Rare and threatened plant communities of Estonia

JAANUS PAAL

Institute of Botany and Ecology, University of Tartu, Lai Str. 46, 51005 Tartu, Estonia

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This paper introduces the criteria for identifying rare and threatened plant communities in Estonia. An overview of such communities is given and the general problems associated with their protection are briefly discussed. Of forest communities, alvar forests and boreo-nemoral forests must be preserved very carefully. Once widely distributed minerotrophic mobile-water swamp forests and flood plain forests nowadays cover only a small area. Numerous rare communities are associated with coastal regions and islands. Wooded meadows, the most species rich vascular plant communities in northern Europe, as well as flooded meadows and many other communities require continuation of traditional management for their preservation.

Keywords: categories; criteria; grasslands; woodlands; wetlands; cryptogam communities; maintenance; Baltic.

General features of the Estonian environment

Landforms and soils

Although the territory of Estonia encompasses only 47,450 km², its landscapes are unique and varied. The topography has developed as a result of the eroding and accumulating action of the continental ice sheet and the subsequent postglacial transgressions of the Baltic Sea. Estonia was freed from the glacial ice 13,500–11,000 years ago (Raukas, 1986). The crystalline bedrock lies deeper than 100 metres and consequently has no influence on recent landforms. The bedrock in North, West and Central Estonia consists mainly of Ordovician and Silurian carbonate limestones, marls and dolomites, whereas South Estonia is a region of Devonian sandstones and locally of carbonate rocks. Moraines attain more thickness (up to 200 m) in South Estonia (Raukas, 1996).

Orographically Estonia is a section of the East European Plain, being situated 0–317 m above sea level. The territory can be divided into two parts: Lower Estonia and Upper Estonia (Fig. 1). The former was, following the retreat of the ice, inundated by the sea for a considerably longer time than Upper Estonia (Varep, 1972). The western part of the country, including numerous islands and bays, and the large lake depressions in the eastern part belong to Lower Estonia. The limestone bedrock of the West Estonian islands and of the West Estonian Lowland is mostly covered by thin calcareous soils overgrown with juniper, with forest areas, bogs, fens and marshes also represented. The depressions of Lake Peipsi and Lake Võrtsjärve are covered by extensive flood plain meadows, wetlands, and forests.


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Figure 1. Landscape regions of Estonia (after Varep, 1972): 1. limestone plateaus; 2. limestone and abraded till plains; 3. till plains; 4. hilly moraine landscapes; 5. drumlin landscapes; 6. abraded elevations; 7. kame landscapes; 8. glaciofluvial delta areas; 9. plains of varved clays; 10. plains of periglacial lakes; 11. coastal plains (of marine sands and dunes); 12. mire landscapes.

The landscapes of Upper Estonia are more diverse, the moraine cover is thick, the soil more fertile, and the human population denser compared with that of Lower Estonia. The uplands are intersected by a number of river valleys with outcrops of Devonian red sandstone on high river banks.

Calcareous (rendzina) and peat soils predominate in North, Central and West Estonia. In South Estonia podzols, peaty podzols and peat soils on moraines and sands are widespread. The most fertile sandy clayey soils, related to brown soils, occur on yellowish-grey calcareous moraines (Reintam, 1995).

Climate
Estonia is climatically situated in the mixed forest subdistrict of the temperate zone. It is characterized by warm summers and by moderately mild winters. The vegetation period with average 24-hour air temperatures above +5°C lasts 165–185 days; the period with an average air temperature above +10°C lasts 110–135 days. The climate is humid, especially in coastal regions. Annual precipitation exceeds evaporation roughly twofold. Mean annual precipitation is highest in South Estonia and in the area of the Pandivere Uplands (up to 700 mm per year), and lowest on the large islands of the Baltic Sea (about 550 mm) (Eesti NSV klímaatlas, 1969).
Vegetation

The vegetation of Estonia is rather variable. Forests, mires and grasslands alternate with cultivated land. Forests make up 44–47% of the country's territory, including about 7% coppices and brushwood (Etkerk and Sein, 1993); meadows and grasslands constitute up to 20% (Peterson, 1994). Mires with peat deposit thicknesses greater than 30 cm cover approximately 9150 km² or 21.5% of Estonia. If other waterlogged areas are included, where the peat layer is less than 30 cm thick, 31% of Estonia could be considered to be covered by peaty soils (Valk, 1988).

Geobotanically Estonia belongs to the hemiboreal vegetation zone (Ahti et al., 1968) or to the northern part of the temperate hardwood-coniferous forest zone (Laasimäe, 1965). Most of the forest ecosystems have been influenced by fire, logging or drainage (Lõhmus, 1995). The zonal or climax vegetation type is boreo-nemoral coniferous forest: primarily Norway spruce (Picea abies) forest with silver birch (Betula pendula), aspen (Populus tremula), Scots pine (Pinus sylvestris), and to a lesser extent lime (Tilia cordata), ash (Fraxinus excelsior), mountain elm (Ulmus glabra) and oak (Quercus robur) in the tree layer. Such forests grow on fertile soils and have the highest biomass of our primary plant cover. As a result of the development of agriculture only a small proportion of them have been preserved (Laasimäe, 1975). Today the majority of Estonian forests grow on soils which are of little or no use for agriculture.

Black alder (Alnus glutinosa) and downy birch (Betula pubescens) (rarely spruce and ash) dominate in the canopy layer of swamp forests in which Crepis paludosus, Thelypteris palustris, Calla palustris, Cirsium oleraceum, Filipendula ulmaria etc. are characteristic of the herb layer. Aspen, grey alder (Alnus incana) and most silver birch (Betula pendula) forests are secondary in Estonia, replacing other forest types after clearcutting or covering abandoned fields and grasslands.

Meadows and grasslands are results of the felling of forests and subsequent continuous mowing or pasturing. Swampy meadows (with a peat layer less than 30 cm) on calcium poor moraines are characterized by communities of Carex nigra, C. panicea, Deschampsia cespitosa and Nardus stricta. They have developed, as a rule, from swampy downy birch forests. Wet meadows rich in species, typically with Primula farinosa–Sesleria caerulea and Carex hastiana–C. davalliana communities, lie on calcareous moraines or bedrock.

Mires occur all across the country (Zobel, 1992). The average thickness of the peat deposits is 3.2 m (Valk, 1988), reaching a maximum value of 17 m (Orru, 1995). Extensive fen areas are situated in the western and central parts of the Estonian mainland, larger bogs are located in western, central and northeastern parts. There are two regional types of bog complexes in Estonia (Thomson, 1924; Masing, 1984a): the marginal slopes of the western type are short and have a relatively steep rise; the bogs of the eastern type are convex and have no distinct steep slope. Eastern bogs are favourable for Chamaedaphne calyculata, which does not grow in western bogs. On the other hand, Scirpus cespitosus and Drosera intermedia are characteristic of the mires of the western type and very seldom occur in the eastern part of the country. Differences can also be found in the distribution of Sphagnum species: S. fuscum is typical for the eastern raised bogs, S. rubellum and S. tenellum for the West Estonian bogs.

Laasimäe (1965), combining both ecological and phytocoenotical principles, has established more than 100 associations, 39 association groups and 17 series of plant communities in the Estonian vegetation. According to the results of mapping, eight large
geobotanical districts. 13 subdistricts and 87 micro-districts were established (Fig. 2). Subsequently, forest vegetation has been divided by Lõhmus (1984) into 25 main site types which can be further subdivided according to the dominating tree species into more than 70 subtypes. In the recently compiled classification of Estonian vegetation habitat types (Paa, 1997) the forest site-type list of E. Lõhmus has been extended even further. A number of additional site types (habitat types) with a relatively restricted distribution and low importance for forestry but remarkable from a biodiversity point of view are included, namely *Humulus, Carex elongata, Antennaria, Fragaria, Corylus* and *Salix* types.

**Criteria for rare and threatened communities in Estonia**

The main guideline in modern nature protection activities is the maintenance of biodiversity at all its levels (Glowka et al., 1994). Soulé (1991) distinguishes five divisions: genes, populations, species, assemblages (associations and communities) and whole systems at the landscape or ecosystem level. In order to be able to determine the importance and urgency of different actions, and to ensure the efficient preservation of biodiversity, we need to put our knowledge about all of these levels into a certain order. At species level this has already been realized in the form of national or regional Red Data Books, the same has been, or is being, done in many countries for plant community types or for habitat (biotope) types.

The problems of rare and/or endangered plant communities have been discussed by Estonian botanists for several decades (e.g., Trass, 1957, 1981; Kalda, 1958, 1995; Masing.

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**Figure 2.** Geobotanical districts of Estonia (after Laasimer, 1965). A. West Baltic subprovince: I. district of meadows and wooded meadows of the continental part of West Estonia and the Western Archipelago; II. district of dry meadows of the Northwest and North Estonian coastal zone; III. district of bogs and swamp forests of Intermediate Estonia (Kõrvermaa and Soomaal). B. East Baltic subprovince: IV. district of mires and flood plain meadows of the Pedja River Basin; V. district of spruce and mixed spruce forests of East and Central Estonia; VI. district of raised bogs and swamp forests of Northeast Estonia (Alutaguse); VII. district of flood plain fens and the lower reaches of the Emajõgi River and of the southwestern shore of Lake Peipsi; VIII. district of pine forests on sandy soils of Southeast Estonia.
Rare and threatened plant communities of Estonia

1962, 1984b; Krail, 1975; Laasimer, 1975, 1987; Pulk, 1981a, b, 1984; Zobel, 1982, 1987; Rebassoo, 1988; Truus et al., 1989; Kalda and Paul, 1997; Kukk and Kull, 1997). Although a manuscript of the Red Data Book of species was completed by the end of 1978 and a popular issue published in 1982, the study of threatened communities has been rather episodic and the data collection haphazard, representing a 'by-product' of other botanical investigations. No governmental or academic institution has displayed a sufficient interest in commissioning a systematic inventory of endangered plant communities. Up to now even a proper conception for a Red Data Book of Biotopes (plant communities) is lacking in Estonia, the idea was only once briefly discussed by Laasimer (1982).

Only in the last 2-3 years has the idea of the revision of our plant communities from a biodiversity point of view been injected with a new enthusiasm through the Estonian Ministry of the Environment, since several institutions from neighbouring countries as well as UNEP and the World Bank have offered or are offering support for the realization of related projects (Tambets and Kühvik, 1996). One of the outcomes of this was an overview on Estonian plant community site types published recently (Paul, 1997). This activity is connected with Estonian efforts to move towards the European Community and with attempts to reconcile our nature conservation with the legislative acts of the EC.

The EC Council directive 92/43/EEC of 21 May 1992 (EC, 1992) on the conservation of natural habitats and of wild fauna and flora stresses the need for assessment at a national level of the relative importance of sites for each natural habitat type according to four criteria: (i) degree of representativity; (ii) extent of area; (iii) degree of conservation; and (iv) global assessment. These criteria overlap to a large extent with those most emphasized in the assessment of the conservation value of biotopes (Margules, 1986); representativeness, diversity, rarity, naturalness, area and threat of interference. Still, in many situations, supplementary criteria will either have been added or some criteria substituted, since biological diversity varies from place to place depending on a complex set of environmental variables and the interactions between them (Goldsmith, 1983). Moreover, in view of the dependence on cultural or economic background, criteria connected with biodiversity cannot foresee all the needs for the protection of biotopes.

Confining the discussion now to plant communities and taking into consideration the specific features of the Estonian environment, as well as traditions in nature management and protection, there are three general reasons for affording plant communities protection: biodiversity, cultural importance and direct practical needs. Proceeding from the biodiversity concept of plant communities protection, three components must be taken into account: rarity, level of threat and typicalness, each one of which is a 'complex phenomenon' (Jacket and Poschlod, 1996). Even the definition of what is actually rare is difficult since there is a continuum from commonness to rareness (Usher, 1986). Quite often in nature conservation 'rare' is used more or less as a synonym for 'threatened', the latter being the main criterion for the compilation of Red Data Books of Biotopes (e.g. Blab et al., 1993; Riecken and Ssymank, 1993). Blab et al. (1993, p. 267), for example, suggested that 'biotopes potentially threatened are those which have always been rare or that exist in a small area without being actually threatened'. Still, numerous communities of alvars, wooded meadows or flood plain meadows are not rare in Estonia, but almost all of them are endangered for different reasons. At the same time, the probability of harming some rare community types, such as Lutaria site type forests at the foot of the North Estonian glist or lichen communities, Ramaluncium polymorphae, on sea-shore rocks, for example, is negligible.
The problem of discordant use of ‘rarity’ and ‘threatenedness’ in the categorization of species is thoroughly discussed by Munton (1987) and Gaston (1994). They conclude that there are frequently many species which are regarded as rare in ecological categorization schemes, but which do not enter lists of threatened species. Rarity does not indicate the risk of extinction of a species, it would be more logical to use rarity as a parameter for the assignment of species to different categories of threat rather than as a category itself. Intermixed and confusing use of these concepts also occurs in the definitions of the IUCN Red Data categories (Davis et al., 1986), where taxa categories are listed in ranked order as Extinct, Endangered, Vulnerable, Rare, Intermediate, Out of Danger and Insufficiently Known. Principally the same scheme is followed in the Red Data Book of the Baltic Region (Ingelöv et al., 1993).

The inconsistent use of ‘threatened’ and ‘vulnerable’ in one sequence is also obvious. The latter is a term with a comparatively narrow meaning: it is a synonym for ‘fragile’, while ‘threatened’ can in some situations describe even comparatively stable and widespread community types or even type groups. This was the case, for example, with our wetlands in the period 1950–1970, when in the course of a campaign started by Soviet rules huge areas were drained. An example of the converse is the wooded meadows and flood plain meadows, which have recently been vanishing rather quickly owing to the cessation of traditional usage. Similar examples exist at a species level.

On this basis it seems right to propose rarity categories for community types without coupling them with ‘threatened’ or ‘vulnerable’:

0 Extinct or probably extinct. Communities that are no longer known to exist in the wild within the territory of the republic after repeated searches. Only community types which are authentically documented and have disappeared since 1933 will be considered. (1933 is an arbitrary chosen term, because an overview and classification of Estonian vegetation by T. Lippmaa (1933) was published in this year.)

1 Very rare. Communities that are known in 1–3 localities with a total area less than 1 ha for grasslands or less than 2 ha for woodlands.

2 Rare. Communities that occur in 4–10 localities with a total area less than 3 (5) ha for grasslands or less than 10 (15) ha for woodlands.

3 Fairly rare. Communities that are represented in 11–20 localities with a total area less than 10 (20) ha for grasslands or less than 100 (150) ha for woodlands.

4 Approaching rare. Communities:
   
   • that are likely to move into the previous categories in 2–3 years if the causal factors continue to operate; or
   • that are growing in a restricted number of habitats corresponding to rarity categories 2 or 3, but during the last 5 years are continuously expanding their area; or
   • about which there is insufficient information to decide which of the categories are appropriate; the localities must, consequently, be checked.

The limits for numbers of localities and for total areas are, of course, to some extent arbitrary, but give a certain basis for making more unambiguous decisions.

Plant communities which can be considered as threatened in Estonia are those (Laisimé, 1975, 1987; Trass, 1987; Kalda, 1988; Kalda and Paal, 1997):

(i) which belong to any category of rare types;
(ii) where populations of endangered species grow; here species of wild animals must also be taken into account (see Hammer and Völkli, 1993); if the communities of a particular type are habitats for rare or endangered animals, that type must be accepted as threatened;

(iii) which grow in habitats that are vulnerable owing to human impact or certain natural factors uncommon for the region (e.g. catastrophic flooding or fire, landslide);

(iv) which represent relic communities typical of former climatic periods.

By defining categories of threatened plant community types the concepts ‘rare’ and ‘vulnerable’ are in place, and the categories can be estimated as follows:

1 Very threatened. Community types that are at great risk of total disappearance because of the rarity (rarity category 1) of respective communities, or because of certain adverse causal factors, the impact of which makes the survival of these communities inconceivable.

2 Threatened. Communities that are in danger because of: (i) their relative rarity (rarity categories 2–3); (ii) the great fragility of communities; (iii) because their area has shrunk considerably in a short time span (during the last 2–3 years); (iv) extensive destruction/change of habitat ecological conditions or community structure by adverse natural factors, such as extreme weather conditions, occasional mass invasion of alien species etc.; (v) intense human impact; (vi) the cessation of traditional management.

3 Fairly threatened. Communities that are in considerable danger because of: (i) their general fragility; (ii) their continuously decreasing area; (iii) a ‘creeping depreciation’ (Blab et al., 1993) of habitats on a long-term basis (over a decade and more); (iv) the cessation of traditional management; or (v) the rarity of the communities in countries neighbouring Estonia.

The Pan-European Biological and Landscape Diversity Strategy (1996) emphasizes, in addition to rare communities, the importance of maintaining typical communities, representing the spectrum of their variation in a given region as fully as possible. Thus, in addition to the system of protecting rare and endangered communities (biotopes), a representative network of typical communities must be established in every country or geographical region. In Estonia this activity is in the initial discussion phase only (Kalda and Paul, 1997) and not directly connected with the topics of recent papers.

The criteria for plant communities which merit protection owing to their cultural importance are listed below. These include communities which:

(i) are important for educational purposes – examples are tree stands managed in a particular way or successful forest drainage, communities with interesting naturalized alien species, etc.;
(ii) are important as cultural monuments – old heathen cult sites, scenes of historical events, etc.;
(iii) are monitoring areas or permanent plots for scientific research;
(iv) have a high aesthetic value;
(v) represent certain particular successional stages of great scientific interest;
(vi) have unusual structural features (physiognomy, complexity of layers, species content or unusual proportion of their abundance, etc.) for the type;
(vii) grow in aberrant habitat conditions, representing additional information about the ecological amplitude of that community type.

With respect to direct practical needs, protection should also be offered to communities which: (i) are important for the maintenance of landscapes, e.g. regulating the water balance, preventing erosion or pollution, etc.; (ii) have a high recreational value; (iii) have very productive tree populations (so-called plus trees); or (iv) contain highly productive berry-plant (cowberry, bilberry, cranberry) or certain medicine-plant populations.

**Rare and threatened plant communities**

**Forests**

Alvars are habitats in northern Europe peculiar to North and West Estonia, to southern part of the Scandinavian Peninsula and to some islands of the Baltic Sea. Through the activity of the continental ice sheet and the sea, the bedrock formed by Ordovician and Silurian limestones on alvars is covered with very shallow (rendzina) soil and a xeromesophilous vegetation. The alvar forest type group makes up only 3.2% of the total area of Estonian state forests (Kivist, 1995). In the field layer we find xerophilous species such as *Arctostaphylos uva-ursi*, *Thymus serpyllum*, *Antennaria dioica*, alvar meadow species *Asperula tinctoria*, *Helicotrichon pratense*, *Heuchtherum nummularianum*, mesophilous forest species *Rubus saxatilis*, *Calamagrostis arundinacea*, *Polygonum odoratum*, etc., and several orchids, e.g. *Orchis mascula*, *O. ustulata*, *Ophrys insectifera* (Laasimer, 1975, 1986).

Among the forests of this group *Arctostaphylos* site type birch and oak forests growing on sea-shore shingle walls are very rare. *Calamagrostis* and *Sesleria* site type forests are more frequent, although those with oak or ash stands belong to the categories of rare or very rare, respectively (Table 1). Owing to their vulnerability, almost all alvar forests need attention and must be managed with care wherever they occur in Estonia. They also play an important role in preventing soil erosion. Only selective cutting, ensuring the normal development and renewal of communities, can be permitted.

Stands of **dry boreo-nemoral forest** type group occur on the tops and slopes of moraine hills and drumlins where the soil is rich in carbonates. These forests are Central and South Estonian equivalents of alvar forests. Species usually characteristic of acidic forest soils - *Oxalis acetosella*, *Vaccinium vitis-idaea*, *V. myrtillus*, etc. - grow side by side with species of more nutrient-rich soils - *Hepatica nobilis*, *Brachypodium pinnatum*, *Anemone nemorosa*, *Thuidium abietinum*, etc. In official Estonian forest site type classification this type is not accepted although it was defined more than three decades ago by phytocoenologists (Masing, 1966). *Antennaria*, *Fragaria* and *Corylus* forest site types are included in the group; the rarest communities among them are *Corylus* oak forests and *Corylus* pine-oak forests (Table 1). Communities of the latter type occur fragmentarily on Saaremaa Island, also on sandy ridges in northern, southwestern and western Estonia, as well as on the sandy banks of the Koiva River in South Estonia. According to Eilart (1973) these forests are relics from the Sub-boreal climatic period, and due to the peculiarity of the habitat conditions, they can be treated together with dry boreo-nemoral forests only conditionally.

The **fresh boreo-nemoral forest** type group embraces, according to the most recent classification scheme (Paul, 1997), *Hepatica*, *Aegopodium* and *Lunaria* site types. These
## Table 1. Rare and threatened forest communities: nomenclature of the site type groups and communities follows Paul (1997)

<table>
<thead>
<tr>
<th>Site type group and community</th>
<th>Latin name</th>
<th>Distribution</th>
<th>R</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alvar forests</strong></td>
<td></td>
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<tr>
<td>Arctostaphylos birch forest</td>
<td><em>Arctostaphylos-Betuletum</em></td>
<td>Hiiumaa Island (Isl.), W Estonia (Est.)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Arctostaphylos oak forest</td>
<td><em>Arctostaphylos-Quercetum</em></td>
<td>Saaremaa Isl.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Calamagrostis oak forest</td>
<td><em>Calamagrostis-Quercetum</em></td>
<td>Saaremaa Isl., W Est., seldom N Est.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Calamagrostis ash forest</td>
<td><em>Calamagrostis-Fraxinetum</em></td>
<td>Saaremaa Isl., W Est., seldom N Est.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sesleria oak forest</td>
<td><em>Sesleria-Quercetum</em></td>
<td>Saaremaa Isl., W Est., seldom N Est.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sesleria ash forest</td>
<td><em>Sesleria-Fraxinetum</em></td>
<td>Saaremaa Isl., W Est., seldom N Est.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Dry boreo-nemoral forests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corylus oak forest</td>
<td><em>Corylus-Quercetum</em></td>
<td>Saaremaa Isl., W and Central Est., seldom N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Corylus pine oak forest</td>
<td><em>Corylus-(Quercus)-Pinetum</em></td>
<td>Saaremaa Isl., W and Central Est., seldom N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><strong>Fresh boreo-nemoral forests</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Hepatica oak forest</td>
<td><em>Hepatica-Quercetum</em></td>
<td>Saaremaa Isl., W and Central Est., seldom N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Hepatica ash forest</td>
<td><em>Hepatica-Fraxinetum</em></td>
<td>Saaremaa Isl., W and Central Est., seldom N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Aegopodium oak forest</td>
<td><em>Aegopodium-Quercetum</em></td>
<td>mostly on Est. mainland</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Aegopodium ash forest</td>
<td><em>Aegopodium-Fraxinetum</em></td>
<td>mostly on Est. mainland</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Aegopodium elm-maple-lime forest</td>
<td><em>Aegopodium-(Acer-Tilia)-Ulmietum</em></td>
<td>on slopes of S Est. valleys</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Larixia elm forest</td>
<td><em>Larixia-Ulmietum</em></td>
<td>on the foot of glint in N Est.</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Larixia ash forest</td>
<td><em>Larixia-Fraxinetum</em></td>
<td>on the foot of glint in N Est.</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Larixia alder forest</td>
<td><em>Larixia-Alnetum</em></td>
<td>on the foot of glint in N Est. (2) (2)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Rich paludified forests</strong></td>
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<tr>
<td>Dryopteris alder forest</td>
<td><em>Dryopteris-Alnetum glutinosae</em></td>
<td>fragmentarily on the banks of running waterbodies</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Dryopteris ash forest</td>
<td><em>Dryopteris-Fraxinetum</em></td>
<td>fragmentarily all over Estonia in Pärnu district</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Dryopteris oak forest</td>
<td><em>Dryopteris-Quercetum</em></td>
<td></td>
<td>1</td>
<td>1</td>
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Table 1. (Continued)

<table>
<thead>
<tr>
<th>Site type group and community</th>
<th>Latin name</th>
<th>Distribution</th>
<th>R</th>
<th>T</th>
</tr>
</thead>
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<td>Swamp forests</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><em>Callic</em> alder forest</td>
<td><em>Calico-Alnus glutinosa</em></td>
<td>mostly in NE and SW Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><em>Callic</em> birch forest</td>
<td><em>Calico-Betula pubescens</em></td>
<td>mostly in NE and SW Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Coastal swamp alder forest</td>
<td><em>Alnus glutinosa</em></td>
<td>locally on northern coast</td>
<td>2 (3)</td>
<td>3</td>
</tr>
<tr>
<td>Flood plain forests</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Humulus</em> elm-ash-lime-oak forest</td>
<td><em>Humulo-(Fraxino-Ulivo-Tilio)-Quercetum</em></td>
<td>fragmentarily on flood plains, more in S and Central Est., seldom in NO Est.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carex elongata birch forest</td>
<td><em>Carex elongata</em></td>
<td>fragmentarily on flood plains of larger rivers</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ash forest</td>
<td><em>Carex elongata</em></td>
<td>fragmentarily on flood plains of larger rivers</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Carex elongata alder forest</td>
<td><em>Carex elongata</em></td>
<td>fragmentarily on flood plains of larger rivers</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Salth shrubland</td>
<td><em>Salix pentandra</em></td>
<td>fragmentarily on flood plains of Kasari River delta</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

R, category of rarity; T, category of threatenedness.

Forests grow on the most nutrient-rich calcareous soils which are sufficiently supplied with water all year round. They make up approximately 13% of the state forest area (Kiviste, 1995).

The tree layer in *Hepatica* site type stands is formed mainly by spruce; pine or silver birch are less abundant, only occasionally aspen, grey alder or oak may dominate. In the *Aegopodium* site type forests silver birch most frequently prevails in the tree layer, but spruce is also common. Occasionally stands occur where broad-leaved species - ash, lime (*Tilia cordata*), maple (*Acer platanoides*), elm (*Ulmus scabra*) or soft-leaved elm (*U. laevis*)—are comparatively abundant or even dominating. In the field layer nemoral species such as *Mercurialis perennis*, *Asarum europaeum*, *Hepatica nobilis*, *Stellaria holostea*, *Galeobdolon lutetum*, *Millium effusum* are characteristic. More locally *Allium ursinum*, *Sanicula europaea* and *Cardamine bulbifera* also occur. These forests are relics of the warmer Atlantic climatic period of 5000–6000 years ago, and grow in Estonia near the northern limit of their distribution (Laasimer, 1965). At the beginning of the last decade the total area of oak forests (including cultivated ones) within state forests was approximately 4400 ha, aspen forests 2750 ha, elm and maple forests 150 ha (Kalda, 1995). In the 1970s lime stands were found on less than 100 ha (Paves, 1974). Most of the forest with broad-leaved tree species dominating must be taken under protection.
A unique habitat for boreo-nemoral forests is found at the foot of the North Estonian limestone escarpment (the glint) along the coast of the Baltic Sea. On the serice of mellowed limestone a complex of different soils has developed. Calcareous water often seeps from the upper part of the glint, and on the lower part, on the Cambrian gley deposits, springs frequently supply the communities with mineral-rich water. In the tree layer broad-leaved species prevail: ash, lime, elm, maple and black alder. In addition to common nemoral species, *Lunaria rediviva* as well as *Laniun muculatum*, *Polygonatum odoratum*, *P. multiflorum*, *Actaea spicata*, *Matthiola struthiopteris* are also typical for the undergrowth. These *Lunaria* site type forests are analogous to the eutrophic elm–ash forests in southern Scandinavia (Dickmann, 1994), representing here, on the shore of the Gulf of Finland, their north-eastermost variants. All these communities must be protected in nature reserves; especially the rare *Lunaria* alder forests (Table 1).

Communities of the rich paludified forest type group are widespread, occupying approximately 23% of the area of state forests, but among them the *Dryopteris* site type stands represent only 1.3% of the area (Kiviste, 1995). Communities of the *Dryopteris* site type, where broad-leaved trees – black alder, ash or oak – are dominant occur only very fragmentarily, among them the particularly rare *Dryopteris* oak forests (Table 1).

Minerotrophic swamp forests with mobile groundwater were formerly rather common in Estonia. Typical stands have high stem-tussocks and between them hollows in which *Calla palustris* and *Iris pseudacorus* grow and on the borders of which the sedges – *Carex elongata*, *C. loliacea*, *C. disperma* – predominate. During the last 50 years forests of this type have been extensively drained. At the beginning of the 1980s these forests constituted 2.5% of the area of state forests (Lõhmus, 1984); nowadays they are found on not more than 1% of that area (Kiviste, 1995).

A very special swampy habitat type in Estonia is associated with the depressions or plains between the North Estonian glint and shoreline, separated from the sea by low seawalls but sometimes flooded by seawater. In the tree layer of these forests black alder dominates, but individuals of spruce, birch, grey alder and ash also grow. Owing to the flooding these forests bear a certain similarity to flood plain forests, but here the seawater does not fertilize the soil with alluvium rich in organic substances as in typical flood plains. In the latest survey of Estonian vegetation forests of this type are classified as a 'coastal subtype of minerotrophic swamp forests' (Paul, 1997). These communities should be protected in all the localities where they occur.

Forestsof flood plain type group, where floodwater rich in organic sediments inundates the ground more or less regularly every year and where the tree layer is formed predominantly by broad-leaved species, have survived only very fragmentarily in the valleys of some larger rivers: Koiva, Mustjõe, Pedja, Emajõe, Halliste and Pärnu (Table 1). Owing to their restricted area, these forests are not distinguished in the official forest inventory at all. Nevertheless, two forest site types – *Humulus* and *Carex elongata* – can be clearly distinguished among them (Paul, 1997).

For the protection of flood plain forests as well as minerotrophic swamp forests, maintenance of natural water movements and groundwater level is required. Moreover, the protected areas must be surrounded by a buffer zone, the extent of which will depend on the general water conditions of the surrounding landscape. Both groups of wetland forests are the most species-rich of the forest communities in the boreal zone. On the occasion of forest fires they often serve as sanctuaries where the gene pool of many species is able to survive (Sjöberg and Ericson, 1992). All Estonian flood plain forests and
minerotrophic mobile-water swamp forests must be maintained as nature reserves. The priority of alluvial and riparian forests is also stressed in the Pan-European Biological and Landscape Diversity Strategy (1996).

A summary of threatened forest communities is presented in Table 1. Taking into account the lack of truly reliable data on the frequencies and areas of rare community types (except data on officially accepted forest types), estimation of their rarity and threat level can be accepted only with certain reservations. Respective estimations for grassland (Table 3), and partly also for mire communities (Table 2) are to some extent even more arbitrary since we lack updated information on their area at present. After the collapse of the Soviet regime and the restoration of the Estonian republic, large tracts of cultivated or grazed land were abandoned and they are quickly being overgrown with scrub. Therefore, it may even be impossible to get a proper overview of the area of several community types, especially of semi-natural ones. Before the new pattern of land use has stabilized.

For a better international communication the community names in Tables 1-3 are given in Latin according to the international code of phytosociological nomenclature (Barkman et al., 1986). Up till now only some groups of Estonian plant communities have been investigated and classified according to the Zürich Montpellier phytosociological methodology (e.g. Rebaasoo, 1975b; Pork, 1985). As a result the communities referred to in the tables may not always correspond to those in Central European vegetation classification systems. In studies of boreal vegetation, the importance of dominant species is emphasized more than the role of character-species or differential-species (Whittaker, 1962; Frey, 1973).

Mires

Mires occur in Estonia in all geobotanical regions and therefore their typological variation is comparatively large (see Masing, 1975, 1984a; Ilomets and Kallas, 1995; Paal, 1997). Exploitation of mires for agricultural purposes began in the 17th century. A rapid increase in mire drainage started at the end of the 1940s. During the 1980s, more than 130,000 ha (compared with about 10,000 ha during the entire period before this) of peatland were drained and brought into agricultural use. As a result of this extensive human impact numerous localities of rare mire types have vanished and the area of several formerly rather common types has dramatically decreased. Of rich fen sites, for example, up to 90% no longer retain their natural state (Ilomets and Kallas, 1995). Of poor fens, Carex flavae type communities have the most restricted distribution (Krall et al., 1980) (Table 2).

Due to their species richness the most conspicuous mires in Estonia, on a North European scale, are calcareous fens and spring fens (Trass, 1975). They are situated in northern, northwestern, western Estonia, and on the large western islands where groundwater rich in carbonates and a mild maritime climate have enabled numerous rare plant species to grow. Here we can find Red Data Book species such as Selaginella selaginoides, Pinguicula alpina, Juncus subnodulosus, Liparis loeselii, Gymnadenia odoratissima, Dactylorhiza incarnata, D. fuchsii, D. maculata, Epipactis palustris, Cladium mariscus and Schoenus nigricans. Several fen types more widely distributed in western and central Europe reach the northern distributional limit in Estonia (Table 2).

Over the last 30 years fens on shallow peat, formerly mown annually and then grazed, have become extensively overgrown with bushes (mainly Salix spp. or birch), and their species richness is obviously decreasing (Kukk and Kull, 1997). To preserve the species diversity of these communities it is sufficient to repeat the cutting of shrubs
Table 2. Rare and threatened mire communities (abbreviations as in Table 1); nomenclature of the site types follows Paul (1997)

<table>
<thead>
<tr>
<th>Site type</th>
<th>Community</th>
<th>Distribution</th>
<th>R</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor fen</td>
<td>Carexetum flaveae</td>
<td>locally, mainly in E Est., mainly on western islands, locally in SW, W, NW Est.; on northern limit of its distribution area</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Rich fen</td>
<td>Carexetum davallianae</td>
<td>in W and NW Est., seldom in other localities; on northern limit of its distribution area</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Carexetum hassiennae</td>
<td>in W Est.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Charaetum marisci</td>
<td>mainly on western islands, locally on mainland; on northern limit of its distribution area</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Schoenetaea nigrivantis</td>
<td>in western part of Saaremaa Isl. and on Hiiumaa Isl.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Spring fen</td>
<td>Primula-Seslerietum</td>
<td>mainly in W, N Est., mainly in western islands</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Scorpidio-Schoenactum</td>
<td>in W Est. and on western islands</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Juncetum subaqualilae</td>
<td>in western part of Saaremaa Isl.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Carexetum davallianae</td>
<td>mainly on western islands, locally on mainland</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Minerotrophic quagmire</td>
<td>Scorpidio-Schoenactum</td>
<td>in W Est. and on western islands</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

and mowing every second or at least third year. Spring fens, where they are still preserved, are not usually threatened by scrub, but by the possible destruction of their catchment area. Among them a very rare type is represented by Juncetum subaqualilae (Table 2).

Estonia is still rich in ombrotrophic raised bogs. In several places they form large and complicated systems (Masing, 1982, 1984a) which are some of the best preserved examples of this kind in the boreo-nemoral vegetation zone of North Europe. Although raised bogs are comparatively well protected in Estonia within the existing nature reserves (Kallas, 1995; Külvik, 1996), several well-developed bog complexes or even bog systems in different parts of the country have unique features and should also be taken under protection. Moreover, in northeastern Estonia all mires and especially raised bogs are strongly influenced by air pollution caused by cement plants and power stations whose
ash is alkaline and contains large quantities of heavy metals which accumulate in plant tissues and peat (Punning et al., 1987). Owing to the alkaline ash, the Sphagnum mosses as well as other typical raised bog plants have degenerated and have been replaced by Hieracium pilosella, Prunella vulgaris, Gymnadenia conopsea, etc. (Karofeld, 1987). In this way the number of unspoiled bogs in northeastern Estonia has substantially decreased. To compensate for their loss the system of protected mires must be partly revised.

**Grasslands**

Numerous vegetation types characteristic to Estonia, among them several rare communities, have developed under intensive human activity. These semi-natural communities include all inland grasslands, wooded meadows, alvar grasslands, most coastal meadows and flood plain grasslands. Traditional cultural landscapes are considered by several authors to be highly valuable, representing the history of sustainable land-use over thousands of years (Rosén, 1982; Gibson et al., 1987; Päärtel et al., 1997).

The area of species-rich semi-natural grasslands has decreased considerably during the last half century throughout Europe (Bakker, 1989; van Dijk, 1991; Kiefer and Poschloth, 1996). The encroachment of shrubs and trees will result in lower species richness (Rosén, 1988; Kull and Zobel, 1991; Päärtel et al., 1997), which may also decrease the sustainability of the community (Tilman et al., 1996). Maintenance of such communities demands continued traditional management, in some cases also restoration measurements.

**Alvar grasslands**

On alvars the ecological conditions are mostly determined by the character of the limestone bedrock surface, its weathering, surface relief and soil depth (Albertson, 1950; Rosén, 1982; Zobel, 1987). Alvar vegetation is considered to have a high priority from a global conservation perspective (Rosén, 1982). According to Stern (1938) and Albertson (1950) alvars are unique, integrating certain features of South European and continental Asian steppes, rocky arctic and alpine heaths, and Central European rocky limestone landscapes. On Estonian alvars we find growing together calciphilous species such as Filipendula vulgaris, Sesleria caerulea, Aperula tinctoria, Ranunculus bulbosus, Helianthemum nummularium, Anacamptis pyramidalis, Dittichium flexicaule, Thuillum abietinum, Eucalypta contorta, Tortella spp., subatlantic species such as Phleum bertolonii, Scabiosa columbaria, Orchis morio, Saxifraga tridactylites and Sedum album. Of subarctic species, Potentilla crantzii, Poa alpina, Cerastium alpinum are to be found; species originating from continental steppe regions include Artemisia rapiestris, Potentilla nemorum, Astragalus danicus, Dracocephalum ruschianum and Carelia vulgaris (Laasimer, 1975). An overview of rare alvar grasslands is given in Table 3.

**Wooded meadows**

Wooded meadows are defined as sparse natural tree stands with a regularly mown herb layer. Tree canopy cover is usually in the range of 0.1–0.5 (Kukk and Kull, 1997). Hand mowing by scythe for about 2000 years has given them their typical physiognomy.

At the end of the 19th century wooded meadows in Estonia covered 850,000 ha; according the inventory of 1995–1996 species-rich variants of these were preserved only on 500 ha in western Estonia, and in other regions of Estonia about 200 ha of species-poor and flooded wooded meadows were found (Kukk and Kull, 1997). The problems of
maintaining semi-natural communities have been discussed over a long period (e.g., Krall and Pork, 1970; Krall, 1975; Laasimer, 1975, 1987; Pork, 1981a,b, 1984; Zobel, 1982, 1987) but in 1995–1996 only about 200 ha of the wooded meadows were mown (Kukk and Kull, 1997). At the same time the Estonian wooded meadows that have remained, belong to some of the most species-rich communities in northern Europe (Kull and Zobel, 1991; Kukk, 1996) and, at the 0.2 × 0.2 m to 1 × 1 m scales, even in the world (Peet et al., 1990). Besides other rare plant species, many attractive orchids grow here: Orchis militaris, O. ustulata, Ophrys insectifera, Gymnadenia conopsea, Cephalanthera longifolia, C. rubra, etc.

Wooded meadows are were represented in very different site types and they are usually classified on the basis of herb layer species content and abundance (Laasimer, 1965; Krall et al., 1980, 1986; Kukk and Kull, 1997). Therefore, the list of their rare communities coincides with that of boreo-nemoral and paludified grasslands (Table 3).

Long-term studies (e.g., Breiin, 1979; Heggström, 1990) have demonstrated that, considering all the favourable and deleterious effects of grazing by sheep and cattle in wooded meadows, combined pasturing of both animals as well as mowing would give the best and cheapest result from the management point of view.

**Flood plain grasslands**

The situation for flood plain grasslands is, in general, similar to those for alvars and wooded meadows: their area has reduced rapidly since the 1950s (Pork, 1981a). A large proportion of them have been drained and cultivated, the remaining communities are being overgrown by scrub and forests; their species diversity is continuously decreasing. Though the Estonian flood plain communities have not, until now, been considered rare, several of them will soon be qualified as threatened as a result of their obvious decrease due to the lack of mowing.

**Sea-shore communities**

The shore-line of the Estonian mainland as well as that of its many islands and islets is very intricate and varies in its topography and substrate. These natural conditions have enabled the development of a comparatively high diversity of plant communities here (Rebuss, 1975a, b, 1987). Several coastal meadow community types reach the limit of their distribution in Estonia (Table 3). Protection measures and sustainable management of coastal communities depend on the community type in question.

The pioneer communities on salty marshes, developing as a result of the neotectonic uplift of the Earth’s crust in western and northwestern Estonia, also have rather a limited distribution. For these communities typical halophytes such as Salicornia europaea, Sueda maritima and Halimione portulacoides are characteristic (Rebuss, 1975b, 1987).

Open habitats on shingle and sand must be protected very carefully. During the Soviet occupation years, the Estonian coastal areas were ‘well protected’ as state border zones where in many places only the movement of military patrols was permitted. In the years to come, the ever growing number of tourists and thoughtless construction of buildings close to the sea-shore will result in severe environmental problems (Kask and Raukas, 1996). Populations of species like Eryngium maritimum have probably decreased throughout the whole of Europe due to the overexploitation of sandy beaches for recreation. Its distribution in Estonia is very restricted (Table 3).
Table 3. Rare and threatened grassland and sea-shore communities (abbreviations as in Table 1); the syntaxonomy of coastal meadows is given after Rehoo (1976) with some corrections.

<table>
<thead>
<tr>
<th>Site type</th>
<th>Community and its variants</th>
<th>Distribution</th>
<th>R</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry alvar</td>
<td>Ditricho-Thymetum</td>
<td>locally on Saaremaa and Hiiumaa Isl., and N Est. limestone plain</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>grassland</td>
<td>Sedum acre - S. album var.</td>
<td>in western part of Saaremaa Isl.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Helictotricho-Calamagrostis var.</td>
<td>locally on Saaremaa and Hiiumaa Isl., and W Est. coast</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fresh alvar</td>
<td>Carex flaccua-Seslerietum</td>
<td>in NW Est., seldom in W Est.</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>grassland</td>
<td>Artemisia reptilis var.</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Scleria-Potentillastrum frutescens</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dry boreo-nemoral</td>
<td>Carex montana-Seslerietum</td>
<td>mainly in W and NW Est., seldom in other localities</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>grassland</td>
<td>Melanocryon-Seslerietum</td>
<td>mainly in W and NW Est., seldom in other localities</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Carex pallescens-Seslerietum</td>
<td>in W Est., coastal region</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fresh boreo-nemoral</td>
<td>Carex pallescens-Seslerietum</td>
<td>mainly on islands, in W Est., in N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>grassland</td>
<td>Carexetum hastianae</td>
<td>in W and NW Est., seldom in other localities</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rich paludified</td>
<td>Carexetum davallianae</td>
<td>mainly on western islands, locally on mainland</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>grassland</td>
<td>Prinula-Seslerietum</td>
<td>mainly in W and N Est.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Sulfine</td>
<td>Eleocharietum parvulae ass.</td>
<td>locally on Hiiumaa and Vormsi Isl., in N Est.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>coastal</td>
<td>Eleocharietum nigilimus ass.</td>
<td>on islands and coast of N Est., on coast of W Est.: on southern limit of its</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>meadow</td>
<td>Carexetosum mackenzii subass.</td>
<td>distribution area</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Salicetum europaeae ass.</td>
<td>on islands and islands of W Est.: (Väinameri); on north eastern limit of its</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Poaceetetum maritimae ass.</td>
<td>distribution area</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sparganietum sabulic ass.</td>
<td>on islands of W Est.; on relative northeastern limit of its distribution</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Gianco maritinae-Juncetum gerardi ass.</td>
<td>area first on islands and coast of W Est.: on northern coast; on southern</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Carexetosum eestri subass.</td>
<td>limit of its distribution area</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Carexetosum glaucoeae subass.</td>
<td>limit of its distribution area</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Site type</td>
<td>Community and its variants</td>
<td>Distribution</td>
<td>R</td>
<td>T</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Suprasaline</td>
<td><em>Sagina maritima</em>–<em>Cochlearia dumosae</em> ass.</td>
<td>on Vilsandi and Vaika Isl.; on northeastern limit of its area.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>coastal meadow</td>
<td><em>Honeckya pedicellata</em>–<em>Leymus arenarius</em> ass.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Elymus farctus</em> subsp. <em>boreali-atlanticus</em> var.</td>
<td>on Suuremaa and Hiiumaa Isl.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Lathyrus japonicus</em> sp. <em>maritimus</em> var.</td>
<td>in N and W Est.; on southeastern limit of its distribution area</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Festucaea rubrae</em> ass. <em>Artemisia maritima</em> subass.</td>
<td>in western part of Suuremaa Isl., on islets of W Est.; on northeastern limit of its distribution area</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Polygonum hydropiperis</em>–<em>Bidentum tripartitum</em> ass.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Myosotis laxa</em> var.</td>
<td>on Suuremaa and Hiiumaa Isl., in N Est.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Crambe maritima</em> ass.</td>
<td>on islands and coast of W Est.; on northeastern limit of its distribution area</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Festucaea rubrae</em> ass. <em>Angelica publris</em> var.</td>
<td>in southern part of Suuremaa Isl., on islets of W Est. (Väinameri), on coast of W Est.; on western limit of its distribution area</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Tetragonobus maritimus</em> var.</td>
<td>on Suuremaa Isl., on islets and coast of W Est.; on northeastern limit of its distribution area</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Dianthus superbus</em> var. <em>Ammophiletum arenarius</em> ass.</td>
<td>on islets of W Est., on Hiiumaa Isl.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Brown dune</td>
<td><em>Erigeron maritimus</em> var. <em>Eryngietum</em></td>
<td>on islands and coast of W Est. on Islands of Aksi and Koipsi, on N Est. coast</td>
<td>1 (2)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Brackish</td>
<td><em>Bolboschoenactum maritini</em> ass.</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>shallow water</td>
<td><em>Samolus valerandi</em> var.</td>
<td>in southern coast of Suuremaa and Hiiumaa Isl.; on northern limit of its distribution area</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Coastal dunes

At least one of the islets in the Gulf of Finland (e.g. Aksi or Koipsi) should be placed under protection urgently since coastal heaths dominated by *Euphrasia nemorosa* ssp. *nigrum*, a characteristic habitat type for our northern islands, occur here. In places, both subspecies, ssp. *nigrum* and ssp. *hermaphroditum* can be found together. The latter is at its south-easternmost distribution limit in the North Estonian islets and coast.

Communities of cryptogams

In vegetation analyses bryophyte and lichen species usually are registered together with vascular species, since they constitute an integral part of plant communities. In certain specific ecological conditions or habitats cryptogams can also form communities where vascular species are almost or totally lacking. These communities often consist of rare species or have special structural features. Their importance for the maintenance of biodiversity has hitherto not received sufficient attention.

On the bottom of oligotrophic lakes, for example, rare communities representing *Warnstorfietum trichophylleae* and *Fontinalietum dalecarlicae* types grow. These community types, like the other types of cryptogam communities, correspond to unions of synusia (Kipp (1933, 1938) and Trass (1981), and are often monodominant.

On stony and decaying wood in forest rivulets, *Scapanietum undulatae*, *Dichelyrtum falcatae*, *Dichodontietum pellucidi*, and *Thamnobryetum alopecuri* (with *Amblystegium fluviatile* and *A. tenax*) can be found. On sandstone cliffs, *Pohlia–Leptobryietum communities* occur, including *Leptobryum pyriforme*, *Pohlia cruda*, *P. prolifera*, *Pogonatum annigerum*, *Mniium stellare*, *Tortula ramosa*, and *Schistoschegelum pennatum*. *Conocephalietum conicum* communities with *Conocephalum conicum*, *Marchantia polymorpha* and *Pella epiphylla* are also found. Here and there the lichen community *Cystolepideum ephemerum* grows. On limestone cliffs and on the glisten, *Pohlia–Seligerietum communities* with *Seligeria padilla*, *S. calcarea*, *S. domnica*, *Gymnostomum calcareum*, *G. aeruginosum*, and *Pohlia melanodon* can develop. In similar habitats *Neckero Homalotheciellum communities* can also occur. These communities are formed by *Homalothecium sericeum*, *H. lutescens*, *Neckera complanata*, *Campylium trichophyllum*, *Didymium flexicaule*, *Bryoequisetum recurvirostrum* and *Myxella juncetum*. Monosynusial unions of lichens – *Aspiciletum calcareum*, *Lecanoretum dispersae* and *Caloplaeacetum saxicola* – also grow here.

The lichen community, *Collenietum fuscovirens*, formed by various *Collema* species, occurs on the plate alvars of western islands. The *Fulgensietum brevicaule* community is found on thin alvar soil; it includes several rare lichens such as *Tominia sedifolia*, *Psora decipiens*, *Flavocetraria nivalis*, and *Valpiceptrum subulatum*.

In primeval forests, communities (synusia) of bryophytes growing on decaying wood also need attention. Here, rare *Scapanietum apiculatae*, *Anastrophyllietum heterozonae* occur beside the more common *Calypogientum suecicae*, *Lepidopterietum ventricosa* and *Novellietum curtisii* on large logs.

Several comparatively rare lichen communities grow on erratic (magmatic) boulders: *Aspiciletum cinerea*, *Lecanoretum maridis*, *Lecanoretum cupicolae* and *Physeteum caesiae*. *Lasallietum pastulantae* communities occur mainly in North and West Estonia. *Ramalietum polymorphae* communities grow on seashore rocks, while the *Caloplaeacetum scapulatis* community is found in similar habitats but in the saline zone only. A number of rare species (e.g. *Caloplaeata verruculifera*, *C. marina*, *Lecanora helicopsis*, etc.) form the latter community.
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References


Rare and threatened plant communities of Estonia


