The management of the coastal grasslands of Estonia

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Abstract

The coastal grasslands of the west coast of Estonia and the island Hiiumaa were investigated in the years 2000-2002. The main goal of the work is to investigate the actual ecological conditions of coastal meadows, to provide detailed information on the biodiversity, productivity and the hay quality of coastal grasslands as well as to identify the problems with the exploitation of coastal grasslands. The properties of the investigated soils (*Hyposalic Fluvisols*), nutrient cycle in plant-soil system and the influence of grazing on the coastal biotope are discussed.

In Hiiumaa the investigated farm has approximately 400 ha of coastal meadows and the area is grazed by horses and beef cattle (100 cattle units all together). It makes the grazing intensity very low: only 1 cattle unit per ha, but the grazing intensity is not equal in different areas. The productivity of grasslands varied remarkably in the investigated areas (94 to 421 g m^{-2}): there was overgrazing in some areas and in other places the intensity was not enough to suppress the spreading of *Phragmites australis*.
Keywords: coastal grasslands, biodiversity, coastal soils, management of coastal meadows, quality of grass, grazing with cattle and horses.

1 Introduction

Estonia is located on the shore of the Baltic Sea: from 57º30' to 59º40' N and from 21º45' to 28º15'E and the length of coastline is about 3,794 km. According to a very rough estimation, some 25% of the coastline of Estonia is suitable for the development of coastal meadows [19]. In the 1960s some 0.6% (28 750 ha) of the Estonian territory was estimated to be covered with coastal plant


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associations [13]. The area of coastal meadows has decreased 4 to 5 times compared to the beginning of the 20th century, now reaching 7000 ha [22].

Coastal grasslands have been traditionally grazed by cattle, horses and sheep for a long time period. One reason for this was the relatively good quality of grass that met the requirements of livestock in extensive farming. Nowadays the situation has changed and farmers prefer to use highly productive and good quality grasslands for grazing and production of fodder.

It is essential to continue the traditional utilisation of coastal meadows to preserve the biodiversity of the area as the special ecological value of salt marshes is founded in the rich and specialised vegetation. But at the same time it should be economically profitable for farmers to run and manage these areas. The quality of fodder is an important factor for farms, which use the coastal areas for grazing.

The goal of this study was to analyse the actual ecological conditions of coastal meadows, to provide detailed information on the biodiversity, productivity and the hay quality of coastal grasslands as well as to identify the problems concerning exploitation of coastal grasslands.

2 Materials and methods

The study area is situated on the west coast of Estonia near Matsalu bay (IA-6) and the island Hiiumaa (Fig.1)

The investigated farm (total area 544 ha) in South-Eastern Hiiumaa embraces approximately 400 ha of coastal meadows and the whole area (divided into 3-7 parts) is grazed by horses (55) and beef cattle (total 66, *incl.* 3 pedigree animals of Scottish highland cattle) – all in all approximately 100 animal units. Thus, the grazing intensity is quite low and it was not equal on the whole area, depending on the productivity of the meadow. In some places the grazing has been not intensive enough to suppress the spreading of reed (*Phragmites australis*). The annual mean temperature of the study area is +3.7…+6.0, annual mean precipitation 600…650 mm and mean ice cover period 90 days [8]. The growing seasons of the experimental years were different: the vegetation period in the year 2000 was characterised by relatively low temperatures (12.9 °C) and substantial rainfall (396 mm), the year 2001 was quite humid and favourable for grass growth, but the year 2002 was very hot and dry. Owing to the extensive grazing system there was no strong grass deficit in coastal meadows even in 2002.

The phytomass in each research area was cut in four replications (plots of 6 m^2), weighed and an average sample (1 kg) was taken to estimate DM yield. The sample for botanical analysis was taken separately and divided by species and weighed separately. Plant material was analysed for crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF), P, K, Ca, Mg. Digestible DM (DDM= 88.90-(0.779*ADF), %), DM daily intake (DMI=120/NDF, % of cattle weight), relative feed value (RFV=(DMI*DDM)/1.29, points) and metabolizable energy (ME) content were calculated on the basis of ADF and NDF [17].

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Figure 1: Islands Hiiumaa and Kassari with investigation areas (IA) on the west coast of Estonia.

Soils were described by digging pits and samples for soil analysis were taken from humus layer (0-10cm), oven-dried, and sieved trough a 2 mm sieve. Soil samples were analysed for C according to Tjurin method, N according to Kjeldahl, P, K, Ca and Mg according to Mehlih-3 [23].

ANOVA was used for statistical analysis and Standard Deviation (SD) is presented.

3 Results and discussion

Nowadays the area of coastal meadows has decreased all over the world mostly due to changes in the management of coastal areas and less due to discontinuation of the utilisation of coastal grasslands. In Estonia, unlike in Western Europe, the reason for diminishing of coastal meadows is the discontinuation of traditional use of grasslands, which means grazing and cutting. Traditionally, large areas of seashore meadows and islands were grazed and mown, but after the 1940s the management almost ceased and the shore landscape changed considerably, since the stands of the common reed (*Phragmites australis*) expanded widely in many shore meadows. Changes in

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landscape, plant communities and bird fauna (eutrophication, construction of summer-cottages, decrease of ice coverage in winter and ice duration) are important factors which have influenced these areas [11].

Although Estonia is in a relatively good state regarding the number and area of seminatural wetlands, as compared to the majority of countries in Europe, management of coastal meadows needs to be continued in order to preserve these habitats [14].

3.1 Plant communities and biodiversity of coastal grasslands

The plant associations of the investigated areas are determined according to the classification system developed by J. Paal [18]. The most common plant associations in the investigated coastal meadows were *Clauco – Juncetum gerardii* and *Festucetum rubrae* (Table 1).

Table 1: The botanical composition of investigation areas.

Site no	Plant association	Dominating plants
1	*Clauco–Juncetum gerardii*	*Juncus gerardii, Festuca rubra, Glaux maritima, Lotus corniculatus, Triglochin maritimum, Cerastium holosteoides, Potentilla anserina, Juncus compressa, Trifolium maritimum*
2	*Clauco–Juncetum gerardii*	*Juncus gerardii, Festuca rubra, Glaux maritima, Helictotrichon pratense, Triglochin maritimum, Agrostis stolonifera, Potentilla anserina*
3	*Clauco–Juncetum gerardii*	*Juncus gerardii, Festuca rubra, Glaux maritima, Helictotrichon pratense, Triglochin maritimum, Agrostis stolonifera, Potentilla anserina*
4	*Festucetum rubrae*	*Festuca rubra, Trifolium pratense, Juncus gerardii, Glaux maritima, Triglochin maritimum, Poa pratensis, Carex nigra, Potentilla anserina*
5	*Phragmitetum australis*	*Phragmites australis*
6	*Deshampsio–Caricetum nigrae*	*Deshampsio caespitose, Carex nigra, Molinia coerulea, Sesleria coerulea, Centaurea jacea, Vicia cracca, Galium boreale*

According to studies by E. Roosaluste [21] the diversity of vascular plant species and plant communities on Estonian coastal grasslands is relatively high having 340 species in saline and suprasaline zone. There are 52 protected species growing in coastal plant communities and 76 species are endangered and listed in the Estonian Red Data Book. The main factors that endanger the species are overgrowing of grasslands, trampling, picking and construction activities [15].

There are many studies [4, 6], which confirm that grazing increases the species richness in semi-natural meadows, but also opposing studies indicating that the species richness was higher in the ungrazed areas than in the grazed ones

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[7, 12]. However, it should be noted that weaker competitors and rare species can benefit from grazing [9]. As shown in the work of G. Loucougaray *et al.* [16] it is clear that both cattle and horses forage selectively amongst the different plant communities and also within the community. Those herbivores are used to graze in a patchy way and produce a mosaic of vegetation.

3.2 Productivity of coastal grasslands

During the inventory made in the years 1978-81, the area of coastal meadows was estimated to be 9513 ha [3] and of that the plant association *Clauco–Juncetum gerardii* occupied 30%, *Festucetum rubrae* – 17% and *Caricetum paniceo–nigrae* (12%), *Ophioglosso – Seslerietum* and *Tetragonolobo – Molinietum* 11%, other associations covered smaller areas. Productivity of those plant communities was also recorded and it is compared with plant associations of the present investigation. The productivity stayed between 940 kg ha^{-1} in *Ophioglosso–Seslerietum* to 4210 kg ha^{-1} in *Deshampsio–Caricetum nigrae* plant community (Fig. 2)

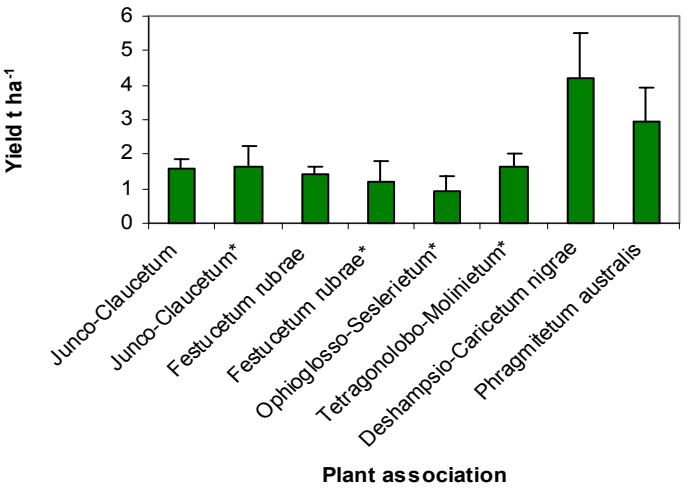

Figure 2: The productivity of plant associations of investigated coastal grasslands and grasslands* inventoried in the years 1978-1981 [3].

The variation in productivity of coastal grasslands depends on soil conditions (soil texture, moisture conditions, available nutrients), plant associations and management. The productivity varied on different investigation sites, being very low (50 kg ha^{-1}) on often grazed coastal grasslands dominated by *Juncus gerardii* on clayey soil. The relatively high productivity occurred on *Areni-Humic Glaysol* coastal grassland located further away from the seashore and flooding, so that an already remarkable humus horizon (30 cm) was developed. The

productivity of *Deshampsio-Caricetum nigrae* association reached up to 4210 kg ha^{-1} for one cut.

Phragmites australis usually produces dence and monocultural stands at the waterline, where species richness is low, it can survive in ungrazed shore meadows, but it suffers from grazing [24]. The investigated *Phragmitetum australis* association was influenced by grazing activities, it remained rather sparse and due to that had relatively low productivity reaching 3.11 tons per hectare. The discontinuation of grazing speeds up the spreading of reed but at the same time it is essential for feeding cows especially during dry summers when the clay or sand textured soil will dry and the productivity of other grass species stays at a very low level. Also in the second half of the vegetation period, when the production of grass is lower and the feeding quality decreases, it is essential for cattle to get those fresh reed shoots.

3.3 Soils and nutrient cycle of coastal grasslands

According to WRB classification the investigated coastal soils are classified as *Areni-Humic Glaysols* (Matsalu) and *Hyposalic Fluvisols* (Kassari). Saline littoral soils are formed on low coastal territories of the Baltic Sea and contain comparatively high amounts of soluble salts as chlorides, sulphates, etc. They are young soils with a slightly differentiated epigleyic profile [20].

Table 2: Soil properties of investigated grasslands.

Soil characteristics	Coastal grasslands (Kassari)	Coastal grassland (Matsalu)
pH_{KCl}	5.3	6.9
C, %	15.3	4.5
N, %	1.1	0.45
C/N	14.1	10.2
P, mg kg^{-1}	8.4	2.2
K, mg kg^{-1}	452	125
Ca, mg kg^{-1}	1031	6864
Mg, mg kg^{-1}	3091	750

Investigated *Hyposalic Fluvisols* are described by a thin well-rooted humus horizon having high content of carbon, C/N ratios for organic material in soils were reaching up to 14 (Table 2). The depth of the organic layer in these uplifting seashore areas is quite low reaching from 2 to 6 cm (thicker on small patches with sea material). The content of soluble salts in coastal soils is caused by the influence of seawater as the soil is flooded and the level of groundwater is high. The salinity of seawater in the Baltic Sea is not very high, ranging from 5.5 ‰ up to 6.5 ‰ west of the islands Saaremaa and Hiiumaa [2]. The content of plant available nutrients in coastal grassland soils was relatively high by Mg, Ca, Na and K but the content of phosphorous stayed at a very low level, which can be the restrictive factor for plant growth.

Grazing, trampling, and dung deposition by large herbivores often result in a zone of decreasing impact on many vegetation and soil parameters including herbaceous vegetation cover, soil bulk density, and penetrability away from water points [1]. The effect of trampling appears to be less severe on vegetated grasslands than on poor or bare soil [25]. Haynes and Williams [10] have stated that grazing animals affect the movement and utilization of nutrients through the soil and plant system, and thus on the fertility of pasture soils.

3.4 The hay quality of coastal grasslands

Traditionally the plant associations in coastal meadows have been used for grazing for a long time due to the stable quality of feed and good animal performance. But at the same time it should be economically profitable for the farmers to run and manage these areas. The quality of fodder is an important factor for farms using the coastal areas for grazing.

Table 3: The quality of hay from different types of pastures of investigation area (M±SD).

Parameters of the hay quality	Sown grassland (Kassari)	Coastal grassland (Kassari)	Coastal grassland (Matsalu)	*Phragmites australis* association
Crude protein (CP), %	10.26±1.37	9.63±1.03	8.54±0.17	8.9±1.68
Acid detergent fibre (ADF), %	34.84±5.96	37.08±2.39	36.8±3.64	40.6±1.99
Neutral detergent fibre (NDF), %	58.1±5.78	63.74±3.53	50.8±4.45	74.5±1.46
Digestibility (% of DM)	59.76±6.46	60.01±1.87	59.5±4.75	56.1±4.10
Dry matter intake (DMI)	2.08±0.20	1.89±0.11	2.34±0.10	1.63±0.05
Relative feed value (RFV, points)	99.8±15.34	87.9±5.92	109.5±4.95	71±6.40
Metabolizable energy (ME, MJ kg^{-1})	9.63±0.87	9.305±0.35	9.2±0.26	8.8±0.58
P, %	0.16±0.06	0.133±0.03	0.12±0.04	0.13±0.05
K, %	1.73±0.14	1.26±0.26	1.44±0.11	2.09±0.08
Ca, %	0.81±0.28	0.42±0.11	0.32±0.10	0.38±0.04
Mg, %	0.13±0.04	0.26±0.07	0.22±0.04	0.16±0.06

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The low values of grass quality for fodder were determined in the plant association dominated by *Phragmites australis.* But relatively high values were found in analysing the sward rich in *Juncus gerardii*. The content of mineral elements (Ca, Mg, K) in hay was satisfactory but the content of phosphorous was too low (Table 3). The requirements for phosphorous for heifers and low productive milking cows should be 0.3-0.42 % in DM [5]. Digestibility showed low to satisfactory values, reaching from 56% in case of *Phragmites australis,* to 60 % in coastal grasslands reaching up to 68% there in the plant association including mainly *Juncus gerardii* in its botanical composition. This plant association also had a good energetic value containing 10.8 MJ/kg of metabolizable energy. The reason for low digestibility of DM is high content of acid detergent fibre in fodder.

When comparing the hay quality of different types of grasslands in that area, it is obvious that the lowest values were in the *Phragmites australis* plant association. At the same time, cattle were not only provided with reed but they could also eat the grass of much better quality – the associations rich in *Juncus gerardii***,** or sown grasslands rich in valuable forage legumes and grasses. Such a mixed diet seemed to be very suitable for beef cattle and horses. The first experience on Ristitee farm on using Scottish highland cattle for nature-saving management of coastal meadows is also quite promising. For the dairy cows the most restrictive factors for getting high productivity are low productivity of such meadows, and low protein and energy contents of grass.

4 Conclusions

Coastal grasslands of the Baltic Sea are not natural biotopes but they are developed by traditional agricultural use, mainly by grazing beef cattle and sheep. The privatisation of collective farms since 1991 and the insufficient development of private farms have led to the decrease of the number of cattle. The consequences of this can be changes in flora, the overgrowth of meadows, and the disappearance of many species, which finally leads to the degradation of species diversity on coastal grasslands.

The quality of grass on coastal meadows varies remarkably, ranging from a low quality in case of *Phragmites australis,* to a relatively high quality in the plant association, dominated by *Juncus gerardii*. The quality of fodder and content of nutrients of coastal grasslands showed similar or even better values compared to sown grasslands. The biodiversity of coastal grasslands of Estonia is relatively high and distribution of plant species is influenced among other factors also by trampling and grazing effect of livestock. Soils are rich in plant available nutrients like Ca, Mg, Na and K but poor on phosphorous that can be one of the restrictive factors of plant growth and the low content of phosphorous in fodder.

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