

A study into the effects of micro-topography and edaphic factors on vegetation community structure

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Abstract

This study examines the influence of micro-topography and other environmental parameters on managed coastal grasslands in Estonia. Vegetation community types were identified and abundance and frequency of plant species were recorded within 105 vegetation quadrats. A dGPS approach was used to record mean elevations within 1m² quadrats, as well as soil moisture, soil organic matter content, soil pH, conductivity, N, P and K values. A significant difference was recorded for different vegetation community types, and mean differences were between 4 and 19cm dependant on the vegetation community type.

Keywords wet-grasslands, micro-topography, vegetation communities, hydrology

Introduction

Coastal wet grasslands are wetlands of ecological importance as they support characteristic biological diversity (Joyce & Wade, 1998; Benstead et al, 1999). These wet grasslands are made up of a mosaic of habitat types (Rebassoo 1975b; Peñacoo, 1987; Paal 1998; Burnside et al 2007; Berg 2009) influenced by micro-topography, hydrology, sediment type and management.

In managed areas a variety of habitat types occur, Burnside et al (2007) developed a phytosociological key using TWINSpan analysis for these wet grasslands. This habitat classification for vegetation communities within these grassland systems has been used in this study to investigate which environmental factors had the greatest effect in determining the location of the vegetation community types within coastal wet grasslands.

The aim of the study has been to produce a new method for rapid landscape assessment using dGPS technology and vegetation quadrats to assess landscape vulnerability to rising sea levels due to climate change.

Seven habitat groupings were used in the study these included RS (Reed Swamp), CS (Clubrush Swamp), LS (Lower Shore), US (Upper Shore), OP (Open Pioneer), TG (Tall Grassland) and SW (Scrub and developing Woodland).

Methods

Individual habitat patches were identified throughout the study site which was located in the Tahu coastal meadow of the Silma Nature Reserve in western Estonia. Fifteen quadrats were located in the field site using a stratified random approach with quadrats placed in randomly selected patches of each of the seven habitat types throughout the coastal meadow. 1m² were used and within the quadrats all plant species were recorded as well as their abundance using the Domin scale (Rodwell 1995). Twenty randomly selected points were recorded within each quadrat using a dGPS. Soil samples were also collected within each quadrat for analysis of soil organic matter, N, P, K, salinity and soil moisture in the laboratory. The data were tested using a series of Kruskal Wallis tests to identify which factors significantly differed between each habitat type and a further series of modified Mann-Whitney tests were performed in order to identify which factors differed between which habitat types. Further analysis included a PCA, to determine which factors correlated to which

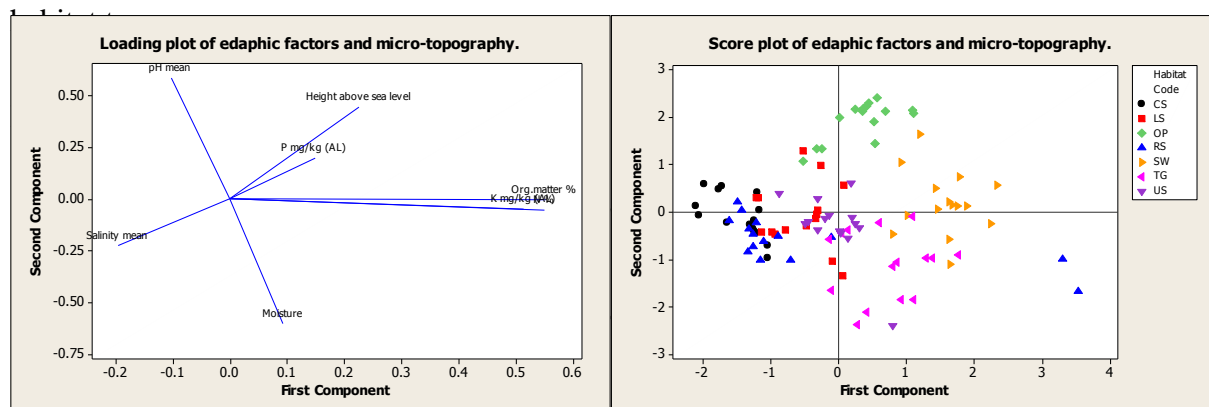


Figure 1 shows a Loading and Score plot output from a PCA.

The main factors that affected the CS and RS habitat types were low Z values (altitude), organic matter content and N/K values with high salinity (see figure 1). The LS and US habitat types seemed to be affected with median values of each factor. The OP habitat type had the highest pH and very low moisture content. The TG habitat was found to have low pH

and conductivity as well as high organic matter and N/K values. The SW habitat had the highest organic matter and N/K values and low moisture, pH and conductivity.

Habitat Code	N %	P mg/kg	K mg/kg	Org. matter %	pH	Salinity $\mu\text{s/cm}$	Height m	Moisture %
CS	0.7062	23.8973	232.5700	14.1847	5.0377	1933.3667	0.0111	58.6667
RS	0.9470	34.6287	396.2107	20.4413	5.0120	2060.7000	0.1059	62.6933
LS	0.7441	32.6413	311.4293	15.7953	6.1120	1402.3000	0.2991	54.8400
US	1.1167	30.8393	414.5113	26.0580	5.8180	2126.5667	0.3393	47.2400
OP	0.0461	27.6047	129.1260	1.0560	6.9257	2234.9127	0.3785	19.9733
TG	1.7101	28.7733	486.1300	40.5600	6.0630	759.8667	*0.5693	49.7533
SW	1.4293	40.7453	426.7660	33.9480	6.2380	347.4000	0.6197	23.4867

Table 1 shows the mean soil N, P, K, Organic matter, pH, salinity, moisture and the mean height above sea level for each of the habitat types. *Mean value does not show full spread of height range above sea level overlapped with OP.

As can be seen in table 1 groupings can be found for each of the examined factors. A lower height grouping which always includes CS and RS and invariably includes LS and to a lesser extent US which has low soil N, K, organic matter content, pH and moisture content and high height above sea level and salinity. The OP habitat type is typically not in any group except with CS and RS for salinity. And the upper height grouping which always includes TG and SW and invariably includes US and less often LS and has high soil N, K, organic matter content and moisture content and neutral pH as well as low salinity and soil moisture content.

Soil P was not found to significantly differ amongst any of the habitat types.

Discussion

This study shows that very small differences in altitude of the order of 4 cm can have a significant effect on vegetation community type. With the exception of TG all of the habitat types were contained within quite narrow altitudinal bands.

The CS habitat type was found at the lowest altitude and therefore had high moisture content. For the CS habitat type altitude and moisture were the factors limiting its location and abundance. For RS it was typically found at a higher altitude than CS although the soil moisture levels in this habitat type were not significantly higher than in CS. This was due to the fact that during the duration of the study a mild onshore wind caused the CS, RS and LS habitat types to be inundated although it was noted that duration of inundation was lower for the higher altitude vegetation types (Ward, pers. obs.) The limiting factor for the spread of RS to higher altitudinal areas has been shown to be management (Berg, 2009). The LS and US

habitat types were confined to their respective altitudinal heights and soil moisture content was the main factor affecting their location. OP was found in localised depressions with little vegetation cover. This habitat type overlapped altitudinally with the lower altitude areas of TG although had much lower N/K, soil organic matter and moisture levels and much higher pH and conductivity. In previous visits it was noted that after inundation events this habitat type formed standing pools (Ward pers. obs.). Following evaporation of these pools the habitat type is typically left with surface salt deposits. This creates ideal habitat conditions for sparse halophytic vegetation species such as *Suaeda maritima* and *Juncus gerardii* which are rare in the eastern Baltic area (EC habitat directive 92/43/EEC 1992). This sparse vegetation is unlikely to develop organic rich soils.

The TG habitat type was found to have an overlapping altitude with OP and SW. In the higher areas of the TG habitat type there were found mixed TG and SW stands. It would appear that in the upper areas of the wet grassland both SW and TG vegetation can occur although SW is less tolerant of high moisture levels and will not occur if the area has been continuously managed.

The lower habitat types (CS, RS, LS and US) are subjected to longer and more frequent inundation times by brackish water causing higher soil conductivity than less frequently inundated habitat types. The anaerobic conditions caused by flooding also limit the breakdown of organic material causing lower soil organic matter content, N/K. The higher altitude habitat types (TG and SW) are rarely inundated and so tend to have much lower soil conductivity and much higher soil organic matter and N/K. The higher areas have also had a longer time to develop organic soils, having been above sea level for a longer period of time. Isostatic uplift in the area is of the order of 2.8mm/year (Vallner et al, 1988). The OP habitat type appears to be more affected by higher evaporation rates leaving high levels of salt in the soil (a rare occurrence in the eastern Baltic). This creates an ideal habitat for a sparse covering of halophytes which are unlikely to develop thick organic soils (due to low vegetation coverage).

The small altitudinal differences between habitat types, isostatic land uplift and sea level rise linked to climate change will all have a strong effect on the future development of these important wetland mosaics.

This study has developed a methodology which is quick to implement and uses accurate height information obtained from dGPS to relate to vegetation community types. This type of landscape data will be valuable in assessing the potential impact of rising sea levels and in assisting the development of future landscape management regimes.

References

- Benstead, P., Jose, P., Joyce, C. and Wade, M. (1999) *European Wet Grasslands: Guidelines for management and restoration*. RSPB. UK.
- Berg, M. (2009) Abandonment and Reinstated Management upon Coastal Wet Grasslands in Estonia. Doctoral thesis. (unpublished)
- Burnside, N., Joyce, C., Puurman, E. and Scott, D. (2007) Use of vegetation classification and plant indicators to assess grazing abandonment in Estonian coastal wetlands. *Journal of Vegetation Science*. 18: 645–654
- European Union (1992) *EC habitat directive 92/43/EEC* <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:PDF>
- Joyce, C. & Wade, M. (1998) Wet grasslands: a European perspective. In: Joyce, C. and Wade, M. (1998) *European Wet Grasslands: Biodiversity, Management and Restoration*. John Wiley & Sons. UK.
- Paal, J. (1998) Rare and threatened Estonian plant communities. *Biodiversity and Conservation*. 7: 1027-1049
- Rebassoo, H. E. (1975b) *Sea shore plant communities of the Estonian Islands*. I-II, Academy of Sciences Estonian SSR, Tartu
- Rodwell, J. (1992) *British Plant Communities*. Volumes I-V. Cambridge University Press. UK
- Vallner, L. Sildvee, H. and Torim, A. (1988). Recent Crustal Movements in Estonia. *Journal of Geodynamics*. 9: 215-223
- Ребассоо Х Э (1987) *Биоценозы островов восточной части Балтийского моря, их состав, классификация и сохранение*. I-II Валгус Таллин.