are large plants, mostly referred to as aquatic plants large enough to be seen by the naked eye. Macrophytes affect, and in turn get affected by, their surroundings. They are relatively slow to react to changes in their surroundings, therefore, an inventory of macrophytes is considered to mirror the spring/pre-summers' nutrient status rather than the status at the sampling occasion in the end of the summer (Naturvårdsverket, 2007a). Macrophytes show a difference in preference to nitrogen, phosphorous, pH and alkalinity and they are incorporated in indices of many kinds in Europe. Some such indices include the Macrophyte Biological Index for Rivers, Mean Trophic Rank, Ellenberg Index and others (Schneider, 2007). In Sweden, a Trophic Macrophyte Index (TMI) in lakes have been adopted and developed (Naturvårdsverket, 2007a).

Uppsala county administration has classified several rivers and lakes in the county according to The WFD. Problems with this classification process has been to classify rivers using macrophytes due to the lack of data and baselines, and to get corresponding results when different biological elements are compared.

Therefore, the aims of the present study were (1) to investigate as to whether it is suitable to use macrophytes to determine the status of a river; and (2) whether the ecological status determined by macrophytes corresponds with the ecological status based on benthic fauna classification.

METHODS

Study sites

Most of Uppsala County was once sea floor and therefore the ground is naturally rich in nutrients. Because of this, it is well suited for agriculture, and large areas have been farmed for a long time. The present study investigated two study sites, and they were both situated along the river Skatmmansöån, within the catchment of Örsundaån, in Uppsala County (Figure 2).

Figure 2. The locations of the two sampled sites along river Skattmansöån, west of Uppsala, Sweden.

Heavy farming surrounds the first site and it has been ditched and straightened at one or several occasions. ("farm site"; Figure 3; coordinates X: 6625647 and Y: 1573580 in the Swedish national grid, RT 90 2.5 G W). The River Skattmanöån flows into the river Örsundaån, which is a bigger river, just downstream of the farm site. Benthic fauna and chemical data have been sampled at this site earlier for the National Survey program, and this provided the primary reason why this site was chosen for macrophyte inventory, as an example of a heavily affected site.

The second site was located approximately 12 km upstream in the catchment, and was within Skattmansöådalens nature reserve ("nature reserve site: Figure 3a and 3b, coordinates X: 6635443 and Y: 1570053 in the Swedish national grid, RT 90 2.5 G). The nature reserve was implemented to preserve the valley and the open area with a long history of cultivation as well as usage for research, education and outdoor life (Uppsala County administrative board, 2008). The river at the nature reserve meanders deep within the valley and is surrounded by pasturelands and forest (Figure 3c and 3d). The river has not been ditched or straightened at this site. The nature reserve site has no earlier sampling of any elements, therefore macrophytes and benthic fauna were both sampled at this site. Water samples were not considered to be worth sampling at this site. This since the chemical values tend to fluctuate highly through time and, as a consequence, would possibly result in a false picture of the overall water chemistry, as several sampling occasions would not be possible within the time limit of this study.

Figure 3. The sampling sites of river Skattmansöån (a) The farm site from above (b) the farm site seen from the river (c) The nature reserve site from above showing the valley (d) the nature reserve site seen from the river (the river is in the left hand side of the picture).

Macrophytes

Macrophyte inventory

Macrophyte inventorying of the two sites on the river Skattmansöån was conducted from 29th August to 10th September 2007. The inventory was performed according to the Swedish Environmental Protection Agency's (EPA) directive for macrophytes in running water (Naturvårdsverket, 2003). The method requires that both macrophytes, and the vegetation on the banks of the river, are noted. Sampling was conducted by forming transects using a tape measure that was strung from one bank to the other. 14 transects were sampled in the farm site and 15 in the nature reserve site. The first transect was furthest down the stream at the site, and the distance to the next transect was approximately 3 meters upstream from the previous transect. Transects were divided into quadrants of 0.25 * 0.25 metres. Each bank had 8 quadrants per transect (totalling 2 metres from the water on each side), and the first quadrant was adjacent to the river with the eighth furthest from the water. The number of water quadrants could vary depending on the width of the river. Water quadrant number 1 was always up against the left bank of the river looking upstream (Figure 4). In each quadrant, each species of plant found was noted. All the plants that could not be identified in the field were taken to the laboratory for identification. On the first transect of each site the height difference between the river and the bank at 1 and 2 metres from the river was noted for each side.

A description of the locality (Appendix 1 and 2) with a general vegetation composition of the surrounding area (within 0-30 meters from the river) and vegetation composition of the banks (0-5 meters from the river), as well as a general note on things that could influence the site was conducted (e.g. farming, drainage).

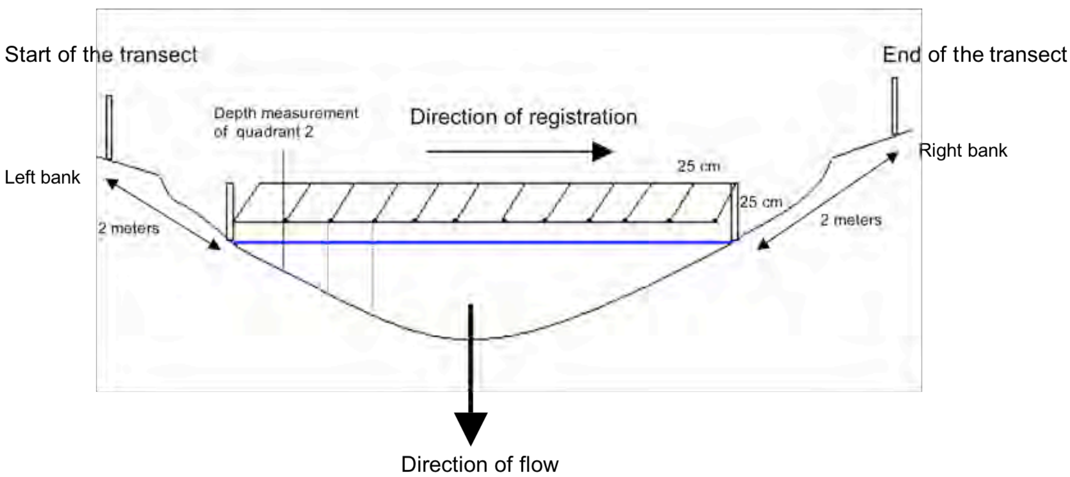

Figure 4. A simple picture showing the transect setup over the river, adapted from Naturvårdsverket (2003).

Ellenberg nitrogen values for plants species

The Ellenberg nitrogen index was created by a German ecologist and is often used in terrestrial and aquatic ecosystems to assess environmental stress. By looking at the community set up, an assessment of the environment can be made since different plants have different responses to environmental stressors (Staniszewski *et al*. 2006). This index has indicator values for six ecological factors: light, temperature, continentality, moisture, reaction and nitrogen. These factors are divided into 9, so-called, "indicator values" depending on their ecological optimum (Ewald, 2003). Here only the nitrogen indicator value was used to assess the nutrient loading.

A value of 1 means that the plants need the smallest amount of nitrogen in the surrounding and 9, the upper extreme, the plant needs or prefers very high concentration of nitrogen levels (Table 1), the Ellenberg values were acquired from "Ellenberg index values, 2008".

Macrophyte diversity indices

Diversity can be measured by using biological indices and there are many different indices developed for different purposes. A β diversity index is a measure of to what extent the diversity of two or more spatial units differ (Magurran, 2004). In the present study, two β diversity indices were used. They included (1) the Whittaker's measure, which examines the difference of sample diversity richness in relation to total species richness, and (2) the Jaccard Index, or Marczewski-Steinhaus index (MS), which focuses on the difference in species composition and is formulated as a complementarity or similarity/dissimilarity measure. They were chosen because they both can be used for binary presence/absence data (Magurran, 2004).

For the Whittaker's measure and the Marczewski-Steinhaus distance, the results fall between 0, complete similarity, and 1, maximum diversity (Table 1). In the present study, the indices described above were used to compare each sites' land transects and the sites water transects separately.

Complementarity index

A complementarity index can measure the distinctiveness of two localities or evenness across transects (Table 1). Complementarity is simply another name for a β diversity index, and the more complementary the two sites are the higher the β diversity (Magurran, 2004). It can be used to cover distinctiveness of species composition over a larger scale as well as over a smaller scale, such as the difference of the mite fauna on the tree trunk and the leaves on a single tree species (Colwell and Coddington, 1994). In this study it was used to compare transects within each site to see if the transects differed within each site. The complementarity index varies from 0, when transects are identical to one-another, to 100%, when transects are completely different.

Trophic macrophyte index and Ecological quality ratio

Trophic macrophyte index (TMI) is based on that aquatic plants will reflect the nutrient status of a lake (eutrophic or oligotrophic) (Frauke, 2007). It has been developed, and used, for rivers in Germany to establish differences of trophic statuses of running waters (Schneider and Melzer, 2003). Sweden has only adapted the index to measure nutrient statuses of lakes in Sweden, with the aim to modify it for rivers in the future (Frauke, 2007).

Ecological quality ratio (EQR) is based on TMI and other indices for other biological elements. It has a range of 0 to 1, which represents the status or the potential of the site where it ranges from bad to high status. EQR is calculated for a quality element such as macrophytes or benthic fauna, and is then divided into the classes high, good, moderate, unsatisfactory or poor (Naturvårdsverket, 2007a). The reference values are based on lakes and rivers that are considered to have a high ecological status, where parameters like make-up of surrounding areas, ditching and draining are considered as well as total nitrogen, phosphorous and pH values. TMI's indicator values as well as weight factors, reference values and baselines used in this investigation were according to "Naturvårdsverket, 2007b".

TMI is calculated by a simple formula (Table 1), which takes into account the preference for nutrient levels by macrophytes (in this case total phosphorous) and the weight factor that indicate the niche width along the total phosphorous gradient.

Benthic fauna

Benthic fauna sampling

Benthic fauna sampling was conducted according to the Swedish EPA's method "Undersökningstyp: Bottenfauna i sjöars littoral och i vattendrag-tidsserier" (Naturvårdsverket, 1996). This method was used previously when the farm site was sampled and therefore, in order to get comparable results, was chosen for the nature reserve site. The method has been designed to describe the status and/or examine the changes of benthic fauna species composition over time. The species composition reflects the influence from the surrounding areas and the results can therefore be used to judge how airborne pollutants, discharge, land use and other actions in the river basin influence the ecosystem. The method itself is simple and was conducted on 28th September 2007. Benthic fauna were caught using a sieve with a mesh size of 0.6 mm. The sampling area was a defined 10-metre strip, which was as homogenous as possible in respect to the substrate, vegetation, water depth and current. From the 10-metre strip, five replicates were sampled. This was done by using a hand sieve and stirring the bottom with the foot over an area corresponding to 25 cm in width for a length of 1 metre. After the sampling, the contents of the sieve were collected in a bucket and large stones and

branches were removed. The last step was to conserve each sample by adding 96% alcohol to a final concentration of 70% alcohol.
All the samples were transported to an accredited benthic fauna identifier at the Swedish University of Agricultural Sciences (SLU) for counting and identification on the same day.

Benthic fauna indices

As a biological element, benthic fauna is extensively used in many European countries to assess rivers water quality (Triest *et al.* 2001). Since macroinvertebrates are a highly diverse group, it is most likely that some will react with a change in water quality. Due to their relatively long life span, macroinvertebrates can act as a continuous monitor of the water chemistry that surrounds them (Triest *et al.* 2001). Sweden has incorporated and developed several indices based on the information from the rest of Europe to fit the Swedish conditions.

Average Score Per Taxon (ASPT) is a sensitivity index. It gives a score based on the sensitivity of benthic fauna families against environmental influences. Families that are sensitive give high indicator values and families that have a high tolerance level give low indicator values (Johnson and Goedkoop, 2007). This index also integrates the effect from eutrophication, acidification and destruction of the habitat like ditching and clearing (Naturvårdsverket, 2007a). The indicator values for each family were retrieved from Johnson and Goedkoop (2007). ASPT is calculated by taken the sum of the indicator values and dividing it with the number of occurring families (Table 1).

The Saprobie index is an index that calculates a value depending on the species found, the species abundance and the response this species has to organic pollution or pollutants, (Triest *et al.* 2001). The purpose of the index is to classify the river from unpolluted to extremely polluted water, it uses the self cleaning effect of a river after a wastewater discharge point and is done so by monitoring the change. The index is calculated by taking the saprobic value for each species found, times the number of individuals (Table 1) (UNRALS, 2008).

Multimetric indices combine the values from several "simple" indices, such as the Saprobie and ASPT indices. Multimetric indices are regarded as more robust and able to better detect environmental changes since they are not as sensitive to fluctuations over time and variation between testers (Johnson and Goedkoop, 2007).

The DJ-index (Table 1) is a multimetric index that is composed of five simple indices. These include (1) number of taxa of *Ephemeroptera*, *Plecoptera* and *Trichoptera* (EPT), (2) the relative abundance (%) of *Crustacea*, (3) the relative abundance (%) of EPT, (4) ASPT and (5) the Saprobie index (Johnson and Goedkoop, 2007).

Ecological quality ratio for benthic fauna

The EQR for benthic fauna is calculated in a similar way as for macrophytes (Table 1). The reference and minimum values can be found in Johnson and Goedkoop (2007).

Table 1. Calculated indices in the sites and transects, formula/formulas and in which range of values they extent.

Index	Site and transects used	Formula	Range of values
Whittaker´s β_w measure	Compares the sites water and land transects	$\beta_w = S/\alpha - 1$ [a]	0 to 1
Marczewski-Steinhaus distance	Compares the sites water and land transects	$C_{MS} = 1\text{-}a/ a+b+c$ [b]	0 to 1
Complementarity index	Compares the farm sites water and land transects	$C_T = \Sigma U_{jk}/ n \Rightarrow Ujk = Sj+Sk - 2Vjk$ [c]	0 to 100%
Complementarity index	Compares the nature reserve sites water and land transects	$C_T = \Sigma U_{jk}/ n \Rightarrow Ujk = Sj+Sk - 2Vjk$ [c]	0 to 100%
Ellenberg Nitrogen index	Gives a value for each site using water and land transcts within the site	N-index = $\sum P_i * N_i$ [d]	1 to 9
TMI	Gives a value for each site using water transects within the site	TMI = $\Sigma(\text{Indicatorvalue}_{Sp.} * \text{Weightfactor}_{Sp.}) / \Sigma \text{ Weightfactor}_{Sp}$	1 to 10
EQR for macrophytes	Gives a value for each site using water transects within the site	EQR = (Obs. trophic index - 1) / (Ref. value - 1)	0 to 1
EQR for benthic fauna: ASPT index	Gives a value for each site	EQR_{ASPT} = (Obs. value – Min. value) / (Ref. value – Min. value)	0 to 1
EQR for benthic fauna: DJ index	Gives a value for each site	EQR_{DJ} = (Obs. value – Min. value) / (Ref. value – Min. value)	0 to 1

[a] S = total no. of sp. in both sites
α = average sample richness
[b] a = total no. of sp. in both samples.
b and c= no. of sp. present only in sample 1 respectively sample 2
[c] Ujk = no. of sp. not shared
Vjk = no. of sp. Shared
Sj and Sk = no. of sp.in the transects j and k
n = no. of transects
[d] Pi = relative cover of the ith sp.
Ni = the sensitivity value of the ith species

RESULTS

Macrophyte presence in water transects

The farm site was clearly different, in community composition of macrophytes, from the nature reserve site (Figure 5, Table 2). The farm site was dominated by *Equisetum fluviatile* and *Sparganium* sp, while the nature reserve site was dominated by *Typha latifolia* and *Schoenoplectus lacustris*. The nature reserve site had in total 10 species of macrophytes, while the farm site had 8 species. The sites had 5 species of macrophytes in common. The species unique for the nature reserve site were relatively few numbered except for *Typha latifolia*.

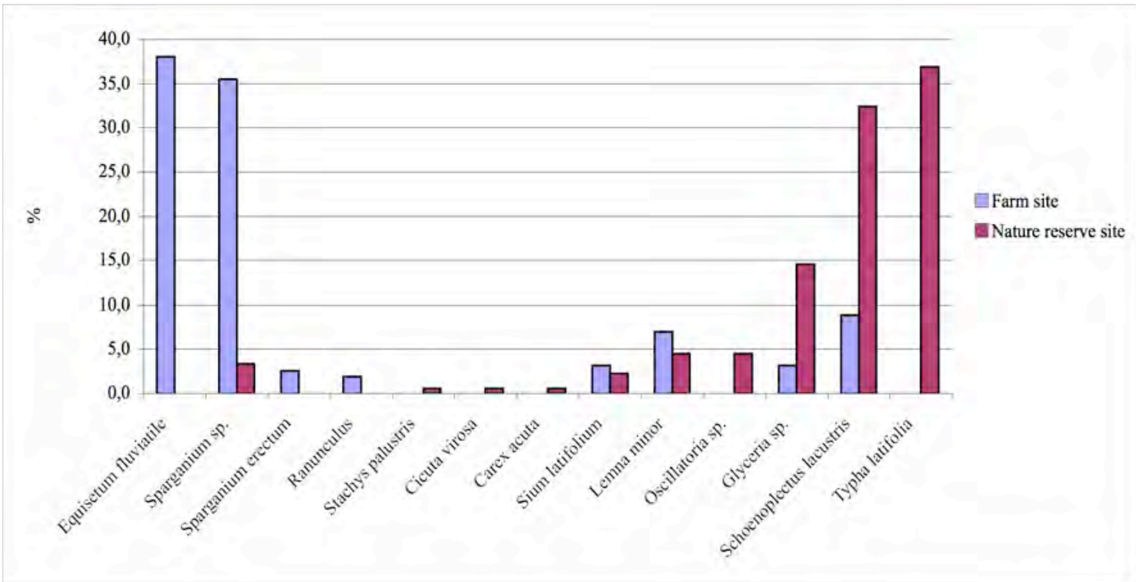

Figure 5. Percentage occurrence of macrophytes. Percentage refers to the proportion of the number of quadrants in which the specific species occur. Data includes the water transects, at the two sites.

Table 2. Macrophyte occurrence and percentage data for the water transects in both the farm site and the nature reserve site. Numbers of plants found for each species (#) refer to number of quadrants containing the specific species, and percentage (%) refer to the rate at which they occur in the total number of quadrants with vegetation.

		Farm site		Nature reserve site	
Latin name	**Swedish name**	**#**	**%**	**#**	**%**
Typha latifolia	Bredkaveldun	0	0,0	66	36,9
Stachys palustris	Knölsyska	0	0,0	1	0,6
Sparganium sp.	Igelknopp	56	35,4	6	3,4
Sparganium erectum	Storigelknopp	4	2,5	0	0,0
Sium latifolium	Vattenmärke	5	3,2	4	2,2
Schoenoplectus lacustris	Säv	14	8,9	58	32,4
Ranunculus		3	1,9	0	0,0
Oscillatoria sp.		0	0,0	8	4,5
Lemna minor	Andmat	11	7,0	8	4,5
Glyceria sp.	Mannagräs	5	3,2	26	14,5
Equisetum fluviatile	Sjöfräken	60	38,0	0	0,0
Cicuta virosa	Sprängört	0	0,0	1	0,6
Carex acuta	Vasstarr	0	0,0	1	0,6
Total number of sp.		**8**		**10**	
sp. in common between the sites		**5**			
Total number of sp. recorded in both sites		**13**			

Plant presence in land transects

The farm site was clearly different in community composition of macrophytes from the nature reserve site (Figure 6, Table 3). The farm site was not clearly dominated by any species but the most common species were *Calystegia sepium*, *Glyceria* sp. and *Urtica dioica.* While the nature reserve site was dominated by *Glyceria* sp.*,* *Carex* sp., and *Typha latifolia*. The farm site had a much higher species diversity compared to the nature reserve site. The nature reserve site had 3, to the site common species, and 15 species that occurred in less than 5% of the quadrants. The farm site had, on the other hand, no dominating species, and only 8 of the total 33 species occurred in more than 5% of the quadrants.

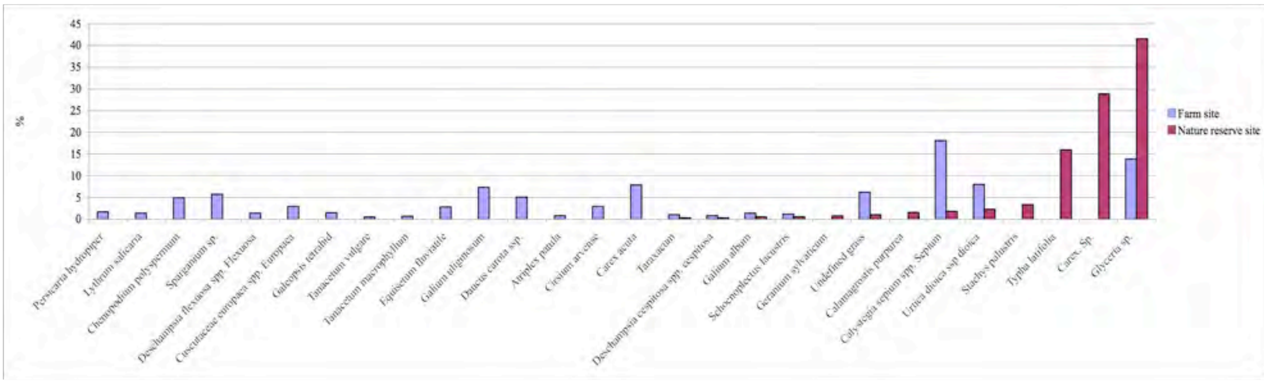

Figure 6. Percentage occurrence of macrophytes. Percentage refers to the proportion of the number of quadrants with vegetation the specific species occur in the land transects, at both the farm site and the nature reserve site. Species that occurred in total less than 2 times in the sites were excluded from the graph.

Table 3. Macrophytes occurrence and percentage data for the land transects in both the farm site and the nature reserve site. Numbers of plants found for each species (#) refer to number of quadrants containing the specific species, and percentage (%) refer to the rate they occur in the total number of quadrants with vegetation.

Latin name	**Swedish name**	**Farm site #**	**Farm site %**	**Nature reserve site #**	**Nature reserve site %**
Atriplex patula	Vägmålla	5	0,8	0	0,0
Bidens tripartita	Brunskära	1	0,2	0	0,0
Calamagrostis purpurea	Brunrör	0	0,0	6	1,5
Calystegia sepium	Snårvinda	111	18,1	7	1,8
Carex acuta	Vasstarr	48	7,8	114	28,9
Chenopodium polyspermum	Fiskmålla	30	4,9	0	0,0
Cirsium arvense	Åkertistel	18	2,9	0	0,0
Cirsium vulgare	Vägtistel	0	0,0	1	0,3
Crepis sp		1	0,2	0	0,0
Cuscutaceae europaea	Nässelsnärja	18	2,9	0	0,0
Cyperaceae sylvaticus	Skogssäv	0	0,0	1	0,3
Daucus carota ssp.	Vildmorot	31	5,0	0	0,0
Deschampsia cespitosa	Tuvtåtel	5	0,8	1	0,3
Deschampsia flexuosa	Kruståtel	8	1,3	0	0,0
Elytrigia repens	Kvickrot	2	0,3	0	0,0
Equisetum fluviatile	Sjöfräken	17	2,8	0	0,0
Galeopsis tetrahid	Pipdån	9	1,5	0	0,0
Galium album	Stormåra	8	1,3	2	0,5
Galium palustre elongatum	Stor vattenmåra	2	0,3	0	0,0
Galium uliginosum	Sumpmåra	45	7,3	0	0,0
Geranium sylvaticum	Skogsnäva	0	0,0	3	0,8
Glyceria sp.	Mannagräs	85	13,8	164	41,5
Lythrum salicaria	Fackelblomster	8	1,3	0	0,0
Persicaria hydropiper	Bitterpilört	10	1,6	0	0,0
Plantago major	Gårdsgroblad	2	0,3	0	0,0
Ranunculus sceleratus	Tiggarranunkel	2	0,3	0	0,0
Schoenoplectus lacustris	Säv	7	1,1	2	0,5
Sium latifolium	Vattenmärke	1	0,2	2	0,5
Sparganium erectum	Stor igelknopp	1	0,2	0	0,0
Sparganium sp.	Igelknopp	35	5,7	0	0,0
Stachys palustris	Knölsyska	0	0,0	13	3,3
Tanacetum macrophyllum	Röllikekrage	4	0,7	0	0,0
Tanacetum sp.		2	0,3	0	0,0
Tanacetum vulgare	Renfana	3	0,5	0	0,0
Taraxacum	Maskros sp.	6	1,0	1	0,3
Trifolium medium L	Skogsklöver	0	0,0	1	0,3
Trifolium pratense	Rödklöver	0	0,0	1	0,3
Tripleurospermum perforatum	Baldersbrå	2	0,3	0	0,0
Typha latifolia	Bredkaveldun	0	0,0	63	15,9
Undefined grass		38	6,2	4	1,0
Urtica dioica	Brännässla	49	8,0	9	2,3
Total number of sp.		**33**		**18**	
sp. In common		**10**			
Total number of sp. recorded in both sites		**41**			

Ellenberg nitrogen values for plants species

All *Carex* spp. were assumed to be *Carex acuta* and all *Glyceria* spp. were assumed to be *Glyceria maxima*. Both sites had a mean Ellenberg index value close to 7, which indicates that both sites were nitrogen rich (Table 4), with a slightly higher value at the nature reserve site.

Table 4. Species names, occurrence, relative cover in percent, Ellenberg values and calculated Ellenberg weighted values for the combined land and water transects for both the farm site and the nature reserve site.

Latin name	Swedish name	Farm site #	Farm site Relative cover	Natur reserve site #	Natur reserve site Realtive cover	Ellenberg value	Farm site Ellenberg weighted value	Natur reserve site Ellenberg weighted value
Atriplex patula	Vägmålla	5	0,008	0	0,000	7	0,058	0,000
Bidens tripartita	Brunskära	1	0,002	0	0,000	8	0,013	0,000
Calystegia sepium	Snårvinda	111	0,185	7	0,013	9	1,662	0,115
Carex acuta	Vasstarr	48	0,080	115	0,210	4	0,319	0,841
Chenopodium polyspermum	Fiskmålla	30	0,050	0	0,000	8	0,399	0,000
Cicuta virosa	Sprängört	0	0,000	1	0,002	5	0,000	0,009
Cirsium arvense	Åkertistel	18	0,030	0	0,000	7	0,210	0,000
Cirsium vulgare	Vägtistel	0	0,000	1	0,002	8	0,000	0,015
Cuscutaceae europaea	Nässelsnärja	18	0,030	0	0,000	7	0,210	0,000
Daucus carota	Vildmorot	31	0,052	0	0,000	6	0,309	0,000
Deschampsia cespitosa	Tuvtåtel	5	0,008	1	0,002	3	0,025	0,005
Elytrigia repens	Kvickrot	2	0,003	0	0,000	7	0,023	0,000
Equisetum fluviatile	Sjöfräken	77	0,128	0	0,000	5	0,641	0,000
Galeopsis tetrahid	Pipdån	9	0,015	0	0,000	6	0,090	0,000
Galium album	Stormåra	8	0,013	2	0,004	5	0,067	0,018
Galium palustre elongatum	Stor vattenmåra	2	0,003	0	0,000	6	0,020	0,000
Galium uliginosum	Sumpmåra	45	0,075	0	0,000	2	0,150	0,000
Geranium sylvaticum	Skogsnäva	0	0,000	3	0,005	7	0,000	0,038
Glyceria sp.	Mannagräs	90	0,150	190	0,347	9	1,348	3,126
Lemna minor	Andmat	11	0,018	8	0,015	6	0,110	0,088
Plantago major	Gårdsgroblad	2	0,003	0	0,000	6	0,020	0,000
Ranunculus sceleratus	Tiggarranunkel	2	0,003	0	0,000	9	0,030	0,000
Schoenoplectus lacustris	Säv	21	0,035	60	0,110	6	0,210	0,658
Sium latifolium	Vattenmärke	6	0,010	6	0,011	7	0,070	0,077
Sparganium erectum	Stor igelknopp	5	0,008	0	0,000	7	0,058	0,000
Stachys palustris	Knölsyska	0	0,000	14	0,026	6	0,000	0,154
Tanacetum vulgare	Renfana	3	0,005	0	0,000	5	0,025	0,000
Trifolium medium L	Skogsklöver	0	0,000	1	0,002	3	0,000	0,005
Tripleurospermum perforatum	Baldersbrå	2	0,003	0	0,000	6	0,020	0,000
Typha latifolia	Bredkaveldun	0	0,000	129	0,236	8	0,000	1,887
Urtica dioica	Brännässla	49	0,082	9	0,016	9	0,734	0,148
Sum		**601**	**1**	**547**	**1**		**6,8**	**7,2**

Macrophyte diversity indices

Whittaker´s β_w measure

The Whittaker´s β_w measure indicated that the water transects were different from each other (0.44) and the land transects differed to a greater extent from each other (0.66). (See table 2 and 3 for species names and occurrences at both sites and in both land and water transects).

Marczewski-Steinhaus distance

Marczewski-Steinhaus distance measure indicated high degree of diversity between the sites in both the water and the land transects. The results have the same trend as for the Whittaker´s β_w diversity measure, with a higher degree of similarity across water transects (0.62) than across land transects (0.76).

Complementarity index

The water transects, in both sites, were relatively homogenous in composition and arrangement of species (farm site 18.4%, nature reserve 23%). This was also the case for the land transects at the nature reserve site (24%) while the farm site had more of a heterogeneous composition of species (62.4%).

Trophic macrophyte index and Ecological Quality Ratio

Only two species were found that had indicator values and weight factors according to Naturvårdsverket (2007b). They were *Glyceria* sp. and *Lemna minor*. They were used to calculate TMI for both sites. Their indicator values and weight factors can be seen in Table 5.

Table 5. Indicator values and weight factor from "Naturvårdsverket" (2007b), for the two species found in both sites.

Species	Indicator value	Weight factor
Glyceria sp.	7	0,8
Lemna minor	4	0,8

The TMI value was 5.5 at both sites, which, in turn, gives an EQR of 0.62. Therefore, given these index values, the status of macrophytes at these sites was in the "moderate, unsatisfactory, poor" category. In Sweden no further divisions of this category have been made due to the limited amount of data (Naturvårdsverket, 2007b).

Benthic fauna

Ecological Quality Ratio for benthic fauna

The benthic fauna indices were calculated with Asterics software and the values in both sites can be seen in table 6. For each value of the simple indices an "index norm" is calculated to later calculate the EQR for the DJ- index (Table 7). The EQR for ASPT and the DJ -indices are both in the "high" category for both sites (Table 8), meaning that these sites have a high ecological status according to the Swedish baselines of benthic fauna in running water (Johnson and Goedkoop, 2007). This means that the taxonomic composition and abundance more or less corresponds to undisturbed conditions (Directive 2000/60/EC, 2000).

Table 6. Calculated indices and index norms for farm and nature reserve sites. The nature reserve site was sampled in 2007 for this study, and the farm was sampled for the *national survey programme* in 2000. Baselines for status classification can be found in "Johnson and Goedkoop" (2007).

	Farm	**Nature reserve**
Saprobic Index	1,96	2,21
index norm	2,00	2,00
Average score per Taxon	5,83	5,33
index norm	2,00	2,00
- Crustacea [%]	12,90	4,71
index norm	2,00	2,00
- EPT-Taxa [%]	16,72	39,83
index norm	2,00	2,00
- EPT-Taxa	12,00	6,00
index norm	2,00	2,00
DJ-index	1,00	1,00
ASPT-index	1,08	0,99

Table 7. Criteria for normalising the "simple" indices to be able to calculate the EQR of the DJ-index.

Index		**Criteria**	
Number of EPT taxa	< 5	5, 12	> 12
% Crustacea	> 22.2	0.5, 22.2	< 0.5
% EPT taxa	< 10.4	10.4, 52.1	> 52.1
ASPT	< 5	5, 6.3	> 6.3
Saprobic-index	> 2.5	1.9, 2.5	< 1.9
$Index_{norm}$	**1**	**2**	**3**

Table 8. Reference values for ASPT and DJ- indices as well as values for EQR classification and calculated values for ASPT and DJ – indices for both sites.

	ASPT- index	**DJ -index**
Reference value	0	10
High	> 0.90	> 0.80
Good	0.70 - 0.90	0.60 - 0.80
Moderate	0.45 - 0.70	0.40 - 0.60
Unsatisfactory	0.25 - 0.45	0.20 - 0.40
Poor	< 0.25	< 0.20
Farm site	1,08	1
Nature reserve site	0,99	1

A summary of all the results (table 9) shows that the water and land transects of the two sites are different when looking at Marczewski-Steinhaus distance measure, Whittaker´s $\beta_W$measure and the complementarity index. But the results for the sites are the same or get the same status classification when looking at the Ellenberg index and EQR for TMI, DJ and ASPT indices.

Table 9. Calculation and value for each index and site as well as a short interpretation of the result.

Index	Site and transects used	Value	Interpretation
Whittaker´s β_w measure	Water transects, both sites	0.44	The two sites water transects are different
Whittaker´s β_w measure	Land transects, both sites	0.61	The two sites land transects are different
Marczewski-Steinhaus distance	Water transects, both sites	0.62	The two sites water transects are different
Marczewski-Steinhaus distance	Land transects, both sites	0.76	The two sites land transects are different
Complementarity index	Water transects, farm site	18.43%	Homogenous in composition and arrangement of sp.
Complementarity index	Water transects, nature reserve site	22.93%	Homogenous in composition and arrangement of sp.
Complementarity index	Land transects, farm site	62.43%	Heterogeneous in composition and arrangement of sp.
Complementarity index	Land transects, nature reserve site	23.87%	Homogenous in composition and arrangement of sp.
Ellenberg Nitrogen index	Water and land transects, farm site	6.8	Nitrogen rich site
Ellenberg Nitrogen index	Water and land transects, nature reserve site	7.2	Nitrogen rich site
TMI	Water transects, farm site	5.5	"Moderate, unsatisfactory, poor" status classification
TMI	Water transects, nature reserve site	5.5	"Moderate, unsatisfactory, poor" status classification
EQR for macrophytes	Water transects, farm site	0.62	"Moderate, unsatisfactory, poor" status classification
EQR for macrophytes	Water transects, nature reserve site	0.62	"Moderate, unsatisfactory, poor" status classification
EQR for benthic fauna: ASPT index	Farm site	1.08	"High status" classification
EQR for benthic fauna: ASPT index	Nature reserve site	0.99	"High status" classification
EQR for benthic fauna: DJ index	Farm site	1.0	"High status" classification
EQR for benthic fauna: DJ index	Nature reserve site	1.0	"High status" classification

DISCUSSION

When doing inventories one hope for similar results independently of index used, in this study this was not the case. When looking at macrophytes you could clearly see that the sites were different from each other according to the presence/abundance data, Marczewski-Steinhaus distance measure, Whittaker´s β_w measure and the complementarity index. However the results changed when looking at the Ellenberg index, TMI, DJ and ASPT indices, which showed that both sites had nearly the same values for all of these indices, and hence should have the same status.

The two sites investigated in the present study were clearly different when looking at the species composition of macrophytes in the water and land transects. There was slightly greater macrophyte species richness in the water transects of the nature reserve site than in the farm site. However the farm site had greater species richness in the land transects than the nature reserve site. The dominating aquatic species of the farm site were *Equisetum fluviatile* and *Sparganium* sp. while the dominating water living species of the nature reserve were *Typha latifolia* and *Schoenoplectus lacustris. Typha latifolia* and *Sparganium* sp. are species that are considered indicators of a site with high nutrient levels (Mossberg and Stenberg, 2003). The nature reserve land transects were dominated by *Glyceria* sp. and *Carex acuta,* and the farm site land transects had no dominating species**.** In the farm sites land transects the most common species were *Calystegia sepium*, *Glyceria.* sp. and *Urtica dioica*, of which all are considered to be signs of relatively high nutrient levels (Mossberg and Stenberg, 2003).

When natural high nutrient levels occur, there can be problems to assess the effects of additional nutrient enrichments. In these cases, variation in species composition may be due to factors other than nutrient levels, such as the size of the watercourse or if the river is regulated (Bernez *et al.* 2004). Bernez *et al*. (2004) showed that the total and absolute plant species richness varied greatly among the basins studied, and this was mostly due to differences in geology and substrate. Bernez *et al*. (2004) also found that the relative and absolute species richness increased further downstream, and most of the species were shared between the upstream and downstream sites. Bernez *et al.* (2004) argued that the plants shared among sites had a strong capacity to adapt to large spectrums of environmental conditions (i.e. had a broad niche). In the present study, the species richness in water transects decreased in the site further downstream, the farm site, and this decrease could possibly be due to changes in river morphology (e.g. stream canalisations and regulation) as well as mechanical and chemical weed control.

The farm site was located in the middle of a large area of farmland, downstream of the nature reserve site. The nature reserve site had, in spite of this, a slightly higher Ellenberg nitrogen index. However, this slightly higher value could be due to the construction of the Ellenberg index, which (1) sometimes has problems to show reliable results in strongly modified habitats (Staniszewski *et al.* 2006); (2) is not likely to be as good an indicator in disturbed or unstable communities (Dzwonko, 2001); (3) was developed for terrestrial plants that absorb nitrogen from the soil and not for aquatic plants that can in some cases absorb nutrients from the water (Staniszewski *et al.* 2006).

Diversity indices

The two diversity indices showed that the sites differed moderately in diversity and that they had different species communities. The water transects of each of the two sites were more similar than the land transects at the two sites. This could be due to the different morphology of the sites; the nature reserve site had more of a flood plain, while the farm site had steep banks close to the water channel. These banks might allow for terrestrial plants which are more adapted to dryer conditions to occupy these habitats, as opposed to the flood plain-like situation at the nature reserve site. This flood plane might prevent species that are sensitive to flooding to colonise.

Marczewski-Steinhaus distance measure indicates, in comparison to Whittaker´s β_w measure, a higher degree of diversity between the sites in both the water and the land transects. Whittaker´s β_w only takes into account the average sample richness and the number of species, whereas the Marczewski-Steinhaus distance is calculated based on species presence-absence in the compared sites. Hence the slightly different results reflect how these indices are calculated.

The nature reserve water and land transects, and the water transects at the farm site, were very similar to each other according to the complimentarity index. However, the land transects in the farm site got a high value for the complementarity index, indicating that there was a high degree of variation within these transects. This could partly be explained by the morphology of the river, as with the diversity indices.

Trophic macrophyte index and Ecological Quality Ratio for macrophytes

The calculated TMI had the same value for both sites since the same species were used for the calculation. The other species found in the sites did not have indicator values and weight factors, thus they could not be included in this index. According to The WFD, a moderate ecological status for macrophytes means that (1) the composition of macrophyte taxa differ moderately from the type-specific community and is significantly more distorted than at good status, and (2) moderate changes in the average macrophyte abundance is evident. However this result is not entirely applicable to a river, since the index has been developed for lakes in Sweden and not rivers. Nevertheless, it can possibly be used as a guideline when no other indices are available. Even if the community set up of species might differ, there is definitely overlap of species occurrences in lakes and rivers, and plants should have the similar preferred nutrient levels whether they occur in a lake or a river. Since the TMI is based on macrophytes' preferred nutrient levels, and since it is used to classify the status of Swedish lakes, it should, therefore also be able to give us an indication of the status of a river.

Benthic fauna

The farm site that was sampled for the national survey program had as good results as the nature reserve site did in the present study. Even though the ASPT index is designed to incorporate influences from ditching and clearing, in this case, no affect on the benthic fauna community could be discovered with the aid of this index. The DJ index did not show any difference between the sites. Hence the benthic fauna EQR values calculated from these indices indicated that both sites had a "high" ecological status. A high ecological status according to The WFD means that: (1) "the taxonomic composition and abundance corresponds totally or nearly totally to undisturbed conditions; (2) the ratio of disturbance sensitive taxa to insensitive taxa shows no signs of alteration from undisturbed levels; (3) the level of invertebrate taxa shows no sign of alteration from undisturbed levels".

Conclusion

At this time, it is doubtful as to whether it is possible to use macrophytes to make a status classification of the river Skattmansöån according to The WFD. Although the nature reserve site was clearly more aesthetically valuable and less morphologically disturbed than the farm site, these differences were not portrayed in the results based on macrophytes. Therefore it might be better to use a multimetric approach by incorporating hydromorphological information when assessing macrophytes in the future.

In addition, the benthic fauna and the macrophyte results did not concur. While the benthic fauna results suggested that both sites should have a "high" status, the macrophyte results gave evidence for a "moderate, unsatisfactory to poor" status of both sites. Hence, depending on what kind of biological element is investigated, the results can differ, and this provides the impetus for a recommendation to sample several biological elements to conduct a locality status classification. Therefore, a greater understanding of the different elements, and why and how they differ to such a great extent, would help future status classification of rivers.

Even though some of the indices were designed to measure habitat disturbance, in the present study they seemed not to do this. The ASPT index, and therefore also the DJ index, should give a lower value for the farm site due to its high levels of disturbance (e.g. ditching and straightening). This was not the case and, therefore, one wonders how accurate this index is when it is not able to detect these impacts. It is recommended to improve the accuracy of the indices and their ability to classify water system's health, it is necessary to include information about the morphological disturbances water systems have experienced, as well as to incorporate more knowledge about the effects surrounding areas have had on the water systems. In spite of these issues, it would be recommended for the time being to sample benthic fauna out of benthic fauna and macrophytes. Mainly because of benthic faunas wider usage as an indicator, but also because benthic fauna sampling and indices have been altered and improved for the Swedish conditions.

Sandin *et al.* (2003) concluded that it is very important to choose the right locality to sample. The locality has to be representative for the watercourse in general, but it also has to be suitable for the biological element sampled, otherwise the status classification might be incorrect. Sandin *et al.* (2003) showed that localities that were suitable for sampling of benthic algae, benthic fauna and fish were not suitable for sampling of macrophytes. Hence, the question is if the biological element sampled, should also steer the locality where this sampling ought to occur. In this case it would therefore be helpful to have a habitat inventory as a base for decision making to where different biological elements should be sampled within a specific watercourse.

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REFERENCES

Bernez, I., Daniel, H., Haury, J. an Ferreira, M, T. 2004 Combined effects of environmental factors and regulation on macrophyte vegetation along three rivers in western France. *River research and applications*. 20: 43-59

Colwell, R. K. and Coddington, J. A. 1994. Estimating Terrestrial Biodiversity through Extrapolation. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences (London).* 345: 101-118

Directive 2000/60/EC, 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities.* L 327/1

Dzwonko, Z. 2001. Assesment of light and soil condition in ancient and recent woodlands by Ellenberg indicator values. *Journal of Applied Ecology*. 38, 942-951

European Commission, 2008. Attitudes of European citizens towards the environment. Special Eurobarometer 295/ Wave 68.2 – TNS Opinion & SocialSocial

Ewald, J. 2003. The sensitivity of Ellenberg indicator values to the completeness of vegetation releve's. *Basic and Applied Ecology.* 4:507-513.

Frauke, E. 2007. Bedömningsgrunder för makrofyter i sjöar- Bakgrundsrapport. Forskningsrapport 2007:17. Institutionen för tillämpad kemi och geovetenskap. Luleå tekniska universitet, Luleå.

Hallingbäck, T. and Holmåsen, I. 2000. Mossor en fälthandbok. Stenströms Bokförlag AB/ Interpublishing, Stockholm.

Hägerhäll-Aniansson, B., Vidarve, M. and Magnusson, C. 2005. Rapport 5489. En bok om svensk vattenförvaltning. Naturvårdsverket. ISBN 91-620-5489-9

Johnson, R. K. and Goedkoop, W. 2007. Bedömningsgrunder för bottenfauna i sjöar och vattendrag- Användarmanual och bakgrundsdokument. Instutionen för miljöanalys, SLU, Uppsala.

Magurran, A. E. 2004. Measuring biological diversity. Blackwell publishing. 108 Cowley road, Oxford OX4 1JF, UK. ISBN 0-632-05633-9.

Mossberg, B. and Stenberg, L. 2003. Den nya nordiska floran. Wahlström & Widstrand.

Naturvårdsverket, 1996. Handledning för miljöövervakning Undersökningstyp: Bottenfauna i sjöars littoral och vattendrag- tidsserier

Naturvårdsverket 2003. Handbok för miljöövervakning. Undersökningstyp: Makrofyter i vattendrag

Naturvårdsverket, 2007a. Status, potential och kvalitetskrav för sjöar, vattendrag, kustvatten och vatten i övergångszon. En handbok om hur kvalitetskrav i ytvattenförekomster kan bestämmas och följas upp. Handbok 2007:4. Utgåva 1. December 2007.

Naturvårdsverket. 2007b. Naturvårdsverket Bilaga A, 2007. Bedömningsgrunder för sjöar och vattendrag, Bilaga A, till Handbok 2007:4.

Sandin, L., Andersson, B., Bergengren, J., Bergquist, B., Broberg, O., Dahlberg, M., Fölster, J., Jarlman, A. and Östlund, M. 2003. Undersökning av påväxt, bottenfauna, makrofyter och fisk längs en naturlighetsgradient i Emåns & Mörrumsåns avrinningsområden. Rapport 2003:4. Institutionen för miljöanalys, Sveriges Lantbruksuniversitet.

Schneider, S. and Melzer, A. 2003. The trophic index of macrophytes (TIM)- a new tool for indicating the trophic state of running waters. *International Review of Hydrobiology*. 88: 49-67

Schneider, S. 2007. Macrophyte trophic indicator values from a European perspective. *Limnologica* 37: 281-289

Staniszewski, R., Szoszkiewicz, K., Zbierska, J., Lesny, J., Jusik, S. and Clarke, R. T. 2006. Assessment of sources of uncertainty in macrophyte surveys and the consequences for river classifiaction. *Hydrobiologia* 566:235-246.

Triest, L., Kaur, P., Heylen, S. and De Pauw, N. 2001. Comparative monitoring of diatoms, macroinvertebrates and macrophytes in the Woluwe River (Brussel, Belgium). *Aquatic Ecology* 35: 183-194

Internet references

ASTERICS free software, http:// **www.aqem.de/start.htm**, acquired 21**th** April 2008.

Uppsala county administrative board, 2008. http://www.c.lst.se/templates/Naturreservat.aspx?id=672, viewed 19th May 2008.

WISE (Water Information System for Europe), http://ec.europa.eu/environment/water/water-framework/info/decision_en.htm, viewed 25th September 2007.

Ellenberg index values, 2008. http://statedv.boku.ac.at/zeigerwerte/, viewed 5th May 2008 .

UNRALS. 2008. University of Natural Resources and Applied Life Sciences, Vienna. http://www.boku.ac.at. Viewed 23rd May 2008.

Picture

County administrative board, 2008. http://www5.g.lst.se/verksam/experter/naturvard/vattendirektivet/vattendirektiv_distrikt.htm, acquired 7th April 2008.

APPENDIX 1.

Locality description of the farm site

Sampling dates	29th of August, 3d and 5th of September 2007
Watercourse	Skattmansöån
Locality	Farm site
Watercourse maximum width (m)	4.45
Mean depth (m)	0.36
Maximum depth (m)	0.82
Average flow velocity (m/s)	0.12
Turbidity of water	Very turbid
Water colour	Highly coloured
Mean water temperature(C°)	10.4
Mean air temperature (C°)	16.0
Local environment*	
Deciduous forest	
Coniferous forest	
Mixed forest	
Clear-cut forest	
Wetland	
Field	1
Meadows/ Open pasture land	
Heath	
Boulders	
Artificial land	
Tree	
Bushes	
Grasses	
Other	3
Dominating species:	
Cirsium arvense	
Urtica dioica ssp dioica	
Galium spp.	
Poaceae spp.	
Galium album	
Salix sp.	
Water vegetation*	
Helofytes	1
Nympeides	
Elodeides	
Isoetides	
Mosses	
Benthic algae	
Dominating species:	
Sparganium sp.	2
Equisetum fluviatile	1
Lemna minor	1
Shading of water surface by vegetation (%)	0
Height difference between the river and the bank	
Left side, 1 metre from the water (cm)	90

Left side, 2 metres from the water (cm)	120
Right side, 1 metre from the water (cm)	80
Right side, 2 metres from the water (cm)	160

Plants found outside the transects:
Achillea millefolium
Tripleurospermum perforatum
Daucus carota ssp.
Sinapis arvensis

Influence/ Other annotations:
The sides of the river are heavily eroded, and the river is ditched and straightened (2= strongly affected). The area is heavily influenced by agriculture and Salix is cultivated on one of the sides of the river.

* Grading from 1, dominating to 3, least dominating.

APPENDIX 2.

Locality description of the nature reserve site

Sampling dates	7th and 10th of September 2007
Watercourse	Skattmansöån
Locality	Nature reserve site
Watercourse maximum width (m)	3.45
Mean depth (m)	0.30
Maximum depth (m)	0,74
Average flow velocity (m/s)	0,025
Turbidity of water	Very turbid
Water colour	Highly coloured
Mean water temperature(C°)	10.1
Mean air temperature (C°)	15.1
Local environment	
Deciduous forest	3
Coniferous forest	3
Mixed forest	
Clear-cut forest	
Wetland	
Field	
Meadows/ Open pasture land	3
Heath	
Boulders	
Artificial land	
Tree	
Bushes	3
Grasses	1
Other	1
Dominating species:	
Juniperus communis	
Picea abies	
Poaceae spp.	
Glyceria sp.	
Water vegetation	
Helofytes	1
Nympeides	
Elodeides	
Isoetides	
Mosses	
Benthic algae	
Dominating species:	
Typha latifolia	2
Glyceria sp.	2
Schoenoplectus lacustris	2
Shading of water surface by vegetation (%)	5
Height difference between the river and the bank	
Left side, 1 metre from the water (cm)	50
Left side, 2 metres from the water (cm)	52
Right side, 1 metre from the water (cm)	80

Right side, 2 metres from the water (cm)	100

Plants found outside the transects:
Achillea millefolium
Alchemilla vestita
Barbula recurvirostris
Bryum capillare
Carex hirta
Cirsium arvense
Convallaria majalis
Corylus avellana
Dactylis glomerata
Daucus carota ssp.
Deschampsia cespitosa spp. cespitosa
Deschampsia flexuosa spp. Flexuosa
Filipendula ulmaria
Galium album
Glyceria sp.
Juniperus communis
Lythrum salicaria
Phleum pratense
Picea abies
Pinus sylvestris
Rhytidiadelphus squarrosus
Rosa dumalis
Serratula tinctoria
Stachys palustris
Thlaspi caerulescens
Urtica dioica ssp dioica

Influence/ Other annotations:
Slightly ditched, farms and pasturelands are located in the vicinity to the river.

* Grading from 1, dominating to 3, least dominating.